ACADEMIC CURRICULA 2016 - 2020

BACHELOR'S DEGREE PROGRAMME

B.Tech

Curricula & Syllabi

KIIT UNIVERSITY

(Declared U/S 3 of UGC Act, 1956)

Bhubaneswar, Odisha, India

ACADEMIC CURRICULA

2016-2020

BACHELOR'S DEGREE PROGRAMME

B. Tech

Course Structure and Detailed Syllabi
for students admitted in
2016-17
Academic Session

KIIT UNIVERSITY
Declared U/S 3 of UGC Act, 1956
Bhubaneswar, Odisha, India

All the precautions have been taken to print the Course Curriculum accurate. However, mistakes if any will be corrected as and when noticed. The University reserves the right to include/exclude any content at any point of time during the progression of the course.

COURSE STRUCTURE FOR FIRST YEAR B.TECH PROGRAMME
(FOR STUDENTS ADMITTED IN THE SESSION 2016-2017)
(Syllabus common to All Branches of Engineering)

FIRST SEMESTER
(SCHEME-I)

Theory							
Sl. No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 1001	Mathematics – I	3	1	0	4	4
2	CS 1001	Programming in C	3	0	0	3	3
3	PH 1003	Physics	3	1	0	4	4
4	ME 1001	Engg. Mechanics	3	1	0	4	4
5	EE 1003	Basic Electrical Engineering	3	0	0	3	3
Total of Theory						**18**	**18**
Practical							
1	CS 1091	Programming Lab in C	0	0	3	3	2
2	PH 1093	Physics Lab	0	0	3	3	2
3	EE 1093	Basic Electrical Engineering Lab	0	0	3	3	2
Sessional							
1	CE 1081	Engg. Graphics	0	0	3	3	2
Total of Practical & Sessional						**12**	**8**
Semester Total						**30**	**26**

SECOND SEMESTER
(SCHEME-I)

Theory							
Sl. No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 1002	Mathematics – II	3	1	0	4	4
2	IT 1002	Object Oriented Programming	3	0	0	3	3
3	CH 1003	Chemistry	3	0	0	3	3
4	EC 1001	Basic Electronics	3	0	0	3	3
5	HS 1003	Professional Communication	2	0	0	2	2
6	CH 1005	Environmental Science	2	0	0	2	2
Total of Theory						**17**	**17**
Practical							
1	IT 1092	Object Oriented Programming Lab	0	0	3	3	2
2	CH 1093	Chemistry Lab	0	0	3	3	2
3	EC 1091	Basic Electronics Lab	0	0	3	3	2
Sessional							
1	ME 1081	Basic Manufacturing Systems	0	0	3	3	2
2	HS 1083	Language Lab	0	0	2	2	1
Total of Practical & Sessional						**14**	**9**
Semester Total						**31**	**26**
1	EAA1	Extra Academic Activity					P/NP

FIRST SEMESTER
(SCHEME-II)

Theory							
Sl. No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 1001	Mathematics – I	3	1	0	4	4
2	CS 1001	Programming in C	3	0	0	3	3
3	CH 1003	Chemistry	3	0	0	3	3
4	EC 1001	Basic Electronics	3	0	0	3	3
5	HS 1003	Professional Communication	2	0	0	2	2
6	CH 1005	Environmental Science	2	0	0	2	2
Total of Theory						**17**	**17**
Practical							
1	CS 1091	Programming Lab in C	0	0	3	3	2
2	CH 1093	Chemistry Lab	0	0	3	3	2
3	EC 1091	Basic Electronics Lab	0	0	3	3	2
Sessional							
1	ME 1081	Basic Manufacturing Systems	0	0	3	3	2
2	HS 1083	Language Lab	0	0	2	2	1
Total of Practical & Sessional						**14**	**9**
Semester Total						**31**	**26**

SECOND SEMESTER
(SCHEME-II)

Theory							
Sl. No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 1002	Mathematics – II	3	1	0	4	4
2	IT 1002	Object Oriented Programming	3	0	0	3	3
3	PH 1003	Physics	3	1	0	4	4
4	ME 1001	Engg. Mechanics	3	1	0	4	4
5	EE 1003	Basic Electrical Engineering	3	0	0	3	3
Total of Theory						**18**	**18**
Practical							
1	IT 1092	Object Oriented Programming Lab	0	0	3	3	2
2	PH 1093	Physics Lab	0	0	3	3	2
3	EE 1093	Basic Electrical Engineering Lab	0	0	3	3	2
Sessional							
1	CE 1081	Engg. Graphics	0	0	3	3	2
Total of Practical & Sessional						**12**	**8**
Semester Total						**30**	**26**
1	EAA1	Extra Academic Activity					P/NP

COURSE STRUCTURE FOR B.TECH IN CIVIL ENGINEERING
(SECOND YEAR TO FOURTH YEAR)

SEMESTER-III

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2001	Mathematics-III	3	1	-	4	4
2	CE 2003	Solid Mechanics	3	1	-	4	4
3	CE 2005	Surveying	3	-	-	3	3
4	CE 2007	Civil Engineering Materials & Construction	3	-	-	3	3
5	CE 2011	Fluid Mechanics-I	3	-	-	3	3
6	CE 2019	Environmental Engineering-I	3	-	-	3	3
Total of Theory						**20**	**20**
Practical							
1	CE 2091	Environmental Engg. Lab.	-	-	3	3	2
2	CE 2093	Material Testing Lab.	-	-	3	3	2
Sessional							
1	CE 2081	Building Drawing	-	-	3	3	2
2	HS 2081	Business Communication	-	-	3	3	2
Total of Practical & Sessional						**12**	**8**
Semester Total						**32**	**28**

SEMESTER-IV

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2004	Numerical Methods	3	1	-	4	4
2	CE 2004	Structural Analysis-I	3	1	-	4	4
3	CE 2008	Advanced Surveying	3	-	-	3	3
4	CE 2014	Fluid Mechanics-II	3	-	-	3	3
5	CE 2016	Transportation Engineering	3	1	-	4	4
6	CE 2018	Design of Concrete Structure-I	3	-	-	3	3
Total of Theory						**21**	**21**
Practical							
1	CE 2092	Fluid Mechanics Lab	-	-	3	3	2
2	CE 2094	Transportation Engg. Lab.	-	-	3	3	2
3	CE 2098	Surveying Field Work	-	-	3	3	2
Sessional							
1	CE 2082	Estimating & Costing	-	-	2	2	1
Total of Practical & Sessional						**11**	**7**
Semester Total						**32**	**28**

SEMESTER-V

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CE 3001	Structural Analysis-II	3	1	-	4	4
2	CE 3007	Design of Steel Structure	3	1	-	4	4
3	CE 3009	Water Resources Engineering-I	3	-	-	3	3
4	CE 3011	Geotechnical Engineering-I	3	1	-	4	4
5	CE 3013	Construction Planning & Management	3	-	-	3	3
6		Department Elective-I	3	-	-	3	3
7	HS 3003	Professional Ethics & Code of Conduct	1	-	-	1	1
Total of Theory						**22**	**22**
Practical							
1	CE 3091	Geotechnical Engineering Lab	-	-	3	3	2
Sessional							
1	CE 3083	Structural Design (Steel)	-	-	2	2	1
2	CE 3085	Hydrologic Design	-	-	2	2	1
3	CE 3087	Transportation Design	-	-	2	2	1
4	TP 3081	Cognitive Aptitude Test-I	-	-	2	2	1
Total of Practical & Sessional						**11**	**6**
Semester Total						**33**	**28**

SEMESTER-VI

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CE 3006	Design of Concrete Structures-II	3	1	-	4	4
2	CE 3008	Environmental Engineering-II	3	-	-	3	3
3	CE 3010	Water Resources Engineering-II	3	-	-	3	3
4	CE 3014	Geotechnical Engineering-II	3	-	-	3	3
5		Institute Elective-I	3	-	-	3	3
6		Open Elective-I	3	-	-	3	3
Total of Theory						**19**	**19**
Practical							
1	CE 3092	Concrete & Structure Lab.	-	-	3	3	2
Sessional							
1	CE 3088	Water Resources Design	-	-	2	2	1
2	CE 3084	Structural Design (RCC)	-	-	2	2	1
3	CE 3086	Geotechnical Engineering Design	-	-	2	2	1
4	CE 3082	Minor Project	-	-	3	3	2
5	TP 3082	Cognitive Aptitude Test-II	-	-	2	2	1
Total of Practical &Sessional						**14**	**8**
Semester Total						**33**	**27**

SEMESTER-VII

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1		Department Elective-II	3	-	-	3	3
2		Department Elective-III	3	-	-	3	3
3		Department Elctive-IV	3	-	-	3	3
4		Institute Elective-II	3	-	-	3	3
5		Open Elective-II	3	-	-	3	3
6	HS 4003	Legal Issues & requirement in Engineering	1	-	-	1	1
Total of Theory						**16**	**16**
Sessional							
1	CE 4081	Project Preparation	-	-	3	3	2
2	CE 4083	Practical Training	-	-	-	-	2
Total of Sessional						**3**	**4**
Semester Total						**19**	**20**

SEMESTER-VIII

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1		Department Elective-V	3	-	-	3	3
2		Open Elective-III	3	-	-	3	3
Total of Theory						**6**	**6**
Sessional							
1	CE 4084	Seminar	-	-	3	3	2
2	CE 4086	General Viva-Voce	-	-	--	-	2
3	CE 4082	Project	-	-	9	9	6
Total of Sessional						**12**	**10**
Semester Total						**18**	**16**

LIST OF INSTITUTE ELECTIVES

Institute Elective – I

Sl. No	Subject Code	Subject Name	Credit
1.	HS 2002	Engineering Economics	3
2.	HS 2006	International Economics	3
3.	HS 2004	Public Finance	3

Institute Elective – II

1.	HS 3006	Entrepreneurship	3
2.	HS 3008	Management Concepts & Practices	3
3.	HS 3002	Organizational Behaviour	3
4.	HS 3004	Human Resource Management	3

LIST OF DEPARTMENT ELECTIVES

Department Electives: I (5th Semester)

Sl. No.	CourseCode	Subject Name	Credit
1	CE 3021	Advanced Solid Mechanics	3
2	CE 3023	Concrete Technology	3
3	CE 6103	Construction Finance Management	3
4	CE 3027	Engineering Geology	3
5	CE 3029	Environmental Impact Assessment & Auditing	3
6	CE 3031	Railways Engineering	3
7	CE 3033	Groundwater Hydrology	3
8	CE 3035	Hydraulic Machines	3
9	CE 3037	Pavement Analysis & Design	3
10	CE 3039	Pavement Materials	3
11	CE 3041	Traffic Engineering & Transportation Planning	3

Department Electives: II, III, IV (7th Semester)

Sl. No.	CourseCode	Subject Name	Credit
1	CE 6339	Advanced Irrigation Engineering	3
2	CE 6239	Advanced Foundation Engineering	3
4	CE 4027	Advanced Steel Design	3

5	CE 6136	Building Services Planning	3
6	CE 6102	Construction Engineering Practices	3
7	CE 4069	Cost Effective Housing	3
8	CE 6241	Design of Bridges	3
9	CE 4029	Disaster Management	3
10	CE 4057	Drainage Engineering & Design	3
11	CE 4077	Earth & Earth Retaining Structures	3
12	CE 4061	Earthquake Engineering	3
13	CE 4063	Finite Element Method in Geo-mechanics	3
14	CE 4051	Flood and Drought Estimation and Management	3
15	CE 6437	Geo-synthetics & Reinforced Earth Structures	3
16	CE 4065	Infrastructure Planning	3
17	CE 4067	Offshore Geotechnical Engineering	3
18	CE 6303	Open Channel Hydraulics	3
19	CE 6105	Pre-stressed Concrete	3
20	CE 4059	Reinforced Concrete Repairs and Maintenance	3
21	CE 6431	Soil Exploration and Field Test	3
22	CE 6235	Soil-Structure Interaction	3
23	CE 4053	Solid and Hazardous Waste Management	3
24	CE 4033	Structural Dynamics	3
25	CE 6307	Remote Sensing & GIS	3

Department Electives: V (8th Semester)

Sl. No.	CourseCode	Subject Name	Credit
1	CE 4020	Pavement Management System	3
2	CE 6238	Composite Structures	3
3	CE 6106	Construction Methods & Equipments	3
4	CE 6446	Geotechnical Earthquake Engineering	3
5	CE 4044	Ground Improvement Engineering	3
6	CE 4030	Machine Foundation Engineering	3
7	CE 6134	Project Quality and Safety Management	3
8	CE 4032	Structural Analysis-III	3
9	CE 6436	Tunnel Engineering	3
10	CE 6342	Water Power Engineering	3
11	CE 4062	Water Resources System Analysis	3
12	CE 6206	Finite Element Method	3
13	CE 6138	Advanced Repairs and Rehabilitation of Structures	3
14	CE 6332	River Engineering & Sediment Transport	3
15	CE 6142	Contract Laws & Regulations	3

COURSE STRUCTURE FOR B.TECH IN COMPUTER SCIENCE & ENGINEERING (SECOND YEAR TO FOURTH YEAR)

SEMESTER- III

Theory							
Sl.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2003	Discrete Mathematics	3	1	0	4	4
2	CS 2001	Data Structures &Algorithms	3	1	0	4	4
3	IT 2003	Web Technology	3	1	0	4	4
4	MA 2001	Mathematics-III	3	1	0	4	4
5	EC 2011	Digital Electronics	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1	CS 2091	Data Structures Lab	0	0	3	3	2
2	IT 2093	Web Technology Lab	0	0	3	3	2
3	EC 2093	Digital Electronics Lab	0	0	3	3	2
Total of Practical						**9**	**6**
Semester Total						**28**	**25**

SEMESTER- IV

Theory							
Sl. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	CS 2008	Design &Analysis of Algorithms	3	1	0	4	4
2	CS 2006	Computer Organization and Architecture	3	1	0	4	4
3	EC 2004	Principle of Digital Communication	3	1	0	4	4
4	MA 2002	Mathematics- IV	3	1	0	4	4
5	CS 2004	Database Management Systems	3	1	0	4	4
6		Institute Elective - 1	3	0	0	3	3
Total of Theory						**23**	**23**
Practical							
1	CS 2096	Design & Analysis of Algorithms Lab	0	0	3	3	2
2	CS 2094	DBMS Lab	0	0	3	3	2
Sessional							
1	HS 2081	Business Communication	0	0	3	3	2
Total of Practical &Sessional						**9**	**6**
Semestr Total						**32**	**29**

SEMESTER- V

Sl.No.	Course Code	Course Title	L	T	P	Total	Credit
Theory							
1	CS 3009	Operating Systems	3	1	0	4	4
2	IT 3003	Software Engineering	3	1	0	4	4
3	IT 3001	Computer Networks	3	1	0	4	4
4	CS 3003	Formal Languages and Automata Theory	3	1	0	4	4
5	CS 3007	High Performance Computer Architecture	3	1	0	4	4
6	HS 3003	Professional Ethics & Code of Conduct	1	0	0	1	1
Total of Theory						**21**	**21**
Practical							
1	CS 3091	Operating Systems Laboratory	0	0	3	3	2
2	IT 3091	Computer Networks Lab	0	0	3	3	2
3	CS 3093	Tools and Techniques Lab	0	0	3	3	2
Sessional							
1	TP 3081	Cognitive Aptitude Test -1	0	0	2	2	1
Total of Practical &Sessional						**11**	**7**
Semester Total						**32**	**28**

SEMESTER- VI

Sl. No.	Course Code	Course Title	L	T	P	Total	Credit
Theory							
1	CS 3004	Computer Graphics	3	1	0	4	4
2	IT 3004	Object Oriented System Design	3	1	0	4	4
3		Department Elective-I	3	0	0	3	3
4	CS 3002	Compiler Design	3	1	0	4	4
5		Open Elective-I	3	0	0	3	3
Total of Theory						**18**	**18**
Practical							
1	CS 3092	Compiler Design Laboratory	0	0	3	3	2
2	CS 3094	Computer Graphics Laboratory	0	0	3	3	2
3	CS 3095	Advanced Programming Lab	0	0	3	3	2
Sessional							
1	CS 3082	Minor Project	0	0	3	3	2
2	TP 3082	Cognitive Aptitude Test-II			2	2	1
Total of Practical &Sessional						**14**	**9**
Semester Total						**32**	**27**

SEMESTER- VII

Sl.No.	Course Code	Course Title	L	T	P	Total	Credit
Theory							
1		Dept.Elective-II	3	0	0	3	3
2		Dept.Elective-III	3	0	0	3	3
3		Dept.Elective-IV	3	0	0	3	3
4		Institute Elective-II	3	0	0	3	3
5		Open Elective - II	3	0	0	3	3
6	HS 4003	Legal Issues & requirement in Engineering	1	0	0	1	1
Total of Theory						**16**	**16**
Sessional							
1	CS 4081	Project (Part-I)	0	0	3	3	2
2	CS 4083	Practical Training	-	-	-	-	2
Total of Sessional						**3**	**4**
Semester Total						**19**	**20**

SEMESTER -VIII

Sl. No.	Course Code	Course Title	L	T	P	Total	Credit
Theory							
1		Open Elective - III	3	0	0	3	3
2		Dept.Elective-V	3	0	0	3	3
Total of Theory						**6**	**6**
Sessional							
1	CS 4082	Project (Part-II)	0	0	9	9	6
2	CS 4084	Seminar	0	0	3	3	2
3	CS 4086	General Viva Voce	-	-	-	-	2
Total of Sessional						**12**	**10**
Semester Total						**18**	**16**

LIST OF INSTITUTE ELECTIVES

Institute Elective – I

Sl. No	Subject Code	Subject Name	Credit
1.	HS 2002	Engineering Economics	3
2.	HS 2006	International Economics	3
3.	HS 2004	Public Finance	3

Institute Elective – II

1.	HS 3006	Entrepreneurship	3
2.	HS 3008	Management Concepts & Practices	3
3.	HS 3002	Organizational Behaviour	3
4.	HS 3004	Human Resource Management	3

LIST OF DEPARTMENT ELECTIVES

Dept. Elective - I

Sl No.	Course Code	Course Title	Credit
1	CS 3022	Parallel and Distributed Computing	3
2	CS 3024	Distributed Operating Systems	3
3	CS 3034	Service Oriented Architecture	3
4	IT 3030	Formal Verification: Theory and Practice	3
5	CS 3026	Distributed Database Systems	3
6	IT 3029	Software Design and Validation	3
7	CS 3032	Big Data	3

Dept. Elective – II

Sl No.	Course Code	Course Title	Credit
1	CS 4025	Microprocessor	3
2	CS 4027	Real-time Systems	3
3	IT 4021	Internet of Things	3
4	CS 4029	Embedded System	3
5	IT 3024	Mobile Computing	3

Dept. Elective – III

Sl No.	Course Code	Course Title	Credit
1	CS 4031	Software Testing	3
2	IT 3022	Cloud Computing	3
3	IT 4027	Software Project Management	3
4	IT 4029	Management Information System	3
5	IT 4037	Data Mining and Data Warehousing	3

Dept. Elective – IV

Sl No.	Course Code	Course Title	Credit
1	IT 4031	Information Retrieval	3
2	IT 4033	Natural Language Processing	3
3	CS 4037	Human Computer Interaction	3
4	CS 3030	Computational intelligence	3
5	CS 3028	Artificial Intelligence	3
6	IT 4035	Operation Research	3

Dept. Elective – V

Sl No.	Course Code	Course Title	Credit
1	IT 4022	Cyber Law and Intellectual Property Rights	3
2	IT 4024	Computer Security	3
3	IT 4026	Network Security	3
4	IT 4028	Cyber Security	3

COURSE STRUCTURE FOR B.TECH IN INFORMATION TECHNOLOGY (SECOND YEAR TO FOURTH YEAR)

SEMESTER -III

Theory							
Sl .No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2003	Discrete Mathematics	3	1	0	4	4
2	CS 2001	Data Structures &Algorithms	3	1	0	4	4
3	IT 2003	Web Technology	3	1	0	4	4
4	MA 2001	Mathematics-III	3	1	0	4	4
5	EC 2011	Digital Electronics	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1	CS 2091	Data Structures Lab	0	0	3	3	2
2	IT 2093	Web Technology Lab	0	0	3	3	2
3	EC 2093	Digital Electronics Lab	0	0	3	3	2
Total of Practical						**9**	**6**
Semester Total						**28**	**25**

SEMESTER- IV

Theory							
Sl .No.	**CourseCode**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	CS 2004	Database Management Systems	3	1	0	4	4
2	CS 2006	Computer Organization and Architecture	3	1	0	4	4
3		Institute Elective I	3	0	0	3	3
4	EC 2004	Principle of Digital Communication	3	1	0	4	4
5	MA 2002	Mathematics- IV	3	1	0	4	4
6	CS 2008	Design & Analysis of Algorithms	3	1	0	4	4
Total of Theory						**23**	**23**
Practical							
1	CS 2094	DBMS Lab	0	0	3	3	2
2	CS 2096	Design & Analysis of Algorithms Lab	0	0	3	3	2
Sessional							
1	HS 2081	Business Communication	0	0	3	3	2
Total of Practical & Sessional						**9**	**6**
Semester Total						**32**	**29**

SEMESTER- V

Theory							
Sl.No.	**CourseCode**	**CourseTitle**	**L**	**T**	**P**	**Total**	**Credit**
1	CS 3009	Operating Systems	3	1	0	4	4
2	IT 3003	Software Engineering	3	1	0	4	4
3	IT 3001	Computer Networks	3	1	0	4	4
4	CS 3003	Formal Languages and Automata Theory	3	1	0	4	4
5		Department Elective-I	3	0	0	3	3
6	IT 3005	Cyber Security	3	0	0	3	3
7	HS 3003	Professional Ethics & Code of Conduct	1	0	0	1	1
Total of Theory						**23**	**23**
Practical							
1	CS 3091	Operating Systems Laboratory	0	0	3	3	2
2	IT 3091	Computer Networks Lab	0	0	3	3	2
Sessional							
1	TP 3081	Cognitive Aptitude Test-1	0	0	2	2	1
Total of Practical & Sessional						**8**	**5**
Semester Total						**31**	**28**

SEMESTER- VI

Theory							
Sl .No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	IT 3002	Data Analytics	3	1	0	4	4
2	IT 3004	Object Oriented System Design	3	1	0	4	4
3		Department Elective-II	3	0	0	3	3
4	CS 3002	Compiler Design	3	1	0	4	4
5		Open Elective-I	3	0	0	3	3
Total of Theory						**18**	**18**
Practical							
1	CS 3092	Compiler Design Lab	0	0	3	3	2
2	IT 3092	Data Analytics Lab	0	0	3	3	2
	CS 3093	Tools and Techniques Lab	0	0	3	3	2
Sessional							
1	IT 3082	Minor Project	0	0	3	3	2
2	TP 3082	Cognitive Aptitude Test-II			2	2	1
Total of Practical & Sessional						**14**	**9**
Semester Total						**32**	**27**

SEMESTER- VII

Theory							
Sl. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	IT 4001	Mobile Computing	3	1	0	4	4
2		Dept.ElectiveIII	3	0	0	3	3
3		Institute Elective-II	3	0	0	3	3
4		Open Elective - II	3	0	0	3	3
5		Dept.Elective-IV	3	0	0	3	3
6	HS 4003	Legal Issues & requirement in Engineering	1	0	0	1	1
Total of Theory						**17**	**17**
Sessional							
1	IT 4081	Project (Part-I)	0	0	3	3	2
2	CS 4083	Practical Training	-	-	-	-	2
Total of Sessional						**3**	**4**
SemesterTotal						**20**	**21**

SEMESTER -VIII

Theory							
Sl .No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1		Open Elective - III	3	0	0	3	3
2		Dept.Elective-V	3	0	0	3	3
Total of Theory						**6**	**6**
Sessional							
1	IT 4082	Project (Part-II)	0	0	9	9	6
2	CS 4084	Seminar	0	0	3	3	2
3	CS 4086	General Viva Voce	-	-	-	-	2
Total of Sessional						**12**	**10**
Semester Total						**18**	**16**

LIST OF INSTITUTE ELECTIVES

Institute Elective – I

Sl. No	Subject Code	Subject Name	Credit
1.	HS 2002	Engineering Economics	3
2.	HS 2006	International Economics	3
3.	HS 2004	Public Finance	3

Institute Elective – II

Sl. No	Subject Code	Subject Name	Credit
1.	HS 3006	Entrepreneurship	3
2.	HS 3008	Management Concepts & Practices	3
3.	HS 3002	Organizational Behaviour	3
4.	HS 3004	Human Resource Management	3

LIST OF DEPARTMENT ELECTIVES

Dept. Elective - I

Sl No.	Course Code	Course Title	Credit
1	IT 3021	E-Commerce	3
2	IT 3023	Computer Vision	3
3	IT 3025	Enterprise Resource Planning	3
4	IT 3027	Multimedia Applications	3
5	IT 3029	Software Design and Validation	3

Dept. Elective – II

Sl No.	Course Code	Course Title	Credit
1	CS 3028	Artificial Intelligence	3
2	CS 3030	Computational Intelligence	3
3	IT 3026	Bio-informatics	3
4	IT 3028	Information and Coding Theory	3
5	IT 3030	Formal Verification: Theory and Practice	3

Dept. Elective – III

Sl No.	Course Code	Course Title	Credit
1	IT 4035	Operation Research	3
2	CS 4031	Software Testing	3
3	CS 3034	Service Oriented Architecture	3
4	IT 4027	Software Project Management	3

Dept. Elective – IV

Sl No.	Course Code	Course Title	Credit
1	IT 4037	Data Mining and Data Warehousing	3
2	CS 3026	Distributed Database	3
3	IT 4031	Information Retrieval	3
4	IT 4039	Information Security	3

Dept. Elective – V

Sl No.	Course Code	Course Title	Credit
1	IT 3022	Cloud Computing	3
2	IT 4021	Internet of Things	3
3	CS 4029	Embedded Systems	3
4	CS 4027	Real Time Systems	3

COURSE STRUCTURE FOR B. TECH
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SEMESTER-III

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2003	Discrete Mathematics	3	1	0	4	4
2	CS 2001	Data Structures &Algorithms	3	1	0	4	4
3	IT 2003	Web Technology	3	1	0	4	4
4	MA 2001	Mathematics-III	3	1	0	4	4
5	EC 2011	Digital Electronics	3	0	0	3	3
6	EC 2003	Signals & Systems	3	0	0	3	3
Total of Theory						**22**	**22**
Practical							
1	CS 2091	Data Structures Lab	0	0	3	3	2
2	IT 2093	Web Technology Lab	0	0	3	3	2
3	EC 2093	Digital Electronics Lab	0	0	3	3	2
Total of Practical						**9**	**6**
Semester Total						**31**	**28**

SEMESTER-IV

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	CS 2008	Design & Analysis of Algorithms	3	1	0	4	4
2	CS 2006	Computer Organization and Architecture	3	1	0	4	4
3	MA 2002	Mathematics- IV	3	1	0	4	4
4	CS 2004	Database Management Systems	3	1	0	4	4
5	EC 2016	Communication Engineering	3	1	0	4	4
Total of Theory						**20**	**20**
Practical							
1	CS 2096	Design & Analysis of Algorithms Lab	0	0	3	3	2
2	CS 2094	DBMS Lab	0	0	3	3	2
3	EC 2094	Communication Engineering Lab	0	0	3	3	2
Sessional							
1	HS 2081	Business Communication	0	0	3	3	2
Total of Practical & Sessional						**12**	**8**
Semester Total						**32**	**28**

SEMESTER-V

Sl. No.	Subject Code	Course Title	L	T	P	Total	Credit
Theory							
1	CS 3009	Operating Systems	3	1	0	4	4
2	IT 3003	Software Engineering	3	1	0	4	4
3	CS 3003	Formal Languages and Automata Theory	3	1	0	4	4
4	EC 3007	Digital Signal Processing	3	1	0	4	4
5		Dept Elective-I	3	0	0	3	3
6		Institute Elective – 1	3	0	0	3	3
7	HS 3003	Professional Ethics & Code of Conduct	1	0	0	1	1
Total of Theory						**23**	**23**
Practical							
1	CS 3091	Operating Systems Lab	0	0	3	3	2
2	EC 3097	Signal Processing Lab	0	0	3	3	2
Sessional							
1	TP 3081	Cognitive Aptitude Test-1	0	0	2	2	1
Total of Practical & Sessional						**8**	**5**
Semester Total						**31**	**28**

SEMESTER-VI

Sl. No.	Subject Code	Course Title	L	T	P	Total	Credit
Theory							
1	IT 3001	Computer Networks	3	1	0	4	4
2	CS 3002	Compiler Design	3	1	0	4	4
3	IT 3004	Object Oriented System Design	3	1	0	4	4
4	EC 3016	RF Communication	3	1	0	4	4
5		Open Elective-I	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1	IT 3091	Computer Networks Lab	0	0	3	3	2
2	CS 3092	Compiler Design Lab	0	0	3	3	2
Sessional							
1	CC 3082	Minor Project	0	0	3	3	2
2	TP 3082	Cognitive Aptitude Test-II	0	0	2	2	1
Total of Practical & Sessional						**11**	**7**
Semester Total						**30**	**26**

SEMESTER-VII

Theory							
Sl. No.	Subject Code	Course Title	L	T	P	Total	Credit
1		Dept. Elective-II	3	0	0	3	3
2		Dept. Elective-III	3	0	0	3	3
3		Dept. Elective-IV	3	0	0	3	3
4		Institute Elective-II	3	0	0	3	3
5		Open Elective-II	3	0	0	3	3
6	HS 4003	Legal Issues & requirement in Engineering	1	0	0	1	1
Total of Theory						**16**	**16**
Sessional							
1	CC 4081	Project (Part I)	0	0	3	3	2
2	CC 4083	Practical Training	-	-	-	-	2
Total of Sessional						**3**	**4**
Semester Total						**19**	**20**

SEMESTER-VIII

Theory							
Sl .No.	Subject Code	Course Title	L	T	P	Total	Credit
1		Open Elective - III	3	0	0	3	3
2		Dept.Elective-V	3	0	0	3	3
Total of Theory						**6**	**6**
Sessional							
1	CC 4082	Project (Part II)	0	0	9	9	6
2	CC 4084	Seminar	0	0	3	3	2
3	CC 4086	General Viva Voce	-	-	-	-	2
Total of Sessional						**12**	**10**
Semester Total						**18**	**16**

LIST OF INSTITUTE ELECTIVES

Institute Elective - I

Sl. No	Subject Code	Subject Name	Credit
1	HS 2002	Engineering Economics	3
2	HS 2006	International Economics	3
3	HS 2004	Public Finance	3

Institute Elective – II

1	HS 3006	Entrepreneurship	3
2	HS 3008	Management Concepts & Practices	3
3	HS 3002	Organizational Behavior	3
4	HS 3004	Human Resource Management	3

LIST OF DEPARTMENTAL ELECTIVES

Dept. Elective - I

1	CS 3022	Parallel and Distributed Computing	3
2	EC 3027	Optical and Satellite Communication	3
3	CS 3032	Big Data	3
4	CS 3046	Introduction to Computer Graphics	3

Dept. Elective – II

1	CS 4027	Real-time Systems	3
2	IT 4021	Internet of Things	3
3	EC 4031	Mobile Communication Engg.	3
4	EC 6108	Digital Image Processing	3

Dept. Elective – III

1	CS 4031	Software Testing	3
2	CS 3034	Service Oriented Architecture	3
3	CS 4037	Human Computer Interaction	3
4	CS 3030	Computational Intelligence	3

Dept. Elective – IV

1	EC 6128	Wireless Sensor Networks	3
2	EC 3034	Industrial Data Networks	3
3	EC 3030	Adaptive Systems and Signal Processing	3
4	EC 4044	Information Theory & Coding	3

Dept. Elective – V

1	IT 4022	Cyber Law and Intellectual Property Right	3
2	IT 4026	Network Security	3
3	IT 4028	Cyber Security	3
4	EC 4046	Modern Digital Communication	3

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SEMESTER- III

Theory							
Sl.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2003	Discrete Mathematics	3	1	0	4	4
2	CS 2001	Data Structures &Algorithms	3	1	0	4	4
3	IT 2003	Web Technology	3	1	0	4	4
4	MA 2001	Mathematics-III	3	1	0	4	4
5	EC 2011	Digital Electronics	3	0	0	3	3
6	EC 2005	Semiconductor Devices	3	0	0	3	3
Total of Theory						**22**	**22**
Practical							
1	CS 2091	Data Structures Lab	0	0	3	3	2
2	IT 2093	Web Technology Lab	0	0	3	3	2
3	EC 2093	Digital Electronics Lab	0	0	3	3	2
Total of Practical						**9**	**6**
Semester Total						**31**	**28**

SEMESTER- IV

Theory							
Sl. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	CS 2006	Computer Organization and Architecture	3	1	0	4	4
2	CS 2008	Design &Analysis of Algorithms	3	1	0	4	4
3	MA 2002	Mathematics- IV	3	1	0	4	4
4	CS 2004	Database Management Systems	3	1	0	4	4
5		Institute Elective - 1	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1	CS 2098	COA Lab	0	0	3	3	2
2	CS 2094	DBMS Lab	0	0	3	3	2
3	CS 2096	Design &Analysis of Algorithms Lab	0	0	3	3	2
Sessional							
1	HS 2081	Business Communication	0	0	3	3	2
Total of Practical & Sessional						**12**	**8**
Semester Total						**31**	**27**

SEMESTER- V

Theory							
Sl.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	EC 3003	Microprocessors & Microcontrollers	3	1	0	4	4
2	IT 3003	Software Engineering	3	1	0	4	4
3	IT 3001	Computer Networks	3	1	0	4	4
4	CS 3007	High Performance Computer Architecture	3	1	0	4	4
5	CS 3009	Operating Systems	3	1	0	4	4
6	HS 3003	Professional Ethics & Code of Conduct	1	0	0	1	1
Total of Theory						**21**	**21**
Practical							
1	EC 3093	Microprocessor & Microcontroller Lab	0	0	3	3	2
2	IT 3091	Computer Networks Lab	0	0	3	3	2
3	CS 3091	Operating Systems Lab	0	0	3	3	2
Sessional							
1	TP 3081	Cognitive Aptitude Test-I	0	0	2	2	1
Total of Practical & Sessional						**11**	**7**
Semester Total						**32**	**28**

SEMESTER- VI

Theory							
Sl .No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	EC 3022	Advanced Microprocessors	3	0	0	3	3
2	CS 3024	Distributed Operating Systems	3	0	0	3	3
3	CS 3002	Compiler Design	3	1	0	4	4
4	EC 3011	VLSI Design	3	0	0	3	3
5		Department Elective-I	3	0	0	3	3
6		Open Elective-I	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1	CS 3092	Compiler Design Laboratory	0	0	3	3	2
2	EC 3095	VLSI Lab	0	0	3	3	2
Sessional							
1	CM 3082	Minor Project	0	0	3	3	2
2	TP 3082	Cognitive Aptitude Test-II			2	2	1
Total of Practical & Sessional						**11**	**7**
Semester Total						**30**	**26**

SEMESTER- VII

Theory							
Sl.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1		Dept. Elective-II	3	0	0	3	3
2		Dept. Elective-III	3	0	0	3	3
3		Dept. Elective-IV	3	0	0	3	3
4		Institute Elective-II	3	0	0	3	3
5		Open Elective - II	3	0	0	3	3
6	HS 4003	Legal Issues & requirement in Engineering	1	0	0	1	1
Total of Theory						**16**	**16**
Sessional							
1	CM 4081	Project (Part - I)	0	0	3	3	2
2	CM 4083	Practical Training	-	-	-	-	2
Total of Sessional						**3**	**4**
Semester Total						**19**	**20**

SEMESTER-VIII

Theory							
Sl .No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1		Dept. Elective-V	3	0	0	3	3
2		Open Elective - III	3	0	0	3	3
Total of Theory						**6**	**6**
Sessional							
1	CM 4082	Project (Part - II)	0	0	9	9	6
2	CM 4084	Seminar	0	0	3	3	2
3	CM 4086	General Viva Voce	-	-	-	-	2
Total of Sessional						**12**	**10**
Semester Total						**18**	**16**

LIST OF INSTITUTE ELECTIVES

Institute Elective - I

Sl. No	Subject Code	Subject Name	Credit
1	HS 2002	Engineering Economics	3
2	HS 2006	International Economics	3
3	HS 2004	Public Finance	3

Institute Elective – II

1	HS 3006	Entrepreneurship	3
2	HS 3008	Management Concepts & Practices	3
3	HS 3002	Organizational Behavior	3
4	HS 3004	Human Resource Management	3

LIST OF DEPARTMENT ELECTIVES

Dept. Elective - I

1	IT 3032	Object Oriented Systems	3
2	CS 3022	Parallel and Distributed Computing	3
3	IT 3022	Cloud Computing	3
4	IT 3024	Mobile Computing	3
5	CS 3032	Big Data	3

Dept. Elective – II

1	CS 3046	Introduction to Computer Graphics	3
2	CS 4027	Real-time Systems	3
3	IT 4021	Internet of Things	3
4	CS 3026	Distributed Database Systems	3
5	EC 3024	Embedded Systems	3

Dept. Elective – III

1	CS 4031	Software Testing	3
2	CS 3034	Service Oriented Architecture	3
3	IT 4027	Software Project Management	3
4	IT 4029	Management Information System	3
5	IT 3029	Software Design and Validation	3

Dept. Elective – IV

1	IT 4031	Information Retrieval	3
2	IT 4033	Natural Language Processing	3
3	CS 4043	Machine Learning	3
4	CS 3030	Computational Intelligence	3
5	CS 3028	Artificial Intelligence	3

Dept. Elective – V

1	IT 4022	Cyber Law and Intellectual Property Right	3
2	IT 4024	Computer Security	3
3	IT 4026	Network Security	3
4	IT 4028	Cyber Security	3
5	EC 6108	Digital Image Processing	3

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SEMESTER-III

Theory							
Sl. No.	**Subject Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2001	Mathematics –III	3	1	0	4	4
2	EE 2005	DC Machines and Transformers	3	1	0	4	4
3	EE 2003	Network Analysis	3	1	0	4	4
4	EC 2015	Analog Circuits	3	0	0	3	3
5	CS 2001	Data Structures & Algorithms	3	1	0	4	4
6	ME 2011	Thermodynamics and Hydraulics	3	1	0	4	4
Total of Theory						**23**	**23**
Practical							
1	CS 2091	Data Structures Lab	0	0	3	3	2
2	EE 2091	Networks and Electronics Circuit Lab	0	0	3	3	2
Sessional							
1	HS 2081	Business Communication	0	0	3	3	2
Total of Practical & Sessional						**9**	**6**
Semester Total						**32**	**29**

SEMESTER-IV

Theory							
Sl. No.	**Subject Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2002	Mathematics-IV	3	1	0	4	4
2	EE 2010	AC Machines	3	1	0	4	4
3	EC 2011	Digital Electronics	3	0	0	3	3
4	EE 2016	Electrical Measurements and Measuring Instruments	3	1	0	4	4
5	EE 2012	Linear Control Theory	3	1	0	4	4
6	EE 2014	Electromagnetics	3	0	0	3	3
Total of Theory						**22**	**22**
Practical							
1.	EE 2092	Electrical Measurements Lab	0	0	3	3	2
2.	EE 2094	Digital Circuit Lab	0	0	3	3	2
3.	EE 2096	Electrical Machines Lab	0	0	3	3	2
Total of Practical & Sessional						**9**	**6**
Semester Total						**31**	**28**

SEMESTER-V

Sl. No.	Subject Code	Subjects	L	T	P	Total	Credit
Theory							
1	EE 3007	Power Transmission and Distribution	3	0	0	3	3
2	EE 3005	Power Electronics	3	1	0	4	4
3		Institute Elective I	3	0	0	3	3
4	EC 3003	Microprocessors and Microcontrollers	3	1	0	4	4
5	EC 3013	Principle of Digital Signal Processing	3	0	0	3	3
6		Department Elective-I	3	0	0	3	3
7	HS 3003	Professional Ethics & Code of Conduct	1	0	0	1	1
Total of Theory						**21**	**21**
Practical							
1	EE 3091	Power Electronics Lab	0	0	3	3	2
2	EE 3095	Control System Lab	0	0	3	3	2
3	EE 3093	Microprocessor Lab	0	0	3	3	2
Sessional							
1	TP 3081	Cognitive Aptitude Test-I	0	0	2	2	1
Total of Practical & Sessional						11	**7**
Semester Total						**32**	**28**

SEMESTER-VI

Sl. No.	Subject Code	Subjects	L	T	P	Total	Credit
Theory							
1.	EE 3002	Power System Operation and Control	3	1	0	4	4
2.	EE 3006	Electric Drives and Control	3	0	0	3	3
3.	EC 2016	Communication Engineering	3	1	0	4	4
4.		Institute Elective-II	3	0	0	3	3
5.		Department Elective-II	3	0	0	3	3
6.		Open Elective-I	3	0	0	3	3
Total of Theory						**20**	**20**
Practical							
1.	EE 3092	Power Systems Lab	0	0	3	3	2
2.	EE 3094	Electric Drives Lab	0	0	3	3	2
Sessional							
1.	TP 3082	Cognitive Aptitude Test-II	0	0	2	2	1
2.	EE 3082	Minor Project	0	0	3	3	2
Total of Practical & Sessional						**11**	**7**
Semester Total						**31**	**27**

SEMESTER-VII

Theory							
Sl. No.	**Subject Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1.	EE 4003	Switch Gear and Protection	3	0	0	3	3
2.		Department Elective-III	3	0	0	3	3
3.		Department Elective-IV	3	0	0	3	3
4.		Open Elective-II	3	0	0	3	3
5.	HS 4003	Legal Issues & requirement in Engineering	1	0	0	1	1
Total of Theory						**13**	**13**
Sessional							
1.	EE 4087	Electrical Machine Design	0	0	2	2	1
2.	EE 4083	Practical Training	-	-	-	-	2
3.	EE 4081	Project (Part-I)				3	2
4.	EE 4089	Electrical System Modeling and Simulation	0	0	2	2	1
Total of Sessional						**7**	**6**
Semester Total						**20**	**19**

SEMESTER-VIII

Theory							
Sl. No.	**Subject Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1.		Department Elective-V	3	0	0	3	3
2.		Open Elective-III	3	0	0	3	3
Total of Theory						**6**	**6**
Sessional							
1.	EE 4082	Project (Part-II)	0	0	9	9	6
2.	EE 4084	Seminar	0	0	3	3	2
3.	EE 4086	General Viva-Voce	-	-	-	-	2
Total of Practical & Sessional						**12**	**10**
Semester Total						**18**	**16**

LIST OF INSTITUTE ELECTIVES

Institute Elective-I

Sl. No.	Subject Code	Subject Name	Credit
1.	HS 2002	Engineering Economics	3
2.	HS 2004	Public Finance	3
3.	HS 2006	International Economics	3

Institute Elective-II

1.	HS 3002	Organizational Behavior	3
2.	HS 3004	Human Resource Management	3
3.	HS 3006	Entrepreneurship	3
4.	HS 3008	Management Concepts and Practices	3

DEPARTMENT ELECTIVES

Elective- 1

1.	EE 3021	Principles of Industrial Instrumentation	3
2.	EE 3023	High voltage Engineering	3
3.	EE 3025	Power Station Engineering	3
4.	EE 3027	Electrical Engineering Materials	3

Elective- II

1.	EE 3032	EHV AC Transmission	3
2.	EE 3034	Neural Network, Fuzzy Logic and Evolutionary Algorithm	3
3.	EE 3036	Discrete and Non linear Control Theory	3
4.	EE 3038	Utilization of Electric Power	3

Elective- III

1.	EE 6139	Illumination Engineering	3
2.	EE 4025	Electric Traction and Drive	3
3.	EE 4031	Numerical Relays	3
4.	EE 4037	Advanced Power Electronics	3
5.	EE 4029	HVDC Transmission	3

Elective- IV

1.	EE 6121	Computer Application in Power System	3
2.	EE 4039	Power Quality	3
3.	EE 6336	Smart Grid	3
4.	EE 6123	Power Market Reforms	3

Elective- V

1.	EE 4022	Bio Power	3
2.	EE 4024	Wind Power	3
3.	EE 4026	Solar Power	3
4.	EE 4028	Surge and Lightning Protection and safety devices	3

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SEMESTER-III

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2001	Mathematics-III	3	1	0	4	4
2	EC 2001	Analog Electronic Circuits-I	3	1	0	4	4
3	EC 2003	Signals and Systems	3	0	0	3	3
4	EE 2007	Network Theory	3	0	0	3	3
5	EC 2005	Semiconductor Devices	3	0	0	3	3
6	CS 2001	Data Structures and Algorithms	3	1	0	4	4
Total of Theory						**21**	**21**
Practical							
1	EC 2091	Electronic Circuits and Networks Lab	0	0	3	3	2
2	CS 2091	Data Structures Lab	0	0	3	3	2
Sessional							
1	HS 2081	Business Communication	0	0	3	3	2
Total of Practical & Sessional						**9**	**6**
Semester Total						**30**	**27**

SEMESTER-IV

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2002	Mathematics-IV	3	1	0	4	4
2	EC 2010	Analog Electronic Circuits-II	3	0	0	3	3
3	EC 2012	Analog Communication Techniques	3	0	0	3	3
4	EC 2008	Measurements and Instrumentation	3	1	0	4	4
5	EC 2011	Digital Electronics	3	0	0	3	3
6		Institute Elective-I	3	0	0	3	3
Total of Theory						**20**	**20**
Practical							
1	EC 2092	Analog Integrated Circuits Lab	0	0	3	3	2
2	EC 2093	Digital Electronics Lab	0	0	3	3	2
3	EC 2098	Simulation Lab	0	0	3	3	2
Total of Practical						**9**	**6**
Semester Total						**29**	**26**

SEMESTER-V

Sl. No.	Subject Code	Course Title	L	T	P	Total	Credit
Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	EC 2014	Electromagnetic Theory	3	0	0	3	3
2	EC 3003	Microprocessors and Microcontrollers	3	1	0	4	4
3	EL 3001	Control Systems	3	1	0	4	4
4	EC 3005	Digital Communication Techniques	3	1	0	4	4
5	EC 3007	Digital Signal Processing	3	1	0	4	4
6		Department Elective-I	3	0	0	3	3
7	HS 3003	Professional Ethics & Code of Conduct	1	0	0	1	1
Total of Theory						**23**	**23**
Practical							
1	EC 2094	Communication Engineering Lab	0	0	3	3	2
2	EC 3093	Microprocessor and Microcontroller Lab	0	0	3	3	2
3	EI 3093	Control and Instrumentation Lab	0	0	3	3	2
Sessional							
1	TP 3081	Cognitive Aptitude Test-I	2	0	0	2	1
Total of Practical & Sessional						**11**	**7**
Semester Total						**34**	**30**

SEMESTER-VI

Sl. No.	Subject Code	Course Title	L	T	P	Total	Credit
Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	EC 3012	Antenna & Radio Wave Propagation	3	0	0	3	3
2	EC 3011	VLSI Design	3	0	0	3	3
3		Department Elective-II	3	0	0	3	3
4		Department Elective-III	3	0	0	3	3
5		Open Elective-I	3	0	0	3	3
6		Institute elective-II	3	0	0	3	3
Total of Theory						**18**	**18**
Practical							
1	EC 3095	VLSI Lab	0	0	3	3	2
2	EC 3096	DSP Lab	0	0	3	3	2
Sessional							
1	TP 3082	Cognitive Aptitude Test-II	2	0	0	2	1
2	EC 3082	Minor Project	0	0	3	3	2
Total of Practical & Sessional						**11**	**7**
Semester Total						**29**	**25**

SEMESTER-VII

Sl. No.	Subject Code	Course Title	L	T	P	Total	Credit
Theory							
1	EC 4001	RF and Microwave Engineering	3	1	0	4	4
2	EC 4003	Wireless and Mobile Communication	3	1	0	4	4
3		Department Elective-IV	3	0	0	3	3
4		Open Elective-II	3	0	0	3	3
5	HS 4003	Legal Issues & requirement in Engineering	1	0	0	1	1
Total of Theory						**15**	**15**
Practical							
1	EC 4091	Microwave and Antenna Lab	0	0	3	3	2
2	EC 4093	Wireless Communication and Networking Lab	0	0	3	3	2
Sessional							
1	EC 4083	Practical Training					2
2	EC 4081	Project (Part-I)	0	0	3	3	2
Total of Practical & Sessional						**9**	**8**
Semester Total						**24**	**23**

SEMESTER- VIII

Sl. No.	Subject Code	Course Title	L	T	P	Total	Credit
Theory							
1		Department Elective-V	3	0	0	3	3
2		Open Elective - III	3	0	0	3	3
Total of Theory						**6**	**6**
Sessional							
1	EL 4082	Project (Part-II)	0	0	9	9	6
2	EL 4084	Seminar	0	0	3	3	2
3	EL 4086	General Viva Voce	-	-	-	-	2
Total of Sessional						**12**	**10**
Semester Total						**18**	**16**

LIST OF INSTITUTE ELECTIVES

Institute Elective – I

Sl. No	Subject Code	Subject Name	Credit
1.	HS 2002	Engineering Economics	3
2.	HS 2006	International Economics	3
3.	HS 2004	Public Finance	3

Institute Elective – II

1.	HS 3006	Entrepreneurship	3
2.	HS 3008	Management Concepts & Practices	3
3.	HS 3002	Organizational Behaviour	3
4.	HS 3004	Human Resource Management	3

LIST OF DEPARTMENT ELECTIVES

Dept. Elective – I

1.	EE 3028	Power Electronic Circuits	3
2.	EC 3027	Optical and Satellite Communication	3
3.	EI 3025	Principle of Analytical Instrumentation	3
4.	EC3025	Computational Intelligence	3

Dept. Elective - II & III

1.	EC 3022	Advanced Microprocessors	3
2.	EC 3024	Embedded Systems	3
3.	EI 3023	Neural Network & Fuzzy Logic Control	3
4.	EL 3024	Industrial Automation and Control	3
5.	EC 3028	Data Communication and Networking	3
6.	EC 6112	Communication and Network Security	3
7.	EC 3030	Adaptive Systems and Signal Processing	3
8.	EI 3022	Bio-medical Instrumentation	3

Dept. Elective - IV

1.	EC 6102	Telecommunication Switching Networks and Protocols	3
2.	EC 4033	Smart Antennas	3
3.	EC 6224	Low Power VLSI Design	3
4.	EC 4021	Radar and Television Engineering	3

Dept. Elective - V

1.	EC 6108	Digital Image Processing	3
2.	EC 6316	Microwave Integrated Circuits	3
3.	EC 4046	Modern Digital Communication	3
4.	EC 4044	Information Theory and Coding	3

COURSE STRUCTURE FOR B.TECH IN ELECTRONICS & ELECTRICAL ENGINEERING (SECOND YEAR TO FOURTH YEAR)

SEMESTER-III

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2001	Mathematics-III	3	1	0	4	4
2	EC 2013	Analog Electronics	3	1	0	4	4
3	EE 2007	Network Theory	3	0	0	3	3
4	EC 2003	Signals & Systems	3	0	0	3	3
5	EE 2005	DC Machines & Transformers	3	1	0	4	4
6	CS 2001	Data Structures and Algorithms	3	1	0	4	4
Total of Theory						**22**	**22**
Practical							
1	EC 2091	Electronic Circuits & Networks Lab	0	0	3	3	2
2	CS 2091	Data Structures Lab	0	0	3	3	2
Sessional							
1	HS 2081	Business Communication	0	0	3	3	2
Total of Practical & Sessional						**9**	**6**
Semester Total						**31**	**28**

SEMESTER-IV

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1.	MA 2002	Mathematics – IV	3	1	0	4	4
2.	EE 2010	AC Machines	3	1	0	4	4
3.	EI 2005	Electrical & Electronic Measurements	3	1	0	4	4
4.	EC 2011	Digital Electronics	3	0	0	3	3
5.	EC 2014	Electromagnetic Theory	3	0	0	3	3
6.		Inst. Elective – I	3	0	0	3	3
Total of Theory						**21**	**21**
Practical							
1.	EC 2096	Digital & Linear IC Lab	0	0	3	3	2
2.	EI 2095	Electrical & Electronic Measurements Lab	0	0	3	3	2
3.	EE 2096	Electrical Machines Lab	0	0	3	3	2
Total of Practical						**9**	**6**
Semester Total						**30**	**27**

SEMESTER- V

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	EE 3007	Power Transmission & Distribution	3	0	0	3	3
2	EC 3003	Microprocessors & Microcontrollers	3	1	0	4	4
3	EL 3001	Control Systems	3	1	0	4	4
4	EE 3005	Power Electronics	3	1	0	4	4
5	EC 2016	Communication Engg	3	1	0	4	4
6		Dept. Elective – I	3	0	0	3	3
7	HS 3003	Professional Ethics & Code of Conduct	1	0	0	1	1
Total of Theory						**23**	**23**
Practical							
1	EL 3091	Control Systems Lab	0	0	3	3	2
2	EC 3093	Microprocessor & Microcontroller Lab	0	0	3	3	2
3	EC 2098	Simulation Lab	0	0	3	3	2
Sessional							
1	TP 3081	Cognitive Aptitude Test-I	0	0	2	2	1
Total of Practical & Sessional						**11**	**7**
Semester Total						**34**	**30**

SEMESTER- VI

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	EC 3007	Digital Signal Processing	3	1	0	4	4
2	EE 3002	Power System Operation and Control	3	1	0	4	4
3		Dept. Elective – II	3	0	0	3	3
4		Inst. Elective – II	3	0	0	3	3
5		Open Elective - I	3	0	0	3	3
Total of Theory						**17**	**17**
Practical							
1	EC 3096	DSP Lab	0	0	3	3	2
2	EE 3091	Power Electronics Lab	0	0	3	3	2
3	EE 3092	Power Systems Lab	0	0	3	3	2
Sessional							
1	EL 3082	Minor Project	0	0	3	3	2
2	TP 3082	Cognitive Aptitude Test-II	0	0	2	2	1
Total of Practical & Sessional						**14**	**9**
Semester Total						**31**	**26**

SEMESTER-VII

Sl. No.	Subject Code	Course Title	L	T	P	Total	Credit
Theory							
1	EE 3006	Electric Drives and Control	3	0	0	3	3
2		Dept. Elective - III	3	0	0	3	3
3		Dept. Elective - IV	3	0	0	3	3
4		Open Elective - II	3	0	0	3	3
5	HS 4003	Legal Issues & requirement in Engineering	1	0	0	1	1
Total of Theory						**13**	**13**
Practical							
1	EE 3094	Electric Drives Lab	0	0	3	3	2
Sessional							
1	EE 4087	Electrical Machine Design	0	0	2	2	1
2	EE 4089	Electrical System Modeling & Simulation	0	0	2	2	1
3	EL 4083	Practical Training	-	-	-	-	2
4	EL 4081	Project (Part-I)	0	0	3	3	2
Total of Practical & Sessional						**10**	**8**
Semester Total						**23**	**21**

SEMESTER- VIII

Sl. No.	Subject Code	Course Title	L	T	P	Total	Credit
Theory							
1		Dept. Elective - V	3	0	0	3	3
2		Open Elective - III	3	0	0	3	3
Total of Theory						**6**	**6**
Sessional							
1	EL 4082	Project (Part-II)	0	0	9	9	6
2	EL 4084	Seminar	0	0	3	3	2
3	EL 4086	General Viva Voce	-	-	-	-	2
Total of Sessional						**12**	**10**
Semester Total						**18**	**16**

LIST OF INSTITUTE ELECTIVES

Institute Elective – I

Sl. No	Subject Code	Subject Name	Credit
1.	HS 2002	Engineering Economics	3
2.	HS 2006	International Economics	3
3.	HS 2004	Public Finance	3

Institute Elective – II

1.	HS 3006	Entrepreneurship	3
2.	HS 3008	Management Concepts & Practices	3
3.	HS 3002	Organizational Behaviour	3
4.	HS 3004	Human Resource Management	3

LIST OF DEPARTMENT ELECTIVES

Dept. Elective-I

1.	EC 3027	Optical & Satellite Communication	3
2.	EC 3025	Computational Intelligence	3
3.	EI 3027	Industrial Instrumentation	3
4.	EE 3025	Power Station Engineering	3

Dept. Elective-II

1.	EL 3022	Advanced Control Systems	3
2.	EI 3023	Neural Network & Fuzzy Logic Control	3
3.	EC 3024	Embedded Systems	3
4.	EC 3028	Data Communication & Networking	3

Dept. Elective-III

1.	EC 3030	Adaptive Systems & Signal Processing	3
2.	EC 4031	Mobile Communication Engineering	3
3.	EE 4037	Advanced Power Electronics	3
4.	EE 6121	Computer Application in Power Systems	3

Dept. Elective-IV

1.	EE 4003	Switch Gear and Protection	3
2.	EC 6108	Digital Image Processing	3
3.	EE 4029	HVDC Transmission	3
4.	EE 4025	Electric Traction & Drive	3

Dept. Elective-V

1.	EL 3024	Industrial Automation & Control	3
2.	EE 6336	Smart Grid	3
3.	EE 6123	Power Market Reforms	3
4.	EI 3022	Bio-medical Instrumentation	3

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SEMESTER-III

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2001	Mathematics – III	3	1	0	4	4
2	EC 2003	Signals & Systems	3	0	0	3	3
3	EC 2013	Analog Electronics	3	1	0	4	4
4	EE 2007	Network Theory	3	0	0	3	3
5	EC 2005	Semiconductor Devices	3	0	0	3	3
6	EI 2005	Electrical & Electronic Measurements	3	1	0	4	4
Total of Theory						**21**	**21**
Practical							
1	EC 2091	Electronic Circuits & Networks Lab	0	0	3	3	2
2	EI 2095	Electrical & Electronic Measurements Lab	0	0	3	3	2
Sessional							
1	HS 2081	Business Communication	0	0	3	3	2
Total of Practical & Sessional						**9**	**6**
Semester Total						**30**	**27**

SEMESTER- IV

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2002	Mathematics - IV	3	1	0	4	4
2	EI 2006	Instrumentation - I	3	1	0	4	4
3	EC 2011	Digital Electronics	3	0	0	3	3
4	CS 2001	Data Structures and Algorithms	3	1	0	4	4
5	EE 2008	Electrical Machines	3	1	0	4	4
6	ME 2017	Thermodynamics & Fluid Mechanics	3	1	0	4	4
Total of Theory						**23**	**23**
Practical							
1	EC 2096	Digital & Linear IC Lab	0	0	3	3	2
2	CS 2091	Data Structures Lab	0	0	3	3	2
3	EE 2096	Electrical Machines Lab	0	0	3	3	2
Total of Practical						**9**	**6**
Semester Total						**32**	**29**

SEMESTER-V

Sl. No.	Subject Code	Course Title	L	T	P	Total	Credit
Theory							
1	EC 3007	Digital Signal Processing	3	1	0	4	4
2	EI 3005	Instrumentation – II	3	1	0	4	4
3	EC 2016	Communication Engg	3	1	0	4	4
4	EL 3001	Control Systems	3	1	0	4	4
5	EC 3011	VLSI Design	3	0	0	3	3
6		Inst. Elective - I	3	0	0	3	3
7	HS 3003	Professional Ethics & Code of Conduct	1	0	0	1	1
Total of Theory						**23**	**23**
Practical							
1	EL 3091	Control Systems Lab	0	0	3	3	2
2	EI 3091	Instrumentation Lab	0	0	3	3	2
3	EC 3095	VLSI Lab	0	0	3	3	2
Sessional							
1	TP 3081	Cognitive Aptitude Test-I	0	0	2	2	1
Total of Practical & Sessional						**11**	**7**
Semester Total						**34**	**30**

SEMESTER-VI

Sl. No.	Subject Code	Course Title	L	T	P	Total	Credit
Theory							
1	EC 3003	Microprocessors & Microcontrollers	3	1	0	4	4
2	EI 3004	Process Control – I	3	1	0	4	4
3		Dept. Elective - I	3	0	0	3	3
4		Dept. Elective - II	3	0	0	3	3
5		Inst. Elective – II	3	0	0	3	3
6		Open Elective - I	3	0	0	3	3
Total of Theory						**20**	**20**
Practical							
1.	EC 3093	Microprocessor & Microcontroller Lab	0	0	3	3	2
2.	EC 3096	DSP Lab	0	0	3	3	2
Sessional							
1.	EI 3082	Minor Project	0	0	3	3	2
2.	TP 3082	Cognitive Aptitude Test-II	0	0	2	2	1
Total of Practical & Sessional						**11**	**7**
Semester Total						**31**	**27**

SEMESTER-VII

Sl. No.	Subject Code	Course Title	L	T	P	Total	Credit
Theory							
1	EI 4003	Process Control – II	3	0	0	3	3
2		Dept. Elective – III	3	0	0	3	3
3		Dept. Elective – IV	3	0	0	3	3
4		Open Elective - II	3	0	0	3	3
5	HS 4003	Legal Issues & requirement in Engineering	1	0	0	1	1
Total of Theory						**13**	**13**
Practical							
1.	EI 4091	Process Control Lab	0	0	3	3	2
Sessional							
1.	EI 4085	Instrumentation System Design & Simulation Lab	0	0	2	2	1
2.	EI 4083	Practical Training	-	-	-	-	2
3.	EI 4081	Project (Part – I)	0	0	3	3	2
Total of Practical & Sessional						**8**	**7**
Semester Total						**21**	**20**

SEMESTER-VIII

Sl. No	Subject Code	Course Title	L	T	P	Total	Credit
Theory							
1		Dept. Elective – V	3	0	0	3	3
2		Open Elective - III	3	0	0	3	3
Total of Theory						**6**	**6**
Sessional							
1	EI 4084	Seminar	0	0	3	3	2
2	EI 4086	General Viva Voce	-	-	-	-	2
3	EI 4082	Project (Part - II)	0	0	9	9	6
Total of Sessional						**12**	**10**
Semester Total						**18**	**16**

LIST OF INSTITUTE ELECTIVES

Institute Elective – I

Sl. No	Subject Code	Subject Name	Credit
1.	HS 2002	Engineering Economics	3
2.	HS 2006	International Economics	3
3.	HS 2004	Public Finance	3

Institute Elective – II

1.	HS 3006	Entrepreneurship	3
2.	HS 3008	Management Concepts & Practices	3
3.	HS 3002	Organizational Behaviour	3
4.	HS 3004	Human Resource Management	3

LIST OF DEPARTMENT ELECTIVES

Dept. Elective – I

1.	EE 3028	Power Electronics Circuits	3
2.	EI 3021	Material Science	3
3.	EI 3023	Neural Network & Fuzzy Logic Control	3
4.	EC 3024	Embedded Systems	3

Dept. Elective-II

1.	EC 3034	Industrial Data Networks	3
2.	EI 3026	Fiber Optic Instrumentation	3
3.	EC 3032	Telemetry & Remote Control	3
4.	EI 3024	Virtual Instrumentation	3

Dept. Elective-III & IV

1.	EI 3025	Principle of Analytical Instrumentation	3
2.	EI 3022	Bio-medical Instrumentation	3
3.	EI 4033	Nonlinear Control Theory	3
4.	EI 4029	Instrumentation for oil & gas industries	3
5.	EC 4031	Mobile Communication Engg.	3

Dept. Elective-V

1.	EI 4028	Power Plant Instrumentation	3
2.	EC 6108	Digital Image Processing	3
3.	EC 6128	Wireless Sensor Networks	3
4.	EC 6313	Optimization Techniques in Engineering	3

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SEMESTER-III

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2001	Mathematics-III	3	1	0	4	4
2	EC 2017	Electronic Devices & Circuits	3	1	0	4	4
3	EE 2007	Network Theory	3	0	0	3	3
4	MA 2003	Discrete Mathematics	3	1	0	4	4
5	CS 2001	Data Structures and Algorithms	3	1	0	4	4
6	EC 2003	Signals and Systems	3	0	0	3	3
Total of Theory						**22**	**22**
Practical							
1	EC 2091	Electronic Circuits and Networks Lab	0	0	3	3	2
2	CS 2091	Data Structures Lab	0	0	3	3	2
Sessional							
1	HS 2081	Business Communication	0	0	3	3	2
Total of Practical & Sessional						**9**	**6**
Semester Total						**31**	**28**

SEMESTER-IV

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2002	Mathematics-IV	3	1	0	4	4
2	EC 2011	Digital Electronics	3	0	0	3	3
3	EC 2008	Measurements and Instrumentation	3	1	0	4	4
4	CS 2008	Design & Analysis of Algorithms	3	1	0	4	4
5	CS 2004	Database Management Systems	3	1	0	4	4
6	CS 2006	Computer Organization and Architecture	3	1	0	4	4
Total of Theory						**23**	**23**
Practical							
1	EC 2096	Digital & Linear IC Lab	0	0	3	3	2
2	CS 2096	Design & Analysis of Algorithms Lab	0	0	3	3	2
3	CS 2094	DBMS Lab	0	0	3	3	2
Total of Practical						**9**	**6**
Semester Total						**32**	**29**

SEMESTER-V

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	EC 3003	Microprocessors and Microcontrollers	3	1	0	4	4
2	EC 2016	Communication Engineering	3	1	0	4	4
3	EL 3001	Control Systems	3	1	0	4	4
4		Institute Elective-I	3	0	0	3	3
5	CS 3009	Operating systems	3	1	0	4	4
6	IT 3003	Software Engineering	3	1	0	4	4
7	HS 3003	Professional Ethics & Code of Conduct	1	0	0	1	1
Total of Theory						**24**	**24**
Practical							
1	EC 3093	Microprocessor and Microcontroller Lab	0	0	3	3	2
2	EC 2098	Simulation Lab	0	0	3	3	2
Sessional							
1	TP 3081	Cognitive Aptitude Test-I	0	0	2	2	1
Total of Practical & Sessional						**8**	**5**
Semester Total						**32**	**29**

SEMESTER-VI

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	EC 3007	Digital Signal Processing	3	1	0	4	4
2	EC 3011	VLSI Design	3	0	0	3	3
3	IT 3001	Computer Networks	3	1	0	4	4
4		Department Elective-I	3	0	0	3	3
5		Open Elective-I	3	0	0	3	3
6		Institute Elective-II	3	0	0	3	3
Total of Theory						**20**	**20**
Practical							
1	EC 3096	DSP Lab	0	0	3	3	2
2	EI 3093	Control and Instrumentation Lab	0	0	3	3	2
Sessional							
1	TP 3082	Cognitive Aptitude Test-II	0	0	2	2	1
2	EM 3082	Minor Project	0	0	3	3	2
Total of Practical & Sessional						**11**	**7**
Semester Total						**31**	**27**

SEMESTER-VII

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1		Department Elective - II	3	0	0	3	3
2		Department Elective - III	3	0	0	3	3
3		Department Elective - IV	3	0	0	3	3
4		Open Elective - II	3	0	0	3	3
5	HS 4003	Legal Issues & requirement in Engineering	1	0	0	1	1
Total of Theory						**13**	**13**
Practical							
1	EC 3095	VLSI Lab	0	0	3	3	2
Sessional							
1	EM 4083	Practical Training	-	-	-	-	2
2	EM 4081	Project (Part-I)	0	0	3	3	2
Total of Practical & Sessional						**6**	**6**
Semester Total						**19**	**19**

SEMESTER-VIII

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1		Department Elective – V	3	0	0	3	3
2		Open Elective – III	3	0	0	3	3
Total of Theory						**6**	**6**
Sessional							
1	EM 4082	Project (Part-II)	0	0	9	9	6
2	EM 4084	Seminar	0	0	3	3	2
3	EM 4086	General Viva Voce	-	-	-	-	2
Total of Sessional						**12**	**10**
Semester Total						**18**	**16**

LIST OF INSTITUTE ELECTIVES

Institute Elective – I

Sl. No	Subject Code	Subject Name	Credit
1.	HS 2002	Engineering Economics	3
2.	HS 2006	International Economics	3
3.	HS 2004	Public Finance	3

Institute Elective – II

1.	HS 3006	Entrepreneurship	3
2.	HS 3008	Management Concepts & Practices	3
3.	HS 3002	Organizational Behaviour	3
4.	HS 3004	Human Resource Management	3

LIST OF DEPARTMENT ELECTIVES

Dept. Elective – I

1.	IT 3042	Introduction to Web Technology	3
2.	CS 3033	Principle of Automata Theory	3
3.	EI 3025	Principle of Analytical Instrumentation	3
4.	EC 3027	Optical and Satellite Communication	3

Dept. Elective - II

1.	EC 3022	Advanced Microprocessors	3
2.	EC 3024	Embedded Systems	3
3.	CS 3030	Computational Intelligence	3
4.	EL 3024	Industrial Automation and Control	3

Dept. Elective - III

1.	EC 6128	Wireless Sensor Network	3
2.	EC 4031	Mobile Communication Engineering	3
3.	EC 4044	Information Theory and Coding	3
4.	EC 6112	Communication and Network Security	3

Dept. Elective - IV

1.	CS 3032	Big Data	3
2.	IT 4021	Internet of Things	3
3.	CS 3022	Parallel and Distributed Computing	3
4.	IT 3022	Cloud Computing	3

Dept. Elective - V

1.	EC 6224	Low Power VLSI Design	3
2.	EC 6108	Digital Image Processing	3
3.	CS 3034	Service Oriented Architecture	3
4.	IT 3021	E-Commerce	3

COURSE STRUCTURE FOR B. TECH
IN ELECTRONICS & CONTROL SYSTEM ENGINEERING
(SECOND YEAR TO FOURTH YEAR)

SEMESTER-III

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2001	Mathematics-III	3	1	0	4	4
2	EC 2003	Signals & Systems	3	0	0	3	3
3	EC 2013	Analog Electronics	3	1	0	4	4
4	EE 2007	Network Theory	3	0	0	3	3
5	EC 2005	Semiconductor Devices	3	0	0	3	3
6	EI 2005	Electrical & Electronic Measurements	3	1	0	4	4
Total of Theory						**21**	**21**
Practical							
1	EC 2091	Electronic Circuits & Networks Lab	0	0	3	3	2
2	EI 2095	Electrical & Electronic Measurements Lab	0	0	3	3	2
Sessional							
1	HS 2081	Business Communication	0	0	3	3	2
Total of Practical & Sessional						**9**	**6**
Semester Total						**30**	**27**

SEMESTER-IV

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	MA 2002	Mathematics-IV	3	1	0	4	4
2	EI 2006	Instrumentation-I	3	1	0	4	4
3	EC 2011	Digital Electronics	3	0	0	3	3
4	CS 2001	Data Structures & Algorithm	3	1	0	4	4
5	EE 2008	Electrical Machines	3	1	0	4	4
6	ME 2017	Thermodynamics & Fluid Mechanics	3	1	0	4	4
Total of Theory						**23**	**23**
Practical							
1	EC 2096	Digital & Linear IC Lab	0	0	3	3	2
2	CS 2091	Data Structures Lab	0	0	3	3	2
3	EE 2096	Electrical Machine Lab	0	0	3	3	2
Total of Practical						**9**	**6**
Semester Total						**32**	**29**

SEMESTER-V

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	EC 3007	Digital Signal Processing	3	1	0	4	4
2	EC 3011	VLSI Design	3	0	0	3	3
3	EI 3005	Instrumentation-II	3	1	0	4	4
4	EC 2016	Communication Engineering	3	1	0	4	4
5	EL 3001	Control Systems	3	1	0	4	4
6		Inst. Elective-I	3	0	0	3	3
7	HS 3003	Professional Ethics & Code of Conduct	1	0	0	1	1
Total of Theory						**23**	**23**
Practical							
1	EC 3096	DSP Lab	0	0	3	3	2
2	EI 3091	Instrumentation Lab	0	0	3	3	2
3	EL 3091	Control Systems Lab	0	0	3	3	2
Sessional							
1	TP 3081	Cognitive Aptitude Test-I	0	0	2	2	1
Total of Practical & Sessional						**11**	**7**
Semester Total						**34**	**30**

SEMESTER-VI

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	EC 3003	Microprocessors & Microcontrollers	3	1	0	4	4
2	EL 3022	Advanced Control Systems	3	0	0	3	3
3	EL 3024	Industrial Automation and Control	3	0	0	3	3
4		Dept. Elective-I	3	0	0	3	3
5		Dept. Elective-II	3	0	0	3	3
6		Open. Elective-I	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1	EL 3092	Advanced Control System Lab	0	0	3	3	2
2	EC 3093	Microprocessor & Microcontroller Lab	0	0	3	3	2
Sessional							
1	EN 3082	Minor Project	0	0	3	3	2
2	TP 3082	Cognitive Aptitude Test-II	0	0	2	2	1
Total of Practical & Sessional						**11**	**7**
Semester Total						**30**	**26**

SEMESTER-VII

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1.		Dept. Elective-III	3	0	0	3	3
2.		Dept. Elective-IV	3	0	0	3	3
3.		Open. Elective-II	3	0	0	3	3
4.		Inst. Elective-II	3	0	0	3	3
5.	HS 4003	Legal Issues & requirement in Engineering	1	0	0	1	1
Total of Theory						**13**	**13**
Practical							
1.	EN 4091	Industrial Automation and control Lab	0	0	3	3	2
Sessional							
1.	EN 4083	Practical Training	0	0	0	0	2
2.	EN 4081	Project(Part-I)	0	0	3	3	2
Total of Practical & Sessional						**6**	**6**
Semester Total						**19**	**19**

SEMESTER-VIII

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1		Dept. Elective –V	3	0	0	3	3
2		Open Elective-III	3	0	0	3	3
Total of Theory						**6**	**6**
Sessional							
1	EN 4084	Seminar	0	0	3	3	2
2	EN 4086	General Viva Voice	0	0	0	0	2
3	EN 4082	Project(Part-II)	0	0	9	9	6
Total of Sessional						**12**	**10**
Semester Total						**18**	**16**

LIST OF INSTITUTE ELECTIVES

Institute Elective-I

SI. No	Subject Code	Subject Name	Credit
1.	HS 2002	Engineering Economics	3
2.	HS 2006	International Economics	3
3.	HS 2004	Public Finance	3

Institute Elective-II

1.	HS 3006	Entrepreneurship	3
2.	HS 3008	Management Concepts & Practices	3
3.	HS 3002	Organizational Behaviour	3
4.	HS 3004	Human Resource Management	3

LIST OF DEPARTMENT ELECTIVES

Dept. Elective-I

1.	EE 3028	Power Electronic Circuits	3
2.	EC 3024	Embedded Systems	3
3.	EI 3021	Material Science	3
4.	EI 3022	Bio-medical Instrumentation	3

Dept. Elective-II

1.	EC 3034	Industrial Data Networks	3
2..	EI 3024	Virtual Instrumentation	3
3.	EE 3006	Electric Drives and Control	3
4.	EC 6224	Low Power VLSI Design	3

Dept. Elective-III & IV

1.	EI 3023	Neural Network & Fuzzy Logic Control	3
2.	EI 4023	Process dynamics and Control	3
3.	EI 3026	Fiber Optic Instrumentation	3
4.	EC 3032	Telemetry and Remote Control	3

Dept. Elective-V

1.	EI 4028	Power Plant Instrumentation	3
2.	EC 6108	Digital Image Processing	3
3.	EC 6313	Optimization Techniques in Engineering	3
4.	EI 4033	Nonlinear Control theory	3

COURSE STRUCTUE FOR B.TECH IN MECHANICAL ENGINEERING (SECOND YEAR TO FOURTH YEAR)

SEMESTER-III

Theory							
Sl. No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME 2001	Engineering Thermodynamics	3	1	0	4	4
2	ME 2003	Fluid Mechanics	3	0	0	3	3
3	EE 2009	Electrical Machines and Power Electronics	3	0	0	3	3
4	ME 2007	Material Science and Engineering	3	0	0	3	3
5	ME 2009	Kinematics & Kinetics of Machines	3	0	0	3	3
6	MA 2001	Mathematics-III	3	1	0	4	4
Total of Theory						**20**	**20**
Practical							
1	ME 2091	Fluid Mechanics Lab	0	0	3	3	2
2	EE 2093	Electrical Machines and Power Electronics Lab	0	0	3	3	2
Sessional							
1	ME 2083	Machine Drawing and CAD	0	0	3	3	2
2	ME 2085	Manufacturing Practice	0	0	3	3	2
Total of Practical & Sessional						**12**	**8**
Semester Total						**32**	**28**

SEMESTER-IV

Theory							
Sl. No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME 2002	Machine Dynamics	3	0	0	3	3
2	ME 2008	Fluid Dynamics & Hydraulic Machines	3	0	0	3	3
3	ME 2010	Basic Manufacturing Processes	3	0	0	3	3
4	ME 2019	Mechanics of Solids	3	1	0	4	4
5	ME 2014	Engineering Metrology and Measurements	3	0	0	3	3
6	MA 2004	Numerical Methods	3	1	0	4	4
Total of Theory						**21**	**20**
Practical							
1	ME 2096	Machine Kinematics and Dynamics Lab	0	0	3	3	2
2	ME 2098	Hydraulic Machines Lab	0	0	3	3	2
3	ME 2090	Material Testing Lab	0	0	3	3	2
Sessional							
1	HS 2081	Business Communication	0	0	3	3	2
Total of Practical & Sessional						**12**	**8**
Semester Total						**33**	**28**

SEMESTER-V

Theory							
Sl. No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME 3011	Heat Transfer	3	0	0	3	3
2	ME 3003	Internal Combustion Engines & Gas Turbines	3	0	0	3	3
3	ME 3015	Manufacturing Processes and Design	3	1	0	4	4
4	ME 3009	Fundamentals of Machine Design	3	0	0	3	3
5	ME 3017	Industrial Engineering & Operations Research	3	0	0	3	3
6		Institute Elective-I	3	0	0	3	3
7	HS 3003	Professional Ethics & Code of Conduct	1	0	0	1	1
Total of Theory						**20**	**20**
Practical							
1	ME 3095	Heat Transfer Lab	0	0	3	3	2
2	ME 3097	Metrology & Instrumentation Lab	0	0	3	3	2
3	ME 3099	Advanced Mechanical Lab	0	0	3	3	2
Sessional							
1	ME 3081	Machine Design	0	0	3	3	2
2	TP 3081	Cognitive Aptitude Test-I	0	0	2	2	1
Total of Practical & Sessional						**14**	**9**
Semester Total						**34**	**29**

SEMESTER-VI

Theory							
Sl. No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME 3014	Refrigeration and Air Conditioning	3	0	0	3	3
2	ME 3010	Metal Cutting & Cutting Tool Design	3	1	0	4	4
3	ME 3012	Design of Machine Elements	3	0	0	3	3
4		Department Elective-I	3	0	0	3	3
5		Institute Elective-II	3	0	0	3	3
6		Open Elective-I	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1	ME 3092	IC Engines & RAC Lab	0	0	3	3	2
Sessional							
1	ME 3088	Tool Design	0	0	3	3	2
2	ME 3086	Computer Aided Design and Analysis	0	0	3	3	2
3	TP 3082	Cognitive Aptitude Test-II	0	0	2	2	1
4	ME 3082	Minor Project	0	0	3	3	2
Total of Practical & Sessional						**14**	**9**
Semester Total						**33**	**28**

SEMESTER-VII

Theory							
Sl. No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1		Department Elective-II	3	0	0	3	3
2		Department Elective-III	3	0	0	3	3
3		Department Elective-IV	3	0	0	3	3
4		Open Elective-II	3	0	0	3	3
5	HS 4003	Legal Issues & requirement in Engineering	1	0	0	1	1
Total of Theory						**13**	**13**
Practical							
1	ME 4093	Computational Technique Practice Lab	0	0	3	3	2
Sessional							
1	ME 4083	Practical Training	-	-	-	-	2
2	ME 4081	Project (Part-I)	0	0	3	3	2
Total of Practical & Sessional						**6**	**6**
Semester Total						**19**	**19**

SEMESTER-VIII

Theory							
Sl. No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1		Open Elective-III	3	0	0	3	3
2		Department Elective-V	3	0	0	3	3
Total of Theory						**6**	**6**
Sessional							
1	ME 4082	Project (Part-II)	0	0	9	9	6
2	ME 4084	Seminar	0	0	3	3	2
3	ME 4086	General Viva-Voce	-	-	-	-	2
Total of Sessional						**12**	**10**
Semester Total						**18**	**16**

LIST OF INSTITUTE ELECTIVES

Institute Elective – I

Sl. No	Subject Code	Subject Name	Credit
1.	HS 2002	Engineering Economics	3
2.	HS 2004	Public Finance	3
3.	HS 2006	International Economics	3

Institute Elective – II

1.	HS 3002	Organizational Behavior	3
2.	HS 3004	Human Resource Management	3
3.	HS 3006	Entrepreneurship	3
4.	HS 3008	Management Concepts & Practices	3

LIST OF DEPARTMENT ELECTIVES

Sl. No.	Subject Code	Subject Name	Credit
Department Elective-I			
1.	ME 3020	Advanced Manufacturing Processes	3
2.	ME 3022	Principles of Turbomachines	3
3.	ME 3024	Mechanical Vibration and Noise Engineering	3
4.	ME 3026	Mechatronics	3
5.	ME 3028	Supply Chain Management	3
Department Elective-II			
1.	ME 4031	Power Plant Engineering	3
2.	ME 4033	Fundamentals of Finite Element Method	3
3.	ME 4063	Metal Forming Processes	3
4.	ME 4037	Total Quality Management	3
5.	ME 4069	Computer Integrated Manufacturing	3
Department Elective-III			
1.	ME 4051	Robotics and Flexible Manufacturing Systems	3
2.	ME 4053	Fluid Power Engineering and Control	3
3.	ME 4049	Advanced Mechanics of Solids	3
4.	ME 4057	Production and Operations Management	3
5.	ME 4059	Mechanics of Composite Materials	3
Department Elective-IV			
1.	ME 4071	Automobile Engineering	3
2.	ME 4073	Computational Fluid Dynamics	3
3.	ME 4075	Machine Tools Technology	3
4.	ME 4077	Advanced Operations Research	3
5.	ME 4079	Additive Manufacturing	3
Department Elective-V			
1.	ME 4060	Mechanical Measurements and Control	3
2.	ME 4062	Tribology	3
3.	ME 4064	Alternative Fuels and Renewable Energy	3
4.	ME 4066	Machine Maintenance & Condition Monitoring	3
5.	ME 4068	Industrial Safety	3

COURSE STRUCTURE FOR B.TECH IN MECHANICAL (AUTOMOBILE) ENGINEERING (SECOND YEAR TO FOURTH YEAR)

SEMESTER-III

Theory							
Sl. No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME 2001	Engineering Thermodynamics	3	1	0	4	4
2	ME 2003	Fluid Mechanics	3	0	0	3	3
3	EE 2009	Electrical Machines and Power Electronics	3	0	0	3	3
4	ME 2007	Material Science and Engineering	3	0	0	3	3
5	ME 2009	Kinematics & Kinetics of Machines	3	0	0	3	3
6	MA 2001	Mathematics-III	3	1	0	4	4
Total of Theory						**20**	**20**
Practical							
1	ME 2091	Fluid Mechanics Lab	0	0	3	3	2
2	EE 2093	Electrical Machines and Power Electronics Lab	0	0	3	3	2
Sessional							
1	ME 2083	Machine Drawing and CAD	0	0	3	3	2
2	ME 2085	Manufacturing Practice	0	0	3	3	2
Total of Practical & Sessional						**12**	**8**
Semester Total						**32**	**28**

SEMESTER-IV

Theory							
Sl. No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME 2002	Machine Dynamics	3	0	0	3	3
2	ME 2008	Fluid Dynamics & Hydraulic Machines	3	0	0	3	3
3	ME 2010	Basic Manufacturing Processes	3	0	0	3	3
4	ME 2019	Mechanics of Solids	3	1	0	4	4
5	ME 2014	Engineering Metrology and Measurements	3	0	0	3	3
6	MA 2004	Numerical Methods	3	1	0	4	4
Total of Theory						**21**	**20**
Practical							
1	ME 2096	Machine Kinematics and Dynamics Lab	0	0	3	3	2
2	ME 2098	Hydraulic Machines Lab	0	0	3	3	2
3	ME 2090	Material Testing Lab	0	0	3	3	2
Sessional							
1	HS 2081	Business Communication	0	0	3	3	2
Total of Practical & Sessional						**12**	**8**
Semester Total						**33**	**28**

SEMESTER-V

Sl. No.	Course Code	Subject	L	T	P	Total	Credit
Theory							
1	ME 3011	Heat Transfer	3	0	0	3	3
2	ME 3003	Internal Combustion Engines & Gas Turbines	3	0	0	3	3
3	ME 3015	Manufacturing Processes and Design	3	1	0	4	4
4	ME 3009	Fundamentals of Machine Design	3	0	0	3	3
5	ME 3017	Industrial Engineering & Operations Research	3	0	0	3	3
6		Institute Elective-I	3	0	0	3	3
7	HS 3003	Professional Ethics & Code of Conduct	1	0	0	1	1
Total of Theory						**20**	**20**
Practical							
1	ME 3095	Heat Trasfer Lab	0	0	3	3	2
2	ME 3097	Metrology & Instrumentation Lab	0	0	3	3	2
3	ME 3099	Advanced Mechanical Lab	0	0	3	3	2
Sessional							
1	ME 3081	Machine Design	0	0	3	3	2
2	TP 3081	Cognitive Aptitude Test-I	0	0	2	2	1
Total of Practical & Sessional						**14**	**9**
Semester Total						**34**	**29**

SEMESTER-VI

Sl. No.	Course Code	Subject	L	T	P	Total	Credit
Theory							
1	ME 3014	Refrigeration and Air Conditioning	3	0	0	3	3
2	ME 3010	Metal Cutting & Cutting Tool Design	3	1	0	4	4
3	ME 3012	Design of Machine Elements	3	0	0	3	3
4		Department Elective-I	3	0	0	3	3
5		Institute Elective-II	3	0	0	3	3
6		Open Elective-I	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1	ME 3092	IC Engines & RAC Lab	0	0	3	3	2
Sessional							
1	ME 3088	Tool Design	0	0	3	3	2
2	ME 3086	Computer Aided Design and Analysis	0	0	3	3	2
3	TP 3082	Cognitive Aptitude Test-II	0	0	2	2	1
4	ME 3082	Minor Project	0	0	3	3	2
Total of Practical & Sessional						**14**	**9**
Semester Total						**33**	**28**

SEMESTER-VII

Theory							
Sl. No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1		Department Elective-II	3	0	0	3	3
2		Department Elective-III	3	0	0	3	3
3		Department Elective-IV	3	0	0	3	3
4		Open Elective-II	3	0	0	3	3
5	HS 4003	Legal Issues & requirement in Engineering	1	0	0	1	1
Total of Theory						**13**	**13**
Practical							
1	ME 4093	Computational Technique Practice Lab	0	0	3	3	2
Sessional							
1	ME 4083	Practical Training	-	-	-	-	2
2	ME 4081	Project (Part-I)	0	0	3	3	2
Total of Practical & Sessional						**6**	**6**
Semester Total						**19**	**19**

SEMESTER-VIII

Theory							
Sl No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1		Open Elective-III	3	0	0	3	3
2		Department Elective-V	3	0	0	3	3
Total of Theory						**6**	**6**
Sessional							
1	ME 4082	Project (Part-II)	0	0	9	9	6
2	ME 4084	Seminar	0	0	3	3	2
3	ME 4086	General Viva-Voce	-	-	-	-	2
Total of Sessional						**12**	**10**
Semester Total						**18**	**16**

LIST OF INSTITUTE ELECTIVES

Institute Elective – I

Sl. No	**Subject Code**	**Subject Name**	**Credit**
1.	HS 2002	Engineering Economics	3
2.	HS 2004	Public Finance	3
3.	HS 2006	International Economics	3

Institute Elective – II

1.	HS 3002	Organizational Behavior	3
2.	HS 3004	Human Resource Management	3
3.	HS 3006	Entrepreneurship	3
4.	HS 3008	Management Concepts & Practices	3

LIST OF DEPARTMENT ELECTIVES

Sl. No.	**Subject Code**	**Subject Name**	**Credit**
Department Elective-I			
1.	AE 4032	Noise, Vibration and Harshness	3
2.	AE 4034	Automotive Safety and Lighting	3
3	AE 4036	Automotive Chassis, Suspension and Transmission System	3
4.	AE 4038	Automotive Materials and Processes	3
Department Elective-II			
1.	AE 4041	Assembly Line Automation	3
2.	AE 4043	Optimization Techniques	3
3.	AE 4045	Automotive Electrical Systems and Electronics	3
4.	AE 4047	Theory and Design of Jigs and Fixture	3
Department Elective-III			
1.	AE 4061	Fuels and Emissions	3
2.	AE 4063	Total Quality Management in Automobiles	3
3.	AE 4065	Engine Tribology	3
4.	AE 4067	Off-Road Vehicles	3
Department Elective-IV			
1.	AE 4031	Tractor and Farm Equipments	3
2.	AE 4033	Combustion Engineering	3
3.	AE 4035	Two and Three Wheelers	3
4.	AE 4037	Vehicle Maintenance	3
Department Elective-V			
1.	AE 4042	Automotive Instrumentation Systems	3
2.	AE 4044	Vehicle Dynamics	3
3.	AE 4046	Marketing Management	3
4.	AE 4048	Total Life Cycle Management	3

COURSE STRUCTURE FOR B. TECH IN MECHATRONICS ENGINEERING (SECOND YEAR TO FOURTH YEAR)

SEMESTER-III

Sl. No.	Subject Code	Course Title	L	T	P	Total	Credit
Theory							
1	ME 2017	Thermodynamics and Fluid Mechanics	3	1	0	4	4
2	ME 2013	Kinematics and Dynamics of Machines	3	1	0	4	4
3	EC 2013	Analog Electronics	3	1	0	4	4
4	EE 2011	DC, AC and Special Electrical Machines	3	1	0	4	4
5	MA 2001	Mathematics-III	3	1	0	4	4
Total of Theory						**20**	**20**
Practical							
1	ME 2091	Fluid Mechanics Lab	0	0	3	3	2
2	EE 2095	DC, AC and Special Machines lab	0	0	3	3	2
3	ME 2095	Machine Kinematics and Dynamics Lab	0	0	3	3	2
Sessional							
1	ME 2083	Machine Drawing and CAD	0	0	3	3	2
Total of Practical & Sessional						**12**	**8**
Semester Total						**32**	**28**

SEMESTER-IV

Sl. No.	Subject Code	Course Title	L	T	P	Total	Credit
Theory							
1	ME 2007	Material Science and Engineering	3	0	0	3	3
2	MH 2002	Principles of Machine Tools	3	0	0	3	3
3	ME 2020	Solid Mechanics and Machine Design	3	1	0	4	4
4	EC 2011	Digital Electronics	3	0	0	3	3
5	EI 2008	Introduction to Instrumentation Engineering	3	0	0	3	3
6	MA 2004	Numerical Methods	3	1	0	4	4
Total of Theory						**20**	**20**
Practical							
1	EC 2096	Digital and Linear IC Lab	0	0	3	3	2
2	EI 2096	Measurement Lab	0	0	3	3	2
Sessional							
1	ME 2085	Manufacturing Practice	0	0	3	3	2
2	HS 2081	Business Communication	0	0	3	3	2
Total of Practical & Sessional						**12**	**8**
Semester Total						**32**	**28**

SEMESTER-V

Sl. No.	Subject Code	Course Title	L	T	P	Total	Credit
Theory							
1	EC 3003	Microprocessors and Microcontrollers	3	1	0	4	4
2	EE 3009	Principle of Control Systems	3	0	0	3	3
3	EE 3011	Power Electronics and Drives	3	1	0	4	4
4	EI 3007	Sensors and Actuators	3	1	0	4	4
5		Institute Elective-1	3	0	0	3	3
6	HS 3003	Professional Ethics & Code of Conduct	1	0	0	1	1
Total of Theory						**19**	**19**
Practical							
1	EC 3093	Microprocessor and Microcontroller Lab	0	0	3	3	2
2	EI 3097	Sensors and Actuators Lab	0	0	3	3	2
3	EE 3097	Power Electronics and Drives Lab	0	0	3	3	2
Sessional							
1	ME 3081	Machine Design	0	0	3	3	2
2	TP 3081	Cognitive Aptitude Test-1	0	0	2	2	1
Total of Practical & Sessional						**14**	**9**
Semester Total						**33**	**28**

SEMESTER-VI

Sl. No.	Subject Code	Course Title	L	T	P	Total	Credit
Theory							
1	MH 3002	CIM and Robotics	3	0	0	3	3
2	MH 3006	Industrial Automation	3	0	0	3	3
3	MH 3008	Design of Mechatronic systems	3	0	0	3	3
4		Department Elective-I	3	0	0	3	3
5		Institute Elective-II	3	0	0	3	3
6		Open Elective-I	3	0	0	3	3
Total of Theory						**18**	**18**
Practical							
1	MH 3092	CIM and Robotics Lab	0	0	3	3	2
2	MH 3096	PLC Lab	0	0	3	3	2
Sessional							
1	MH 3084	Mechatronics Lab	0	0	3	3	2
2	TP 3082	Cognitive Aptitude Test-II	0	0	2	2	1
3	MH 3082	Minor Project	0	0	3	3	2
Total of Practical & Sessional						**14**	**9**
Semester Total						**32**	**27**

SEMESTER-VII

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1		Departmental Elective -II	3	0	0	3	3
2		Departmental Elective -III	3	0	0	3	3
3		Departmental Elective -IV	3	0	0	3	3
4		Open Elective-II	3	0	0	3	3
5	HS 4003	Legal Issues & requirement in Engineering	1	0	0	1	1
Total of Theory						**13**	**13**
Practical							
1	ME 4093	Computational Technique Practice Lab	0	0	3	3	2
Sessional							
1	MH 4083	Practical Training	0	0	0	0	2
2	MH 4081	Project (Part-I)	0	0	3	3	2
Total of Practical & Sessional						**6**	**6**
Semester Total						**19**	**19**

SEMESTER-VIII

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1		Departmental Elective-V	3	0	0	3	3
2		Open Elective-III	3	0	0	3	3
Total of Theory						**6**	**6**
Sessional							
1	MH 4082	Project (Part-II)	0	0	9	9	6
2	MH 4084	Seminar	0	0	3	3	2
3	MH 4086	General Viva-voce	0	0	0	0	2
Total of Sessional						**12**	**10**
Semester Total						**18**	**16**

LIST OF INSTITUTE ELECTIVES

INSTITUTE ELECTIVE -1

Sl.No	Subject Code	Subject Name	Credit
1.	HS 2002	Engineering Economics	3
2.	HS 2004	Public Finance	3
3.	HS 2006	International Economics	3

INSTITUTE ELECTIVE - II

1.	HS 3002	Organizational Behavior	3
2.	HS 3004	Human Resource Management	3
3.	HS 3006	Entrepreneurship	3
4.	HS 3008	Management Concepts & Practices	3

LIST OF DEPARTMENT ELECTIVES

DEPARTMENT ELECTIVE - 1

1.	ME 3020	Advanced Manufacturing Processes	3
2.	EC 3022	Advanced Control Systems	3
3.	MH 3032	Modeling and Simulation of Mechatronic Systems	3
4.	MH 3034	Product Design and Development	3

DEPARTMENT ELECTIVE - II

1.	ME 4037	Total Quality Management	3
2.	MH 4039	Process Planning and Cost Estimation	3
3.	EI 3023	Neural Network & Fuzzy Logic Control	3
4.	MH 4041	Micro and Nano Manufacturing Systems	3

DEPARTMENT ELECTIVE - III

1.	MH 4043	Micro Electro Mechanical Systems	3
2.	ME 3028	Supply Chain Management	3
3.	IT 4027	Software Project Management	3
4.	ME 4079	Additive Manufacturing	3

DEPARTMENT ELECTIVE - 1V

1.	ME 4077	Advanced Operations Research	3
2.	ME 4066	Machine Maintenance and Condition Monitoring	3
3.	ME 4033	Fundamentals of Finite Element Method	3
4.	AE 4045	Automotive Electrical Systems and Electronics	3

DEPARTMENT ELECTIVE - V

1.	MH 4036	Intelligent Manufacturing Systems	3
2.	ME 4057	Production and Operations Management	3
3.	EI 3022	Bio-Medical Instrumentation	3
4.	ME 4068	Industrial Safety	3

COURSE STRUCTURE FOR B. TECH IN AEROSPACE ENGINEERING (SECOND YEAR TO FOURTH YEAR)

SEMESTER-III

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	AS 2001	Aerospace Thermodynamics	3	1	0	4	4
2	AS 2003	Introductory Aerodynamics	3	0	0	3	3
3	EE 2009	Electrical Machines & Power Electronics	3	0	0	3	3
4	ME 2015	Manufacturing Technology	3	0	0	3	3
5	ME 2019	Mechanics of Solids	3	1	0	4	4
6	MA 2001	Mathematics - III	3	1	0	4	4
Total of Theory						**21**	**21**
Practical							
1	AS 2091	Aerospace Thermodynamics Lab	0	0	3	3	2
2	EE 2093	Electrical Machines & Power Electronics Lab	0	0	3	3	2
Sessional							
1	ME 2083	Machine Drawing & CAD	0	0	3	3	2
2	ME 2085	Manufacturing Practice	0	0	3	3	2
Total of Practical & Sessional						**12**	**08**
Semester Total						**33**	**29**

SEMESTER-IV

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	AS 2002	Automatic Control Theory	3	0	0	3	3
2	AS 2004	Aerospace Structures - I	3	0	0	3	3
3	AS 2006	Aerodynamics - I	3	0	0	3	3
4	AS 2008	Propulsion - I	3	0	0	3	3
5	AS 2010	Aerospace Materials Technology	3	0	0	3	3
6	MA 2004	Numerical Methods	3	1	0	4	4
Total of Theory						**19**	**19**
Practical							
1	AS 2092	Aerospace Structures Lab - I	0	0	3	3	2
2	ME 2090	Material Testing Lab	0	0	3	3	2
3	AS 2094	Aerodynamics Lab - I	0	0	3	3	2
Sessional							
1	HS 2081	Business Communication	0	0	3	3	2
Total of Practical & Sessional						**12**	**08**
Semester Total						**31**	**27**

SEMESTER-V

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	AS 3009	Aerodynamics – II	3	0	0	3	3
2	AS 3011	Aerospace Structures – II	3	0	0	3	3
3	AS 3013	Propulsion – II	3	0	0	3	3
4	AS 3015	Aircraft Performance	3	0	0	3	3
5	AS 3017	Aircraft Systems & Instrumentation	3	0	0	3	3
6		Institute Elective - I	3	0	0	3	3
7	HS 3003	Professional Ethics & Code of Conduct	1	0	0	1	1
Total of Theory						**19**	**19**
Practical							
1	AS 3091	Aerospace Structures Lab - II	0	0	3	3	2
2	AS 3093	Aerodynamics Lab - II	0	0	3	3	2
3	AS 3095	Propulsion Lab	0	0	3	3	2
4	AS 3097	Aircraft Systems Laboratory	0	0	3	3	2
Sessional							
1	TP 3081	Cognitive Aptitude Test - I	0	0	2	2	1
Total of Practical & Sessional						**14**	**09**
Semester Total						**33**	**28**

SEMESTER-VI

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1	AS 3010	Aircraft Stability & Control	3	0	0	3	3
2	AS 3012	Space Mechanics	3	0	0	3	3
3	AS 3014	Avionics	3	0	0	3	3
4		Departmental Elective - I	3	0	0	3	3
5		Institute Elective - II	3	0	0	3	3
6		Open Elective - I	3	0	0	3	3
Total of Theory						**18**	**18**
Practical							
1	AS 3092	Aeroengine & Airframe Lab	0	0	3	3	2
2	AS 3094	Avionics Lab	0	0	3	3	2
3	AS 3096	Aerospace Measurement Lab	0	0	3	3	2
Sessional							
1	TP 3082	Cognitive Aptitude Test - II	0	0	2	2	1
2	AS 3082	Minor Project	0	0	3	3	2
Total of Practical & Sessional						**14**	**09**
Semester Total						**32**	**27**

SEMESTER-VII

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1		Department Elective - II	3	0	0	3	3
2		Department Elective - III	3	0	0	3	3
3		Department Elective - IV	3	0	0	3	3
4		Open Elective - II	3	0	0	3	3
5	HS 4003	Legal Issues & requirement in Engineering	1	0	0	1	1
Total of Theory						**13**	**13**
Practical							
1	AS 4091	Aircraft Maintenance & Design Lab	0	0	3	3	2
Sessional							
1	AS 4081	Project (Part-I)	0	0	3	3	2
2	AS 4083	Practical Training	0	0	0	0	2
Total of Practical & Sessional						**06**	**06**
Semester Total						**19**	**19**

SEMESTER-VIII

Theory							
Sl. No.	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credit**
1		Open Elective - III	3	0	0	3	3
2		Department Elective - V	3	0	0	3	3
Total of Theory						**06**	**06**
Sessional							
1	AS 4082	Project (Part-II)	0	0	9	9	6
2	AS 4084	Seminar	0	0	3	3	2
3	AS 4086	Grand Viva	0	0	0	0	2
Total of Sessional						**12**	**10**
Semester Total						**18**	**16**

LIST OF INSTITUTE ELECTIVES

Institute Elective – I

Sl. No	Subject Code	Subject Name	Credit
1.	HS 2002	Engineering Economics	3
2.	HS 2004	Public Finance	3
3.	HS 2006	International Economics	3

Institute Elective – II

Sl. No	Subject Code	Subject Name	Credit
1.	HS 3002	Organizational Behavior	3
2.	HS 3004	Human Resource Management	3
3.	HS 3006	Entrepreneurship	3
4.	HS 3008	Management Concepts & Practices	3

LIST OF DEPARTMENTAL ELECTIVES

Sl. No	Subject Code	Subject Name	Credit
Department Elective-I			
1.	AS 3032	Theory of Aero-elasticity	3
2.	ME 3022	Principles of Turbomachines	3
3.	AS 3034	Wind Tunnel Technique	3
4.	AS 3036	Theory of Combustion	3
5.	ME 3028	Supply Chain Management	3
Department Elective-II			
1.	AS 4031	Computational Aerodynamics	3
2.	ME 4033	Fundamentals of Finite Element Method	3
3.	ME 4041	Operations Research	3
4.	ME 4043	Total Quality Management & Reliability Engineering	3
5.	ME 4069	Computer Integrated Manufacturing	3
Department Elective-III			
1.	AS 4035	Satellite & Space System Design	3
2.	ME 4053	Fluid Power Engineering and Control	3
3.	AS 4037	Cryogenics	3
4.	ME 4045	Boundary Layer Theory	3
5.	ME 4059	Mechanics of Composite Materials	3
Department Elective-IV			
1.	AS 4039	Airframe Repair & Maintenance	3
2.	ME 4073	Computational Fluid Dynamics	3
3.	AS 4041	Rockets & Missiles	3
4.	AS 4043	Hypersonic Aerodynamics	3
5.	ME 4079	Additive Manufacturing	3
6.	AS 4045	Aerostat, Airship, Parachutes	3
Department Elective-V			
1.	ME 4068	Industrial Safety	3
2.	ME 4064	Alternative Fuels and Renewable Energy	3
3.	AS 4032	Helicopter Aerodynamics	3
4.	AS 4034	Airport & Airlines Management	3
5.	AS 4036	Ageing Aircraft/ Engine life extension technologies	3
6.	AS 4038	Smart Structures	3

OPEN ELECTIVES

In the B.Tech Curricula for all Branches of Engineering, three Open Electives have been introduced starting with 6^{th} semester.

A tentative list of subjects have been prepared by various Schools to be offered as Open Electives to students of other Schools. The detailed Curriculum for some of those subjects included in the list have been approved by Academic Council and the remaining ones will be approved in due course.

The final list of subjects to be offered by each School for students of other Schools as Open Elective would be announced atleast one semester ahead of the actual semester where the Open Elective is offered so that students can give their choice of subjects out of this list based on the availability of slots in that subject.

Open Electives may also include industry sponsored courses (with limited number of seats) in a Branch for its own students or students of some other disciplines, which is listed at the end.

LIST OF OPEN ELECTIVES (AUTUMN SEMESTER)

SCHOOL OF APPLIED SCIENCES

Sl. No.	Subject Code	Subject Name	Prerequisite
1	CH 4041	Composite materials & structure (Chem)	NIL
2	CH 3043	Renewable energy sources (Chem)	NIL
3	PH 3041	Quantum Mechanics for Engineers (Phys)	NIL
4	MA 3041	Advanced Numerical Techniques (Maths)	NIL
5	MA 3043	Number Theory	Mathematics – I & II
6	MA 3045	Linear Algebra	Mathematics – I & II
7	MA 3047	Introduction to Analysis	Mathematics – I & II
8	MA 3049	Statistics and Stochastic Processes	Mathematics – I & II

SCHOOL OF CIVIL ENGINEERING

Sl. No.	Subject Code	Subject Name	Prerequisite
1	CE 4071	Basic Transportation Engineering	NIL
2	CE 4073	Fundamentals of RCC Structure	NIL
3	CE 4075	Fundamentals of Soil Physics	NIL

SCHOOL OF COMPUTER ENGINEERING

Sl. No.	Subject Code	Subject Name	Prerequisite
1	IT 4041	Network Security & Cryptography	NIL
2	CS 3028	Artificial Intelligence	Programming Skill
3	CS 4031	Software Testing	Software Engineering
4	IT 4029	Management Information System	NIL
5	IT 4027	Software Project Management	NIL

SCHOOL OF ELECTRICAL ENGINEERING

Sl. No.	Subject Code	Subject Name	Prerequisite
1	EE 4043	Elements of Power Electronics	Basic Electronics& Basic Electrical Engineering
2	EE 4045	Non-Conventional Energy Systems	Basic Electrical Engineering
3	EE 4047	Electrical Instrumentation	Basic Electrical Engineering
4	EE 4049	Control System	Circuit Theory
5	EE 4051	Active and Passive filters	Circuit Theory and Basic Electronics

SCHOOL OF ELECTRONICS ENGINEERING

Sl. No.	Subject Code	Subject Name	Prerequisite
1	EC 3045	Introduction to Control Systems	Basic Electrical Engg.
2	EC 4041	Microprocessor, Microcontroller & Applications	Digital Electronic Circuits
3	EI 3027	Industrial Instrumentation	Basic Electronics & Basic Electrical Engg.
4	EC 4031	Mobile Communication Engineering	Communication Engineering / Introduction to Communication Engineering
5	EC 3027	Optical & Satellite Communication	Communication Engineering / Introduction to Communication Engineering
6	EI 3022	Bio-medical Instrumentation	Basic Electronics & Basic Electrical Engg.

SCHOOL OF MECHANICAL ENGINEERING

Sl. No.	Subject Code	Subject Name	Prerequisite
1	ME 4035	Computer Controlled Manufacturing Systems	NIL
2	ME 4039	Fundamentals of Computational Fluid Dynamics	Introduction to Fluid Mechanics and Heat Transfer
3	ME 4061	Renewable Energy Sources	NIL
4	ME 4065	Automobile Technology	Applied Thermodynamics / Thermodynamics and Hydraulics / Thermodynamics and Fluid Mechanics
5	ME 4067	Quality Engineering and Management	NIL

SCHOOL OF LAW

Sl. No.	Subject Code	Subject Name	Prerequisite
1	LW 1011	Law of Contract	NIL
2	LW 3015	Intellectual Property Law	NIL
3	LW 4811	Law Relating to Patent	NIL
4	LW 2011	Constitutional Law of India – I	NIL

SCHOOL OF MANAGEMENT

Sl. No.	Subject Code	Subject Name	Prerequisite
1	BB 1201	Financial Accounting	NIL
2	BB 1702	Psychology	NIL
3	BB 2101	Organizational Behavior	NIL

LIST OF OPEN ELECTIVES (SPRING SEMESTER)

SCHOOL OF APPLIED SCIENCES

Sl. No.	Subject Code	Subject Name	Prerequisite
1	CH 4042	Material Technology (Chem)	NIL
2	PH 4042	Nano Science & Technology (Phys)	NIL
3	PH 4044	Photonics (Phys)	NIL
4	MA 4042	Finite Element Analysis (Maths)	NIL
5	MA 4044	Functional Analysis	Mathematics – I & II
6	MA 4046	Optimization Techniques	Mathematics – I & II
7	MA 4048	Fuzzy Logic	Mathematics – I & II

SCHOOL OF CIVIL ENGINEERING

Sl. No.	Subject Code	Subject Name	Prerequisite
1	CE 3070	Fundamentals of Project Management	NIL
2	CE 3072	Bio-remediation	NIL
3	CE 3074	Construction Materials & Specifications	NIL
4	CE 3076	Tropical Hydrology & Water Resources	NIL
5	CE 4070	Global Warming & Climate Change	NIL
6	CE 4072	Green Buildings	NIL
7	CE 4074	Environmental Chemistry	NIL

SCHOOL OF COMPUTER ENGINEERING

Sl. No.	Subject Code	Subject Name	Prerequisite
1	IT 3040	Introduction to Software Engineering	NIL
2	CS 3044	Relational Date-Base Management System	NIL
3	IT 3042	Introduction to Web Technology	C++
4	CS 3040	Data Structure using C	C
5	CS 3044	Introduction to Operating System	NIL
6	CS 3046	Introduction to Computer Graphics	NIL
7	CS 3042	Computer Organization	NIL
8	IT 3021	E-Commerce	NIL
9	IT 3025	ERP	NIL
10	CS 4041	Pattern Recognition	Programming Skill
11	IT 4021	Internet of Things	Programming skill JAVA/ Web Technology
12	IT 3027	Multi Media Application	NIL
13	IT 4042	Cloud Services	Programming skill & Software Engineering

SCHOOL OF ELECTRICAL ENGINEERING

Sl. No.	Subject Code	Subject Name	Prerequisite
1	EE 3040	Electric Power Generation Technology	Basic Electrical Engineering
2	EE 3042	Principles of Energy Conversion	Basic Electrical Engineering
3	EE 3044	Circuit Theory	Basic Electrical Engineering
4	EE 3046	Solar Power Technologies	Physics & Basic Electrical Engineering
5	EE 4042	Sensor Technology	Electrical Instrumentation
6	EE4044	Energy Management and Audit	Basic Electrical Engineering
7	EE 4046	Fundamentals of Electrical Drives	Introduction to Electrical Machines and Power Electronics/ Principles of Energy Conversion *and* Elements of Power Electronics

SCHOOL OF ELECTRONICS ENGINEERING

Sl. No.	Subject Code	Subject Name	Prerequisite
1	EC 2015	Analog Circuits	Basic Electronics
2	EC 2011	Digital Electronics	Basic Electronics
3	EL 3024	Industrial Automation & Control	Control Systems / Introduction to Control Systems
4	EC 3044	Introduction to Communication Engineering	Basic Electronics
5	EC 6108	Digital Image Processing	Introduction to Digital Signal Processing
6	EC 3011	VLSI Design	Digital Electronics

SCHOOL OF MECHANICAL ENGINEERING

Sl. No.	Subject Code	Subject Name	Prerequisite
1	ME 3032	Introduction to Fluid Mechanics and Heat Transfer	Mathematics –I
2	ME 3034	Applied Thermodynamics	Mathematics –I
3	ME 3036	Strength of Materials	Engg. Mechanics
4	ME 3038	Kinematics and Dynamics of Machinery	Mathematics-I
5	ME 3040	Engineering Materials	Chemistry
6	ME 4050	Robotics	NIL
7	ME 4054	Biomechanics	NIL
8	ME 4056	Mechatronic Systems	Basic Electronics
9	ME 4052	Introduction to Composite Materials	NIL
10	ME 4058	Finite Element Method for Engineers	Mathematics-I

SCHOOL OF LAW

Sl. No.	Subject Code	Subject Name	Prerequisite
1	LW 1012	Special Contract	NIL
2	LW 2012	Constitutional Law of India – II	NIL

SCHOOL OF MANAGEMENT

Sl. No.	Subject Code	Subject Name	Prerequisite
1	BB 1202	Cost & Management Accounting	NIL
2	BB 1706	Principle & Practice of Management	NIL

INDUSTRY SPONSORED COURSES
(Under Open Elective – I)

Sl. No.	Subject Code	Subject Name	Open for
1	EC 3042	Media & Applications	E&TC, Comp. Sc & IT
2	EC 3046	Fiber Technology	E&TC, E&E
3	EC 3048	Mobile Backhaul Systems	E&TC, E&E
4	EE 3030	Overhead Power Transmission Line Construction & Management	Electrical
5	ME 3030	Product Life Cycle Management	Mechanical

APPLIED SCIENCES

PH 1003 PHYSICS Cr - 4

Course Outcome : At the end of the course, the students will be able to :

CO1. learn the concept of wave, wave motion, interference and diffraction phenomena.

CO2. understand the mechanism of LASER technology and optical fibers and also the utilization in various disciplines (Medical, Defence, Security, and Communication system).

CO3. learn the generation of electromagnetic waves and their interaction with matter.

CO4. understand the fundamentals of solid structure, arrangements, and orientations etc.for the study materials particularly in the field of experimental research.

CO5. understand the different properties of matter which are used in various fields of engineering.

Prerequisite : NIL

Oscillations and Waves :

Damped and forced oscillations, Resonance, sharpness of resonance, types of waves and wave equation. Interference of light, analytical treatment of two source interference, distribution of energy, Newton's Rings, Applications. Diffraction of light, Types of diffraction, Fraunhoffer diffraction by single slit, diffraction grating, determination of wavelength of light by grating.

Laser and Optical Fiber :

Spontaneous and stimulated emission, population inversion, pumping, Ruby Laser, applications. Principle of optical fiber, optical fiber as wave guide, Types of optical fiber, acceptance angle, numerical aperture, Applications.

Electromagnetic Theory :

Gradient, divergence and curl, Maxwell's equations in differential and integral form, electromagnetic wave equation in free space, plane wave solutions, transverse nature of electromagnetic waves.

Quantum Mechanics :

Inadequacy of Classical mechanics, de Broglie hypothesis for matter waves, Phase velocity and Group velocity, Heisenberg's uncertainty principle, wave function and its physical interpretation, Schrodinger's equations, particle in one dimensional box, potential barrier , tunneling and applications.

Thermodynamics :

Laws of thermodynamics, thermodynamic processes, variables, internal energy, enthalpy, entropy, Gibb's free energy, Maxwell's relations, T-S diagrams.

Mechanical Properties of Matter :

Stress, strain, Hooke's law, elastic constants and their relations, torsional pendulum, cantilever, stress-strain diagrams.

Crystallography :

Lattice, basis and crystal structure, unit cell, crystal systems, number of atoms per unit cell, coordination number, packing fraction for *cubic* lattice, lattice planes, Miller indices, relation between interplanar distance and Miller indices, X-ray diffraction and Bragg's law.

Text Book

1. Engineering Physics, B. K. Pandey and S. Chaturvedi, Cengage Publication, New Delhi, 2013.
2. Concepts of Modern Physics, A. Beiser, Tata McGraw-Hill Publication, 2007.

Reference Book

1. Engineering Physics, Gaur and S. C. Gupta, Dhanpat Rai Publications, New Delhi, 2003.
2. Engineering Physics, Dutta R. Joshi, Tata McGraw-Hill Publication, 2010.
3. Quantum Mechanics, L. I. Schiff, Tata McGraw-Hill Publication, 2010.
4. Introduction to Solid State Physics, C. Kittel, Wiley India Pvt. Ltd. 7^{th} Edition, 2007.
5. Elements of Properties of Matter, D. S. Mathur, 11 th edition, S. Chand and Co., New Delhi.

CH 1003 CHEMISTRY Cr - 3

Course Outcome : At the end of the course, the students will be able to :

CO1. understand the MOT of covalent bonding and bonding in complexes.

CO2. understand the condition of spontaneity and equilibrium and find conducive conditions for different industrial processes.

CO3. use electrochemical cell to measure pH, K_{sp}, equilibrium constant etc., understand working of modern batteries and theories of corrosion.

CO4. able to write rate law of complex reactions, understand theories of reaction rate and catalysis.

CO5. identify unsaturation, type of unsaturation, functional groups present in organic molecules and theoretically calculate λ_{max}.

Prerequisite : NIL

Chemical Bonding :

MO theory to explain bonding in homo and hetero nuclear diatomic molecules, Band theory: band diagrams for conductor, insulator and semiconductors, Bonding in complexes: VBT, CFT, Application of CFT in explaining magnetic moment and colour of complexes.

Chemical Equilibrium and Thermodynamics :
Internal Energy, enthalpy, entropy and free energy, dependence of free energy on temperature and pressure, Gibb's-Helmholtz equation, conditions of spontaneity and equilibrium, Equilibrium constants K_p and K_c, Free energy change and equlibrium constants, Le Chatelier's Principle and its applications to industrial syntheses, van't Hoff isotherm and isochore, Clapeyron-Clausius equation, partial molar properties, chemical potential, Gibb's -Duhem equation.

Electrochemistry :

Conductance, effect of concentration, ionic mobilities- Kohlrausch's law and application, transport number, determination by Hitrof's method, types of electrodes, electrode/Cell potential, Nernst equation and applications: to find electrode/cell potential, equilibrium constant, solubility product and pH, modern batteries : fuel cells (AFCs, PEMFs, SOFCs, MCFCs), Zn-air battery, Li- ion battery, Ni-MH battery), corrosion: mechanism of dry and wet corrosion, types of wet corrosion, prevention.

Chemical Kinetics :

Rate of the reaction and rate law, rate laws of multi- step reactions (steady state approximation), parallel, opposing and consecutive reactions, theory of reaction: collision theory, Lindemann's modification and absolute reaction theory, catalysis: types, theories, kinetics of enzyme catalysis (Michaeli's Menten mechanism).

Spectroscopy :

UV-Vis spectroscopy: Beer Lambert's law, types of transition, concept of auxochrome and chromophore, factors affecting λ_{max} and , Woodward-Fieser rules for calculation of λ_{max} in diene systems, IR spectroscopy: types of vibration, Hooke's law, detection of functional groups like C-C, C=C, -OH, $-NH_2$ and -C=O.

Text Book

1. Engineering Chemistry, Jain & Jain; 16th Edition, Dhanpat Rai Publishing Company
2. Elementary Organic Spectroscopy, Y. R. Sharma; Revised Edition,4th Edition, S. Chand Group

Reference Book

1. Advanced Inorganic Chemistry, Satya Prakash, G. D. Tuli, R. D. Madan; 2012, S. Chand Group
2. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma, M. S. Pathania; 42^{nd} Edition, 2007, Vishal Publishing Co.
3. Elements of Physical Chemistry, Samuel Glasstone; 2nd Edition, Macmillan
4. Spectrometric identification of organic compounds, R.M. Silverstein, F.X. Webster, D. Kiemle, 7th Edition, 2005, Wiley

CH 1005 ENVIRONMENTAL SCIENCE Cr - 2

Course Outcome : At the end of the course, the students will be able to :

CO1. understand different components and composition of environment and importance of EIA.

CO2. understand different air pollutants and their controlling measures, some important global phenomena.

CO3. understand different water pollutants, sewage treatment, estimate different water quality parameters.

CO4. understand different principles of green chemistry, R_4M_4 principle, Cradle to Grave approach.

CO5. identify biochemical effects of toxic wastes, different steps in solid waste management.

Prerequisite : NIL

Overview :
Overview on environment, terminologies, components of earth: lithosphere, atmosphere and biosphere, concept of black body radiation and albedo. Importance, scope and principles of EIA.

Air Pollution :

Primary and secondary air pollutants, smog (oxidizing and reducing), important environmental issues: ozone layer depletion, acid rain, green-house effect, controlling measures: electrostatic precipitator, cyclone separator, catalytic converter, scrubbing).

Water Pollution :

Types and sources of water pollutants, sewage treatment: primary, secondary and tertiary treatments, Acid-Base chemistry, pH and buffer, analysis of water quality parameters like DO, BOD, alkalinity, hardness, chloride, fluoride, USEPA and WHO guidelines for drinking water.

Green Chemistry :

Basic principles of green chemistry with examples, matrices to explain greenness, R^4M^4 model with specific reference to ecno-burette, life cycle analysis (Cradle to grave approach).

Waste Management :

Classification of solid wastes, toxic and biochemical effects of solid wastes (heavy metals, bio-medical and radioactive wastes), sources and generation, management of solid wastes: collection, segregation, disposal).

Text Book

1. Environmental Chemistry, A. K. De; 7th Edition, New Age International Publishers.

Reference Book

1. Fundamentals of Environment and Ecology, D. De, D. De; 2013, **S.** Chand Group
2. Engineering Chemistry, Jain & Jain; 16th Edition, Dhanpat Rai Publishing Company
3. Environmental Science and Engineering, Aloka Debi, Second Edition; Universities Press
4. Text Book of Environmental Studies for Undergraduate Courses, Erach Bharucha; 2nd Edition,Universities Press
5. A Textbook of Environmental Studies, Sashi Chawla; 2012, Mc Graw Hill

MA 1001 MATHEMATICS-I Cr - 4

Course Outcome : At the end of the course, the students will be able to :

CO1. understand the concept of modeling and formulation of Differential equation of physical problems.

CO2. apply different methods to solve ODE problems(First order) involving growth-decay, cooling effects and electrical circuits etc.

CO3. know the geometrical significances of ODEs like orthogonal trajectories.

CO4. get the concept on different types of roots of higher order ODEs.

CO5. develop an ability to solve higher order ODEs.

CO6. use Matrices as a tool of Linear Algebra.

CO7. apply the knowledge of consistency/inconsistency of a linear system.

CO8. get the concept of solving vector equations.

Prerequisite : NIL

Ordinary Differential Equations :

Basic concepts and definitions of 1st order differential equations; Formation of differential equations; solution of differential equations: variable separable, homogeneous, equations reducible to homogeneous form, exact differential equation, equations reducible to exact form, linear differential equation, equations reducible to linear form (Bernoulli's equation); orthogonal trajectories , applications of differential equations.

Linear Differential equations of 2nd and higher order :

Second order linear homogeneous equations with constant coefficients; differential operators; solution of homogeneous equations; Euler-Cauchy equation; linear dependence and independence; Wronskian; Solution of non-homogeneous equations: general solution, complementary function, particular integral; solution by variation of parameters; undetermined coefficients; higher order linearhomogeneous equations; applications.

Differential Calculus(Two and Three variables):

Taylor's Theorem, Maxima and Minima ,Lagrange's multipliers

Matrices, determinants, linear system of equations:

Basic concepts of algebra of matrices; types of matrices; Vector Space, Sub-space, Basis and dimension, linear system of equations; consistency of linear systems; rank of matrix; Gauss elimination; inverse of a matrix by Gauss Jordan method; linear dependence and independence, linear transformation; inverse transformation ; applications of matrices; determinants; Cramer's rule.

Matrix-Eigen value problems:

Eigen values, Eigen vectors, Cayley Hamilton theorem, basis, complex matrices; quadratic form; Hermitian, Skew-Hermitian forms; similar matrices; diagonalization of matrices; transformation of forms to principal axis (conic section).

Text Book

1. Kreyszig E., Advanced Engineering Mathematics ,Wiley ,9th edition.
2. Shanti Narayan and P.K.Mittal, Differential Calculus, S. Chand, reprint 2009

References Book

1. Grewal B.S., Higher Engineering Mathematics, Khanna Publishers,36th edition
2. Dass H.K., Introduction to engineering Mathematics, S.Chand & Co Ltd, 11th edition
3. Ramana B.V., Higher Engineering Mathematics, TMH, 1st edition
4. J.Sinha Roy and S Padhy , A course on ordinary and partial differential Equation , Kalyani Publication, 3rd edition

MA 1002 **MATHEMATICS-II** **Cr-4**

Course Outcome : At the end of the course, the students will be able to :

CO1. get a comprehensive knowledge on Laplace transform and to solve IVPs by using it.
CO2. understand the concept of power series and solution of ODEs by using power series method.
CO3. know the power series solution of special type of ODEs such as Legendre and Bessel's equations.
CO4. understand the geometrical/physical significance of Vector calculus.
CO5. develop an ability to solve multiple Integrals.
CO6. apply Green's theorem, Gauss Divergence Theorem & Stoke's Theorem.
CO7. get the concept of periodic and non periodic functions.
CO8. know the concept of finding Fourier series, Fourier Integral, Fourier Transform of periodic and non periodic functions.

Prerequisite : Mathematics -I (MA 1001)

Laplace Transforms:

Laplace Transform, Inverse Laplace Transform, Linearity, transform of derivatives and Integrals, Unit Step function, Dirac delta function , Second Shifting theorem, Differentiation and Integration of Transforms, Convolution, Integral Equation, Application to solve differential and integral equations, Systems of differential equations.

Series Solution of Differential Equations:

Power series; radius of convergence, power series method, Frobenious method; Special functions: Gamma function, Beta function; Legendre's and Bessel's equations; Legendre's function, Bessel's function ,orthogonal functions; generating functions.

Fourier series, Integrals and Transforms:

Periodic functions, Even and Odd functions, Fourier series, Half Range Expansion, Fourier Integrals, Fourier sine and cosine transforms, Fourier Transform

Vector Differential Calculus:

Vector and Scalar functions and fields, Derivatives, Gradient of a scalar field, Directional derivative, Divergence of a vector field, Curl of a vector field.

Vector Integral Calculus:

Line integral, Double Integral, Green's theorem, Surface Integral, Triple Integral, Divergence Theorem for Gauss, Stoke's Theorem.

Text book

1. Kreyszig E., Advanced Engineering Mathematics , Wiley ,9th edition.

Reference book

1. Grewal B.S., Higher Engineering Mathematics, Khanna Publishers, 36th edition
2. Dass H.K., Introduction to engineering Mathematics, S.Chand & Co Ltd, 11th edition
3. Ramana B.V., Higher Engineering Mathematics, TMH, Ist edition
4. J.Sinha Roy and S Padhy, A course on ordinary and partial differential Equation, Kalyani Publication , 3rd edition

MA 2001 **MATHEMATICS-III** **Cr-4**

Course Outcome : At the end of the course, the students will be able to :

- CO1. get the concept of PDEs and comparative study of PDEs and ODEs.
- CO2. understand the Wave and diffusion equations and their solution under different boundary and initial conditions.
- CO3. get the knowledge of classifications of two-dimensional PDEs and transforming them to their normal forms.
- CO4. use the Laplace transform in solving PDEs.
- CO5. develop an ability to solve PDEs under different coordinate systems.
- CO6. apply geometrical representation of complex numbers in Argand Plane and use of complex functions.
- CO7. know Complex differentiation and integration etc.
- CO8. understand the concept of solving real integrations using complex residual integration.

Prerequisite : Mathematics-I (MA 1001) & Mathematics - II (MA 1002)

Partial Differential Equations:

Basic concepts, Solution of PDE by Variable Separable method, Mathematical Modeling of one dimensional Wave equation and its solution, Classification of PDE and transformation into its Normal form, D'Alembert's solution of Wave equation, Solution of one dimensional Heat equation, Steady state flow of heat in a rectangular bar, Solution of one dimensional heat equation by Fourier Integral, Solution of two dimensional wave equation, Laplace Equation in Polar, Cylindrical and Spherical coordinates and applications. Solution of PDE by use of Laplace Transform.

Complex Analysis:

Complex Numbers and Functions:

Basic concept ,Complex functions, Derivatives, Analyticity, Cauchy Riemman equations, Exponential, Trigonometric, hyperbolic, Logarithmic functions, general powers,

Complex integration:

Line integral, Line Integral of independent path, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytic function. Taylor's series, Maclaurin's series, Laurent's series, Expansion of functions, singularities, Residues, Residue Integration method, Evaluation of Real Integrals;

Mapping:

Conformal mapping and linear fractional transformation(LFT).

Text Book

1. Advanced Engineering Mathematics by Erwin Kryeszig, Wiley, INC, 9^{th} Edition.

Reference Book

1. Higher Engineering Mathematics by B. V. Ramanna, TMH, 2007.

MA 2002 **MATHEMATICS-IV** **Cr-4**

Course Outcome : At the end of the course, the students will be able to :

CO1. know the error analysis in data handling.
CO2. understand the numerical techniques to solve non-linear algebraic / transcendental equations.
CO3. use the difference operators and different numerical methods to interpolate and extrapolate from given set of data.
CO4. understand the applications of numerical differentiations and integrations.
CO5. approximate the solution of system of linear equations with emphasis on eigen value problems.
CO6. know the concept of solving numerically the initial and boundary value problems of ODEs.
CO7. get the knowledge regarding concept of probability and its use in day to day problems.
CO8. understand the concept of probability distributions, expectation and its applications on real life problems.

Prerequisite : Mathematics-I (MA 1001)

Approximations & Errors:

Approximation of numbers by truncation and rounding-off, Types of errors,

Numerical solution of Non linear equations:

Solutions by Bisection Method, Fixed Point Iteration Method , Newton-Raphson Method, Regula-Falsi and Secant Method, Rate of Convergence of Secant & Newton-Raphson Method .

Interpolation & Approximation:

Finite Differences, Operators and Relation between them. Interpolation: Newton's forward and backward difference interpolation, Newton's divided difference interpolation and Lagrange interpolation.
Approximation of functions by best fit straight line, quadratic and exponential curves using Least Square Method .

Numerical Differentiation & Integration:

Numerical differentiation of 1^{st} and 2^{nd} order using difference table. Trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rules , Gauss-Legendre's two points and three points formulae. Error in Numerical Integration.

Numerical Solution to ODE:

Taylor series Method, Euler's Method, Modified Euler's Method, Runge-Kutta Methods of order 2 and 4, reduction of 2^{nd} order ODE to 1st order ODE and its solution by R-K method of order four.

Solution of System of Linear Equations:

LU- factorization(Crout, Doolittle & Cholesky), solutions by Gauss-Seidel and Gauss-Jacobi methods.
Largest eigen value and corresponding eigen vector by Power Method.

Probability Theory:
Introduction to Probability, Random variables and Probability distributions, Mean and Variance of probability distributions, Mathematical expectation, Moments and moment generating function. Binomial and Poisson distributions, Normal distribution.

Text Book

1. Advanced Engineering Mathematics by Erwin Kreszig, Wiley, INC, 9th Edition.

Reference Book

1. Higher Engineering Mathematics by B. V. Ramanna, TMH, 2007.
2. Higher Engineering Mathematics by B. S. Grewal, Khanna Publisher, 36th Edition.
3. Numerical Methods for Scientific and Engineering Computation by Jain , Iyenger and Jain, New age International (P) Ltd, 6th Edition.
4. Numerical Methods by Arumugam, Thangapandi and Somasundaram, Scitech Publishers, 2nd Edition.

MA 2003 DISCRETE MATHEMATICAL STRUCTURE Cr-4

Course Outcome : At the end of the course, the students will be able to :

CO1. apply the translation of real problems of natural language into mathematical and/or machine languages and develop systems to determine their solutions .

CO2. get the knowledge of classical logics to understand various soft system methodologies like Artificial intelligence fuzzy expert system, genetic algorithms .

CO3. get the concept of pattern recognition and define clustering. In addition to that relational data base management system and its operational calculus.

CO4. understand the method of invariants and well-founded ordering to prove correctness and termination of processes and state machines.

CO5. know the recurrence relation will be able to derive closed-form and asymptotic expressions from series and recurrences for growth rates of processes. In addition to thatmodeling and analyzing computational processes using analytic and combinatorial methods

CO6. get the concept of Boolean algebra will support them in their subjects like Switching theory, digital circuit design and Sequential machines.

CO7. apply Graph theory in related areas like Syntactic analysis, Fault detection and diagnosis in computers, Scheduling problems and Minimal-path problems, network flow problems.

CO8. understand the elementary properties of modular arithmetic their applications in cryptography and hashing algorithms.

Prerequisite : NIL

Logic:

Proposition, Truth values, Connectives, Logical equivalence of composite statement (using truth table & without truth table), Predicates and Quantifiers, Rules of Inference, Methods of Induction.

Set, Relation & Function:

Set, Operations on set, Principles of Inclusion and Exclusion, Relation, Types of relations, Properties on Binary Relation, Equivalence relation, partial ordering, relation, Hasse diagram, Lattice, Definition of function, Injection, Bijection, Surjection, Permutation function.

BooleanAlgebra:

Lattices and Algebraic system, principles of duality law, Basic properties, Boolean function and Boolean Expressions, DNF & CNF.

Recurrence Relation and their solutions:

Discrete numeric function and their manipulation, Generating Function,
Concept of Recurrence Relation with constant coefficients, Solution of Recurrence Relation.(Direct Method and by using generating function).

Graph Theory:

Basic Terminology, Types of Graphs, Group Code, Isomorphic Test, Adjacency & Incident Matrix, Paths, Circuit, shortest path Algorithms (Dijkstra),Tree, Rooted Tree, Binary Tree, spanning tree, cut set, MST Algorithms.(PRIM & KRUSKHAL), Planar Graph

Groups and Rings:

Concept of binary operations, Algebraic structures, Semigroup, monoid, Group, Abelian group with examples. Properties of groups, Cyclic groups and its generator, Sub group, Normal subgroup, cosets, Lagrange's Theorem, Homomorphism and Isomorphism, ring, field, Integral domain (Definition with examples)

Text Book

1.Discrete Mathematical Structure, PHI by Kolman, Busby & Ross.

Reference Book

1. Elements of Discrete Mathematics.A Computer oriented approch by C.L Liu,D.P.Mohapatra(Tata Mc GrawHill 4th Edition-2013)
2. Discrete Mathematics and its Applications by Kenneth H Rosen (Tata Mc GrawHill 4th Edition)

MA 2004 NUMERICAL METHODS Cr-4

Course Outcome : At the end of the course, the students will be able to :

CO1.	know the error analysis in data handling.
CO2.	understand the numerical techniques to solve non-linear algebraic / transcendental equations.
CO3.	use the difference operators and different numerical methods to interpolate and extrapolate from given set of data.
CO4.	understand the applications of numerical differentiations and integrations.
CO5.	know the concept of solving numerically the initial and boundary value problems of ODEs.
CO6.	solve initial and boundary value problems involving PDEs solved numerically
CO7.	get the knowledge regarding concept of Probability and solution of day to day problems
CO8.	obtain the Knowledge of probability distributions, expectation and its applications on problems

Prerequisite : Mathematics-I (MA 1001)

Approximations & Errors:
Approximation of numbers by truncation and rounding-off, Types of errors,

Numerical solution of Non linear equations:

Solutions by Bisection Method, Fixed Point Iteration Method , Newton-Raphson Method, Regula-Falsi and Secant Method, Rate of Convergence of Secant & Newton-Raphson Method .

Interpolation & Approximation:

Finite Differences, Operators and Relation between them. Interpolation: Newton's forward and backward difference interpolation, Newton's divided difference interpolation and Lagrange interpolation.

Numerical Differentiation & Integration:

Numerical differentiation of 1^{st} and 2^{nd} order using difference table. Trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rules , Gauss-Legendre's two points and three points formulae. Error in Numerical Integration.

Numerical Solution to ODE:

Taylor series Method, Euler's Method, Modified Euler's Method, Runge-Kutta Methods of order 2 and 4, reduction of 2^{nd} order ODE to 1st order ODE and its solution by R-K method of order four.

Solution of System of Linear Equations:
Solutions by Gauss-Seidel and Gauss-Jacobi methods.

Numerical Solution to PDE:
Types of Partial differential equations, Finite difference approximations of derivatives, Numerical solution of Laplace equation by five point formula, Numerical solution of Parabolic equations by Schmidt method and Crank-Nicolson method.

Probability Theory:

Introduction to Probability, Random variables and Probability distributions, Mean and Variance of probability distributions, Mathematical expectation, Moments and moment generating function. Binomial and Poisson distributions, Normal distribution.

Text Book

1. Advanced Engineering Mathematics by Erwin Kreszig, Wiley, 9th edition.

Reference Book

1. Higher Engineering Mathematics by B. V. Ramanna , TMH, 2007.
2. Higher Engineering Mathematics by B. S. Grewal , Khanna Publisher, 36^{th} Edition.
3. Numerical Methods for Scientific and Engineering Computation by Jain , Iyenger and Jain, New age International (P) Ltd, 6^{th} Ediction.
4. Numerical Methods by Arumugam, Thangapandi and Somasundaram, Scitech Publishers, 2^{nd} Edition.

HUMANITIES

HS 1003 PROFESSIONAL COMMUNICATION Cr-2

Course Outcome : At the end of the course, the students will be able to :

CO1. get a basic idea about that communication is two-way transactional process and know the practicalimplications and their challenges in the workplace.

CO2. familiarize with English pronunciation and learn to use neutral accent successfully and communicate ideas effectively**.**

CO3. know practical uses of English grammar in technical writing and be able to use grammar correctly and unambiguously.

CO4. draft different business communication documents like reports, letters, memos and retain a logical flow while writing to get a positive response in the workplace

CO5. apply relevant writing formats to develop paragraphs, essays, letters, emails, reports and presentations.

CO6. summarize & comprehend a large text and technical contents. Address explicit and implicit meaning of a text.

Prerequisite : NIL

UNIT: 1 Communication: Process, Methods of communication and Interpersonal communication

Communication-Definition and Concept., Process of Communication
Elements of Communication, Steps/ Phases of Communication
Means/ Methods / Mode of Communication
Verbal- Oral, Written
Non Verbal- Sign Language, Body language
Flow of Communication: Formal and Informal
Barriers of Communication-Intrapersonal, interpersonal and organizational barriers
Listening-Definition, difference between hearing and listening, advantages of listening

UNIT II : Business Writing

Paragraph Writing- Techniques and skills
Business letter
Report writing

Unit III : Basics of Grammar

Parts of Speech , Types of Verbs-Transitive & Intransitive, Stative & dynamic, Time and Tense, Articles and Preposition, Quantifiers . Active and Passive Voice, Error Detection in Sentences, Subject Verb Agreement & Modifier.

UNIT IV: Basic Sounds, Vocabulary & Reading Skill

Introduction- Sound & Spelling mismatch; Problem sounds and MTI
Analogy and Sentence Completion
Rules of word formation, Antonyms & Synonyms
Reading Skills

Text Book

1. Technical Communication Principles & Practices. Meenakshi Raman and Sangeeta Sharma OUP. Second Edition-2011

Reference Book

1. A Communicative English Grammar. Geoffrey Leech and Jan Svartvik. Third Edition. Routledge Publication. New York.2013.
2. English Vocabulary in Use (advance) Michael McCarthy, Felicity O Dell, Cam. Univ. Press. Second Endition.2001.
3. Practical English Usage : International.Michel Swan, OUP.2006.
4. The Oxford Grammar (English) Sidney Greenbaum, Oxford University Press India. 1st Edition. 2005
5. Verbal Ability and Reading Comprehension for the CAT. Arun Sharma and Meenakshi Upadhyay, TMH, New Delhi,2007
6. Better English Pronunciation, Cambridge University Press, J D O'Connor, 2nd Edition (Paper Back) 2013
7. BCOM . Carol M.Lehman, Debbie D.DuFrene and Mala Sinha Cengage Learning, New Delhi
8. Communication Skills For Technical Students by T.M. Farhathullah.Orient Blackswan.Chennai.2002.
9. English and Communication Skills for Students of Science and Engineering.SP Dhanavel, Orient Blackswan.Chennai.2009

HS 2002 ENGINEERING ECONOMICS Cr-3

Course Outcome : At the end of the course students will be able to :

CO1. learn the fundamentals of Engineering Economics.
CO2. understand and use Economic concepts in making business decisions.
CO3. use economic information to manage the organization.
CO4. use economic tools with respect to acceptance or rejection of investment proposals.
CO5. know the current issues relating to economic environment.

Prerequisite – NIL

UNIT-I : **Introduction to Economics and Engineering Economics**

Basic concepts of Economics: Demand Analysis, Supply Analysis, Market Equilibrium. Revenue Analysis. Demand Forecasting- Quantitative Methods.

UNIT-II : Production and Cost Analysis

Short Run and Long Run Production Functions, Producer's Equilibrium condition.Cobb-Douglas Production Function. Cost Concepts: Short Run and Long Run Cost curves. Break-Even Analysis.Market: Perfect Competition, Monopoly, Discriminating monopolist.

UNIT-III : Time Value of Money

Interest Formulas and their applications. Evaluation of Investment, Proposals-Present Worth method of comparison, Future worth method of comparison, Annual Equivalent Method of comparison,Economic Appraisal Technique-Net Present Value, Rate of Return, Cost Benefit analysis.Depreciation and Income Tax Consideration. Inventory control.

UNIT-IV : Money Banking

Functions of commercial banks.Inflation.Money market and Capital market. Business cycle and Business policies. National Income Accounting.

Text Book

1. Engineering Economics .James L.Riggs, David D.Bedworth and Sabah U.Randhawa, McGraw Hill, India, 2013.
2. Engineering Economics. R.Panneerselvam, Pub: PHI Learning Private Limited: New Delhi, 2008.

Reference Book

1. Mangerial Economics, Theory and Applications. D.M.Mithani, Himalaya Publication: New Delhi, 2009.
2. Monetary Economics - Instructions, Theory and Policy, S.B.Gupta, S.Chand and Company Limited: New Delhi, 1995.
3. Keynesian and Post-Keynsian Economics. R.D. Gupta. Kalyani Publishers 1994.

HS 2004 PUBLIC FINANCE Cr-3

Course Outcome : At the end of the course students will be able to:

CO1. understand the sources of revenue and heads of expenditure of the different levels of government in the country.
CO2. analyse the effect of public expenditure and revenue on the overall economy.
CO3. learn the role and effect of state policies on the economy.
CO4. know the purpose, effect and areas of budgetary policies.

UNIT-IIntroduction :
Definition and scope of Public Finance. Difference between public finance and Private Finance, Public goods, Private goods and their characteristics. Market Failure, Merit goods, Mixed goods, Externalities and the role of Government. Tax subsidy Analysis, Principle of Maximum Social advantage.

UNIT- IIPublic Expenditure :
Meaning, Classification and canons of public expenditure.Causes of Growth of public Expenditure, Effects of public Expenditure on production, distribution and economic stability.Wagner's law of Increasing State activities, Peacock-Wiseman hypothesis.Trends of Public Expenditure in India.

UNIT-III Public Revenue :
Sources of Public Revenue, Effects of tax on production,Distribution and economic activities.Principles of Taxation-Benefit theory, Ability-to Pay Theory, Subjective and Objective Approaches, Direct and Indirect taxes, Neutrality in taxation.Allocative and Equity aspects of Income tax and commodity taxes. Theory of optimal taxation, Excess Burden of taxes,Tradeoff between Equity and Efficiency. The problem of double taxation.Shifting and Incidence of taxation : Forward and Backward shifting, Tax Capitalization, Incidence of commodity taxes and income tax, VAT, Features of the Indian Tax system.

UNIT-IV Public Debt :
Sources of Public borrowing, Effects of Public Debts, Importance of Public borrowings.Tax vs public debt, Burden of Public Debt, Shifting of Debt burden, Methods of debt redemption.Budget-Concept of Budget- Balanced and Unbalanced budget. Concept of deficit-Revenue,Budgetary,Fiscal and Primary deficit, Budget as an instrument of economic policy.Deficit Financing and its Limitations. Fiscal Policy- Its related problems. Fiscal sector reforms in India.

Text Book

1. Public Finance. B.P.Tyagi,Jai Prakash Nath Publication :Meerat.UP, 1994.
2. Money Banking, International Trade, D.N.Mithani, Himalaya Publishing House: New Delhi, 2012.

Reference Book

1. Public Finance and Policy.Musgrave and Musgrave, Tata McGraw Hill: New Delhi, 1980.
2. Modern Public Finance.B.P.Herber.Richard D. Iruin, Homehood, 1976.

HS 2006 INTERNATIONAL ECONOMICS Cr-3

Course Outcome : At the end of the course students will be able to:

CO1. understand the basics of international trade.
CO2. know the situation and impact of the BOT and BOP of the country.
CO3. learn the system of foreign currency transactions and exchange rate determination.
CO4. know about the existing institutions that regulate the international market.
CO5. learn about the common policies governing International Trade

UNIT-I International Trade :
The importance of International Trade (with emphasis on its significance in the present era of Globalization, measurement of Gains from Trade and their distribution. Theories of International Trade- Absolute and Comparative cost advantage theories, application of opportunity costs, Heckscher – Ohlin Theorem: its empirical Relevance, Leontif Paradox.

UNIT-IIBalance of Trade and Balance of Payment :
Concept of Balance of Trade and Balance of Payments, Causes of Disequilibrium, Measures to correct Disequilibrium (both monetary and non-monetary methods) and their relative merits and demerits.Free Trade vs Protection.

UNIT-III Foreign Exchange :
Demand for and Supply of Foreign exchange, Fixed vs Flexible exchange rate, Rise and Fall of Gold Standard, Theories of exchange rate determination- Mint Parity Theory, Purchasing Power Parity Theory, Balance of Payments Theory.
The Brettonwoods system/IMF.

UNIT-IV **Concept of Terms of Trade** :
Theories of Terms of Trade, Prebisch and Singer Theory, Economic effects of Tariff on National Income, Terms of Trade and Income Distribution, Effects of Quotas, Effective rate of Protection.Forms of economic co-operation- Theory of Custom Union. Changing structure of India's foreign trade since Independence, composition and Direction of India's Foreign Trade, Trends in India's Balance of Payments, Export Promotion and Import Substitution Strategy.GATT/WTO,TRIPS and TRIMS,FERA and FEMA.

Text Book

1. International Economics. Bo Sodersten, Mc Millan, 2004.
2. International Economics. C.P.Kindleberger: Richard.D.Irwin : Mac Millan Publication,1991

Reference Book

1. International Economics. D Salvatore: 8th Edition, Wiley India:New Delhi, 2003.
2. Indian Economy: Ruddar Datt and K.P.M. Sundaram,Publication: S.Chand and Company Limited:New Delhi, 1995.
3. International Trade – Selected Reading, J Bhagawati (Ed.),Cambridge University Press:India, 1998.

HS 3002 ORGANIZATIONAL BEHAVIOUR Cr-3

Course Outcome : At the end of the course the students will be able to:

CO1. know about organisational structure, organisational behaviour and personality development.

CO2. learn about motivational techniques and skill required to work in a group and the process of group decision making.

CO3. know various leadership styles and the role of leader in achievement of organisational objective.

CO4. learn about the reasons organizational change and its development.

UNIT-1-Introduction to Organization and OrganizationalBehaviour :

Meaning and definition of organization, features and principles of organization, Organizational structures and nature of organizational behavior.

UNIT-2-Personality :

Meaning of Personality, Personality Development, Determinants of personality, Application of personality in the organizational level. Motivation-concept of motivation, motivation and behavior, Theories of motivation, Need theory, Hygiene theory, Theory X and Theory Y,Elements of sound motivational system, Motivation in Indian organization.

UNIT-3-Leadership :

Meaning,Theory of leadership, Trait theory,Behavioural theory, Leadership styles, Leadership in Indian Organisation. Group Dynamics-Concept of Group Dynamic, Types of Group, Group Behaviour, Group Decisions, Techniques to improve group decision, merits and de-merits of group decision.

UNIT-4- Organizational Change :

Meaning and Nature of organizational chage,Factors of organizational change, Resistance to change, Factors in resistance, Overcoming resistance to change, Organizational Development-Concept, Objectives and process of organization development.

Text Book

1. ORGB, An innovative Approach to Learning and Teaching ,Organizational Behaviour, Nelson, Quick, Khandelwal, Cengage Learning, 2012.

Reference Book

1. Organizational Behaviour Dr S.S.Khanka, S.Chand, 2014.
2. Organisational Behaviour. Arun Kumar and N.Meenaskshi .Vikas Publishing House, 2009.
3. Managing Organisational Behaviour, Moorhead & Griffin. CENGAGE Learning, 2014.
4. Human Behaviour at Work. Keith Davies, 2002.

HS 3003 PROFESSIONAL ETHICS AND CODE OF CONDUCT Cr-1

Course Outcome : At the end of the course, the students will be able to :

CO1. understand the relevance of ethics and morals in engineering
CO2. apply moral theory in decision making
CO3. appreciate the vulnerability to failure of engineering processes
CO4. comprehend the finer aspects of safety and risk with reference to the responsibilities of engineers.
CO5. understand the link between responsibility, rights and accountability
CO6. understand the global impact of engineering profession

Pre-requisite : Nil

Morals and Ethics in Engineering
Senses of 'Engineering Ethics' – Variety of moral issues- Moral Autonomy- Kohlberg's theory- Gilligan's theory- Professions and Professionalism.

Engineering as Social Experimentation

Engineering as Experimentation- Engineers as responsible Experimenters- Industrial Standards – Titanic disaster as Case Study.

Engineer's Responsibility for Safety

Safety & Risk- Assessment of Safety and Risk- Risk Benefit Analysis- Reducing Risk.

Global Issues

Computer Ethics- Role in Technological Development- Engineers as Managers – Engineers as Expert Witnesses and Advisors.

Recommended Book :

1. Mike Martin and Ronald Schinzinger, "Ethics in Engineering", McGraw Hill, New York, 2005.
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, " *Engineering Ethics Oncepts and Cases*" Thompson Learning, 2000
3. Charles D Fleddermann, "*Engineering Ethics*", Prentice Hall, New Mexico, 1999.
4. Edmund G Seebauer And Robert L Barry, " *Fundamentals of Ethics for Scientists and Engineers*'', Oxford University Press, 2001

HS 3004 HUMAN RESOURCE MANAGEMENT Cr-3

Course Outcome : At the end of the course the students will be able to :

CO1. know the professional and personal qualities of a HR manager.
CO2. learn different methods of selecting human resources through recruitment, training and performance appraisal system.
CO3. know how to develop a favourable working environment in an organisation through participation in management and maintain a good industrial relation for benefit of the society.
CO4. know about consequence of industrial dispute and employee indiscipline of an organization.

Prerequisite : NIL

UNIT-1-Human Resource Management :

Meaning & Definition, Functions, Scope & Objectives, Qualities of a HR Manager

UNIT-2-Human Resource Planning :

Meaning & Definition, Importance of HRP,HRP Process. Barriers of HRP, Factors of sound HRP.

Recruitment – Meaning & Definition, Sources of Recruitment, Recruitment Process, Effective Recruitment. Training & Performance Appraisal- Definition & Objective ,Areas of Training, Meaning & Definition of Performance Appraisa, process, Effective principles of performance Appraisal.

UNIT-3- Industrial Relations :

Concept & Meaning, Objective & Importance, Reasons of poor Industrial Relation. Industrial Disputes- Meaning & Definition, Causes of Industrial Dispute, Prevention of Industrial Dispute, Conditions for good Industrial Relation.

UNIT-4- Workers Participation in Management :

Meaning & Need, Forms of Participation, Scheme of participation ,Merits & Demerits. Collective Bargain- Meaning & Definition, Objective & Importance, Process of Collective Bargain, Effective Condition.

Employee Discipline-Guidelines for action, Penalties & Punishment, Rewards of Discipline**.**

Text Book

1. Human Resource Management. P. Subba Rao, Himalaya Publishing House, 2012.
2. Human Resource Management. K.Aswathappa. Mc GRAW HILL Education, 2013.

Reference Book

1. Human Resource Development Management . A. M.Seikh S.Chand, 2003.
2. Human Resource Management . S.S.Khanka, S. Chand, 2014.

HS 3006 ENTREPRENEURSHIP Cr-3

Course outcome : At the end of the course the students will be able to :

CO1. know the contribution of an entrepreneur and role of SSI units in growth and development of socio economic condition of our country.
CO2. learn market survey, sales promotions and management of working capital through costing and book keeping.
CO3. know different decision making technique and benefit of personal management system as well as motivational methods of an enterprise.
CO4. learn how to prepare a project report and knowledge about different tax system of an enterprise.

UNIT-I :

New Industrial Policy of 1991,Meaning and Definition of Entrepreneurship, Incentives and benefits available to SSI Units and New Entrepreneurs. Dearth of entrepreneurial talent in India, Growth of SSI in India. Procedures to start SSIs.

UNIT-II :

Market survey and research pricing and techniques, Distribution Channel, Sales promotion activities. Raising Finance and enterprise launching.

UNIT-III :

Financial Management, Working Capital Management, Costing,Book Keeping, Break-Even-Analysis. Taxation: Income Tax, Excise duty, Sales tax and VAT.

UNIT-IV :

Decision making – Types, Forecasting-Qualitative and Quantitative methods, Personal Management, Motivation and theories of motivation. Preliminary Project Report (PPR),Detailed Project Report (DPR) writing.

Text Book

1. Entrepreneurial Development.S.S.Khanka. S.Chand, 2007.

Reference Book

1. Industrial Organisation and Engg.Economics. Sharma & Banga.Khanna Publication, 2003.
2. Entrepreneurship New Venture Creation. David H.Holt.Prentice Hall .PHI, 2013.

HS 3008 MANAGEMENT CONCEPTS AND PRACTICES Cr-3

Course outcome : At the end of the course the students will be able to:

CO1. learn the critical management functions, principles and analysis of management theories.
CO2. know about marketing strategies as well as implementation of financial techniques in the organisational level.
CO3. learn about production planning and control and formulation of strategy in organisation.

Prerequisite : NIL

UNIT-1 :

Introduction to Management, Meaning and Nature, Functions of management, Theories of management, Classical theory,modern theory, Principles of management**.**

UNIT-II-Marketing:

Identifying Market segments ,Market mix, product ,price, Distribution and promotion, Advertisement and market research. pricing strategies.

UNIT-III-Finance :

Introduction, Scope & Functions ,financial statements, working capital management, Capital budgeting decision.

UNIT-IV-Production:

Production planning and control, systems and procedure of inventory management, ,strategy Management : Firm and its environment, process of strategic planning.

Text Book

1. Organization And Management. R.D.Agarwal.Tata Mc Graw Hill Pvt. Ltd, 1982.
2. Modern Business Organization And Management. Sherlekar & Sherlekar, Himalaya Publishing House, 2005.

Reference Book

1. Principles & Practices of Management. L.M.Prasad, 2014.
2. A Framework for Marketing, Management-Philip Kotler, 2013.
3. Finanical Management. I.M.Panday, 2010
4. Production and Operations Management. Everett E.Adam Jr. Ronald J.Ebert, 1992.

HS 4003 LEGAL ISSUES AND REQUIREMENT IN ENGINEERING Cr-1

Course Outcome : At the end of the course, the students will be able to :

CO1. understand the various legal requirements in terms of contracts

CO2. know the product liability which an engineer is required to take care while processinghis engineering innovations

CO3. know the various compliance requirements and the regulatory bodies to protect environment

CO4. have a fair idea to protect their engineering inventions from unauthorised exploitation under Intellectual property rights system and laws relating to Information communication technologies

CO5. indentify legal issues in a given case

CO6. understand, analyze and prevent misuse of IT related transactions

Pre-requisite : Nil

Law of Contracts and Law of Torts

Formation of Contract (Sections 2-6 of Indian Contract Act, 1872), Essentials of Contract (Sections 10-23 of Indian Contract Act, 1872), Liability for Defective Products: Product Liability, Consumer Protection Act 1986: Consumers: the concept, definition and scope, Rights of Consumers and Enforcement of Consumer Rights.

Environmental Laws

Environment Protection Act, 1986, Environmental Impact Assessment, 2006, Standards for Emission or Discharge of Environmental Pollutants from various Industries, Landmark cases - Bhopal Gas Tragedy, Taj trapezium case.

Intellectual Property Law

Basic Introduction to Intellectual Property Law, Protecting Engineering Invention: The Patent Approach, Protecting Engineering Invention: The Industrial Designs Approach, Protecting Engineering Invention: The U.S. Utility Model Approach and Need for Utility Model System in India.

Information Technology Law

Protecting Software and other engineering technologies in cyberspace, Maintaining Data Security, technological privacy in Cyberspace, E-Contracts, Electronic and Digital Signatures: Conceptual Analysis.

References:

Legislations :

1. Patents Act 1970 (Unit 3)
   (Relevant Provisions: Chapter III- Section 6 to 11, Chapter IV- Section 11A to 24, Chapter V- Section 25 to 28)
2. Designs Act 2000 (Unit 3)
   (Relevant provisions: Chapter III- Section 3 to Section 9)
3. Information Technology Act 2000 (Unit 4)

Books :

1. Rosencranz, "Environmental Law and Policy in India"
2. Gurdip Singh, "Environmental Laws"
3. V. K. Ahuja, "Law relating to Intellectual Property Rights"
4. Pavan Duggal, " CYBER LAW- Indian Perspective"
5. Howard B. Rockman "Intellectual Property Law for Engineers and Scientists" (ISBN-978-0471449980)
6. Mireille Hildebrant, "Smart Technologies and the End (s) of Law (ISBN- 9781786430229)
7. Avtar Singh, "Law of Contract"
8. Dr. R. K. Bangia, " Law of Torts"

CIVIL ENGINEERING

Programme Educational Objectives (PEOs)

Our program will produce graduates to:

PEO-1. Lead a successful career in industry or pursue higher studies or entrepreneurial endeavours.

PEO-2. Offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.

PEO-3. Demonstrate effective communication skill, professional attitude and a desire to learn

Programme Outcome (POs)

Graduates receiving the Bachelor Degree in Civil Engineering are expected to:

a) Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the conceptualization of engineering models.
b) Identify, formulate, research literature and solve *complex* engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.
c) Design solutions for *complex* engineering problems and *design* systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
d) Conduct investigations of *complex* problems including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
e) Create, select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modeling, to *complex* engineering activities, with an understanding of the limitations.
f) Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
g) Communicate effectively on *complex* engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
h) Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.
i) Understand and commit to professional ethics and responsibilities and norms of engineering practice.
j) Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.
k) Demonstrate a knowledge and understanding of management and business practices, such as risk and change management, and understand their limitations.
l) Recognize the need for, and have the ability to engage in independent and life-long learning.

CE 2003 **SOLID MECHANICS** **Cr- 4**

Course Outcome: At the end of the course, the students will be able to:

CO1. determine different stress & strain in materials under various loading conditions
CO2. determine critical load of compression members for different support conditions
CO3. determine different stress & strain in cylinders & shells
CO4. select appropriate method to locate failure planes in materials for different loading conditions.

Pre-requisite: Engineering Mechanics (ME 1001)

Simple Stresses and Strains:
Concept of Stress, Stress and Strain in Materials Under Tension, Compression and Shear, Elastic Constants, Relation Between Elastic Constants, Thermal Stress and Strain, Stress & Strain of Composite Bars.

Compound Stresses and Strains:
Two Dimensional Stress System, Principal Planes, Principal Stresses, Mohr's Stress Circle, Principal Strains, Mohr's Strain Circle, Principal Stresses Computed From Principal Strains.

Bending Stresses :
Bending Moment and Shear Force Diagram of Determinate Beams, Theory of Simple Bending of Initially Straight Beams.

Shear Stresses in Beams:
Distribution of Normal & Shear Stresses. Shear Center, Shear Flow, Shear Center for Symmetrical sections

Torsion:
Torsion in Solid & Hollow Circular Shafts, Torque and Power Transmitted by Solid and Hollow Shafts, Strength of Shafts, Combined Bending & Torque, Closed Coiled Helical Springs.

Columns & Struts:
Elastic Instability, Euler Theory-Column with One end Free & Other end Fixed, Column with Both ends Hinged, Column with both ends fixed, Column with one end fixed and the other end Hinged, Eccentrically Loaded Column, Column with Initial Curvature.

Cylinders & Shells:
Stresses & Strains in Thin Cylinders and Thin Spherical Shell under Internal Pressure.

Text Book

1. "Strength of Material" by S. S. Ratan, Second Edition, TMH Education Pvt. Ltd, New Delhi
2. "Strength of Material" by R. K. Rajput, Fifth Edition, S. Chand and Co. Ltd.

Reference Book

1. "Strength of Materials" by G. H. Ryder, Third Edition, Macmillan Publisher India Ltd
2. "Elements of strength of Materials" by S. Timoshenko & D. H. Yong, Fifth Edition, EWP an east-west edition
3. "Engineering Mechanics of Solids" by E. P. Popov , Second Edition, PHI Publisher Ltd
4. "Mechanics of Materials" by Gere & Timoshenko Second Edition CBS Publisher.

CE 2004 **STRUCTURAL ANALYSIS –I** **Cr-4**

Course Outcome: At the end of the course, the students will be able to:

CO1. determine various internal forces in beams and frame from bending moment and shear force diagram
CO2. select appropriate method to determine slope and deflection of determinate beams and frames
CO3. determine internal forces in the members of plane & space truss, three hinged arch and cables
CO4. determine absolute maximum internal forces due to rolling or moving loads from Influenced line diagrams.

Pre-requisites: Engineering Mechanics (ME 1001) and Solid mechanics (CE 2003)

S.F.D. & B.M.D.:
Definition, type of supports, shears force and bending moment diagram of all determinate beams, frames etc. S.F.D and B.M.D for the structures with internal hinge, Inter-relation between S.F.D and B.M.D. Obtain B.M diagram from S.F diagram.

Slope And Deflection of Beams:
Double Integration method, Maculay's method, Moment Area method, Conjugate beam method, virtual work (Unit load) method, strain energy method. Castiglione's theorems of strain energy. Maxwell's and Betti's reciprocal theorem.

Analysis of Trusses :
Analysis of forces in members of a simple truss, by joint and section method .Deflection of truss. Williot-Mohr diagram.

Arches & Cables:
Analysis of three hinged parabolic and circular arches for bending moment, normal thrust and redial shear, Analysis of three suspension bridges with their hinged girders.

Influence lines :
Influence lines for determinant beams and Pratt and warren trusses., Influence lines for three hinged arch i.e. for horizontal thrust, bending moment, normal thrust and radial shear.

Rolling loads:
Rolling for simple supported beams, Maximum and absolute maximum values of S.F and B.M due to moving loads.

Text Book

1. "Structural Analysis Vol. I", by S.S. Bhavikatti, 4th Edition, Vikas Publishing House Pvt Ltd, New Delhi.
2. "Structural Analysis", R C Hibbeler, 8th Edition, Pearson Education India.

Reference Book

1. "Fundamentals of structural analysis", S. K. Roy and S. Chakrabarthy, 2nd edition, S. Chand.
2. "Theory of Structures", S. Ramammrutham and R Narayan, Dhanpat Rai, 1993.
3. "Analysis of structure Vol-1", V.N. Vazirani andM.M Ratwani and S.K Dugal, Khanna Publishers, N. Delhi.

CE 2005	**SURVEYING**	**Cr-3**

Course Outcome: At the end of the course, the students will be able to:

CO1: apply the basic principles of surveying and can carry out the survey in the field for various purposes using chain, compass, plane table and theodolite
CO2: perform leveling and contouring of given ground
CO3: set different types of curves

Pre-requisite: Nil

Introduction to Surveying:

Objectives of Surveying, Primary divisions of Surveying, Classification of Surveying, Principles of Surveying, Units of measurements, Plans and Maps, Introduction to types of scales used in Surveying maps, Introduction to Vernier and Types of Vernier, Error due to Wrong Scales, Types of Mistakes and Errors in Surveying (in brief).

Chaining:

Introduction to chaining, Principle of chain surveying, Methods of measuring distance, Types of Chains and Tapes used in Surveying, Other accessories used in chain surveying, Ranging of a Survey line (Direct & Indirect), Process of measuring distances with chains and tapes, Errors caused by wrong chain length (In length, Area and Volume), Types of errors in chaining and taping, Offsets and types of Offsets, Instruments for measuring right angles, chaining on flat and sloping ground, obstacle in chaining, methods of traversing, Precautions during Chain surveying.

Compass Surveying:

Principle of Compass Surveying, Designation of Bearings used in Compass Surveying, Types of Bearing Systems, Declination of the Magnetic Bearing w.r.t. True Bearing, Types of Compasses used in Compass Surveying, Fore Bearing and Back Bearing, Calculation of included angles from Bearings, Computation of Bearing from Internal Angles, Local attraction, Correction of Bearing for Local attraction, Traversing with Compass, Types of errors in Compass surveying, Plotting the compass traversing survey, Adjustments for closing error in closed traverse surveys, Precautions in Compass surveying.

Plane Table Surveying:

Introduction to Plane Table Surveying, Principle of Plane Table Surveying, Plane table accessories, Setting up of plane table in field, Orientation in plane table, Plane table methods (Radiation, Intersection, Traversing and Resection), Comparison of the methods, Two-Point Problem, Three-Point Problem (Tracing Paper method, Graphical method, Trial and error method, Lehmann's rule), Adjustments of the Plane table, Errors in Plane tabling, Advantages and Disadvantages in Plane tabling.

Leveling:

Introduction to Leveling, Terminology of terms used in Leveling, Methods of finding elevation, Direct methods for finding levels, Types of Leveling instruments, Leveling staff, Temporary adjustments in leveling instruments, Basic leveling operation in field and terminology, Balancing back sight and fore sight, Reduction of levels, Height of Collimation Method, Rise and Fall Method, Fly leveling, Check leveling, Profile leveling, Cross section leveling, Reciprocal leveling, Correction for Curvature & Refraction, Distance to the Visible horizon, Dip of the Horizon, Errors in leveling, Advantages of leveling.

Contours:

Introduction to Contours, Terminology used in Contour Operations, characteristics of contours, contour interval, Contouring methods , direct and indirect methods of contouring, Interpolation of contours, Preparing contour maps, uses of contour maps.

Theodolite Survey:

Introduction, Principle of Theodolite Surveying, Essentials of Transit Theodolite, Definitions and Terms used in Theodolite Surveying, Temporary adjustments in Theodolite, Measurement of Horizontal angles and vertical angles, Method of Repetition, Method of Reiteration, Field procedure for Theodolite Surveying, Sources of errors in Theodolite Work, Advantages and Disadvantages of Theodolite Survey, Problems on Omitted Measurements.

Curves:

Types of Horizontal and Vertical Curves, Simple Circular Curve, Elements of a Simple Circular Curve, different methods of setting out-simple circular curves, Compound Curves, transition curves, types of transition curves, Requirements of Vertical Curve, Length of Vertical Curve, Vertical Curves by equation of parabola, Different applications of Curve setting.

Text Book

1. "A Text book of Surveying and Leveling" by R. Agor; Khanna Publishers
2. "Surveying Vol. I" by S. K. Duggal; McGraw Hill Education (India) Private Limited.

Reference Book

1. "Surveying Vol. I" by Dr. B. C. Punmia, Ashok K. Jain & Arun K. Jain; Laxmi Publications (P) Ltd.
2. "Surveying and Leveling" by R. Subramanian; 2nd Edition, Oxford publications, New Delhi.
3. "Plane Surveying" by Dr. Alak De, Reprint 2016, S Chand & Company Pvt. Ltd.
4. "Surveying and Leveling (Part 1)" by T. P. Kanetkar & S. V. Kulkarni; Pune Vidyarthi Griha Prakashan.
5. "Surveying and Leveling" by N. N. Basak; Tata McGraw-Hill Private Limited.
6. "Surveying and Leveling" by S. C. Rangwal, K. S. Rangwala & P. S. Rangwala; Charotar Publishing House Pvt. Ltd.

CE 2007 CIVIL ENGINEERING MATERIALS & CONSTRUCTION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. learn about properties of stones, bricks, cement, concrete, timber.
CO2. learn about different types of Foundations and Masonries

Pre-requisite: Nil

Stones:
Classification, composition, characteristics, uses, method of quarrying and dressing.

Bricks:
Brick earth, method of Brick manufacture, testing of bricks, classification.

Cement:
Portland cement:-Classification, Chemical composition, hydration, tests for cement fineness test, normal consistency, setting time, soundness, tensile and compressive strength.

Concrete:
Composition of concrete, W/C ratio, Workability, Compressive and tensile strength, Nominal Mix design, pozzolanic concrete, Light weight and high density concrete, Elasticity, Shrinkage and creep of concrete.

Timber:
Characteristics and suitability for different purposes, Defects and decay seasoning preservation of timber.

Foundation:

Shallow foundation, Deep foundation, Description and types of spread foundation, Description and types of pile foundations, Methods of pile driving, Pile driving formulae (isolated and group of piles),Excavation and timbering of trenches, Well foundations, Caissons, Cofferdams.

Masonry:
Definition of terms; classification of masonry; stone masonry; classification, dressing, joints, maintenance; Brick masonry; Types of bonds, brick laying, structures in brickwork; Partition walls.

Door & Windows:
Criterion of size; types of doors and windows ventilators and fanlights sash and casement windows, skylights and lanterns; fixture and fastenings for doors and windows.

Floors:
Ground flooring, upper flooring, types, preparation, advantages and disadvantages.

Text Book

1. "A Text Book of Building Construction" by S. K. Sharma, Revised Edition, S. Chand Publication, 1987.
2. "Building Material" by S. S. Bhavikatti, 1st Edition, Vikas Publication.

Reference Book

1. "Building Material" by M. L. Gambhir, 1st Edition, TMH Education, New Delhi.
2. "Building Construction" by B. C. Punmia, Jain & Jain, 10th Edition, Laxmi Publication, New Delhi.
3. "Building Material" by P. C. Verghese, PHI Learning (P) Ltd., New Delhi, 2005
4. "Engineering Materials" by S. C. Rangwala, Charotar Publishing House, 2011.

CE 2008 ADVANCED SURVEYING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. prepare a layout plan using Total station instrument.
CO2. calculate area of traverse by using different methods such as triangulation, aerial photogrammetry.
CO3. use RS & GIS to prepare a map of a certain area.

Pre-requisite: Surveying (CE 2005)

Tacheometry:
Introduction, Principle of Tacheometric Surveying, Uses of Tacheometry, Types of instruments used in Tacheometric Surveying, Methods in the Tacheometric Surveying, Stadia Method, Fixed-hair Method, Determination of Tacheometric Constants, Anallactic Lens, Advantages and disadvantages, Errors in Stadia Surveying, Subtense bar Instrument.

Total Station and Electronic Distance Measurement:
Introduction to Total Station, Advantages and Disadvantages of Total Station, Measuring Angles, Types of Total Station, Advancement in Total Station Technology, Automatic Target Recognition (ATR), Introduction to EDM, Measurement Principle of EDM instrument, EDM instrument characteristics, Classification of EDM, Errors in Electronic Distance Measurement.

Triangulation:
Introduction, Principle of Triangulation, Purpose of Triangulation Surveys, Classification Triangulation, Layout of Triangulation, Ideal figures for triangulation, Size of triangulation, Well conditioned triangle of a triangulation system, Strength of triangulation figures, Accuracy of triangulation, Routine of triangulation survey, Field work of triangulation, Signals and towers, Classification of signals, Base line measurement, Equipments for base line measurement, Number of Zeros, Types of triangulation stations, Triangulation computations.

Photogrammetry:

Introduction, Types of photogrammetry survey, Aerial photogrammetry survey, Principle of photogrammetry and its limitation, Technical terms used in Aerial surveying, Relation between the Principal point, Plumb point & isocentre of a tilted photograph, Displacement of photo image due to height. Flight planning.

Theory of Errors and Adjustments:

Introduction, Definitions, Weight of the observations, Laws of weights, Assignment of weight-age to the field observations, Adjustment of accidental errors, Method of least squares.

GPS:

Introduction to GPS: Available GPS net works, Limitations and applications of GPS; GPS receivers. Standard, Precise Positioning, Broad casting, GPS Errors, Types of segments (Space, Control, User), spatial data, non spatial data, GPS system of various country, Indian Space program, various satellite orbit and their application, DGPS.

Introductions to remote sensing;

Applications and importance of remote sensing, Basic concepts and fundamentals of remote sensing- elements involved in remote sensing, electromagnetic spectrum, remote sensing terminology and units, over view of Indian Remote sensing satellites and sensors, Energy resources, energy interactions with earth surface features and atmosphere, resolution, visual interpretation techniques, basic elements, converging evidence, interpretation for terrain evaluation, spectral properties of water bodies, introduction to digital data analysis.

Geographic Information System (GIS):

Introduction, GIS definition and terminology, GIS categories, components of GIS, fundamental operations of GIS, A theoretical framework for GIS, Data collection and input overview, data input and output. Keyboard entry and coordinate geometry procedure, manual digitizing and scanning, Raster GIS, Vector GIS - Advantages and disadvantages, Map Projections**:** Introduction; Scale Factor; Geometry of the sphere and cone; Areas; Surface areas of solids; Types of Map Projections; Orthographic Projection; Conical Projection**.**

Text Book

1. "Surveying" Vol-2 by S. K. Duggal, 4th Edition, TMH Education Pvt. Ltd, New Delhi
2. "Remote Sensing and GIS" by Basudeb Bhatta, Oxford University Press.
3. "Advanced Surveying, Total station, GIS & Remote sensing" by Satheesh Gopi, R. Sathi Kumar and N. Madhu, Pearson Education, New Delhi

Reference Book

1. "Global Positioning System" by Satheesh Gopi, Revised Edition, TMH Education Pvt. Ltd, New Delhi
2. "A Text Book of Advanced Surveying" by R. Agor; Khanna Publishers.
3. "Surveying" Vol. I, II and III by Dr. B. C. Punmia, Ashok K. Jain and Arun K. Jain; Laxmi Publications (P) Limited.
4. "Remote Sensing and Geographical Information System" by A. M. Chandra and S. K. Ghosh; Narosa Publishing House.
5. "Textbook of Remote Sensing and Geographical Information System" by M. Anji Reddy, BS Publications.
6. "Textbook of Remote Sensing and Geographical Information System" by Kali Charan Sahu, Atlantic Publications

CE 2011 **FLUID MECHANICS-I** **Cr - 3**

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the fundamental concepts of fluid mechanics
CO2. applythe basic equations of fluid statics to determine forces on planar and curved surfaces submerged in a static fluid; to manometers: to the determination of buoyancy and stability
CO3. understand the concept of fluid kinematics, stream functions, velocity potentials and Laplace equation.
CO4. use Euler's and Bernoulli's equations and the conservation of mass to determine velocities, pressures and accelerations for fluids
CO5. apply the concepts of laminar flow
CO6. perform dimensional analysis for problems in fluid mechanics.

Pre-requisite: Engineering Mechanics (ME 1001)

Introduction:
Properties of Fluids, Concept of Shear Stress in Fluids, Newtonian, Non Newtonian & Ideal Fluids.

Fluid-Statics:
Pressure at a Point, Pascal's Law, Pressure Head and Piezometric Head, Measurement or Pressure (Manometers), Pressure on Plane & Curved Surfaces, Buoyancy & Floating Bodies, Stability of Floating Bodies, Metacentre.

Fluid Kinematics:
Fluid Motion, Fluid Acceleration, Types of Flows, Stream Lines, Path Lines, Streak Lines and Stream Tubes, Concept of Control Volume, Continuity Equation, Rotational & Irrotational Motion, Stream Function & Velocity Potential Function, Potential Flow & Laplace Equation.

Fluid Dynamics:
Euler's Equation, Bernoulli's Energy Equation, Application Of Bernoulli's Energy Equation, Pitot Tube, Venturimeter, Orifice Meter, Flow Through Orifices And Mouth Pieces, Momentum Principles, Application Of Momentum Equation, Force On Pipe Bend.

Laminar Flow:
Navier Stoke's Equation, Laminar Flow Through Circular Pipes, Stoke's Law, Measurement Of Viscosity.

Dimensional Analysis & Model Analysis:
Dimensions, Physical Quantities In Fluid Flow, Dimensionally Homogeneous Equations, Buckingham's Π Theorem And Model Studies.

Text Book

1. "A text book of Fluid Mechanics and Hydraulic Machines" by R.K. Rajput, S. Chand and Company Ltd. 2006.
2. "Engineering Fluid Mechanics" by K. L. Kumar, 8th Revised Edition, S. Chand & Company Ltd.

Reference Book

1. "Engineering Fluid Mechanics" by R.J. Garde & A. G. Mirajgaonker, Scitech Publications (India) Private Limited.
2. "Fluid Mechanics & Hydraulic Machines" by Sukumar Pati, 1st Edition, Tata McGraw-hill Publication.
3. "Fluid Mechanics" by V.L. Streeter, E.B. Wylie & K.M. Bedford, 9th Edition, Tata McGraw-hill Publication.
4. "Fluid mechanics" by Frank M. White, 7th Edition, Tata McGraw-hill Publication
5. "Hydraulics & Fluid Mechanics" by P.N. Modi & S.M. Seth, 19th Edition, Rajsons Publication Private Limited.

CE 2014 **FLUID MECHANICS-II** **Cr-3**

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the concepts of laminar and turbulent boundary layer

CO2. determine minor and major head losses for flows through pipes and design simple pipe systems to deliver fluids under specific conditions

CO3. solve problems for uniform gradually varied and rapidly varied flow in open channel.

Pre-requisites: Engineering Mechanics (ME 1001) and Fluid Mechanics-I (CE 2011)

Boundary Layer Theory:
Laminar & Turbulent boundary layer, momentum equation for Boundary layer, hydrodynamically smooth & rough surfaces.

Pipe flow:

Darcy-Weisbach formula, Laminar flow in pipes, velocity distribution & resistance to flow, resistance to flow in turbulent flow, Moody's diagram.

Pipe flow problem:

Energy losses in transition, pipe fittings & valves, problems on siphons, pipes in series and parallel, branching of pipes, pipe networks.

Flow in open channels:

Uniform flow-Chezy's & Manning's formulae, Uniform flow problems, hydraulically efficient section, Energy & momentum equations, specific energy, flow in transitions. Gradually varied flow - Differential equation of GVF, Flow profiles, GVF computation. Rapidly varied flow, Hydraulic jump, Water Hammer, Surge tank**.**

Text Book

1. "Fluid Mechanics through problems" by R. J. Garde, 3rd Edition, Newage International Publishers, New Delhi
2. "Flow in Open Channels" by K. Subramanya, 3rd Edition, TMH Education Pvt. Ltd, New Delhi

Reference Book

1. "Hydraulics & Fluid Mechanics" by P. N. Modi & S. M. Seth, 19^{th} Edition, Rajsons Publication Private Limited.
2. "Fluid Mechanics & Hydraulic Machines" by Sukumar Pati, 1^{st} Edition, Tata McGraw-hill Publication.
3. "Fluid Mechanics" by V.L. Streeter, E.B. Wylie & K.M. Bedford, 9^{th} Edition, Tata McGraw-hill Publication, New Delhi.
4. "Fluid mechanics" by Frank M. White, 7^{th} Edition, Tata McGraw-hill Publication, New Delhi.

CE 2016 **TRANSPORTATION ENGINEERING** **Cr-4**

Course Outcome: At the end of the course, the students will be able to:

CO1. identify the current trends of transportation
CO2. characterize pavement materials and develop the acceptance criteria
CO3. analyze and design the highway geometric elements
CO4. determine stress condition and design of pavements
CO5. design traffic infrastructure based on given situation
CO6. select feasible airport site, decide runway orientation, design geometric elements of runway and taxiway, and decide runway length and airport lighting.

Pre-requisite: Nil

Introduction:
Definition of Transportation Engineering, Role of transportation, different modes of transportation and their merits and demerits, scope of highway engineering.

Highway development in India:
Jayakar Committee, Central Road Fund ,Indian Roads Congress, Central Road Research Institute ,Motor vehicle act, Highway Research board, First twenty year road plan, Second twenty year road plan, Third twenty year road plan.

Classification of roads:
Classification of roads by various road plans, classification of urban roads, Road pattern.

Highway alignment and Engineering surveys:
Requirements, factors controlling the highway alignment, Drawings & Reports, New Highway Project, Map study, reconnaissance survey, preliminary survey, final location and detail surveys.

Highway Geometric Design:
Importance of geometric design, design control and criteria, Highway cross section element, Typical cross section of road, Sight distance, SSD, OSD, ISD, Design of horizontal alignment, Superelevation, Attainment of super elevation, Widening of pavement on horizontal curve, Horizontal transition curve, Set-back distance on horizontal curves, Curve resistance, Design of vertical alignment, Grade compensation, Summit curve and Valley curve.

Highway Materials:
Significance of subgrade soil, CBR test, desirable properties of road aggregate, Test for road aggregate, Bituminous materials, Bitumen, Tar, types of bitumen, Test on bitumen, Marshall Method of Bituminous Mix Design.

Pavement Design:
Difference between Flexible and Rigid pavement, Design of Flexible pavement as per IRC: 37-2012 and Design of Rigid pavement as per IRC: 58-2011.

Traffic Engineering:
Scope of traffic engineering, Traffic characteristics, Traffic studies, Traffic volume study, Speed studies, Origin and Destination(O&D) study, Traffic flow characteristics, Traffic capacity study, Parking study, Accident studies, Level of Service, Passenger Car Unit(PCU), Relationship between Speed, Travel Time, Volume, Density and Capacity, Regulatory sign, Informatory signs, Traffic Signals, Rotary intersection, Mini Roundabout.

Road Drainage:
Significance of highway drainage, Requirements of highway drainage, Surface drainage, Cross drainage, Sub-Surface drainage, Road construction in water-logged area.

Highway maintenance:
Introduction, causes of pavement failures, failure in flexible pavement and rigid pavement, maintenance of flexible and rigid pavement.

Introduction to Airport Engineering & Aircraft Characteristics:
Advantages & Limitations of Air Transport, Structure & Organization of Air Transport in India-DGCA, NAA, IAAI, AAI, FAA, ICAO, Relation Between Aircraft & Airport, Weight Components, Aeroplane Component Parts, Military & Civil Aircrafts, Aircraft Characteristics.

Airport Planning:
Airport Master Plan- FAA & ICAO Recommendations, Regional Planning, Data Required Before Site Selection, Airport Site Selection, Site Surveys & Drawings, Estimation of Future Air Traffic.

Terminal Area & Airport Layout:
Airport Classification, Terminal Area, Building & Building Area- Functions, Site Location, Requirements, Planning Considerations, Noise Control, Aprons- Gate Positions & Parking System, Hangers, Typical Airport Layout.
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Airport Obstructions:
Zoning Laws, Classification of Obstructions, Approach Zone, Turning Zone

Runway Design:
Runway Orientation, Cross wind Component & Wind Coverage, Wind Rose, Basic Runway Length, Correction for Elevation, Temperature & Gradient, Runway Geometric Design Standards.

Taxiway Design:
Factors Controlling Taxiway Layout, Taxiway Geometric Design Standards, Turning Radius, Exit Taxiways-Location & Design, Fillets, Separation Clearance, Holding Aprons, Bypass Taxiway.

Visual Aids & Air Traffic Control:
Airport Markings, Airport Lighting, Need of Air Traffic Control, Air Traffic Control Network, Visual Flight Rules, Instrumental Flight Rules, Control Tower, Air Traffic Control Aids, Instrumental Landing System

Airport Drainage:
Characteristics & Requirements of Airport Drainage, Design Data, Surface, Sub-surface & Subgrade Drainage Design.

Text Book

1. "Highway Engineering" by S. K. Khanna & C. E. G. Justo, 10th Edition, Khanna Publishers, New Delhi.
2. "Airport Planing and Design", by S. K. Khanna , M. G. Arora , S. S. Jain, 6th edition, Nem Chand & Brothers

Reference Book

Highway Engineering

1. "Principles, Practice and Design of Highway Engineering (Including Airport Pavements)" by S. K. Sharma, Revised Edition, S.Chand Publishers.
2. "Course in Highway Engineering" by S. P. Bindra, 5th edition, Dhanpat Rai Publications (P) Ltd.
3. "Principles Of Transportation Engineering" By Partha Chakroborty, Animesh Das, 1st Edition, PHI Learning Private Limited-New Delhi.
4. "Transportation Engineering – An Introduction", C. J. Khisty and B. K. Lall, 3rd Edition, Prentice Hall.
4. "Guidelines For The Design Of Plain Jointed Rigid Pavements For Highways", Third Revision, IRC:58-2011, Indian Roads Congress 2011.
5. "Guidelines For The Design Of Flexible Pavements", Third Revision, IRC:37-2012, Indian Roads Congress July 2012.

Airport Engineering

1. "Airport Engineering" by S. C. Rangwala, 14th edition, Charotar Publishing House Pvt. Ltd., Anand, Gujarat.
2. "Planning and Design of Airports" by R. M. Horonjeff&F. X. Mckelvey, 5th Edition, McGraw-Hill Professional.

CE 2018 DESIGN OF CONCRETE STRUCTURES-I Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. determine strength of reinforced concrete beams and slabs at various support conditions as per Limit state design

CO2. design reinforced concrete beams and slabs at various support conditions for different loadings as per Limit state design

CO3. design staircases for different support conditions as per Limit state design

Pre-requisites: Solid Mechanics (CE 2003), Civil Engineering Materials & Construction (CE 2007) andStructural Analysis-I (CE 2004)

Introduction:
Materials, Basic properties of concrete and reinforcement.

Basic working stress and limit state design concepts.

Analysis & Design of R. C. Beams:
Analysis of singly-doubly reinforced sections, flanged sections.
Design of simply supported and continuous beam subjected to flexure, shear and torsion by limit state methods.
Design of Slabs:
Design of one-way and two-way slab (simply supported and continuous) by limit state methods.

Design of staircases:
Different components of Staircase, Design Of dog-legged staircase.

Text Book

1. "Design of Concrete Structures", U. Pillai & D. Menon, Tata Mcgraw Hill publishing company ltd. New Delhi 2003
2. "Reinforced Concrete Limit State Design", by A. K. Jain, Nem Chand & Bros, 2002

Reference Book

1. "Limit state design of reinforced concrete", by P C Varghese, Prentice Hall of India pvt ltd. New Delhi 2002
2. "Design of Reinforced Concrete structure" by S. Ramamruthum, 17th Edition, Dhanpat Rai & sons, New Delhi.

CE 2019 ENVIRONMENTAL ENGINEERING–I Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. estimate the water demand for a particular area.
CO2. design different types of water intake structures based on water source and select proper type of pump for conveyance of water.
CO3. categorize and measure the physical, chemical and biological parameters responsible for water pollution.
CO4. design various units of a water treatment plant.
CO5. identify the parameters responsible for air pollution and their control strategies.
CO6. identify the parameters responsible for noise pollution and their preventive measures.

Pre-requisite:Nil

Water Supply Engineering:
General requirement for water supply, sources of water supply, Estimation of water demand. Intake structures, pumping and transportation of water.Physical, chemical and biological characteristics of water and their significance, Water quality criteria, Water borne diseases.

Engineered systems for water treatment:
Aeration, sedimentation, softening, coagulation, filtration, ion exchange, and disinfection. General description of water distribution system.

Air Pollution:
Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits.

Noise Pollution:
Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

Text Book

1. "Water Supply Engineering & Environmental Engineering (Vol. I)" by S.K. Garg., Twentieth Revised Edition, Khanna Publishers, 2013.
2. "Environmental Engineering", H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Seventh Edition, McGraw Hill, 1985.

Reference Book

1. "Introduction to Environmental Engineering", M.L. Davis & D.A. Cornwell, Fourth Edition, Tata McGraw Hill, 2010.
2. "Unit Operations and Processes in Environmental Engineering", T.D. Reynolds & P.A. Richards, Second Edition, PWS Publishing Company, CENGAGE Learning, 2009.
3. "Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, GoI, New Delhi, 2009.

CE 3001 STRUCTURAL ANALYSIS–II Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. determine the degree of static and kinematic indeterminacy of various types of structures and selection of method of analysis

CO2. determine the internal force components using Slope deflection method, Moment distribution method, Kani's method, Strain energy method, Consistent deformation method and theorem of three moments.

CO3. determine the internal force components using suitable method in two hinged arches and two hinged suspension cable bridges.

Pre-requisites: Solid Mechanics (CE 2003) and Structural Analysis -1 (CE 2004)

Redundancy:

Degree of static and kinematic indeterminacy plane and space trusses and frames.

Analysis by classical methods: .

Analysis of fixed beams, propped cantilever beam by consistent deformation method. Continues beams by Theorem of three moments

Analysis of beams and frames by, Slope deflection method, Moment distribution method, Kani's method and Strain energy method.

Analysis of two hinged arches and fixed arches.

Suspension bridges with two hinged girder.

Text Book

1. "Structural Analysis Vol. II" by S.S. Bhavikatti, 4th Edition, Vikas Publication
2. "Indeterminate structural analysis" by C. K. Wang, 1st Edition, TMH Pvt Ltd., New Delhi.

Reference Book

1. "Theory of Structures" by S. Ramammrutham, Dhanpat Rai Publication, New Delhi.
2. Analysis of structures Vol-II By V. N. Vazirani and M. M Ratwani and S.K Dugal, Khanna Publishers, N. Delhi.
3. Indeterminate structural Analysis by J.S. Kenney Oxford &IBH Publishing Co Pvt Ltd , New Delhi,

CE 3006 DESIGN OF CONCRETE STRUCTURES-II Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. design different types of reinforced concrete compression members and isolated footings as per Limit state design

CO2. design various types of piles and pile caps

CO3. design different components of water tank, water tank supporting structures

CO4. understand pre-stressing systems and determine the pre-stressing force required in a beam

CO5. evaluate different types of losses in pre-stress.

Pre-requisites: Solid Mechanics (CE 2003), Structural Analysis-I (CE 2004), Structural Analysis-II (CE 3001) and Design of Concrete Structure-I (CE 2018)

Design of column:
Design of short and long columns with axial and eccentric loading

Design of Footing:
Design of isolated &combined column footing (Only slab type).

Design of pile:
Design of piles and pile caps(pile cap for 4 & 3 pile).

Design of water tank:
Design of circular water tank with flexible base and rigid base.

Introduction to pre-stressed concrete:
Introduction to pre-stressing systems, analysis of beam sections at transfer and service loads and losses in pre-stressing.

Text Book

1. "Design Of Reinforced Concrete structure" by S. Ramamruthum, 17th Edition, Dhanpat Rai & sons, New Delhi.

Reference Book

1. "Design of Concrete Structures" by U. Pillai & D. Menon, Tata Mcgraw Hill publishing company ltd., New Delhi, 2003
2. "Advanced Reinforced concrete" by P C Varghese, Pentice-hall of India pvt. ltd. New Delhi, 2002.
3. "Reinforced Concrete limit state design" by A. K. Jain, Nem Chand & Bros, 2002.
4. "Limit state design of reinforced concrete" by P C Varghese, Pentice-hall of India pvt. ltd., New Delhi, 2002.
5. "Pre-stressed Concrete", by N. Krishna Raju, Tata McGraw Hill publishing company ltd, New Delhi

CE 3007 DESIGN OF STEEL STRUCTURES Cr-4

Course Outcome: At the end of the course, the students will able to;

CO1. understand different rolled steel structural members and their connections
CO2. design different types of connections (bolted & welded) as per Limit state design
CO3. design different types of rolled steel structural members for axial and bending load as per Limit state design
CO4. design plate girders as per Limit state design.
CO5. design beam-column and appropriate column bases for steel columns as per Limit state design.

Pre-requisites: Solid mechanics (CE 2003) and Structural Analysis-1 (CE 2004)

Introduction:
Properties of structural steel, IS rolled section.

Plastic analysis:
Plastic analysis of beams and frames.
Connections:
Simple and moment resistant bolted and welded connections.
Tension members:
Design of tension members.
Compression members:
Design of compression members, single angle, column with cover plate, lacings and battens.
Beams:
Design of laterally supported and unsupported beam.
Beam-column:
Design of beam-column.
Column bases:
Design of slab base, gusseted base, and grillage footing
Text Book

1. "Design of Steel Structure", by S.K. Duggal, Mc Graw Hill Education Pvt. Ltd
2. "Design of Steel Structures", by N. Subramanian, Oxford University Press, 2012

Reference Book

1. "Design of Steel Structures by Limit State Method as per IS 800-2007" by S. S. Bhavikatti, 2nd edition, I.K International publishing house pvt. Ltd.
2. "Design of Steel Structures V-II", by S. Ramchandra, Standard Pub.

CE 3008 ENVIRONMENTAL ENGINEERING–II Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify the physical, chemical and biological characteristics of sewage.
CO2. estimate sewage and storm water discharge and thereby design sewer pipeline and storm water drain.
CO3. design modern and low cost wastewater treatment plants.
CO4. assess the impact of sewage discharge on land and water bodies.
CO5. list the various appurtenances used in sewerage system.
CO6. characterize solid wastes and methods of their collection and transportation.
CO7. manage solid wastes using different techniques.

Pre-requisite: Environmental Engineering – I (CE 2019)

Wastewater Engineering:
Physical, chemical and biological characteristics of sewage. Generation and collection of wastewater, sanitary, storm and combined sewerage systems, Quantities of sanitary wastes and storm water. Design of sewerage system.

Treatment of sewage:
Primary- screening, grit chamber, skimming tanks, sedimentation, Secondary- Basics of microbiology, classification of secondary treatments, activated sludge process, trickling filter, Tertiary- Removal of nitrogen and phosphorus, Miscellaneous treatments- oxidation ponds, aerated lagoons. Sludge digestion and handling. Septic tank, Imhoff tank. Disposal of effluent and sludge in land and water bodies, Wastewater disposal standards.

Sewer Appurtenances:
Manholes, Drop manholes, Lampholes, street inlets, catch basins, flushing tanks, storm water regulators, grease and oil-traps, inverted siphons.

Municipal Solid Waste Management:
Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse, recycle, energy recovery, treatment and disposal.

Text Book

1. "Environmental Engineering Vol-II" by S. K. Garg, Revised Edition, Khanna Publisher, New Delhi.

Reference Book

1. "Environmental Engineering", Peavy H.S., Rowe, D.R. and Tchobanoglous, G.. Seventh Edition, Tata McGraw Hill, 1985
2. "Wastewater Engineering: Treatment and Resource Recovery", Metcalf & Eddy, Inc., Arthur, J., Tchobanoglous, G., Burton, F., Tsuchihashi, R. and Stensel, D.H. Fifth Edition, McGraw Hill Companies Inc., 2013
3. "Water Supply and Sewerage", Terence J. McGhee. Sixth Edition, Tata McGraw Hill, 2014.
4. "Water and Wastewater Technology", M.J. Hammer. Seventh Edition, Prentice Hall, 2011.
5. "Handbook of Solid Waste Management", Tchobanoglous G. and Kreith, F., Second Edition; McGraw Hill, 2002.
6. "Water and Wastewater Engineering", Davis, Mackenzie. First Edition, McGraw Hill, 2010.

CE 3009 WATER RESOURCES ENGINEERING-I Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. check the consistency of rainfall data and calculate the probability of rainfall over a given return period.

CO2. determine the evaporation, evapo-transpiration and rate of infiltration.

CO3. apply the concept of various stream flow measurement methods and derive unit hydrograph, synthetic and instantaneous unit hydrograph.

CO4: describe irrigation types and methods and determine water requirement of crops.

CO5. classify the canals, design irrigation channels and apply the concept of Kennedy and Lacey theory, design Canal Fall & Cross Drainage Work.

Pre-requisite: Nil

Introduction:
Hydrologic cycle, Water-Budget Equation and Applications in Engineering

Precipitation:
Forms and weather systems for precipitation, Characteristics of precipitation in India, Measurement, preparation & presentation of rainfall data, mean precipitation, DAD Curves and Frequency of point rainfall

Abstractions from Precipitation:
Different types of abstractions, Evaporation, Infiltration-process, measurement, infiltration capacity and indices.

Stream flow Measurement:
Measurement ofstage,velocity, area-velocity method, Stage-discharge relationship

Runoff:
Catchment characteristics, yield, flow duration curve, flow mass curve and sequent peak algorithm, Curve Number Method

Hydrograph:
Components, Base flow, effective rainfall, Unit hydrograph- application and Derivation, Method of superposition and S-curve.

Irrigation:
Definition, necessity, Benefits & ill effects of irrigation, types of irrigation & methods of irrigation

Water Requirements of Crops:
Soil water plant relationship, base period, crop period, duty and delta relationships, factors affecting Duty, G.C.A., C.C.A., intensity of irrigation, kor-watering, kor period, kor depth, cash crop, crop rotation, determination of Irrigation requirement of crops, irrigation scheduling, Assessment of irrigation water, irrigation efficiencies, consumptive use.

Canal Irrigation systems:
Classification of canals, Alignment, Different types of canals, Distribution system, Design of stable channels in India, Regime Channel, Kennedy's Theory, Use of Garret's diagram, Lacey's theory, Design procedure of irrigation channels, different types of lining and its construction.

Canal Falls:
Necessity. Location, Elementary concept of different types of canal falls. Design of a Trapezoidal notch fall.

Cross drainage works:
Type of cross drainage works, Design consideration of Cross Drainage Work (Aqueduct & Syphon Aqueduct)

Text Book

1. "Engineering Hydrology" by K. Subramanya; 4th Edition, Tata Mcgraw Hill publishing company ltd, New Delhi
2. "Irrigation Engineering & Hydraulic Structures" by S.K. Garg, Khanna Publishers

Reference Book

1. **"**Applied Hydrology" by V. T. Chow, D. R. Maidment & L. W. Mays, McGraw Hill Book Co, Singapore, 1988.
2. Water Resources Engineering by Larry W. Mays, Willy Student Edition-2001

CE 3010 WATER RESOURCES ENGINEERING-II Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. study flood frequency by using Gumbel and Log person type III Method.
CO2. explain the concept of hydrologic flood routing.
CO3. identify the sites for construction of reservoirs and dams.
CO4. determine the forces acting on gravity dam and design of gravity dam.
CO5. describe the types, causes of failure and criteria for safe design of earthen dam

Pre-requisite: Water Resources Engineering-I (CE 3009)

Flood:
Methods of estimation, Flood frequency studies (Gumbel's method, Log Pearson type III method), Design flood, Risk and reliability.

Flood Routing:
Basic equation, Hydrologic storage routing-Modified Pul's and Goodrich method, Hydrologic channel routing-Muskingham method of channel routing

Diversion Head works:
Concept of weir & barrage, Layout of diversion heads works, Theory of seepage, concept of Blight's creep theory, Lanes Weighted creep theory, Khosla'a theory on permeable foundation. Design of weir on permeable foundations.

Reservoirs:
Preliminary concept of reservoir planning, types of reservoirs, selection of site, Silting of reservoirs.

Dams:
Classification, Investigation, Site selection, economical height of dam.

Gravity dams:
Forces acting on gravity dam, structural stability of gravity dam, Elementary profile of a Gravity dam, High & Low gravity dam, Concept of design of gravity dam, Construction of Galleries, joints, foundation treatment of gravity dam.

Earth Dams:
Types of earth dams, causes of failure of earth dams, criteria for safe design of earth dams, determination of phreatic line and flow net, measures to control seepage through earth dams and their foundations.

Spillways:
Types and Description, Design Aspects of Ogee of spillways.

Text Book

1. "Engineering Hydrology" by K. Subramanya; 4th Edition, Tata McGraw Hill, New Delhi
2. "Irrigation Engineering & Hydraulic Structures" by S.K. Garg, Khanna Publishers

Reference Book

1. "Applied Hydrology"by V. T. Chow, D. R. Maidment & L. W. Mays, McGraw Hill Book Co, Singapore, 1988.
2. "Water Resources Engineering" by Larry W. Mays, Willy Student Edition-2001

CE 3011 GEOTECHNICAL ENGINEERING-I Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. identify the soil types and classify based on index properties.
CO2. evaluate the capillarity and permeability characteristics of soil strata.
CO3. determine the seepage pressure in soil due to ground water using graphical method.

CO4. determine effective stress under various conditions to lead failures of hydraulic structures by piping and remedial measures.
CO5. determine various shear strength parameters of soil.
CO6. evaluate the compaction methods and field compaction control.
CO7. determine the long term settlement of foundations based on consolidation theory.

Pre-requisite: Nil

Introduction and Classification:
Definition of soil, origin & formation of soil, General types of soil and soil deposits, Cohesive and cohesion less soils. Basic definitions, Relationship & inter-relationships. Index properties of soils & their determination. Classification base on grain size and plasticity characteristics.

Permeability of soils:
Darcy's law and its range of validity, Discharge velocity, Seepage velocity Laboratory determination of Co-efficient of permeability (K):-constant head permeability, Falling head permeability. Indirect determination of K, Factors affecting permeability, Permeability of stratified soils, Co-efficient in an inclined direction.

Effective stress principle:
Nature of effective stress, Effect of water table fluctuation on effective stress. Effective stress in a soil mass under different hydraulic conditions, Increase in effective stress due surcharge. **Capillarity of soil and capillary zones**. Effective stress in soils saturated by capillary action, Seepage pressure, Effective stress under steady seepage conditions, Quick Sand Condition.

Seepage analysis:
Laplace's equation ,Stream and Potential Functions, flow net, characteristics of flow net, graphical method, flow net for anisotropic soils, flow net in non-homogeneous soil mass, uses of flow net.

Shear strength:
Basic concept, Mohr-coulomb-failure criteria. Methods of determination of shear strength parameters: Shear tests-Direct shear test, Triaxial compression test, Unconfined compression test, Vane shear test; advantage and disadvantage of direct shear and triaxial compression test, advantages of unconfined compression test and vane shear test.
Compaction of Soils:
Objects, Measurement of compaction: Determination of OMC & MDD by standard & modified proctor compaction test. Factors affecting compaction, Zero air voids line, field compaction control using of proctor - Needle.

Consolidations of Soils:
Introduction, Principles of consolidation, soil spring analogy, consolidation characteristics of laterally confined soil, pressure void ratio diagram, Normally consolidated and over consolidated soils, Estimation of reconsolidation pressure, Terzaghi's theory of one dimensional consolidation, Laboratory consolidation test, Determination of coefficient of consolidation, Consolidation settlement.

Text Book

1. "Soil Mechanics & Foundation Engineering" by B.N.D Narasinga Rao, Wiley India Pvt Ltd, New Delhi, 1st Ed 2015
2. "Soil Mechanics & Foundation Engineering" by B. C. Punmia, Ashok K. Jain & Arun Kumar Jain, 4th Edition, Laxmi Publication, New Delhi.

Reference Book

1. “Principle of Geotechnical Engineering” by B. M. Das & Khaled , 8th Edition, Global Engineering USA .
2. "Basic and applied soil mechanics" by Gopal Ranjan & A. S. R. Rao, New age international publication, 2012
3. “Soil Mechanics and Foundation Engineering” by K. R. Arora, Standard Publisher, 2012
4. “Soil Mechanics and Foundation Engineering” by V.N.S. Murthy, CBS Publisher, 2012

CE 3013 CONSTRUCTION PLANNING AND MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify different aspects of DPR preparation.
CO2. optimize the cost and time of a Project by using CPM & PERT Techniques.
CO3. optimize resources in a project.
CO4. describe material procurement method and control for a project.

Pre-requisite: Nil

Construction Management:
Objective and function of Construction Management, Stages in Construction, Work Break Down Structure, Construction planning, Scheduling & monitoring, Bar charts. Elements of Network, Network rules, Critical path analysis of CPM network, Activity times & floats, Optimization through CPM technique, Program Evaluation & Review Techniques (PERT) & its three time estimates.

Contracts:
Essentials of Contract, Various types of Contract, General conditions and principles, Methods of tendering, Earnest Money, Security Money, Arbitration, Termination of Contract.

Construction equipment:
Selection of construction equipment, Cost of owning and operating, Engineering fundamentals of equipment, Excavating & transporting equipments, Hauling & conveying equipments.

Text Book

1. "Construction Planning & Management", by U. K. Shrivastava, Galgotia Publications Pvt. Ltd, May 2010
2. "Construction Project Management" by Kumar Neeraj Jha, Pearson Education

Reference Book

1. "Basics of Construction Management" by Ajay Kumar Singhal, Skill Enhancement Academy
2. "Construction Planning & Management", by P.S. Gahlot and B.M. Dhir, New Age International (P) Limited Publishers,2012
3. "Construction Planning & Management", by Dr. A. K. Jha, Pearson Publication.
4. "Estimating and costing", by Dr. B. N. Dutta, UBSPD, 2013
5. "Construction Management & Planning", by B. Sengupta & H.Guha, TMH Education (P) Ltd, New Delhi
6. "Construction Planning Equipment and methods", by R.L. Peurity, McGraw-Hill Publishing Company, 2011
7. "Construction Planning and Plant", by A. J. Ackerman & C. H. Locher, McGraw Hill Company,1940
8. "Construction Equipment and its Planning and application", by M. Verma, Metropolitan Book Co. 1975.
9. "Civil Engineering Contracts and Estimating", by B. S. Patil & Orient Logman Ltd New Delhi
10. "Construction Planning & Managemen", by B.C. Punmia, laxmi Publications

CE 3014 **GEOTECHNICAL ENGINEERING-II** **Cr-3**

Course Outcome : At the end of the course, the students will be able to:

CO1. determine the vertical stress distribution on horizontal and vertical plane below the ground surface due to various shapes of footings.

CO2. evaluate the bearing capacity of shallow foundations founded in soil.

CO3. select type of pile foundations based on the soil type and its geotechnical design.

CO4. identify type of earth pressures behind retaining structures.

CO5. identify failure mechanisms of cuttings and embankment using slope stability analysis.

CO6. select appropriate soil exploration methods in geotechnical engineering.

Pre-requisite: Geotechnical Engineering-I (CE 3011)

Bearing Capacity of Shallow Foundations:
Introduction, Rankine's analysis for cohesion less soils, Terzaghi's bearing capacity equation, Factors influencing bearing capacity of soil including effect of water table , size of footings and eccentricity of loading, plate load test, Selection of type of foundations, Depth of foundation, Floating Foundation

Pile Foundations:
Classification of piles, Load carrying capacity of single piles by static and dynamic formulae (Hilley's and Engineering News formula) Group action of piles, Negative skin friction.

Earth Pressure and Retaining Structures:
Active & passive earth pressure, Rankine's theory for active and passive earth pressure, Coulomb's theory Pressure against solid retaining walls without and with uniformly distributed load surcharge, Effect of submergence.

Stability of Slopes:
Stability of infinite slopes, Swedish, slice method and friction circle method of analysis, stability of homogeneous finite earth slopes without surcharge with steady seepage and under sudden drawdown condition.

Site Investigations:
Methods of exploration, Preservation,. standard penetration test and static cone penetration test.

Text Book

1. Foundation Engineering - Geotechnical Aspects" by P.C. Varghese, 11th Printing, 2014, PHI Learning Pvt Ltd, New Delhi.
2. Principles of Foundation Engineering" by B.M.Das, 7th Edition, Cengage Learning India Pvt. Ltd, New Delhi.

Reference Book

1. "Foundation Analysis and Design" by J. E. Bowles, TMH Education, New Delhi.
2. "Basic and applied soil mechanics" by Gopal Ranjan & A. S. R. Rao, New age international publication, 2012.
3. "Soil Mechanics and Foundation Engineering" by K. R. Arora, Standard Publisher, 2012.
4. "Soil Mechanics and Foundation Engineering" by V.N.S. Murthy, CBS Publisher, 2012.

CE 3021 ADVANCED SOLID MECHANICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand different theories of failure
CO2. determine stress at any point in cross section of unsymmetrical bending
CO3. analyze curved beams and thin walled cylinders
CO4. determine stresses in beams due to thermal loading

Pre-requisites: Solid Mechanics (CE 2003) and Structural analysis I (CE 2004)

Theories of failures:
Maximum principal stress theory, Maximum shearing stress theory, Maximum strain theory, Total strain energy theory, Maximum distortion energy theory, Octahedral shear stress theory.

Unsymmetrical bending:
Symmetrical and unsymmetrical bending, Stress at any point in cross section, Determination of stress in beams with unsymmetrical section.

Flexural and Shear Centre:
Shear centre for symmetrical and un-symmetrical section.

Thick Walled Cylinders:
Lame's theory of thick walled cylinders.

Thermal Analysis:
Thermo-elastic stress and strain relation, Equation of equilibrium, Stresses in beams due to thermal loading.

Text Book

1. "Strength of Materials, Part 2", by S. Timoshenko, 3rd Edition, CBS Publishers and Distributors Pvt. Ltd.

Reference Book

1. **"**Advanced Mechanics of Material", by A. P. Boresi & R. J. Schmidt, 6th ed., Wiley, 2003.

CE 3023 CONCRETE TECHNOLOGY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify different types of concrete and its properties.
CO2. determine strength and durability of concrete.
CO3. design concrete mixes for the given conditions.
CO4. select types of admixture and special concrete for given condition.

Pre-requisite: Civil Engineering Materials & Construction (CE 2007)

Concrete Materials:
Types of material, cement types, testing of materials.

Concrete:
Workability, Factors affecting workability, type of tests.

Strength of concrete:
Water cement ratio, gain of strength with age, effect of maximum size of aggregate, relationship between compressive and tensile strength, high strength concrete, high performance concrete.

Elasticity, shrinkage and creep of concrete.

Durability of concrete:
Permeability, carbonation, sulphate attack, alkali-aggregate reaction, chloride attack.

Concrete Mix design:
Concept & types, example.

Destructive and non destructive testing of hardened concrete.

Admixtures

Special Concrete:
Lightweight Concrete. High density concrete. Hot weather and cold weather concreting, Polymer concrete, Fibre reinforced concrete, Self compacting concrete.

Text Book

1. "Concrete Technology" by M. S. Shetty, 4th Edition, S. Chand Publisher, New Delhi.
2. "Concrete Technology", by M. L. Gambhir, McGraw Hill Education, New Delhi, 2013.

Reference Book

3. "Properties of concrete", A.M. Neville, 4th Edition, Pearson Education Pvt. Ltd., New Delhi.
4. "Concrete Technology" by S. Bhavikati, I. K. International Pvt.Ltd.

CE 3027 ENGINEERING GEOLOGY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. acquire the knowledge of the most important rocks and minerals
CO2. understand the relationship between rocks and engineering
CO3. understand weathering as they influence civil engineering works
CO4. understand mass movement as they influence civil engineering works
CO5. understand the role of geology in the design and construction process of underground opening in rocks.
CO6. apply geology concepts and approaches on rock engineering projects
CO7. identify and classify soil and rock using basic geological classification system.

Pre-requisite: **Nil**

General Geology:
Branches and scope of geology, Earth, its position in the solar systems, surface features and internal structure, work of natural agencies like lakes, oceans, atmosphere, wind, streams, sea, glacier, earth movements. Types of weathering, mountains and mountain building.

Mineralogy:
Definition of crystal and a mineral, the study of the physical properties and occurrence of quartz, Feldspar, Mica, Kyanitie, calcite, tale, corundum, gypsum, fluorite, biotite, mus, covite, graphite, realgar, magnetite, limonite, pyrite , galena, barite dolomite, garnet, tourmaline, chalcopyrite, opal, topaz, autite, hornblende, epidate, kaolinite, diamond.

Petrology:
Formation and classification of rocks into three types, igneous, sedimentary and metamorphic rocks, description of physical properties for constructional purposes of granite, pegmatite, dolerite, gabbzo, basalt, sandstone, conglomerate, breccias, limestone, shale, schist, marble, quartzite, khondalite, slate, gneiss, and esite, stratigraphy of India(a general idea),principles of correlation, fossils, their preservation and significance.

Structural geology:
strike and dip, out crops, volcanoes, overlaps, inliers and outliers, types classification of folds, faults, joints, unconformities, surface mapping, identification of potential zones of weakness or failure, analysis using stereonetes.

Earthquakes and landslides:
Classification, causes and effects of earthquakes and landslides, seismic curve, seismographs, seismograms, accelograms, seismic problems of India, seismic zones of India, remedial measures to pr3event damage for engineering structures, case histories.

Geological investigation:
Interpretation of geological maps, use of aerial maps in geological surveying, geophysical methods as applied to civil engineering for subsurface analysis (Electrical and seismic methods).

Geology of dams and reservoirs:
Types of dams, requirements of dam site, preliminary and detailed geological investigations for a dam site, important international and Indian examples of failures of dams and their causes, factors affecting the seepage and leakage of the reservoirs and the remedial measures, silting of reservoirs.

Rock mechanics and tunneling:
Purposes of tunneling and geological problems connected with tunneling, geological considerations in road alignment, roads in complicated regions problems after road construction, geology of bridge sites.

Text Book

1. "Engineering Geology", by Parbin Singh, S.K.Kataria and Sons, 2009

Reference Book

1. "Structural Geology", by H. P. Billings, Prentice Hall Publishers, Third edition

CE 3029 ENVIRONMENTAL IMPACT ASSESSMENT & AUDITING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify the roles of EIA and environmental audits;
CO2. prepare an EIA Report required to evaluate the environmental sustainability of any project.
CO3. conduct an environmental audit and evaluate its result.

Pre-requisite: **Nil**

Evolution of EIA; EIA at project; Regional and policy levels; Strategic EIA; EIA process; Screening and scoping criteria; Rapid and comprehensive EIA.

Specialized areas like environmental health impact assessment; Environmental risk analysis; Economic valuation methods; Cost-benefit analysis; Expert system and GIS applications; Uncertainties; Practical applications of EIA; EIA methodologies; Baseline data collection; Prediction and assessment of impacts on physical, biological and socio-economic environment.

Environmental management plan; Post project monitoring, EIA report and EIS; Review process.
Case studies on project, regional and sectoral EIA; Legislative and environmental clearance procedures in India and other countries, Sating criteria; CRZ; Public participation.
Resettlement and rehabilitation. Environmental auditing.

Text Book

1. "Introduction to Environmental Impact Assessment: A Guide to Principles and Practice", by B. M. Noble, Oxford University Press, USA, 2005.
2. "Introduction to Environmental Impact Assessment: Principles, and Procedures, Process, Practice and Prospects (The Natural and Built Environment Series"), by J. Glasson, Routledge; 3rd edition, 2005.

Reference book

1. "Methods of Environmental Impact Assessment (The Natural and Built Environment Series)" , by P. Morris, 2nd edition, Spon Press, USA, 2001.
2. "Environmental Assessment", by R. K. Jain, L. V. Urban, G. S., Stacey, Harold, E. Balbach, 2 edition, McGraw-Hill Professional; 2001.

CE 3031 RAILWAYS ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. explain & design permanent waterway
CO2. perform geometric design of railway track
CO3. design signaling system.

Pre-requisite: Transportation Engineering (CE 2016)

Introduction to Railway Engineering :
History of Railway Lines, Role of Indian Railways, Development of Railways in India, Classification of Railway Line (by tonnage, gauge length, speed on railway line).

Alignment of Railway Lines: Ideal requirements of Alignment, Factors affecting alignment, Preliminary surveys and Engineering surveys on Alignment.

Permanent Way:
Introduction to Permanent Way of a railway line, Requirements of Ideal Permanent Way, Cross sections, Forces acting on track, Coning of wheels and its Advantages and Disadvantages, Functions of rail, Defects in rail, Creep of rail, Theories on Creep, Measurement and Prevention of Creep, Sleeper, Types of Sleepers, Functions of Sleeper, Sleeper Density, Fastenings and Joints, Requirements of Ideal Rail Joints, Requirements of Ideal Fastening, Types of Fasteners and Joints, Fish Plates, Elastic Fastening, Types of Elastic Fastening, Criteria for determining length of rails, Ballast, Functions of Ballast, Characteristics of Good Ballast, Minimum depth of Ballast Cushion, Sub-grade and Formation, Slopes of Formation.

Geometrical Design of Railway Tracks :
Necessity of Good Geometric Design, Causes of Derailment, Gradients and Types of Gradients, Grade Compensation on Curves, Degree of a Curve, Super elevation on Curves or Cant, Equilibrium Super elevation for different Gauges, Safe speed on Curves, Negative Super elevation, Transition Curve and its Objectives of Providing Transition Curve, Shift, Length of Vertical Curves, Widening of Gauges on Curves.

Rolling Stock :
Types of traction, Locomotives and other rolling stock, Resistance due to friction, Wave action, Wind resistance, Curvature Stresses, Stresses at Starting and Stopping, Tractive effort of Locomotive, Hauling Power of Locomotive.

Railway Stations and Yards :
Purpose, Site Selection, Facilities, Requirements, Classification, Platforms, Types of Yards, Catch sidings, Ship Sidings, Foot Over Bridges, Subways, Cranes, Weight Bridge, Loading Gauge, Loading Ramps, Locomotive Sheds, Ash Pits, Water Columns, Turntable, Triangles, Traverser, Carriage Washing Platforms, Buffer Stop, Scotch Block, Derailing Switch, Sand Hump, Fouling Mark.

Points & Crossings:
Necessity of point and crossings, turnout, left hand turnouts and right hand turnouts, point of switches and its component parts, crossings and its component parts, number of crossing and angle of crossing.

Signaling and inter locking:
Objects of signaling, classification and types of signals, centralized traffic control system (CTC), automatic train control system (ATC), track circuiting. Necessity and functions of interlocking, methods of interlocking, mechanical device for interlocking

Track Drainage:
Sources Of Moisture In Railway Track, Significance & Requirements Of Track Drainage, Drainage Systems, Cross Drainage.

Safety in Railways:
Railway Accidents & Derailments- Classification, Causes & Prevention, Duties Of Railway Staff In Serious Accidents, Emergency Restoration Of Railway Traffic.

Administration & Modern Developments In Railways:
Indian Railway Administration & Railway Expenses, Rates & Fares, Modernization of Track, Traction, High & Super High Speeds, Miscellaneous Developments

Text Book

1. "A Text book of Railway Engineering" by S.C. Saxena and S.P. Arora, Dhanpat Rai Publications, New Delhi.

Reference Book

1. "Railway Engineering" by Satish Chandra and M.M. Agarwal, Oxford University Press, New Delhi.
2. "Railway Engineering" by B.L. Gupta and Amit Gupta, Standard Publishers and Distributors, New Delhi.
3. "Indian Railway Track" by M.M. Agarwal, Standard Publishers and Distributors, New Delhi.
4. "Railway Engineering" by S.C. Rangwala, Charotar Publishing House Pvt. Ltd., Anand, Gujarat.

CE 3033 GROUND WATER HYDROLOGY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. explain groundwater concept and construction of shallow and deep well.
CO2. analyze well hydraulics for steady and unsteady flow in aquifer.
CO3. identify modern methods of groundwater exploration.
CO4. explain the concept of ground water pollution and management.

Pre-requisite: **Nil**

Hydrologic cycle, Water balance, Occurrence of ground water: Origin, geological formations as aquifers, type of aquifers, groundwater basins, springs.

Darcy's Law, validity of Darcy's Law permeability, laboratory and field measurement of permeability, groundwater Flow lines.

Well Hydraulics, steady flow to a well, steady radial flow to a well in confined aquifer and unconfined aquifer, unsteady radial flow into a confined aquifer, Non equilibrium Theis equation, Theis method of solution, multiple well system.

Methods of constructions of deep and shallow wells: The percussion (or cable tool) method of drilling, Direct circulation hydraulic rotary method, Down the hole hammer method, well logs-receptivity logging, testing of wells for yield.
Surface and Subsurface investigations of groundwater, Geophysical exploration, Electrical resistivity method, aerial photo interpretation, remote sensing applications to ground water exploration, test drilling.
Artificial recharge by water spreading, through pits and shaft, recharge through other methods.

Groundwater management: Concepts of Basin management, Equation of hydrologic equilibrium, groundwater basin investigations, conjunctive use of surface and groundwater.

Text Book

1. "Groundwater Hydrology", by D. K. Todd, John Wiley and Sons.

Reference Book

1. "Groundwater and Tube Wells", by S. P. Garg, Oxford and IBH Publishing Co., New Delhi.
2. "Hand book of Applied Hydrology", by V. T. Chow, McGraw-Hill Publishing Company, New York.
3. "Ground Water", by H. M. Raghunath, New Age International Publishers; 3rd edition, Dec 2007.

CE 3035 HYDRAULIC MACHINES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. acquire fundamental knowledge on effect of hydrodynamic force on various types of vanes
CO2. understand hydro-electric power stations
CO3. understand the concepts of the working and design aspects of hydraulic machines like turbines and pumps
CO4. design various components of pumps and turbines
CO5. understand the working principle of miscellaneous hydraulic machines like press, accumulator, crane etc.

Pre-requisites: **Fluid Mechanics-I (CE 2011) and Fluid Mechanics-II (CE 2014)**

Impact of Jets:
Force exerted by the jet on Stationary Vertical plate, Moving plates, Series of Vanes, Radial curved vanes.

Turbines :
Introduction to turbines, General Layout of a Hydro-electric Power Plant, Classification of Heads and efficiency of a turbine, Pelton Wheel, Radial Flow Reaction Turbines, Francis Turbine, Axial Curves of flow Reaction Turbine, Draft tube, Specific Speed, Unit Quantities, Characteristic Curves of Hydraulic Turbines, Governing of Turbine.

Centrifugal Pumps:
Parts of Centrifugal Pump, Work Done by the Centrifugal Pump on water, Head and efficiency of Centrifugal Pump, Multistage Centrifugal Pumps, Specific Speed, Priming, Characteristic curves of Centrifugal Pumps, cavitations, suction lift, net positive suction head.

Reciprocating Pumps:
Parts Of Reciprocating Pump, Working of Reciprocating Pump, Slip of Reciprocating Pump, Classification, Variation of velocity and Acceleration in the suction and delivery pipe due acceleration of the piston, effect of variation of velocity on friction in the suction and delivery pipe, Indicator diagram, air vessels, Comparison between centrifugal and reciprocating Pumps.

Fluid System:
Hydraulic Press, Hydraulic accumulator, Hydraulic intensifier, Hydraulic Ram, Hydraulic Lift, Hydraulic Crane, Hydraulic Coupling, Hydraulic Torque converter, Air lift Pump, Gear-Wheel Pump.

Text Book

1. "Hydraulics & Fluid Mechanics" by P. N. Modi & S. M. Seth, 19th Edition, Rajsons Publication Private Limited.
2. "Fluid Mechanics & Hydraulic Machines" by R.K. Bansal, 9th Edition, Laxmi Publications, New Delhi.

Reference Book

1. "Fluid Mechanics & Hydraulic Machines" by Sukumar Pati, 1st Edition, Tata McGraw-hill Publication.
2. "Fluid Mechanics & Hydraulic Machines: Problems and Solutions" by K. Subramanya, 1st Edition, Tata McGraw-hill Publication.
3. "A text book of Hydraulic Machines" by R.K.Rajput, 5th Edition, S. Chand and Company Ltd. 1999

CE 3037 PAVEMENT ANALYSIS AND DESIGN Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. analyze & identify the engineering characteristics of pavement materials & to adapt ideal material that will fit engineering requirements of road works
CO2. explain the principles & factors affecting pavement design
CO3. design of flexible and rigid pavements using IRC, AASHTO and other important methods of design
CO4. optimally design pavement formation width components like carriageway, shoulder, drainage etc. and inspect performance of composite theoretically.

Pre-requisite: Transportation Engineering (CE 2016)

Stresses in Flexible Pavements:
Types of component parts of pavements, highway and airport pavements, materials used in pavement, layered system concepts, stress solution for one, two and three layered systems, fundamentals of design concepts, introduction to analysis using KENLAYER.

Stresses in Rigid Pavements:
Westergaard's theory and assumptions, stresses due to curling, stresses and deflections due to loading, frictional stresses, stresses in dowel bars and tie bars, introduction to stress analysis using KENSLAB.

Factors Affecting Pavement Design:
Variable considered in pavement design, classification of axle types, standard and legal axle loads, tyre pressure, contact pressure, ESWL, EWLF and EAL concepts, traffic analysis: AADT, growth factor, lane distribution factor, directional distribution factor and vehicle damage factor.

Design of Flexible Pavements:
IRC method of flexible pavement design, Asphalt Institute's methods with HMA and other base combinations, AASHTO method of flexible pavement design, design of flexible pavement shoulders.

Design of Rigid Pavements:
IRC methods of rigid pavement design, AASHTO method of rigid pavement design, design of rigid pavement shoulders.

Design of Pavement Drainage:
Detrimental effects of water, methods for controlling water in pavements, drainage materials: aggregates, geotextiles, pipes, estimation of inflow, determination of drainage capacity.

Text Book

1. Pavement Analysis and Design" by Y. H. Huang, Dorling Kindersley (India) Pvt. Ltd., New Delhi, India

Reference Book

1. "Principles of Pavement Design" by E. J. Yoder and M. W. Witczak, Wiley and Sons, New York, USA, 1975.
2. "Specifications for Roads and Bridge Works", Ministry of Road Transport and Highways, Indian Road Congress, New Delhi, India.
3. IRC: 37 (2012) "Guidelines for Design of Flexible Pavements", Indian Road Congress, New Delhi.
4. IRC: 58 (2011) "Guidelines for Design of Plain Jointed Rigid Pavements for Highways", Indian Road Congress, New Delhi.

CE 3039 PAVEMENT MATERIALS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify properties of aggregate and bituminous binders used in pavement.
CO2. Design and evaluate bituminous mixes for non stabilized and stabilized roads.
CO3. explain cement concrete, semi rigid, non conventional and new pavement materials.
CO4. evaluate different modern testing.

Pre-requisite: Nil

Introduction:
Types and Component Parts of Pavements, Highway and Airport Pavements, Materials used in Pavements.

Soil Properties:
Basic Soil Properties Relevant to Pavement Applications, Resilient Modulus, and Modulus Of Sub-Grade Reaction, Testing of Subgrade, Soil Stabilization.

Conventional aggregates:
Source, Physical Properties of Aggregates, Preparation, Grading and Blending, Testing and Their Evaluation.

Bitumen & Bituminous binders:
Basic Properties of Bitumen, Polymer and Rubber Modified Bitumen, Testing and Applications.

Bituminous mixes:
Design, Testing and Evaluation, Dynamic Modulus, Flow Time and Flow Number of Bituminous Mixes, Modeling of Bituminous Binders and Mixes.

Cement Concrete Pavement Materials:
Materials for Cement Concrete and Semi-Rigid Pavements, Design of Mixes for Stabilized Roads.

Flexible And Rigid Pavement Distresses:
Distresses in Pavements, Distress Survey, Pavement Maintenance other than overlay, Fog spray, Slurry seal and micro surfacing, Treatments of cracks and joints in Rigid pavement, Mud Jacking.

Non-conventional and new pavement materials:
Applications and Limitations of Non-Conventional Pavement Materials, Use of Geosynthetics and Other Materials in Pavements, Modern Methods of Testing and Evaluation of Paving Materials.

Text Book

1. “Principles of Transportation Engineering”, by P. Chakraborty and A. Das, PHI Publication, 1st Ed. 2nd reprint 2005.

Reference Book

1. “Principles of Transportation and Highway Engineering”, by G. V. Rao, Tata Mc. Graw Hill, 1st Ed. 1995.
2. “Principles of Traffic and Highway Engineering” by N.J.Garber, L.A.Hoel and R.Sarkar, Cengage Learning India Pvt. Ltd., First Indian Reprint 2009.
3. "Pavement Engineering: Principles and Practice", Rajib B. Mallick,Tahar El-Korchi, Second Edition, CRC Press
4. "Highway Engineering" by S. K. Khanna & C. E. G. Justo, 10^{th} Edition, Khanna Publishers, New Delhi.
5. “Manual for Construction and Supervision of Bituminous works”, by Indian Roads Congress, New Delhi, 2005.
6. Relevant IRC, ASTM and AASHTO codes and specifications.

CE 3041 TRAFFIC ENGINEERING AND TRANSPORTATION PLANNING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify the different aspects of traffic engineering
CO2. determine traffic RU characteristics at various sections of road
CO3. design traffic facilities
CO4. explain the concept of transportation planning
CO5. explain the economic evaluation of transportation plan.

Perquisite: Transportation Engineering (CE 2016)

Traffic Engineering:
Traffic Engineering-Definition, Functions & Importance; Road User Characteristics, Human Factors Governing Road User Behavior, Vehicle Characteristics, Slow Moving Traffic Characteristics In Indian Conditions**.**

Traffic Engineering Studies:
Traffic Volume & Occupancy Survey, Origin and Destination Studies, Speed, journey time and delay Measurements; Parking Studies, Use of Photographic methods in Traffic Survey, Fundamental relationships & diagrams in Traffic Engineering.

Highway capacity analysis:
Cases of different types of highways, Highway capacity; Design of Intersection; Parking types; Off street parking; Facilities.

Traffic control devices:
Channelization, rotary and Traffic signals, Traffic Signs and Road marking, Road Accidents.

Transportation Planning:
Brief ideas about urban and regional transportation systems; Components of transportation system planning, Planning Surveys, Trip generation and distribution, Traffic assignment and modal split, Optimal scheduling, Computer applications in Traffic Engineering & Transportation Planning.

Text Book

1. “Traffic Engineering & Transportation Planning”, by L. R. Kadyali, 4th Edition, Khanna Publishers

Reference Book

1. “Transportation Engineering and Planning”, by C. S. Papacostas and P. D. Prevedouros, 3rd Edition, PHI
2. “Transportation Engg: An introduction”, by C. J. Khisty & B. K. Lall, 3rd Edition, PHI, 2006.
3. “Principles of Transportation Engg”, by P. Chakraborthy and A. Das, 1st Edition, 2nd reprint 2005. PHI
4. "Modelling Transport", Juan de Dios Ortúzar, Luis G. Willumsen, 4th Edition, Wiley
5. "Highway Engineering" by S. K. Khanna & C. E. G. Justo, 10th Edition, Khanna Publishers, New Delhi.

CE 3070 FUNDAMENTALS OF PROJECT MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. apply concepts to address specific management needs at the individual, team, division and/or organizational level
CO2. formulate strategies allowing organizations to achieve strategic goals
CO3. apply team-building skills
CO4. investigate complex business problems to propose project-based solutions
CO5. manage creative teams and project processes effectively and efficiently.

Pre-requisite: **Nil**

Introduction:
What is Project and Project Management, Role of a Project Manager, The Project Life Cycle, Characteristics of the Project Life Cycle, Project Phases.

Project Management Process:
Project Management Process Groups, Initiating Process, Planning Process, Executing Process, Monitoring and Controlling Process, Closing Process.

Project Management Knowledge Areas:
Introduction, Integration Management, Scope Management, Time Management, Cost Management, Quality Management, Human Resource Management, Communications Management, Risk Management, Procurement Management.

Text Book

1. A Guide To The Project Management Body Of Knowledge *(Pmbok® Guide)*—Fourth Edition

Reference Book

1. Project Management, The Managerial Process, The McGraw-Hill Company, Clifford F. Gray, Erik W. Larson

CE 3072 BIOREMEDIATION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the fundamentals of microbial bioremediation and its feasibility as well as significance overconventional treatment technologies.
CO2. analyze & identify the various aspects of bioremediation like biodegradation of contaminants and pollutants, bioconversion including the genetic aspects of contaminant degradation.
CO3. design of bioremediation systems or methods for soil, liquid and slurry phase remediation.
CO4. optimally design hybrid need based remedial systems for better desired output.

Pre-requisite: **Nil**

Bioremediation Principles:
Introduction about Bioremediation, Current Bioremediation Practices and its Application to Green Environment.

Bioremediation Systems and Processes:
Solid, Liquid and Slurry phase bioremediation.

Factors influencing bioremediation:
Environmental, Physical and Chemical factors Influencing Bioremediation Process.

Genetics of Bioremediation:
Genetic responses of microorganisms to the presence of pollutants: Plasmid coded inducible degradative enzymes; Microbial transformation reactions: Aerobic and Anaerobic Biotransformation.

Applications of Bioremediation:
Application of genetically engineered microorganisms for hazardous waste management; Microbial detoxification of specialty chemicals (insecticides, herbicides, fungicides, polychlorinated biphenyls, heavy metals); Microbial cleaning of gases: biofiltration and bioscrubbing.

In-situ Bioremediation: .
Current advances on in-situ bioremediation practices, Laboratory stage bio-treatability studies for bioremediation; Management of bioremediation projects

Text Book

1. "Microbial Bioremediation", by Rajedran, P., and Gunasekharan,P.,1st Edition, Mjp Publishers, India, 2011.

Reference Book

1. Baker, K H., and Herson, D. S., Bioremediation, McGraw-Hill Publishing Company, New York, 1994 .
2. Eweis, J. B., Ergas, S. J., Chang D. P. Y., and Schroeder E. D., Bioremediation Principles, McGraw-Hill Publishing Company, Singapore, 1998.
3. Cookson, J.T. Jr., Bioremediation Engineering – Design and Application, McGraw Hill Publishing Company, New York, USA, 1995.
4. Young, L.Y., and Cerniglia, C.E., Microbial Transformation and Degradation of Toxic Organic Chemicals, Wiley–liss Publishers, New York, USA, 1995.

CE 3074 CONSTRUCTION MATERIALS & SPECIFICATIONS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. know the various type of construction materials used for construction purpose.
CO2. know and understand the necessities of specifications of the materials with respect to quality and quantity for a construction work.
CO3. know the engineering specifications containing detailed description of all workmanship and materials for a complete project in accordance with plan and drawings.
CO4. know the specifications regarding the quality of workmanship to be achieved during construction..

Pre-requisite: **Nil**

Bricks:
Classification, Methods of brick manufacture, Testing of bricks.

Cement: .
Classification, Chemical composition, Cement manufacturing process, Tests on cement

Aggregates: .
Fine and coarse aggregates, Gradation of sand, Tests on aggregates

Concrete: .
Composition of concrete, W/C ratio, Nominal mix design, pozzolanic concrete, Light weight and high density concrete, Tests on concrete

Bituminous materials:
Manufacturing of Bitumen, Tests on bitumen, Grades of bitumen.

Geosynthetics:
Geo textiles, geogrids, geonets, geomembrane, geosynthetic clay liner, geocells, geo composites, Pre fabricated vertical drains, Applications of geosynthetic materials.

Reinforcement and Structural Steel:
Steel manufacturing process, Types of reinforcement steel and application, Grades of structural steel, Various types of standard sections.

Non structural materials :
Thermal insulation and acoustic absorption materials, Water proofing materials, Flooring materials.

Text Book

1."A Text Book of Building Construction" by Dr. S.K.Sharma, Revised Edition, S.Chand Publication, 1987.
2."Building Material" by S.S.Bhavikatti, 1st Edition, Vikas Publication.

Reference Book

1 “Building Material” by M. L. Gambhir, 1st Edition, TMH Education, New Delhi.
2 “Building Construction” by B. C. Punmia, Jain & Jain, 10th Edition, Laxmi Publication, New Delhi.
3.“Building Material” by P. C. Verghese, PHI Learning (P) Ltd., New Delhi, 2005
4."Engineering Materials" by S.C.Rangwala, Charotar Publishing House, 2011.

CE 3076 TROPICAL HYDROLOGY & WATER RESOURCES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. check the consistency of rainfall data and calculate the probability of rainfall over a given return period.
CO2. determine the evaporation evapo-transpiration and rate of infiltration.
CO3. apply the concept of various stream flow measurement methods and derive unit hydrograph, synthetic and instantaneous unit hydrograph.
CO4. determine flood discharge using probability distribution functions
CO5. analyze flood routing in reservoir and channel

Pre-requisite: **Nil**

Introduction:
Hydrologic cycle, Water-Budget Equation and Applications in Engineering.

Precipitation:
Forms and weather systems for precipitation, Characteristics of precipitation in India, Measurement, preparation & presentation of rainfall data, mean precipitation, DAD Curves and Frequency of point rainfall.

Abstractions from precipitation:
Evaporation, Evapotranspiration, Infiltration-process, measurement, infiltration capacity and indices.

Stream flow Measurement:
Measurement ofstage,velocity, area-velocity method, Stage-discharge relationship.

Runoff:
Catchment characteristics, yield, flow duration curve, flow mass curve and sequent peak algorithm.

Hydrograph:
Components, Base flow, effective rainfall, Unit hydrograph- application and Derivation, Method of superposition and S-curve,
Flood:
Methods of estimation, Flood frequency studies (Gumbel's method, Log Pearson type III method), Design flood, Risk and reliability.

Flood Routing:
Basic equation, Hydrologic storage routing-Modified Pul's and Goodrich method, Hydrologic channel routing-Muskingham method of channel routing, hydraulic flood routing.

Flood Control works:
Flood flows, types of flood control works.

Erosion & Reservoir Sedimentation:
Erosion process, Estimation, Channel Erosion, Reservoir Sedimentation, Trap Efficiency, Density Current, Life of reservoir.

Text Book

1. "Engineering Hydrology" by K. Subramanya; 4th Edition, Mc. Graw Hill, New Delhi

Reference Book

2. "Applied Hydrology" by V.T.Chow, D.R.Maidment & L.W.Mays, McGraw Hill Book Co, Singapore, 1988

CE 4020 PAVEMENT MANAGEMENT SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. evaluate the various aspects of pavement management
CO2. evaluate pavement roughness
CO3. understand various techniques of rehabilitation of pavement

Pre-requisite: Transportation Engineering (CE 2016)

Introduction:

Importance of Pavement Management Systems (PMS), Components of PMS and their activities; Application of PMS, Pavement Investment Planning, Analysis, Evaluation & Selection of Pavement Design Strategies, Major steps in implementing PMS- Inputs; Design, Construction and Maintenance; Rehabilitation and Maintenance Management Systems, Preventive Maintenance, Recent developments in PMS.

Evaluation of pavements:
Factors affecting pavement performances, Techniques for functional and structural evaluation of pavements: Devices adopted, Serviceability Concepts; Structural Number And Energy Concepts- Need For Conditioning And Strengthening, Visual Rutting, Distress models & material characterization for flexible & rigid pavements, Pavement Deflection – Different Methods and BBD, Skid Resistance, Roughness, Evaluation of pavement safety, Pavement Performance Modeling Approaches and Methods of Maintaining WBM, Bitumen and Cement Concrete Roads, Quality Assurance; Quality Control – ISO 9000.

Pavement roughness:
Measurement of profile, tolerance standards in quality control, waves and deformations, Measurement of rebound deflection, roughness index, Effect of traffic, fuel, chemicals and environmental conditions, Recent techniques for measuring road roughness.

Pavement rehabilitation:
Pavement rehabilitation techniques: Overlay- types, design & construction procedures; Economics of overlays; Recycling of flexible and rigid pavements.

Pavement distress & maintenance:
Distresses in Pavements, Distress Survey, Pavement Maintenance other than overlay, Fog spray, Slurry seal and micro surfacing, Treatments of cracks and joints in Rigid pavement, Mud Jacking.

Text Book

1. "Pavement Evaluation and Maintenance Management System", R Srinivasa Kumar**,** Universities Press (India)

References Book

1. "Modern pavement management", Ralph Haas, W. Ronald Hudson, John P. Zaniewski, Krieger Pub Co
2. "Pavement Engineering: Principles and Practice",Rajib B.Mallick, Tahar El-Korchi, Second Edition, CRC Press
3. "PavementManagement Airports, Roads & Parking Lots", M.Y.Shahin, 2nd edition, Springer Publication.
4. "Pavement Analysis and Design", Y. H. Huang, 2nd edition, Pearson Education
5. "The Design and Performance of Road Pavements", D. Croney & P. Croney, 3rd Edition, McGraw Hill Professional.
6. "Deterioration and Maintenance of Pavements", Derek E. Pearson, ICE Publishing
7. "Principles Of Transportation Engineering", Partha Chakroborty, Animesh Das, 1st Edition, PHI Learning Private Limited-New Delhi.
8. Relevant AASHTO/ IRC and other Codes and Specifications

CE 4027 ADVANCED STEEL DESIGN Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. design and detailing of gantry girder and roof truss using limit state method
CO2. design of steel member using cold formed light gauge steel
CO3. design and detailing of power transmission tower, steel chimney and water tank using working state method.

Pre-requisite: **Design of Steel Structure (CE 3007)**

Design of Gantry girder.
Design of cold formed light gauge steel beams and columns.
Design of roof truss.
Design of power transmission tower
Design of water tankwith staging.
Design of self supported steel chimney.

Text Book

1. "Design of Steel Structures V-II", by S. Ramchandra, Standard pub.
2. Design of steel Structures (LSM)", by S.K Duggal Mc Graw Hill Education pvt Ltd.

Reference Book

1. "Design of Steel Structure", by N. Subramanian, 2nd edition, Oxford publication.
2. "Design of Steel Structure" by K. S. Sai Ram, Pearson Education Pvt. Ltd, New Delhi.
3. "Design of steel structure", by S.S Bhavikatti, I.K I Publishers.
4. "Design of steel structure", by Gaylord & Gaylord., TMH publication, 3rd edition, 2010.

CE 4029 DISASTER MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. explain causes of different natural disasters.
CO2. identify appropriate rehabilitation and retrofitting technique for structures.
CO3. identify different management techniques during disasters.

Pre-requisite: Nil

Cyclones: Formation, Cyclonic precipitation, anti-cyclones.
Flood: Flood and its estimation, Flood warning, Flood protection measures.
Earthquake:
Causes of earthquake, plate tectonics, seismic zoning map, Characteristics of strong ground motions & attenuation, damage assessment
Rehabilitation and retrofitting of structures
Environmental disaster: Impact assessment studies, computation and preparedness.
Disaster management: Developing appropriate technology for disaster mitigation, Role of management teams, importance of awareness, alertness and preparedness camp

Text Book

1. "Earthquake resistant building construction", N. Sharma, S. K. Kataria & Sons, New Delhi.

Reference book

1. "Engineering Hydrology", K. Subramanian, Tata McGraw Hill, New Delhi.
2. "Elementary Hydrology", V. P. Singh, Prentice Hall of India.
3. "Disaster Mitigation, Preparedness, Recovery and Response", V. P. Singh, SBS Publishers & Distributors Pvt. Ltd. Heinemann.
4. "Practical Guide to Environmental Management", F. B. Friedman, McGraw Hill.

CE 4030 MACHINE FOUNDATION ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand basic theory of vibrations of Single Degree of Freedom systems
CO2. analyse and design problems related to machine foundations
CO3. determine the stiffness and damping constants of different types of foundations
CO4. determine the response of machine foundations under the effect of different types of dynamic loading.

Pre-requisites: Geotechnical Engineering I (CE 3011) and Geotechnical Engineering II (CE 3014)

Vibration of elementary Systems:
Vibration motion, vector representation of harmonic motion, Single degree of freedom system: Free Vibrations- damped and undamped, Forced Vibrations – damped and undamped.

Dynamics of soil-foundation System:
Types of machine foundation, design criteria, dynamic loads, physical modeling and response analysis, Barken's approach, Ford & Haddow's analysis, Hammer foundation, I. S. Codes.

Dynamic soil testing techniques:
Cyclic plate load test, block vibration test, shear modulus test, geophysical methods, Resonance-column test, Two & three borehole techniques, Model tests using centrifuge and shake table, recent developments.

Vibration isolation and control:

Vibration transmitted through soil media, active and passive isolation, vibration isolation – rigid foundation and flexible foundation, method of isolation, properties of material and media used for isolation, vibration control of existing machine, foundation isolation by barriers.

Guidelines for design and construction of machine foundation:
Data required for design of reciprocating, impact and rotary type machines, guidelines for the design of different type machines, construction guidelines, guidelines for providing vibration absorbers.

Text and Reference Book

1. "Foundation for Machine", by S. Prakash, Wiley, 1988.
2. "Soil Dynamics and Machine Foundations", by Swami Saran, Galgotic Pulbication Pvt Ltd, New Delhi.
3. "Vibrations of Soil and Foundations", by Richard, Hall & Wood, Prentice Hall, June 1970
4. "Dynamics of Structures", by Anil K. Chopra Prentice Hall, 4th edition 2012.
5. "Vibration Analysis and Foundation Dynamics", by N. S. V. Kameswara Rao, S. Chand New Delhi.

CE 4032 STRUCTURAL ANALYSIS-III Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. apply the concept of energy theorems to determine the internal forces in structure.
CO2. determine absolute maximum internal forces due to rolling or moving loads of indeterminate structures from Influenced line Diagrams by Muller-Breslau principle.
CO3. perform plastic analysis of frame structure.
CO4. determine the internal forces in rigid joined plane frame, continuous beam, pin joined plane frame by flexibility and stiffness matrix methods.

Pre-requisites: Structural Analysis I (CE 2004) and Structural Analysis II (CE 3001)

Energy theorems:
Total potential Energy, Complimentary Energy, Simple examples.

Influence Line Diagrams for redundant structures:
Muller-Breslau Principle, Influence lines for bending moment, Shear force and reaction components for single redundancy.

Plastic Analysis:
Stress-strain relation for mild steel, rigid plastic theory, Behavior of fixed beam, Evaluation of fully plastic moments for double and mono symmetric sections, Upper bound and lower bound theorems, Application of upper bound theorems for beams and frames, Combinations of mechanisms with simple examples, Load interaction diagram, Characteristics of yield surface.

Matrix Analysis:
Direct flexibility and stiffness methods, Applicable to redundant beams and portal frames.

Text Book

1. "Structural Analysis-2", by S. S. Bhavikatti, Fourth edition, Vikas Publishing House Pvt, Ltd.
2. "Matrix Analysis", by Pandit & Gupta, TMH Education, New Delhi

Reference Book

1 "Indeterminate Structure", by J.S.Kinney, Addison Wesley Publication Co.
2 "Fundamental of Limit Analysis of Structure", by Manick Selvem, Dhanpat Rai Publication, 2012.

CE 4033 STRUCTURAL DYNAMICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: analyze single degree of freedom (SDOF) system for damped and undamped free vibration systems
CO2: analyze single degree of freedom system for damped and undamped forced vibration for harmonic, periodic, impulse and general dynamic loads
CO3: analyze multi degree of freedom (MDOF) system for damped and undamped free vibration systems
CO4: analyze Free and Forced vibration of distributed mass system of Beam

Pre-requisites: Solid Mechanics (CE 2003) and Structural Analysis-I (CE 2004)

Single degree of freedom system:
Equation of motion, Damped and undamped free vibration, Response to harmonic, Periodic, impulse load and general dynamic load, Duhamel's integral

Multi degrees of freedom system:
Equation of motion, Free vibration analysis, Dynamic response and modal analysis.

Free and Forced vibration of distributed mass system:
Beam.

Text Book

1. Dynamics of Structures: Theory and Applications to Earthquake Engineering", by A. K. Chopra, Prentice Hall of India.
2. "Earthquake resistance design of structures", by Pankaj Agarwal & Manish Shikhande, Prentice hall (PHI).

Reference Book

1. "Dynamics of structures", by R. W. Clough and J. Penzien, McGraw-Hill Inc.

CE 4044 GROUND IMPROVEMENT ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: apply the ground improvement technique using admixtures and advanced technique using grouting
CO2: identify the relevance of reinforcing elements to resist the lateral earth pressures
CO3: apply suitable techniques for the deep compaction of granular soils and improvement of cohesive soils
CO4: utilize ground anchors and soil nails for design of soil retained structures
CO5: identify methods to accelerate the consolidation settlement of cohesive soil using preloading methods and vertical drains.

Pre-requisites: Geotechnical Engineering- I (CE 3011) and Geotechnical Engineering II (CE 3014)

Introduction:
Need – methods – suitability – Mechanical modification: principle - Surface compaction: Field compaction and equipments, compaction specification and controls. Vibration methods: dynamic consolidation, vibratory rollers, Vibro floatation

Drainage methods:
Well point systems, deep well drainage, vacuum dewatering system, design of dewatering system – field permeability tests, dewatering by electro osmosis. Preloading, sand drains, wick drains- Thermal methods case studies

Chemical stabilization:
Cement stabilization- factors affecting soil cement mixing-admixtures- lime stabilization-effect of lime on soil properties construction of lime stabilized bases-bituminous stabilization- thermal stabilization- electrical stabilization.

Grouting:
Classification – Methods – Types – grouts – equipments, grouting design and layout, grout monitoring – applications – Case studies.

Earth Reinforcement:
Mechanism and concept- stress strain relationship of reinforced soil-design theories and stability analysis of retaining wall-tie back analysis-coherent gravity analysis- application areas of earth reinforcement.

Geotextiles:
Soil reinforcement with geotextiles- classification- concepts geotextiles as separators, filters, and drainage media-damage and durability of geotextiles.

Text Book

1. Geotechnical Engineering", by Shashi K Gulhati and Manoj Datta, 9th Reprint edition, TMH Education Pvt. Ltd.
2. "Ground Improvement techniques",by P. Purushothama Raj, Laxmi publications Pvt. L, 2005.
3. "Reinforced soil and its engineering application",by Swami Saran, Second Edition, I. K. International Publishing House Pvt. Ltd, 2011.
4. "Principle and Practice of Ground Improvement", by Jie Han,1st Edition, Wily Publication.

Reference Book

1. "Foundation Analysis and Design",by J.E.Bowles, MCGRAW-HILL Higher Education, 5 Edition 1997 .
2. "Soil Improvement techniques and their evolution", by Van Impe, CRC Press, Jan1989.

CE 4051 FLOOD AND DROUGHT ESTIMATION AND MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: learn about various estimation methods of flood
CO2: learn about different methods of flood control, monitoring and forecasting
CO3: learn about drought, drought assessment and monitoring

Pre-requisites: **Water Resources Engineering I (CE 3009) and Water Resources Engineering II (CE 3010)**

Flood Estimation:
Estimation of design flood- Empirical methods, envelope curve method, unit hydrograph method, flood estimation in small watersheds, urban catchment and influence of urban drainage.

Flood Control and Management:
Detailed study of various methods of flood control- flood plain identification, flood disaster monitoring and mitigation procedures, various methods of forecasting data, communication and warning, flood fighting.

Drought Classification:
Importance, definition-NCA classification, direct and indirect losses.

Drought Estimation:
Drought severity assessment, methods in meteorological, hydrological and agricultural aspects.

Drought Monitoring:
Supply and demand oriented measures, drought prone areas programme (DPAP), short term and long-term strategies, drought management.

Text Book

1. "Irrigation Engineering & Hydraulic Structures" by S.K. Garg, Khanna Publishers
2. "Engineering Hydrology" by K. Subhrmanya, TMH Education Pvt. Ltd, New Delhi

Reference Book

1. "Applied Hydrology", by VenTe Chow, David, R. Maidment, Lary, W. Mays.,McGraw Hill Publications, 1995.
2. "Elementary Hydrology", by Vijay P. Singh, Prentice Hall of India, 1994.
3. "Hydrology", H.M. Ragunath , by Wiley Eastern Ltd. 1996.
4. "Handbook of Applied Hydrology", by VenTe Chow, etal , McGraw Hill Publications,1995.

CE 4053 SOLID AND HAZARDOUS WASTE MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. classify solid wastes and understand the functional elements of solid waste management
CO2. understand the aspects of waste generation and its effects on public health and environment
CO3. identify the strategies for waste collection, storage, transport and disposal
CO4. select proper waste processing technique
CO5. identify proper ways of source reduction, product recycling and recovery of biological conversion products
CO6. explain various incineration technologies, estimate the energy generation potential of wastes and assess the environmental impacts of incineration
CO7. identify and classify hazardous wastes and select proper strategy for managing and treating them
CO8. understand the concepts of Integrated Waste Management

Pre-requisite: **Environmental Engineering – II (CE 3008)**

Introduction to Solid and Hazardous waste management:
Classification of solid waste – source-based and type-based. Functional elements of solid waste management.

Waste Generation aspects:
Waste generation and composition, Waste characteristics, Effects on public health and environment.

Waste collection, storage, transport and disposal:
Collection components, storage devices, collection operation, Transfer station, Waste collection system design, disposal options – sanitary landfill, landfill gas emission, leachate formation.

Waste Processing techniques:
Mechanical volume and size reduction, component separation, drying and dewatering.

Source reduction, product recycling and recovery of biological conversion products:
Basics of source reduction, Elements of recycling – source separation, drop-off, curbside programme, storage and collection of recyclables etc., Composting, Biogasification.

Incineration and energy recovery:
Incineration technologies, Energy recovery, Air emission and its control.

Hazardous waste (HW):
Management and treatment. Identification and classification of HW, Management strategies of HW, HW treatment – physical, chemical and biological.

Integrated Waste Management (IWM):
Characteristics of IWM, Planning for IWM, Implementation of IWM, Benefits of IWM. Introduction to life cycle assessment tool and its application in IWM.

Text Book

1. "Management of Municipal Solid Waste", by T.V. Ramachandra, Commonwealth of Learning, Canada and Indian Institute of Science, Bangalore, TERI Press, The Energy and Resources Institute, New Delhi, 2006.
2. "Integrated Solid Waste Management", by Tchobanoglous, Thisen & Vigil, McGraw Hill International.

Reference Book

1. "Solid Waste Management in Developing Countries", by A.D. Bhide, Nagpur publications
2. "Environmental Pollution Control Engineering", C.S. Rao, Wiley Eastern, Manual of solid waste of management, CPHEEO
3. " Hazardous Waste Management" by Lagrega, Buckingham & Evans, McGraw Hill International

CE 4057 DRAINAGE ENGINEERING AND DESIGN Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand, plan and design drainage of agricultural land
CO2. understand, plan and design urban drainage system.

Pre-requisite: Nil

Drainage of Agricultural Land:
Nature and extent of Drainage Problems; drainage Investigation; Steady and transient state drainage equations; Design, alignment, construction and maintenance of surface and subsurface drainage systems; Design, construction and maintenance of mole drains; Guideline for the selection of envelope materials for subsurface drain; Design, construction and maintenance of well drains; Drainage machineries.

Urban Drainage :
Introduction; Approaches to urban drainage – piped or natural systems, types of piped system, urban water system; Storm water – introduction, runoff generation, overland flow and storm water quality; System components and layout of urban drainage system – introduction, building drainage, system components and design; Hydraulics of urban drainage, Storm sewers, Structural design and construction – types of construction, site investigation, open-trench construction, tunneling and trenchless methods; Storm water management.

Text Book

1. "Land and Water Management Engineering " by V.V.N Murty and M.K. Jha; 6th Edition, Kalyani Publishers, Ludhiana, India.
2. "Urban Drainage" by D. Butler and J.W. Davis;3rd Edition, Spon Press, London and Newyork

Reference Book

1. "Irrigation Engineering & Hydraulic Structures" by S.K. Garg, Khanna Publishers.

CE 4059 REINFORCED CONCRETE REPAIRS & MAINTENANCE Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand condition Survey, Evaluation and Assessment of Damage detection methods concrete structures
CO2. perform repair analysis and design using different materials and methodologies
CO3. understand various methods of protection of concrete structures and rebar corrosion
CO4. understand maintenance of concrete structures

Pre-requisite: Nil

Introduction:
Causes of deterioration of concrete structures. Effects of climate, moisture, temperature, chemicals, wear, erosion and loading on serviceability and durability. Design and construction errors. Causes of seepage and leakage in concrete structures. Formation of cracks including those due to corrosion.

Condition Survey, Evaluation and Assessment of Damage:
Diagnostic methods and analysis. Destructive, Semi destructive and Non-Destructive methods including Core test, Carbonation test , Chloride test, Petrography, Corrosion Analysis, Cover meter test, Rebound Hammer test,Ultrasonic Pulse Velocity test, Crack measurement techniques, Concrete Endoscopy and Thermal imaging, Pull-off test and Pull-out test etc.

Materials and Methodology of Repairs:
Repair analysis and design. Repair materials and their properties. Methodologies of crack and patch repair used of Polymer modified mortar, Polymer modified concrete, Polymer concrete. Injection grouting. Shortcreting. Joints and sealants. Rebar corrosion crack repair.

Protection of Concrete Structures: .
Protective materials and their properties for moisture barrier systems, Above-grade and below grade waterproofing of concrete structures. Systems like integral, crystalline, coatings, membranes etc,. Thermal protection coatings

Rebar Corrosion Protection:
Methods of Corrosion protection. Corrosion inhibitors, Corrosion resistant steels, Cathodic Protection, Pre-packaged zinc sacrificial anode, Snap-on zinc mesh anode CP system.

Maintenance of concrete structures:
Facets of maintenance. Planned preventive maintenance. Maintenance cycles. Statutory legislation and obligation.

Text & Reference Book

1. "Concrete Repair and Maintenance", by Peter H .Emmons & Gajanan M. Sabnis, Galgotia Publication.
2. "Repairs and Rehabilitation", by Compilation from Indian Concrete Journal-ACC Publication.
3. "Guide to Concrete Repair and Protection", HB84-2006, A joint publication of Australia.
4. "Concrete Repair Association", by CSIRO and Standards Australia.
5. "CPWD hand book on Repairs and Rehabilitation of RCC buildings" by DG(Works), CPWD, Government of India (Nirman Bhawan), http://www.cpwd.gov.in/handbook.pdf.
6. "Guide to Concrete Repair", by Glenn Smoak, US Department of the Interior Bureau of Reclamation, Technical Service Center , http://books.google.co.in.
7. "Management of Deteriorating Concrete Structures", by George Somerville, Taylor and Francis Publication.
8. "Concrete Building Pathology", by Susan Macdonald, Blackwell Publishing.
9. "Testing of Concrete in Structures", by John H. Bungey, Stephen G. Millard & Michael G. Grantham, Taylor & Francis Publication.
10. "Durability of concrete and cement composites", by C.L.Page & M.M. Page,Woodhead Publishing.

CE 4061 EARTHQUAKE ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify the parameters of earthquake and seismic zones of India
CO2. determine dynamics responses of free vibration and forced vibration (un-damped & damped) for single degree of freedom systems
CO3. Construct response spectra and select proper value for design from given dynamic properties
CO4. determine dynamics responses of un-damped free vibration for multi degree of freedom systems
CO5. Use standard earthquake codes for design of structure

Pre-requisite: Nil

Single degree freedom system:
Free and forced vibration

Multi degree freedom systems:
Free vibrations of un-damped systems, Determination of frequencies by Rayleigh’s method and Stodola method, Un-damped and damped free vibrations with viscous damping, Vibration isolation, Response spectra, India seismic zoning map.

Earthquake resistant design of RC multi- storeyed buildings and masonry buildings as per provision in IS code:

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India seismic zoning map

Seismic retrofitting of RC and masonry buildings

Text Book

1. "Earthquake resistance design of structures", by Pankaj Agarwal & Manish Shikhande, Prentice hall (PHI).

Reference Book

1. "Dynamics of structures (Theory and applications to Earthquake Engineering)", by Anil K. Chopra PH(I) New Delhi.

CE 4062 WATER RESOURCES SYSTEM ANALYSIS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. develop a simulation model related to water resources planning.
CO2. explain reservoir operation, planning and management of water resources projects.
CO3. explain economics for hydro-systems, water pricing and allocation policies.

Pre-requisites: Water Resources Engineering I (CE 3009) andWater Resources Engineering II (CE 3010)

Objective of water resources development, economic analysis and discounting techniques.

Conditions of project optimality, graphic optimization techniques for multipurpose projects.

Analytical optimization techniques for water resources projected by linear programming, non-linear programming and dynamic programming, optimization by simulation, mathematical models for large scale multipurpose projects, different case studies.

Stochastic optimization techniques, water quality subsystems.

Optimum operation model for reservoir systems by incremental dynamic programming, sequencing of multipurpose project.

Text Book

1 "Design of Water", by Arthur Mass et. al., Harvard Univ. Press., Cambridge.

Reference Book

1. "Water Resources Systems" by MacMillan & Co, Prentice Hall, 1962.
2. "Economics of Water Resources Planning", by L.D. James and R. R. Leo, McGraw Hill, New York, 1971.
3. "Water Resources Systems Engineering", by W.A. Hall and J.A. Dracup, McGraw Hill, New York, 1970.

CE 4063 FINITE ELEMENT METHOD IN GEO-MECHANICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the importance of numerical modeling in geotechnical engineering
CO2. solve linear and non-linear systems of equations
CO3. learn finite element formulation, discretization and meshing
CO4. model soil response
CO5. model soil by considering compressibility, yielding, hysteresis

Pre-requisite: Nil

Introduction:
The Continuum, Equations of Equilibrium, Boundary Conditions, Strain displacement relations, Stress strain Relations, Plane stress and plane Strain problems, Different methods of structural analysis including numerical methods. Basics of finite element method (FEM), different steps involved in FEM, Different approaches of FEM, Direct method, Energy approach, Weighted residual Method.

One and Two Dimensional Problems:
Detail formulation including shape functions. stress strain relations, strain displacement relations and derivation of stiffness matrices using energy approach, Assembling of element matrices, application of displacement boundary conditions, Numerical solution of one dimensional problems using bar, truss, beam elements and frames. Derivation of shape function using Lagrange's interpolation, Pascal's triangle, Convergence criteria, Finite Element modelling of two dimensional problems using Constant strain Triangle(CST) elements, Stress strain relations for isotropic and orthotropic materials, Four nodded rectangular elements, axi-symmetric solids subjected to axi-symmetric loading.

Isoparametric Elements:
Natural coordinates, iso-parametric elements, four nodes, eight node elements, Numerical integration, order of integration

Plate Bending:
Bending of plates, rectangular elements, triangular elements and quadrilateral elements, Concept of 3D modelling

Text Book

1. R. D. Cook, Concepts and Applications of Finite Element Analysis, John Wiley 2002(4th)
2. O. C. Zienkiewicz and R. L. Taylor, Finite Element Method, McGraw Hill- 1977

Reference Book

1. D. L Logan, A First Course in the Finite Element Method, PWS Publishing, Boston-1997
2. C. S. Krishnamoorthy, Finite Element Analysis-Theory and Programming, Tata McGraw Hill-1995.

CE 4065 INFRASTRUCTURE PLANNING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the fundamental characteristics of infrastructure.
CO2. understand past and contemporary challenges and trends in the theories and practice of mega infrastructure planning, appraisal and delivery
CO3. acquire basic knowledge of the international, national and regional policies and legislative frameworks, plus market contexts that surround mega infrastructure development
CO4. understand the critical issues concerning sustainable infrastructure investment at all scales.
CO5. apply innovative methods and techniques to infrastructure planning, appraisal and monitoring.

Pre-requisite: Construction Planning and Management (CE 3013)

Definitions of infrastructure; Typical infrastructure planning steps; Planning and appraisal of major infrastructure projects. Screening of project ideas; Life cycle analysis; Multi-criteria analysis for comparison of infrastructure alternatives. Procurement strategies; Scheduling and management of planning activities**.**

Economic Analysis: Concepts and Applications, Principles of methodologies for economic analysis of public works, Social welfare function, indifference curves and tradeoffs, Demand curves and price elasticities; Benefit-cost ratio and internal rate of return; Shadow pricing; Accounting for risk and uncertainty.

Financial Evaluation: Time value of money, Investment criteria, Project cash flows – elements and basic principles of estimation, Financial estimates and projections, Cost of capital, Rate of return; Project risk analysis; Political and social perspectives of infrastructure planning; Case studies.

Text Book

1. A. S. Goodman and M. Hastak, Infrastructure planning handbook: Planning, Engineering, and Economics, McGraw-Hill, New York, 2006.
2. J. Parkin and D. Sharma, Infrastructure planning, Thomas Telford, London, 1999.

Reference Book

1. P. Chandra, Projects: Planning, analysis, selection, financing, implementation, and review, Tata McGraw-Hill, New Delhi, 2009.
2. J. D. Finnerty, Project financing - Asset-based financial engineering, John Wiley & Sons, New York, 1996.
3. A. S. Goodman and M. Hastak, Infrastructure Planning Handbook: Planning, engineering, and economics, McGraw-Hill, New York, 2006.
4. J. Parkin and D. Sharma, Infrastructure planning, Thomas Telford, London, 1999.
5. L. Squire and H. G.van der Tak, Economic analysis of projects, John Hopkins University Press, London, 1975.
6. T. J. Webster, Managerial economics: Theory and practices, Elsevier, New Delhi, 2003.

CE 4067 OFFSHORE GEOTECHNICAL ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. learn about equipment and standard soil investigation methods used in offshore constructions
CO2. understand geotechnical problems related to offshore oil exploration and production
CO3. evaluate procedures relevant for foundations, piles and anchors subjected to cyclic loading

Pre-requisites: Geotechnical Engineering I (CE 3011) and Geotechnical Engineering II (CE 3014)

Classification; Consolidation and shear strength characteristics of marine sediments; Planning and site exploration of offshore drilling, sampling, laboratory testing, in-situ testing methods and geophysical methods.
Current design practice of pile-supported and gravity offshore structures.
Dynamic analysis of offshore structures.
Anchor design, breakout resistance analysis and geotechnical aspects of offshore pipe line and cable design.

Text & Reference Book

1. Graham Dalton, Theory and Practice of Seamanship,Shroff Publishers Delhi..
2. B M Das, Principles of Geotechnical Engineering, Thomson Brooks/Cole.
3. Ramakrishna, T V, Marine and Offshore Engineering, Mahip Distributor Delhi

CE 4069 COST EFFECTIVE HOUSING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. classify the population based on income
CO2. identify the need and problems of lower income and economically weaker section regarding shelter
CO3. identify different low cost materials and use them to build a low cost house.

Pre-requisite: Nil

Income based classification of population. High, Middle, Low Income group and economically weaker section.

Basic shelter issues in India. Mindset of low income group and economically weaker section people. Problems associated with this group with relation to land, living condition and dwelling standards; Recommendation of housing and urban development corporation.

Traditional materials and techniques (rammed earth, sun dried bricks, wood, bamboo, jute); Alternate and developed methods / materials of construction: pressed soil blocks, use of stabilized soil, soil cement blocks, fly ash brick, by-product gypsum, foundation, arch foundation, walling- rat trap bond, roofing- filler slabs. Precast blocks and their use.

Laurie Baker's experiments in low cost housing. ; Modular constructions. Experimental observations/findings of CBRI.

Use of cost effective technologies (CECT) in building constructions, stub foundation, Rat trap bond (walls), brick arches (alternates to lintels) filler slab (roof). Use of Ferro cement.

Cost effective housing for natural disaster mitigation.

Text book

1. "Low cost Housing Technology", L. J. Goodman, R. P. Lama, R. Rajani, F. J. Burian, Pergamon Press, 1979.
2. International Association for Earthquake Engg. Guidelines for Earthquake Resistant Non-Engineered Construction.

Reference book

1. "Are slums inevitable", L. Baker, Centre of science & technology for Rural Development, (COSTFORD) Ayanthple, Thrissur, Kerala.
2. "Houses - How to reduce the building cost", L. Baker, Centre of science & technology for Rural Development, COSTFORD Ayanthple, Thrissur-68003, Kerala.

CE 4070 GLOBAL WARMING & CLIMATE CHANGE Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the importance of global warming
CO2. model and apply the techniques of 'measuring' the Earth's temperature
CO3. assess the 'best predictions' of current climate models
CO4. understand the concept of mitigation measures against global warming
CO5. explain the factors forcing climate change and the extent of anthropogenic influence.

Pre-requisite:Nil

Earth's Climate System:
Role of ozone in environment-ozone layer-ozone depleting gases-Green House Effect, Radiative Effects of Greenhouse Gases-The Hydrological Cycle-Green House Gases and Global Warming – Carbon Cycle.

Atmosphere and its Components:
Importance of Atmosphere, Physical Chemical Characteristics of Atmosphere, Vertical structure of the atmosphere, Composition of the atmosphere, Atmospheric stability, Temperature profile of the atmosphere, Lapse rates, Temperature Inversion, Effects of inversion on pollution dispersion.

Impacts Of Climate Change:
Causes of Climate change , Change of Temperature in the environment, Melting of ice Pole, Sea level rise, Impacts of Climate change on various sectors, Agriculture, Forestry and Ecosystem, Water Resources, Human Health, industry, Settlement and Society, Methods and Scenarios, Projected Impacts for different regions, Uncertainties in the Projected Impacts of Climate Change, Risk of Irreversible Changes.

Observed changes and its causes:
Climate change and Carbon credits, CDM, Initiatives in India-Kyoto Protocol, Intergovernmental Panel on Climate change, Climate Sensitivity and Feedbacks, The Montreal Protocol, UNFCCC, IPCC, Evidences on changes in Climate and Environment on a Global scale and in India.

Climate change and mitigation measures:
Clean Development Mechanism, Carbon Trading, examples of Future Clean Technology, Biodiesel, Natural Compost, Eco- Friendly Plastic, Alternative energy, Hydrogen, Bio-fuels, Solar Energy, Wind, Hydroelectric Power, Mitigation Efforts in India and Adaptation funding, Key Mitigation Technologies and Practices, Energy Supply, Transport, Buildings, Industry, Agriculture, Forestry, Carbon sequestration, Carbon capture and storage (CCS), Waste (MSW and Bio waste), Biomedical, Industrial waste, International and Regional cooperation.

Text Book

1. Dash Sushil Kumar, "Climate Change – An Indian Perspective", Cambridge University Press India Pvt. Ltd, 2007.

Reference Book

1. Adaptation and mitigation of climate change-Scientific Technical Analysis.Cambridge University Press, Cambridge, 2006.
2. Atmospheric Science, J.M. Wallace and P.V. Hobbs, Elsevier / Academic Press 2006.
3. Jan C. van Dam, Impacts of "Climate Change and Climate Variability on Hydrological Regimes", Cambridge University Press, 2003.

CE 4071 BASIC TRANSPORTATION ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand highway system & design
CO2. understand railway and airport system
CO3. understand other modes of transportation engineering

Pre-requisite: **Nil**

Highway Engineering:
Introduction to Transportation Systems, Road Development in India, Highway Engineering – Classification of Roads, Highway Planning - Road cross section - camber, gradient, Super elevation - Sight distance - Horizontal and

Vertical curve, Highway Materials- Soil & Soil properties, Bitumen and bituminous mixes – sources, composition, characterization, various forms - Tests on bitumen- Aggregate test, mix design - Types of pavement - pavement construction and maintenance, Traffic engineering- various studies, Level of Service, Intersections, Road signs, markings & signals, Highway Parking

Railway Engineering:
Introduction, Development & Administration of Indian Railway, Railway surveying, Rolling Stock & track resistances, Tractive power & Tractive resistances, Permanent way, Railway gauges, Sleepers, Ballast, Track design, Stations & yards, Station Equipments, Signalling, High speed Trains, Train Accidents-Causes & Prevention.

Airport Engineering:
Administration, Advantages & Disadvantages of Air transport, Aircraft Characteristics, Airport Obstructions, Typical layout of Airports – Component parts – Objectives of components – Runways – Taxiways – Aprons – Landing, Helicopters, Air traffic control, Airport Marking & Lightning.

Tunnel Engineering:
Introduction-Advantages, disadvantages, economics & selection, Classification of tunnels, Design of shape & size of tunnels, Components of Tunnel, Methods of tunneling, Precautions, Tunnel Lining & drainage.

Docks & Harbor Engineering:
Introduction, Classification & Requirements of ports, harbor, docks, Maintenance of ports & harbours, advantages of docks, Transit shed & warehouse, Tides, wind & waves, Different components of docks, Navigational aids, Breakwater.

Text Book

1. "A Textbook of Transportation Engineering", by S.P. Chandola, 1st Edition, S.Chand (G/L) & Company Ltd.

Reference Book

1. "Transportation Engineering Vol. I & II", by V. N. Vazirani & S. P. Chandola, 5th edition & 8th edition, Khanna Publishers, New Delhi.
2. "Roads, Railways, Bridges, Tunnels & Harbour Dock", by Amit Gupta&B.L.Gupta, 5th edition, Standard Publications.
3. "Highway Engineering", by K. S. Rangwala, 10th edition, Charotar Publishing House Pvt. Limited
4. "Airport Engineering" by S. C. Rangwala, K. S. Rangwala and P. S. Rangwala, Charotar Publishing House Pvt. Ltd., Anand, Gujarat.
5. "Railway Engineering", by Rangwala, 25th edition, Charotar Publishing House Pvt. Ltd.
6. "Harbour, Dock and Tunnel Engineering" by R. Srinivasan, Charotar Publishing House Pvt. Ltd., Anand, Gujarat.

CE 4072 GREEN BUILDING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand necessity and role of green buildings & regarding Indian green building council
CO2. design green buildings considering water, site and material parameters
CO3. understand passive solar design
CO4. handle construction and maintenance of green buildings

Pre-requisite: **Nil**

Introduction To Green Buildings:
Green Buildings, Global warming, requirement of Green Building, Benefits of Green Buildings, Requisites for Constructing a Green Building, sustainable construction focus point: site, water, energy, material, indoor air quality, construction procedures.

Indian Green Building Council:
Introduction to IGBC green homes, Benefits of IGBC, IGBC green home rating system, introduction to USGBC, LEED rating system, procedure to get IGBC certification.

Green Building Design Site issues:
Site analysis and design, site development and layout, **Water issues**: watershed protection, drainage of concentrated Runoff, water efficiency and conservation, rain water harvesting, water reclamation, **Sustainable materials**: Reduce / Reuse / Recycle, Natural Sources, concrete, masonry, metals, wood and plastic, finishes.

Passive Solar Design:
Passive solar design, Day lighting, Building envelope, Renewable energy, **Construction Process And Maintenance Of Green Building**
Environmental construction guidelines, building operations and maintenance.

Indoor Environmental Quality:
Significance, design principle, ventilation control, occupant activity control, significance of acoustics.

Economics Of Green Homes:
Economics of green buildings, Selecting environmentally and economically balanced building materials, Project cost, Income and expenses.

Text Book

1. Green homes by R.K .Gautham, BS publications.
2. Sustainable building technical manual- Green building design, constructions and operation; Produced by Public Technology Inc., US Green Building Council.
3. IGBC Green homes rating system Version 1.0 – A bridged reference guide

Reference Book

1. Green Building A Basic Guide to Building and Remodeling Sustainably; Tree Hugger Consulting.
2. Green Building Handbook, Volume 1, Tom Woolley, Sam Kimmins, Paul Harrison and Rob Harrison; E & FN Spon, an imprint of Thomson Science & Professional

CE 4073 FUNDAMENTALS OF RCC DESIGN Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. know the different properties, types & test of cement.
CO2. know the different gradation of coarse aggregate, test of fine & coarse aggregate, types .
CO3. know the manufacturing process & different grades of steel.
CO4. know the different behavior of concrete.
CO5. know about the concept of stress and strain.
CO6. understand basic design concepts and to be able to design simple beams & columns.

Pre-requisite: **Nil**

Materials for Concrete: Cement:
Physical and chemical properties of cement, Types of cements and their use, Tests on cement.

Fine aggregates and coarse aggregates:
Gradation of fine aggregate, Tests on sand, Tests on coarse aggregates **Steel:** Steel manufacturing process, grades of steel.

Concrete:
Composition of concrete, W/C ratio, Workability, Compressive and tensile strength, Nominal Mix design, Elasticity, Shrinkage and creep of concrete

Concept of Stress and strain: Simple stresses and strains:
Materials under tension, compression and shear stresses, Elastic constants.

Bending Stresses & Shear Stresses in Beams:
Bending Moment and Shear Force Diagram of Determinate Beams, Theory of Simple Bending of Initially Straight Beams.

Basic Design Concept:
Basic working stress and limit state design concepts. Design of singly-doubly reinforced sections Design of columns.

CE 4074 ENVIRONMENTAL CHEMISTRY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. demonstrate knowledge of chemical principles of various fundamental environmental phenomena and processes in air, land and water
CO2. apply the principles of green chemistry for a sustainable future.

Pre-requisite: **Nil**

Introduction to environmental chemistry; Global biogeochemical cycles.
Atmospheric chemistry: gases, particulate matter; Air pollution and its health effects; Climate change.
Soil chemistry - Physico-chemical properties of soil, Classification of soils and their characteristics, Major nutrients of soil, Biofertiliser and their types, Significance of C:N ratio.
Water chemistry - Physico-chemical properties of water and their significances .
Green Chemistry for Sustainable Future: Reagents, Media, Special Importance of Solvents, Role of Catalyst, Biological Alternatives, Biopolymers, Principles and Application of Green Chemistry.

Text Book

1. "Environmental Chemistry", by Manahan, S.E., Lewis publishers, 7th Edition, 2000.

2. "Chemistry for Environmental Engineering and Science", by Sawyer, C.N., MacCarty, P.L. and Parkin, G.F., Tata McGraw-Hill, 5th edition, 2003.

Reference Book

1. "Environmental Chemistry", by De, A.K., New Age International (P) Ltd, Publishers, 4th Edition, 2001.
2. "Environmental Chemistry– A Global perspective", by vanloon, G.W. and Duffy, S.J., Oxford University Press, 1999.
3. "Chemistry Theory and Practice", Anastas, P.T. and Warner, J.C., Green Oxford University Press: New York, 1998.

CE 4075 FUNDAMENTALS OF SOIL PHYSICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand soil basic relationship
CO2. understand soil-water relationship
CO3. understand soil-plant-water relationship

Pre-requisite: **Nil**

Introduction & Basic Relationships:
Soil Physics And Soil Physical Characteristics , Water Properties In Relation To Porous Media.

The Solid Phase:
Particle Sizes, Shapes, And Specific Surface , Clay, The Colloidal Component, Soil Structure and Aggregation.

The Liquid Phase:
Water Content And Potential, Water Flow In Saturated Soil, Water Flow In Unsaturated Soil, Solute Movement And Soil Salinity.

The Field Water Cycle:
Water Entry Into Soil, Surface Runoff And Water Erosion, Redistribution And Retention Of Soil Moisture, Groundwater Drainage And Pollution, Evaporation From Bare Soil And Wind Erosion.

Soil–Plant–Water Relations:
Plant Uptake Of Soil Moisture, Water Balance And Energy Balance In The Field Irrigation And Water-Use Efficiency).

Text Book

"Fundamentals of Soil Physics" by Daniel Hillel, Academic Press.

CE 4077 EARTH & EARTH RETAINING STRUCTURES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. describe potential applications for Earth Retaining Structures (ERS)
CO2. select a technically appropriate and cost-effective ERS
CO3. select appropriate material properties, soil design parameters, and earth pressure diagrams
CO4. perform design analysis and prepare conceptual designs

Pre-requisites: **Geotechnical Engineering I (CE 3011) and Geotechnical Engineering II (CE 3014)**

Earth and Rock Fill Dam:
Choice of types, material, foundation, requirement of safety of earth dams, seepage analysis**.**

Mechanically Stabilized Earth retaining walls:
General considerations, backfill and reinforced materials, construction details, design method, stability.

Soil nailing:
applications, advantages, limitations, methods of soil nailing, case histories, analysis and design**.**

Reinforced Soil:
Introduction, basic components, strength characteristics, soil-reinforcement interface friction**.**

Reinforced Earth wall:
Stability analysis, construction procedure, drainage, design Procedure.

Foundation on Reinforced Soil Bed:
Pressure ratio, analysis of strip, isolated, square and rectangular footing on reinforced soil bed, ultimate bearing capacity of footing on reinforced earth slab. Fiber reinforced soil**.**

Text & Reference Book

1. "Reinforced Soil and its Engineering Application", by Swami Saran, Second Edition, I. K. International Publishing House Pvt. Ltd, 2011.
2. "Soil Mechanics and Foundation Engineering", by V N S Murthy, CBS Publisher, 2009.
3. "Analysis and Design of Foundation", by J. E. Bowles, TMH Education, New Delhi.

CE 6102 CONSTRUCTION ENGINEERING PRACTICES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. explain concreting in different environment and design the formwork.
CO2. explain Fabrication and erection of structures by special construction methodology.
CO3. explain construction of special structures.

Pre-requisites: Civil Engineering Materials & Construction (CE 2007) and Concrete technology (CE 3023)

Concrete construction methods; form work design and scaffolding, slip form and other moving forms, pumping of concrete and grouting, mass concreting (roller compacted concrete), ready mixed concrete.

Various methods of placing and handling concrete, Accelerated curing, hot and cold weather concreting, under water concreting, pre-stressing.

Steel and composites construction methods; Fabrication and erection of structures including heavy structures, Prefab construction, industrialized construction, Modular coordination.

Special construction methods, Construction in Marine environments, high rise construction, Bridge construction including segmental construction.

Incremental construction and push launching techniques, River valley projects.

Text Book

1. "Formwork for Concrete Structures", by Robert L Peurifoy & Garold D. Oberiender, McGraw-Hill, 1996.

Reference Book

1. "Formwork for Concrete", by M.K Hurd, Fifth Edition, Special Publication No-4, (American Concrete Institute, Detroit,1980).
2. "Guide for Concrete Formwork", American Concrete Institute. Box No 19150, Detroit, Michigan-48219.

CE 6103 CONSTRUCTION FINANCE MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. prepare balance sheet of construction accounting
CO2. choose best alternatives for financial investments and assess financial health of organization in a given environment
CO3. explain the depreciation, taxation and inflation of any construction project
CO4. explain the cost elements associated with the contract bidding and tendering
CO5. understand capital budgeting and working capital management parameters, risks, financial ratios, international finance.

Pre-requisite: Engineering Economics (HS 2002)

Construction accounting, Profit & Loss, Balance sheet, Income statement, Ratio analysis, Depreciation and amortization, Engineering economics, time value of money, discounted cash flow, NPV, ROR, PI, comparison, incremental rate of return, benefit-cost analysis, replacement analysis, break even analysis, risks and un-certainty.

Management decision in capital budgeting, taxation and inflation.

Work pricing, cost elements of contract bidding and award, revision due to unforeseen causes, escalation.
Turnkey activities, project appraisal and project yield, working capital management finance. International finance.
Budgeting and budgetary control, Performance budgeting appraisal through financial statements.
Practical problems and case studies, project cash flow.

Text Book

1. "Engineering Economics" by R.Pannerselvam P.H.I, N.D. 2012
2. "Engineering Economics" by J.L.Riggs., Mc Graw Hill , 1976

Reference Book

1. "Construction Planning & Management" by U.K.Shrivastava, Galgotia N.D, 2012.
2. "Project Planning, Analysis, Selection, Implementation & Review" by Prasanna Chandra (Tata McGraw Hill Publishing Co Ltd,ND),2010.
3. "Essentials of Management" by Harold Koontz and Heinz Weihrich (Mc Graw Hill).
4. "Principles of Management" by Dr. M. .M. Verma and Agarwal, Himalaya Publisher, 2008.
5. "Essentials of Management" by B.P. Singh and J.N Chhabra, South Western College Publishing-1991.
6. "Industrial Engg and Management" by Dr.O.P. Khanna, Khanna Publisher - 2008.
7. "Construction Management and Planning" by B. Sengupta and H. Guha Tata Mc Graw Hill, ND 1995.
8. "Principle of Construction Management" by Pilcher, Mc Graw Hill, 1981.

CE 6105 PRE-STRESSED CONCRETE Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. determine the prestressing force required in beam for a prestressing systems
CO2. compute losses and deflections of prestressed concrete members
CO3. compute Flexural Strength &Torsional Resistance of Prestressed Concrete Members
CO4. design End Blocks of a post tensioned prestressed concrete member
CO5. design continuous prestressed concrete beams
CO6. design prestressed concrete pipes, mast and railway sleepers.

Pre-requisites: Structural Analysis-I (CE 2004) and Design of Concrete Structures-I (CE 2018)

Different systems of prestressing, Characteristics of concrete and steel, Other suitable materials, Losses in prestress.

Analysis and design of section for flexure, shear and torsion. Design of compressive member. Limit state design as per IS code. Introduction to Partial prestressing.

Stress distribution in end-block of post tensioned section: Magnel's method, Guyen's method, Rowe's method and IS code method.

Deflection of prestressed structures- short term as well as long term deflections of uncracked and cracked members.

Indeterminate structures- Principles of design of prismatic continuous beams of two and three equal, unequal spans with variable moments of inertia.

Composite construction of prestressed and in-situ concrete.

Design of special structures- Circular tanks, Pipes, Mast, and Railway sleepers.

Text & Reference Book

1. "Prestressed Concrete", by N. Krishna Raju, TMH, New Delhi.
2. "Design of Prestressed Concrete Structure", by T.Y. Lin, Asia Publishing House.
3. "Limit State Design of Prestressed Concrete", by Y. Guyan, Applied Science Publishers.
4. "Prestressed Concrete", by Raja Gopala N. , Narosa Publishing House, New Delhi.
5. "Design of Prestressed Concrete Structures" by T.Y. Lin & Ned H. Burns; John Wiley & Sons.

CE 6106 CONSTRUCTION METHODS & EQUIPMENTS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. prepare owning and operating cost (rate analysis) of any construction equipment.
CO2. select appropriate construction equipments for different purpose and environments.
CO3. explain the output/ production of equipments.

Pre-requisite: Construction Planning and Management (CE 3013)

Construction Equipments:
Factors affecting selection of equipment, Owning and Operating Cost.

Construction Equipment fundamentals:
Classification of Construction Equipment, Earth moving Equipments, Hauling, Hoisting, Conveying Equipments, Aggregate and concrete production Equipments, Pile Driven Equipments, Cranes.

Analysis of production output and costs of Excavating Equipments, Characteristics and performances of equipment for Earth moving.

Deep excavation support systems:
Diaphragm wall, sheet piling, secant pile, contiguous pile, strutting, ground anchors.

Text Book

1. "Construction Planning, Equipment and Methods", R. L. Peurifoy, P. E Clofford ,J Sehexnayder, P.E., Tata Mc Graw Hill Publishing, N.D.

Reference Book

1. "Construction Equipment and Management" by S.C.Sharma, Khanna Publishers, New Delhi.
2. "Construction Equipment and its Planning and Application", by Dr.Mahesh Verma ,Metro Politan Book Company, New Delhi.
3. "Construction Planning and Equipment", by Satyanarayana & Saxena, Standard Publishers Distributors, Edition 3, 1985.
4. "Heavy Construction", by Vazirani & Chandolu, Khanna Publisher Delhi.

CE 6134 PROJECT QUALITY AND SAFETY MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify different techniques of quality control and select the appropriate one for given conditions.
CO2. explain safety and various parameters of safety construction.
CO3. manage accident/injuries during construction according to safety standards.

Pre-requisite: Nil

Introduction to quality planning and control of quality during design of structures, Quantitative techniques in quality control, Quality assurance during construction.

Inspection of materials and machinery in process inspection and test, Preparation of quality manuals, check list and inspection report, Establishing quality assurance system.

Quality standards/ codes in design and construction, Concept and philosophy of total quality management (TQM), Training in quality and quality management systems (ISO-9000).

Concept of safety, Factors affecting safety, Physiological, Psychological and Technological, Planning for safety provisions, Structural safety, Safety consideration during construction, demolition and during use of equipment.

Management of accidents/ injuries and provision of first aid, Provisional aspect of safety, Site management with regard to safety recommendations.

Training for safety awareness and implementation, Formulation of safety manuals, safety legislation, standards/ codes with regard to construction, Quality vs. Safety. Case studies.

Text book

1. "Construction Safety", by Jimmy W. Hinze, Prentice Hall Inc 1997.

References Book

1. "Construction Safety and Health Management",by Richard j.coffe, jimmie Hinze and Theo C.Haud, Prentiee Hall Inc 2001.
2. Tamilnadu Factory Act.
3. "Construction Planning and Management", by UK Shrivastava, Golgotia Publication.

CE 6136 BUILDING SERVICES PLANNING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. explain urban planning.
CO2. explain Functional planning of buildings.
CO3. determine Fire rating of building construction.
CO4. prepare the layout plan of lift &escalator in building as per fire safety rules.

Pre-requisite: Building Drawing (CE 2081)

Components of urban forms and their planning.

Concepts of neighborhood unit, Street system and layout in a neighborhood, Functional planning of buildings.

Optimization of space; Spatial Synthesis graphical techniques, heuristic procedures, formulation of linear and non-linear optimization problem.

Space requirements and relationships for typical buildings, like residential offices, hospitals, etc. Standard fire, fire resistance.

Classification of buildings, means of escape, alarms, Engineering services in a building as a systems, Lifts, escalators, cold and hot water systems, waster water systems, and electrical systems.

Text Book

1. "Environmental Control Systems", by Mooref ,McGraw Hill,Inc 1994

Reference Book

1. "Building Services", by Peter R.Smith & Warren G.Jullian, Applied Science Publisher ltd, London.
2. "Hand book of Buildings and Enclosure" ,by A.J.Elder & Martix Vinder Bary, McGraw Hill Book Co, 1982.
3. "The fire Precautions Act in Practices 1987", by Jane Taylor&Gordon Cooke, Architectural Press, June 1978.

CE 6138 ADVANCED REPAIRS AND REHABILITATION OF STRUCTURES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand different structural strengthening and retrofitting methods of columns, beams, walls, footings and slabs, piers of concrete structures
CO2. understand specialized repair methods of structures
CO3. understand retrofitting by composite materials
CO4. understand seismic retrofitting and post-repair maintenance of structures

Pre-requisite: Nil

Introduction:
Need for strengthening due to various reasons such as ageing, natural calamities, increase of load, change of function and design, construction errors.

Structural Strengthening:
Strengthening and retrofitting of columns, beams, walls, footings and slabs, piers of concrete structures by jacketing, external post-tensioning, replacing or adding reinforcement, plate bonding, textile reinforced concrete.

Specialized Repairs:

Electro chemical repair using re-alkalization and chloride extraction techniques, Specialized repairs for chemical disruption, fire, marine exposure etc, Repair of damaged structures of water retaining structures, hydraulic structures, Pavements and Runways, Tunnels, Bridges, Piers and Flyovers, Parking Garages, Underwater repair, Masonry Repair, Repair and Restoration of Heritage Structures

Retrofitting by composite materials:

Fiber reinforced concrete, Ultra-high performance fibre reinforced concrete (UHPFRC), Fiber reinforced composites, Carbon fibre reinforced polymer (CFRP), Fibre wrapping (Carbon, Aramide, Glass).

Seismic Retrofitting:

Seismic strengthening of existing RC structures, Use of FRP for retrofitting of damaged structures.

Post-Repair Maintenance of Structures:

Protection & Maintenance schedule against environmental distress to all those structures.
Special cares in repair and rehabilitation of heritage structures .

Text & Reference Book

1. "Concrete Repair and Maintenance", Peter H .Emmons & Gajanan M. Sabnis, Galgotia Publication.
2. "Management of Deteriorating Concrete Structures", George Somerville, Taylor & FrancisPublication.
3. "Repairs and Rehabilitation", Compilation from Indian Concrete Journal-ACC Publication.
4. "Guide to Concrete Repair and Protection", HB84-2006, A joint publication of AustraliaConcrete Repair Association, CSIRO and Standards Australia.
5. "CPWD hand book on Repairs and Rehabilitation of RCC buildings", published byDG(Works), CPWD, Government of India (Nirman Bhawan),http://www.cpwd.gov.in/handbook.pdf
6. "Guide to Concrete Repair", by Glenn Smoak, US Department of the Interior Bureau ofReclamation, Technical Service Center , http://books.google.co.in
7. "Concrete Building Pathology", Susan Macdonald, Blackwell Publishing.
8. "Testing of Concrete in Structures", John H. Bungey, Stephen G. Millard & Michael G.Grantham, Taylor & Francis Publication.
9. "Durability of concrete and cement composites", C.L.Page & M.M. Page,WoodheadPublishing.
10. "Concrete Repair, Rehabilitation and Retrofitting", M. Alexander, H. D. Beushausen, F.Dehn & P. Moyo, Taylor & Francis Publication.
11. "Concrete Repair Manual", Volume I & II, Published jointly by ACI, BRE, Concrete Society,ICRI

CE 6142 CONTRACT LAWS & REGULATIONS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. perform estimate and costing of any civil work
CO2. understand tendering & contractual procedures
CO3. understand arbitration and conciliation
CO4. understand claim settlement and dispute resolution

Pre-requisite : Nil

Project cost estimation, rate analysis, overhead charges.

Bidding models and bidding strategies, Qualification of bidders, Owner's and contractor's estimate.

Tendering and contractual procedures.

Indian contract Act 1872, Definition of Contract and its applicability, Types of contracts, International contracts, FIDC, Conditions & specifications of contract, Contract administration.

Claims, compensation & disputes, Dispute resolution techniques, Arbitration and Conciliation Act 1996, Arbitration Case Studies, Professional Ethics, Duties & responsibilities of parties, Management Information System.

Text & Reference Book

1. "Construction Equipment and Job Planning" by S. V. Deodhar, Khanna Publisher, Delhi
2. Laws Relating to Building & Engineering Construction in India by Gajaria G. T. (M. M. Tripathy Pvt. Ltd. Bombay)
3. Contracts and the Legal Environment for Engineers and Architects by Joseph T. Bockrath, 6th Ed, Mc. Graw Hill 2000
4. Estimating & Costing, Specifications and Valuation by M. Chakravorthy, Standard Publisher, 2010

CE 6206 FINITE ELEMENT METHOD Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the fundamentals of finite element method
CO2. derive and know various types of finite elements and its application
CO3. analyze various structures using finite element method
CO4. apply finite element method to structural and geotechnical engineering
CO5. develop computer program for finite elements
CO6. use commercial finite element software for engineering solutions.

Pre-requisites: Engineering Mechanics (ME 1001) and Solid Mechanics (CE 2003)

Fundamentals of finite element :
Equations of Equilibrium, Elements, Degrees of freedom, Stiffness matrices, Different steps involved in finite element analysis, Finite Element modeling, Shape functions, Strain displacement relations, Constitutive relations, Boundary Conditions, Loading type, Solution technique, Convergence criteria.

Formulation Techniques:
Variation methods, Gelerkin method, Weighted residual methods.

One Dimensional Element: Truss element and beam element

Two dimensional Elements :
Constant strain triangular element and rectangular element.

Three dimensional Element :
Tetrahedral element.

Text Book

1. "Introduction to Finite Elements in Engineering", T. R. Chandrupatla and A. D. Belegundu, 4th Edition, Pearson,2012
2. "Concepts and Applications of Finite Element Analysis", by R. D. Cook, 4th Edition, John Wiley & Sons, 2003.

Reference book

1. "The Finite Element Method: Its Basics and Fundamentals ", by O. C. Zienkiewicz, Elsevier; Seventh edition, 2013
2. "Finite Element Procedures", by K. J. Bathe, Prentice Hall, Second edition, 2007

CE 6235 SOIL-STRUCTURE INTERACTION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand various theories applicable to soil structure interaction
CO2. determine Contact pressure and settlement under foundations
CO3. determine earth pressure on different retaining structures
CO4. understand the theories and application methods for modelling soil structure interaction for various typical field situations.

Pre-requisites: Geotechnical Engineering-I (CE 3011) and Geotechnical Engineering-II (CE 3014)

Soil-Foundation Interaction:
Introduction to soil-foundation interaction problems, Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behavior.

Beam on Elastic Foundation:
Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness. Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions.

Elastic Analysis of Pile:

Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap. Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis

Text Book

1. "Foundation Analysis and Design" by J E Bowles- Tata-McGraw Hill
2. "Elastic Analysis of Soil-Foundation Interaction" by Selvadurai, A. P. S Elsevier

Reference Book

1. "Pile Foundation Analysis and Design" by Poulos H. G. and Davis E. H.- John Wiley,1980.
2. "Design Analysis of Beams, Circular Plates and Cylindrical Tanks on Elastic Foundation" by E.S.Melersk.
3. "Beams of Elastic Foundation" by M.Hetenyi, University Michigan Press 1946

CE 6238 COMPOSITE STRUCTURES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. know the classifications of composite material and its applications.
CO2. know the method of manufacturing processes of composite
CO3. know macro and micro-mechanics of composite material.
CO4. learn the failure theories of composite material.
CO5. design a laminate based on the application

Pre-requisites : Civil Engineering Materials and Construction (CE 2007)

Introduction to composite materials: .
Definition,Isotropy, Orthotropy and Anisotropy, Lamina, Laminate, Advantages and limitations, Classification and characteristics of Composite materials, Mechanical behaviour of composite material, Manufacture of laminated fiber reinforced composite material

Macromechanical behavior of lamina:
Stress strain relations for anisotropic materials, Stress strain relations for a lamina of arbitrary orientation, Interlaminar stresses.

Micromechanical behaviour of lamina: .
Volume and mass fraction, Density and void content, Evaluation of elastic moduli: Mechanics of material approach to stiffness

Macromechanical behavior of laminate:
Classical lamination theory: Lamina stress-strain behavior, Stress and strain variation in laminate, Resultant laminate forces and moments, Special cases of laminate stiffnesses.

Strength criterion for an orthotropic lamina: .
Maximum stress failure criterion, Maximum strain failure criterion, Tsai-Hill failure criterion, Tsai-Wu failure criterion, Hoffman failure criterion

Bending of laminated plate:
Assumptions, Equilibrium equation, Solution technique.

Introduction to the design of composite structures:
Design requirements, Material selection and Con figuration selection.

Text Book

1. "Mechanics of Composite Materials", by Robert M. Jones, CRC Press, Second edition, 2015

Reference Book

1. "Mechanics of Composite Materials", by A. K. Kaw, Taylor& Francis-India, Second edition, 2006

CE 6239 ADVANCED FOUNDATION ENGINEERING Cr-3

Course outcome:At the end of the course, the students will be able to:

CO1: determine the soil parameters for foundations subjected to dynamic loads and its control measures
CO2: assess the liquefaction potential of soil strata under earthquake condition
CO3: identify the swelling potential of cohesive soil and its effect on the building, measures to prevent the swelling using various ground improvement and design methods
CO4: identify the ground improvement techniques to make the soil suitable for the construction of structures.

Pre-requisites: **Geotechnical Engineering-I (CE 3011) and Geotechnical Engineering-II (CE 3014)**

Machine Foundations:
Types of Machine Foundations, Basic Definitions, Degree of Freedom of a Block Foundation, General criteria for design of Machine Foundations, Free Vibration, Forced Vibration, Vibration analysis of a Machine Foundation, Determination of Natural Frequency, Design Criteria for Foundations of Reciprocating machines, Reinforcement and construction Details, Mass of Foundation, Vibration Isolation and Control.

Liquefaction of foundation soils under earthquakes:
Introduction, Liquefaction Phenomenon, Effect of Liquefaction on Build environment, Factors Affecting Liquefaction, Assessment of Susceptibility of a Soil to Liquefaction, Prevention of Liquefaction.

Foundations on Expansive soils:
Expansive soils, Identification of Expansive soils, Classification of Expansive soils, Causes of moisture changes in soils, Effects of swelling on buildings, Preventive measures for expansive soils Modification of Expansive soils, Design of foundation in swelling soils, Drilled piers, Belled drilled pier, Under reamed piles, construction of under reamed piles.

Foundation Soil Improvement: .
Stabilization of soil with granular skeleton, chemical, cement, lime , ash, slag & bitumen, Thermal stabilization, Electrical stabilization, Vibration methods of ground improvement, Drainage methods of ground improvement, Pre-compression and vertical drains, Grouting and injection, Reinforced earth, Use of geotextile & modern materials Ground anchors & soil nails

Text Book

1. "Advanced Foundation Engineering", by V. N. S, Murthy, First Edition,CBS Publishers & Distributors.
2. "Foundation Analysis and Design", by J.E.Bowles, 5th Edition, McGraw Hill Higher Education, 1997 .

Reference Book

1. "Soil mechanics and foundation Engineering", by K.R.Arora. Standard Publisher, 2005.
2. "Geotechnical engineering handbook" by B.M.Das, J.Ross Publishing, Cengage learning.
3. "Principles Of Foundation Engineering" by B.M.Das, 7th Edition, Cengage Learning India Pvt. Ltd, New Delhi.
4. "Reinforced soil and its engineering application",by Swami Saran, Second Edition, I. K. International Publishing House Pvt. Ltd, 2011.
5. "Geotechnical Engineering", by Shashi K. Gulhati & Manoj Datta, Tata Mcgraw Hill Publishing Co Ltd, 2014.
6. "Foundation Engineering", by P.C.Verghese, PHI Learning Private Limited, July 2013.
7. "Ground Improvement Techniques" by P. Purushothama Raj, Laxmi publications Pvt. L, 2005.

CE 6241 DESIGN OF BRIDGES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. select appropriate site and design of slab, beam-slab, plate girder and composite Bridge, sub-structure for bridges, bearings, foundations for bridges.
CO2. explain the concept of bridge vibration.

Pre-requisites: Structural Analysis-I (CE 2004), Structural Analysis-II (CE 3001), Design of Concrete Structures-I (CE 2018) and Design of Steel Structure (CE 3007).

Introduction, historical review, engineering and aesthetic requirements in bridge design. Introduction to bridge codes. Economic evaluation of a bridge project, Loading standard, IRC specification, Impact factor.

Site investigation and planning: Scour - factors affecting and evaluation.

Bridge foundations:
Open, pile, well and caisson. Piers, abutments and approach structures-reinforced earth structure; Superstructure - analysis and design of right, skew and curved slabs.

Girder bridges:
Types, load distribution, design. Orthotropic plate analysis of bridge decks. Introduction to long span bridges - cantilever, arch, cable stayed and suspension bridges. Methods of construction of R.C Bridges.

Various types of bearings and their design.

Pre-stressed concrete bridges and steel bridges Fabrication, Launching & creation. Design and construction of construction joints (use of relevant codes of practice are permitted in the examination).

Text & Reference Book

1. "Design of Bridge Structures", by T. R. Jagadeesh & M. A. Jayaram, 2nd Edition, PHI Learning Pvt. Ltd.
2. "Design of Concrete Bridges", by M. G. Aswani, V. N. Vazirani & M. M. Ratwani, 2nd Edition, Khanna Publishers, New Delhi, 2004.
3. "Essentials of Bridge Engineering", D. J. Victor, Oxford and IBH.
4. "Design of Bridges", N. Krishna Raju, Oxford and IBH.
5. "Concrete bridge Practice: Analysis, Design and Economics", V. K. Raina, Tata McGraw Hill.
6. "Dynamics of Railway Bridges", L. Fryba, Thomas Telford Ltd ,April 1996.
7. "Concrete Bridges", by P.E. Mondorf, Taylor & Francis.
8. " Bridge Engineering", S. Ponnuswamy, Tata Mc Graw Hill.

CE 6303 OPEN CHANNEL HYDRAULICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: analyze uniform flow calculations in open channels
CO2: solve problems on dynamics of gradually and spatially varied flow
CO3: analyze rapidly varied flow calculations in open channels
CO4: determine the parameters of unsteady flow.

Pre-requisites: **Fluid Mechanics I (CE 2011) and Fluid Mechanics-II (CE 2014)**

Uniform flow, determination of roughness coefficients and the factors affecting the roughness, computation of uniform flow, flood discharge, determination of normal depth and velocity, flow in composite roughness; Design of channels for uniform flow in non-erodible and erodible with grassed channels.

Dynamics of Gradually varied flow and classification of flow profile, methods of computation, Dynamics of spatially varied flow - analysis of flow profile and computation by method of numerical integration.
Rapidly varied flow, classification, flow over spillway, Hydraulic Jump, types with characteristics of jump, the surface profile and location of the jump, jumps as energy decapitator, rapidly varied flow through non-prismatic channels.

Unsteady flow, dynamics of gradually varied unsteady flow, solution of unsteady flow equations, rapidly varied unsteady flow, positive and negative surges, flood routing, principle and methods of flood routing.

Text Book

1. "Open Channel Flow", by F. M. Henderson, MacMillan Publishing Company, 1996.
2. "Flow in Open Channel", by K. Subramanya, Tata McGraw Hill, New Delhi.

Reference Book

1. "Flow through Open Channel", K. G. Rangaraju, Tata McGraw Hill, New Delhi.
2. "Open Channel Hydraulics", by V.T Chow, McGraw-Hill Publishing Company, New Delhi, 1993.
3. "The Hydraulics of Open Channel Flow An Introduction", by H. Chanson, Elsevier.
4. "River Hydraulics, (Technical Engineering and Design Guides as adapted from the U.S. Army Corps of Engineers, No. 18) New York", ASCE Press.
5. "Engineering Hydraulics", by H. Rouse, John Wiley & Sons.

CE 6307 REMOTE SENSING & GIS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. conduct the satellite based remote sensing survey
CO2. create thematic maps and its integration for a functional use like hydrological data, crop pattern study
CO3. develop confidence of use on the multi-spectral electromagnetic spectrum
CO4. understand and use the various raster and vector data for strategic GIS applications.

Pre-requisite: **Nil**

Introduction to Remote Sensing system:
Data acquisition and processing, Applications, Multi concept in remote sensing.

Physical Basis of Remote Sensing:
EMR nature, definition, nomenclature and radiation laws. Interaction in atmosphere-nature, its effects in various Wave-length regions, atmospheric windows; Interaction at ground surface soils Geometric basis of interaction.

Resolution :
Spectral, spatial, radiometric and temporal; IFOV, FOV, GRE; geometric characteristics of scanners, V/H and S/N ratio; Data products from various air and space borne sensors-aerial photographs, LiDAR, Landsat, SPOT, IRS, ERS, IKONOS etc.

Image Interpretation:
Elements of interpretation; digital image processing and interpretation, Field verification.

Geographical Information systems:
Components of GIS-data acquisition, spatial and attribute data, pre-processing, storage and management; data structures raster and vector data.

GIS analysis functions:
Errors and corrections; data presentation and generation of thematic maps.

Text book
1. "Remote Sensing and GIS", by Basudev Bhatta, Oxford, 2013
2. "Remote Sensing and GIS", by M. Chandra and S. K. Ghosh,Narosa Pub, 2007.
3. "Surveying Volume -2" by S. K. Duggal, Third Edition, Tata Mecgraw Hill- 2011.

Reference Book

1. "An Introduction to GIS", by I. Heywood, S. Cornelius and S. Carver, 2nd Ed, Pearson Education, 2002.
2. "Fundamentals of Remote Sensing", by George Joseph, Universities Press, Second Edition-2011.
3. "Advanced Surveying- Total station, GIS, Remote Sensing" by Satheesh Gopi, R. Sathikumar, N. Madhu, Pearson Eduction-2007
4. "Remote Sensing and Image Interpretation", by T. M. Lillisand, R. W. Kaifer & J. W. Chipman, 6th Edition , John Wiley and sons Inc, Nov 2007.
5. " Remote Sensing and its Applications", by LRA Narayan, Universities Press-2012

CE 6332 RIVER ENGINEERING & SEDIMENT TRANSPORT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. learn about river morphology in respect of engineering, sediment and river regulation systems
CO2. understand analytical and numerical modeling of river morphology and sediment transport
CO3. learn about design of stable channels and river engineering works
CO4. understand sediment transport measurement, sedimentation in reservoirs and its computational methods

Pre-requisites: Water Resources Engineering-I (CE 3009) and Water Resources Engineering-II (CE 3010)

River Flow hydrology, Flow Characteristics (Laminar and Turbulent Flows), Velocity Distribution, Bed Shear Stress, Depth — Discharge Relationship) .

Sediment Sources and Sediment Characteristics: Initiation of Motion of Sediment Transport, Mode of Sediment Transport, Estimation of Sediment Transport and Alluvial Roughness: (Flow Regimes and Bed Forms, Sediment Transport Formulas for Bed Load and Total Load, Suspended Load Formula, Alluvial Channel Roughness.

Design of Stable Channels, Flow and Sediment Transport Measurements, Waterways Engineering Works: (River Engineering Works, Flow Regime Control Structures, Sediment Control Devices for Intake Structures).

Modeling of Sediment Transport and River Morphology: Governing Equations of Flow and Sediment Transport, Propagation of Bed Forms, Analytical Models of Sediment Transport and River Morphology. Numerical Models of Sediment Transport and River Morphology, Accuracy and Stability of Numerical Models.

Sedimentation in Reservoirs: Distribution of Sediment Deposition in Reservoirs, Erosion of Sediment Deposits in Reservoirs, Computation of Sedimentation Volume in Reservoirs, Sedimentation Distribution in Reservoirs.

Text Book

1. K.D. Gupta, River Engineering, Vayu Education of India, 2014.
2. P.Y. Julien, River Mechanics, Cambridge University Press, 2002.
3. C.T. Yang, Sediment Transport: Theory and Practice, Mcgraw-Hill, 1996.
4. A.A. Khan and W. Wu, Sediment Transport: Monitoring, Modeling and management, Earth Sciences in the 21^{st} Century, NOVA Science Publishers, 2013.

CE 6339 ADVANCED IRRIGATION ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1 understand and identify different types & methods of irrigation
CO2. design different surface & sub-surface irrigation methods
CO3. use different types of flow measurement instruments
CO4. design drainage system.

Pre-requisite: Water Resources Engineering-I (CE 3009)

Introduction, objectives of irrigation, type of irrigation and suitability, selection of irrigation method

Irrigation requirement, water balance, soil water relationships, water storage zone, Flow of moisture through root zone, soil physical and chemical properties.

Crop evaporative and drainage requirements, irrigation efficiency and uniformity, Surface irrigation systems, types of surface systems, basin irrigation, border irrigation, furrow irrigation, sprinkler irrigation.

Field measurement techniques, flow measurement, flumes, weirs, irrigation events, advance, wetting, depletion and recession phases.

Infiltration, infiltrometer, ponding methods, soil water, tensiometers, neutron probe, time domain reflectometer, evapotranspiration, crop coefficient, leaf area index, evapotranspiration estimation.

Fundamentals of surface irrigation hydraulics, continuity equation, momentum equation, Hydrodynamic model, zero inertia model and kinematic wave model.

Drainage principles, need for drainage, steady state equations, Hooghoudt, Kirkham, Dagan and Ernst equations. Salt balance, water and salt balance of the root zone, salt equilibrium equation and leaching requirement, leaching efficiency.

Text Book

1. S. K. Garg, Irrigation Engineering and hydraulics structures, Khanna Publishers, 25^{th} Edition.
2. A.M. Michael, Irrigation theory and practice, Vikas Publishinh House Pvt Ltd, 2^{nd} Edition, 2009.
3. Majumdar D. P., "Irrigation Water Management Principles and Practices", Prentice Hall of India, New Delhi, 2004.

CE 6342 WATER POWER ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. design different components of hydroelectric scheme effectively and economically
CO2. explain the construction process of hydropower development project

Pre-requisites: **Fluid Mechanics-I (CE 2011), Fluid Mechanics-II (CE 2014), Water Resources Engineering-I (CE 3009) and Water Resources Engineering-II (CE 3010)**

Concept of water power Engineering, Different heads such as Gross head, Effective head, Design head, rated head, critical head, classifications of water power plants based on hydraulic characteristics, topography, head, capacity of plant, load etc. Major hydroelectric schemes in India.

Planning a site selection of hydropower projects according to availability of Quantity and head of water , estimating of power potential using Mass curve and flow duration curves Economics of water power plants load factor, capacity factor, load curve, effect of pondage on flow duration curve. Estimation of unit cost of hydro power and comparison with unit cost of stream power station, General planning of hydropower projects.

Various types of intake structures. Penstocks of steel pipes economic diameter, number of penstocks wall thickness of steel penstocks, shell theory of design, welded and riveted steel pipes, Accessories of penstocks. Expansion joints anchor blocks and pipe supports. Tunnels. Dimensions and shape economic size of tunnel Tunnel lining.

Theory of water hammer, Arithmetic integration and graphical method of analysis, surge tanks and types of surge tanks theory of simple surge tank and design, Mathematical treatment f water surface oscillations including friction. Pressure relief valves stability of surge tank. Thoma formula, Balancing reservoir and fore bays Pressure.

Selection of type of turbines according to head & specific speed, various types casing of turbines. Determination of their shapes, main relative dimension of runner. Draft tube, its functions, draft tube theory. In take conduits, Preliminary power house dimensioning, general arrangement of power house**.**

Text Book

1. "Water Power Engineering", by M. M. Dandikar & K. N. Sharma, Vikas Publication, 1979.

Reference Book

1. "Water Power Engineering", by H.K. Barrows 2nd Edition, McGraw-Hill, London, 1934
2. "Irrigation Water Resource & Water Power Engineering", by P. N. Modi, Standard Book House Dec 2008

CE 6431 SOIL EXPLORATION AND FIELD TEST Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify sources of subsurface information
CO2. report relevant field reconnaissance information for soil investigation
CO3. perform all the relevant laboratory and field test on soil
CO4. prepare log soil samples and prepare bore-hole logs for civil engineering projects.

Pre-requisites: Geotechnical Engineering-I (CE 3011) and Geotechnical Engineering-II (CE 3014)

General principles of exploration:
Methods of exploration; Boring: Different types of borings.

Sampling methods:
Surface sampling, sampling from boreholes and core boring in soils; Boring and sampling records.

Soil profile:
Pore pressure measuring devices for laboratory and field use; Earth pressure cells.

Vibration-meters:
Pickups and generators for vibration study of machine foundations; Load measuring devices;
Settlement measurements in field.

Text & Reference Book

1. V N S Murthy, "Principles of Soil Mechanics and Foundation Engineering", UBS Publishers Private Ltd, 2002".
2. B M Das, "Principles of Geotechnical Engineering", Thomson Brooks/Cole,

CE 6436 TUNNEL ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. investigate tunnel work
CO2. design tunnels
CO3. understand and decide tunnel amenities

Pre-requisites: Geotechnical Engineering-I (CE 3011), Geotechnical Engineering-II (CE 3014), Design of Concrete Structures-I (CE 2018) and Design of Concrete Structures-II (CE 3006)

Site investigations, Geotechnical Considerations of tunneling.
Design of Tunnels.
Construction & Excavation methods, soft ground tunnels, Rock tunnels.
Micro tunneling techniques, Tunnel support design.
Ventilation of tunnels, tunnel utilities, safety aspects.

Text & Reference Book

1. "Tunnel Engineering Handbook" by J.O. Bickel & T.R. Kuesel, Chapman & Hall, New York,2nd edition,1996.
2. "Rock Mechanics Design in Mining & Tunneling" by Z T Bieniawski, Balkema Publication, Sept 1989.
3. “Engineering in Rocks for Slopes, Foundations and Tunnels” by Ramamurthy, T., PHI Learning Pvt. Limited, 2010.

CE 6437 GEOSYNTHETICS & REINFORCED EARTH STRUCTURES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. develop an understanding of the fundamental concepts that govern the behavior of soils reinforced with geosynthetics
CO2. provide design guidance for allowable tensile strength, vertical reinforcement spacing, length of reinforcement, drainage, seismic loading issues, and different facing systems
CO3. design geosynthetic-reinforced steep slopes and walls.

Pre-requisites: Geotechnical Engineering-I (CE 3011) and Geotechnical Engineering-II (CE 3014)

Historical background; Principles, concepts and mechanism of reinforced earth.
Design consideration for reinforced earth and reinforced soil structures.
Geosynthetics-their composition, manufacture, properties, functions, testing and applications in reinforced earth structures.
Design of reinforced soil structures like retaining walls, embankments, foundation beds etc.; Designing for Separation, Filtration, Drainage and Roadway Applications; Designing for Landfill Liners and Barrier Applications; Case histories of applications.

Text Book

1. Clayton, C.R.I., Milititsky, J. and Woods, R.I., "Earth Pressure and Earth Retaining Structures", Blackie Academic & Professional, 1993.
2. Ingold, T," Reinforced Earth", Thomas Telford Ltd., 1982.
3. G. L. Sivakumar Babu, "An Introduction to Soil Reinforcement and Geosynthetics", Universities Press, India, 2006
4. Swami Saran,"Reinforced Soil and Its Engineering Applications", I. K. International Pvt Ltd, 2005

Reference Book

1. Jones, C.J.F.P, "Earth Reinforcement and Soil Structures", Butterworth, 1985.
   Koerner, R.M, "Designing with Geosynthetics" , Prentice Hall, 1993

CE 6446 GEOTECHNICAL EARTHQUAKE ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand seismic design concepts and current practices for shallow and deep foundations, slopes and retaining walls to enable them to plan and direct the construction activity appropriately

CO2. understand the soil dynamic testing procedure and methodology of seismic design

CO3. understand design methodology and the interpretation in the seismic codes while designing foundations, slopes and retaining walls.

Pre-requisites: Geotechnical Engineering-I (CE 3011) and Geotechnical Engineering-II (CE 3014)

Introduction to Geotechnical Earthquake Engineering. Seismology and Earthquakes, Strong Ground Motion: Parameters and Estimation.

Seismic Hazard Analysis: Deterministic and Probabilistic Analyses, Wave Propagation: 1D and 3D

Dynamic Soil Properties: Lab and Field Determination. Ground Response Analysis. Local Site Effects and Design Ground Motions.

Liquefaction;
Seismic Response Analysis of Slopes, Retaining Walls and Shallow Foundations, Case Studies in Earthquake Geotechnics.

Performance-based Earthquake Geotechnics – An Introduction, Usage of Softwares.

Text Book

1. Kramer, S.L. (1996). "Geotechnical Earthquake Engineering", Prentice Hall, New Jersey, Seventh Impression
2. Bolt, B. A. (2005). "Earthquakes: 2006 Centennial Update", W. H. Freeman, New York.
3. Stein, S. and Wysession, M. (2003). "An Introduction to Seismology, Earthquakes, and Earth Structure", Blackwell Publishing, Oxford.

Reference Book

1. Towhata, I. (2008). "Geotechnical Earthquake Engineering", Springer, Berlin.
2. Ishihara, K. (1996). "Soil Behaviour in Earthquake Geotechnics", Clarendon Press, Oxford.
3. Srbulov, M. (2008). "Geotechnical Earthquake Engineering Simplified Analyses with Case Studies and Examples", Springer, Dordrecht.
4. Srbulov, M. (2011). "Practical Soil Dynamics Case Studies in Earthquake and Geotechnical Engineering"Springer, Dordrecht.

COMPUTER SCIENCE
&
ENGINEERING

Program Educational Objectives (PEOs)

1. To lead a successful career in industry or pursue higher studies or entrepreneurial endeavors.
2. To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.
3. To demonstrate effective communication skill, professional attitude and a desire to learn.

Program Outcomes (POs)

a) Ability to apply knowledge of mathematics, science, engineering, computing to solve complex problems.

b) Ability to identify, analyze and solve complex software and hardware engineering problems.

c) Ability to design, implement and evaluate various computer based systems to meet the needs of the society by considering public health, safety, cultural, societal and environmental issues.

d) Ability to design & conduct experiments and interpret data.

e) Ability to use techniques, skills and modern engineering and IT tools to various relevant engineering practices.

f) Ability to examine and understand the impact of societal, health, safety, legal and cultural concerns at local, national and international levels relevant to engineering practices.

g) Ability to recognize the sustainability and environmental impact of the computer-based engineering solutions.

h) Ability to follow prescribed norms, responsibilities and ethics in engineering practices.

i) Ability to work effectively as an individual and in a team.

j) Ability to communicate effectively through oral, written and pictorial means with engineering community and the society at large.

k) Ability to recognize the need for and to engage in life-long learning.

l) Ability to understand and apply engineering & management principles in executing projects.

CS 1001 **PROGRAMMING IN C** **Cr-3**

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the basic terminology used in C programming.
CO2. write, compile and debug programs written in C.
CO3. use different data types in a C program.
CO4. design programs using decision structures, loops and functions.
CO5. explain the difference between call by value and call by reference.
CO6. understand the dynamics of memory by using pointers.
CO7. create/update basic data files.

Prerequisite: NIL

Introduction to Computer and Programming:

Basic concepts of computer organization, CPU, Memory. I/O devices, Number Systems , Evolution of programming languages, structured programming, Compilation process, source code, object code, executable code, Operating systems, interpreters, linkers, loaders, Algorithms, flow charts, pseudo-code

Program Constructs:

Character set, Identifiers, Keywords, Data Types, Constant and Variables, Operators: Precedence and associativity, Expressions, Statements, Input and Output functions, Control structures: Branching & Looping.

Functions:

Library and User defined functions, Formal and Actual parameters, function prototypes, Parameter passing: Call-by-value, Call-by-reference, Recursion, Storage Classes.

Arrays and Strings:

One dimensional Array, Multidimensional Array and their applications, String Manipulation.

Pointers:

Pointer variable , Pointer Arithmetic, passing parameters by reference, pointer to pointer, pointers to functions, dynamic memory allocation.

Structures, Unions:

Structures, Unions, pointer to structure & pointer to union, linked list.

File Handling:

Declaration of file pointer, opening and closing files, Working with text and binary files.

Additional Features:

Command line arguments, bit wise operators, enumerated data types, type casting, macros, Preprocessor directives.

Text Book

1. Computer fundamentals and programming in C – Pradip Dey & Manas Ghosh, Second Edition, 2013, OXFORD University Press

Reference Book

1. Programming in C – Byron Gottfried,Third Edition, 2010, TMH
2. The 'C' programming language - Ritchi, Kernighan, Second Edition, 2012 D.M.Ritchie, PHI
3. Programming in ANSI C – E. Balaguruswami, Sixth Edition, TMH
4. C The Complete Reference - H.Sohildt, Fourth edition,2000 TMH
5. Let us C - Y. Kanetkar, Twelfth Edition, 2012, BPB Publications
6. Computer Science - A Structured Programming Approach using C – B.A. Forouzan & R.F. Gillberg, Third Edition, 2007, Cengage Learning

CS 2001 DATA STRUCTURES & ALGORITHMS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the concepts of data structure, data type and array data structure.
CO2. analyze algorithms and determine their time complexity.
CO3. implement linked list data structure to solve various problems.
CO4. understand and apply various data structure such as stacks, queues, trees and graphs to solve various computing problems using C-programming language.
CO5. implement and know when to apply standard algorithms for searching and sorting.
CO6. effectively choose the data structure that efficiently model the information in a problem.

Prerequisite: Programming in C (CS 1001)

Introduction

Structures and Unions, Pointers, Dynamic Memory Allocation, Algorithm Specification, Space and Time Complexity

Arrays

Arrays, Abstract Data Type, Dynamically Allocated Arrays, Polynomials, Two-dimensional Array, Address Calculation, Matrix Addition and Multiplication, Sparse Matrix

Linked List

Singly Linked Lists and Chains, Representing Chains in C, Polynomials, Sparse Matrix, Doubly Linked Lists, Circular & Header Linked lists,

Stacks and Queues

Stacks, Stacks using Dynamic Arrays and Linked List, Queues, Queue using Linked List, Circular Queues using Dynamic Arrays, Evaluation of Expressions, Priority Queue, Dequeue

Trees

Introduction, Binary Trees, Binary Tree Traversals, Threaded Binary Trees, Binary Search Trees, AVL Trees, m-way Search Trees, B-Trees, B+-Trees, Tree Operation, Forests,

Graphs

The Graph ADT, Graph Representation, Graph Operation-DFS, BFS

Sorting :

Insertion Sort, Quick Sort, Merge Sort, Heap Sort, Bubble Sort, Selection sort, Radix sort

Searching :

Linear Search, Binary Search, Static Hashing, Dynamic Hashing

Text Book

1. Data Structures, Schaum's OutLines, Seymour Lipschutz, TATA McGRAW HILL

Reference Book

1. Fundamentals of Data Structures in C, 2nd edition, Horowitz, Sahani, Anderson-Freed, Universities Press.
2. Data Structures A Pseudocode Approach with C, 2nd Edition, Richard F. Gilberg, Behrouz A. Forouzan, CENGAGE Learning, India Edition
3. Data Structures and Algorithm Analysis in C, Mark Allen Weiss, Pearson Education, 2nd Edition.

CS 2004 DATABASE MANAGEMENT SYSTEMS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. master the basic concepts and understand the applications of database systems.
CO2. construct an Entity-Relationship (E-R) model from specifications and to perform the transformation of the conceptual model into corresponding logical data structures.
CO3. understand the basic database storage structures and access techniques.
CO4. distinguish between good and bad database design, apply data normalization principles, and be aware of the impact of data redundancy on database integrity and maintainability.
CO5. construct queries and maintain a simple database using SQL.
CO6. apply database transaction management and database recovery.

Prerequisite: NIL

Introduction

General introduction to database systems; Database - DBMS Definition, approaches to building a database, data models, three-schema architecture of a database, challenges in building a DBMS, various components of a DBMS.

Relational Data Model:

Concept of relations and its characteristics, schema-instance, integrity constraints, E/R Model - Conceptual data modelling - motivation, entities, entity types, various types of attributes, relationships, relationship types, E/R diagram notation,

Extended E/R Model, Converting the database specification in E/R and Extended E/R notation to the relational schema. Data Storage and Indexes - file organizations, primary, secondary index structures, hash-based indexing, dynamic hashing techniques, multi-level indexes, B^+ trees.

Relational Query Language:

Relational Algebra operators: selection, projection, cross product, various types of joins, division, example queries, tuple relation calculus, domain relational calculus. Introduction to SQL, Data definition in SQL, Table, Key and Foreign key definitions, Data manipulation in SQL. Nested queries, Notion of aggregation, PL/SQL.

Relational Database Design:

Dependencies and Normal forms - Importance of a good schema design, problems encountered with bad schema designs, motivation for normal forms, dependency theory - functional dependencies, Armstrong's axioms for FD's, closure of a set of FD's, minimal covers, definitions of 1NF, 2NF, 3NF and BCNF, decompositions and desirable properties of them, algorithms for 3NF and BCNF normalization, multi-valued dependencies and 4NF, join dependencies and definition of 5NF.

Transaction Processing:

Concepts of transaction processing, ACID properties, concurrency control, locking based protocols, recovery and logging methods.

Text Book

1. Database System Concepts by Silberschatz, Korth & Sudarshan (McGraw-Hill Education)
2. Fundamentals of Database System By Elmasari & Navathe- Pearson Education

Reference Book

1. Database Management Systems by RamaKrishna & Gehrke (McGraw-Hill Education)
2. Fundamentals of Relational Database management Systems by Sumathi & Esakkirajan, Springer

CS 2006 COMPUTER ORGANIZATION AND ARCHITECTURE Cr- 4

Course Outcome: At the end of the course, the students will be able to:

CO1. understand how computer hardware has evolved to meet the needs of multiprocessing systems, instruction Set Architecture: Instruction format, types, various addressing modes.
CO2. understand the basic components and design of the CPU: the ALU and control unit.
CO3. understand the memory organization: SRAM, DRAM, concepts on cache memory, Memory Interleaving, associative memory, Virtual memory organization.
CO4. understand the I/O Organization: Basics of I/O, Memory-mapped I/O & I/O mapped I/O, Types of I/O transfer: Program controlled I/O, Interrupt-driven I/O, DMA.

Prerequisite : NIL

Basic Structure of Computers:

Computer Types, Functional Units, Basic Operational Concepts, Bus Structures, Machine Instructions and Programs: Memory Location and Addressing mechanism, Memory Operations, IA-32 Register Structure, IA-32 Addressing Modes,IA-32 Instructions, Machine Instruction Format, IA-32 Assembly Language, Program Flow Control, Logic and Shift/Rotate Instructions, Subroutines for IA-32, Programming examples.

Basic Processing Unit:

Some Fundamental Concepts, Execution of a Complete Instruction, Single and Multiple Bus Organization, Hard-wired Control, Micro programmed Control unit.

Arithmetic:

Design of fast adders, Multiplication of Positive Numbers, Signed Operand Multiplication, Fast Multiplication, Integer Division, Floating-point Numbers and Operations.

Memory System:

Basic Concepts, Semiconductor RAM Memories, Read Only Memories, Speed, Size, and Cost, memory module design, Cache Memories – Mapping Functions, Replacement Algorithms, Memory interleaving, Memory Performance Considerations Virtual Memories.

Input/ Output Organization:

Basic Input and Output Operations, Accessing I/O Devices, Interrupts – Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices, Controlling Device Requests, Exceptions, Direct Memory Access. Interface Circuits, Standard I/O Interfaces – PCI Bus, SCSI Bus, USB, Flynn's Classification, RISC vs CISC

Text Book

1. Computer Organization, Carl Hamacher, Zvonko Vranesic, Safwat Zaky, 5th Edition, TMH, 2002.

Reference Book

1. Computer Organization & Architecture, William Stallings, 7th Edition, PHI, 2006.

CS 2008 DESIGN & ANALYSIS OF ALGORITHMS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. use different computational models, order notation and various complexity measures (e.g., running time, disk space) to analyze the complexity/performance of different algorithms.

CO2. describe, apply and analyze the complexity of certain divide and conquer, greedy, and dynamic programming algorithms.

CO3. understand the techniques used for designing fundamental graph theory algorithms and apply them to solve other related problems.

CO4. identify and analyze criteria and specifications appropriate to new problems, and choose the appropriate algorithmic design technique for their solution.

CO5. understand the classes P, NP, and NP-Complete and be able to prove that a certain problem is NP-Complete.

Prerequisite: Data Structure & Algorithms (CS 2001)

Introduction:

Algorithm Design paradigms- motivation, concept of algorithmic efficiency, run time analysis of algorithms, Asymptotic Notations.

Divide and conquer:

Structure of divide-and-conquer algorithms, max-min problem, Binary search, quick sort, randomized quick sort, merge sort, Analysis of divide and conquer run time recurrence relations.

Greedy Method:

Overview of the greedy paradigm ,knapsack problem, Optimal storage on tapes, Job sequencing with deadlines, Activity selection problem, minimum cost spanning tree, Single source shortest path, Huffman's code.

Dynamic programming:

Overview, difference between dynamic programming and divide and conquer, Applications: 0/1 knapsack, Shortest path in graph, Matrix chain multiplication, Traveling salesman Problem, longest Common subsequence.

Graph searching and Traversal:

Overview, Traversal methods (depth first and breadth first search)

Back tracking:

Overview, 8-queen problem, sum of subset, and Knapsack problem

Brach and bound:

LC searching Bounding, FIFO branch and bound, LC branch and bound application: 0/1 Knapsack problem, Traveling Salesman Problem

Computational Complexity:

Complexity measures, Polynomial Vs non-polynomial time complexity; NP-hard and NP complete classes, examples, Approximation Algorithm for travelling sales person problem.

Text Book

1. E. Horowitz, S. Sahni, and S. Rajsekaran, "Funadmentals of Computer Algorithms," Galgotia Publication

Reference Book

1. Sara Basse, A. V. Gelder, " Computer Algorithms," Addison Wesley
2. T. H. Cormen, Leiserson, Rivest and Stein, "Introduction of Computer algorithm," PHI
3. Algorithm Design:Foundation, Analysis&Internet examples By Michael T.Goodrich, Roberto Tamassia , John Wiley & Sons

CS 3002 COMPILER DESIGN Cr 4

Course Outcome : At the end of the course, the students will be able to

CO1. describe the design of a compiler and the phases of program translation from source code to executable code and the files produced by these phases.

CO2. explain lexical analysis phase and its underlying formal models such as finite state automata, push-down automata and their connection to language definition through regular expressions and grammars.

CO3. explain the syntax analysis phase and identify the similarities and differences among various parsing techniques and grammar transformation techniques.

CO4. formal attributed grammars for specifying the syntax and semantics of programming languages.

CO5. identify the effectiveness of optimization and explain the differences between machine-dependent and machine-independent translation.

Prerequisites :Programming in C (CS 1001), Object Oriented Programming (IT 1002) and Formal Languag Automata(CS 3003)

Overview of Compilation:

Introduction to Compiler, Phases of Compilation, Grouping of Phases.

Lexical Analysis:

Role of Lexical Analyzer, Input Buffering, Specification of Tokens, Finite state machines and regular expressions and their applications to lexical analysis.

Syntax Analysis:

Context-free grammars, Top-down Parsing – Backtracking, LL(1), recursive descent parsing, Predictive parsing, Bottom-up parsing – Shift Reduce parsing, LR and LALR parsing, Error recovery in parsing, handling ambiguous grammar.

Semantic analysis:

Intermediate forms of source Programs – abstract syntax tree, polish notation and three address codes. Attributed grammars, Syntax directed translation, Conversion of popular Programming languages language Constructs into Intermediate code forms, Type checker.

Symbol Tables:

Symbol table format, organization for block structures languages, hashing, tree structures representation of scope information.

Code optimization:

Consideration for Optimization, Scope of Optimization, local optimization, loop optimization, frequency reduction, folding, DAG representation.

Data flow analysis:

Flow graph, data flow equation, global optimization, redundant sub expression elimination, Induction variable elements, Live variable analysis, Copy propagation.

Object code generation:

Object code forms, machine dependent code optimization, register allocation and assignment generic code generation algorithms, DAG for register allocation.

Text Book

1. Compilers- Principles, Techniques and Tools, By A.V. Aho, M.S. Lam, R Sethi and J.D.Ullman, Pearson Education.

Reference Book

1. lex &yacc – John R. Levine, Tony Mason, Doug Brown, O'reilly
2. Engineering a Compiler, by Cooper & Linda, Elsevier.
3. Compiler Construction, K.C. Louden, Thomson Brooks/Cole.

CS 3003 FORMAL LANGUAGES & AUTOMATA THEORY Cr -4

Course Outcome: At the end of the course, the students will be able to:

CO1. apply a number of proof techniques to theorems in language design.
CO2. present the theory of finite automata, as the first step towards learning advanced topics, such as compiler design.
CO3. understand the equivalence between Context-Free Grammars and Non-deterministic Pushdown automata.
CO4. develop an understanding of computation through Turing Machines.
CO5. develop a clear understanding of the Chomsky hierarchy for language classes.

Prerequisites: Data Structure & Algorithms (CS 2001) and Discrete Mathematics (MA 2003)

Regular Languages:

Basic Concepts, Deterministic Finite Automata, Non-deterministic Finite Automata, Equivalence of DFA and NFA, Minimization of number of states in a DFA, Regular Expressions, Equivalence of Regular Expressions and Finite State Automata, Closure Properties of Regular Languages, Pumping Lemma for Regular Languages, Myhill-Nerode Theorem, Identification of some non-Regular languages, Decision Problems on Regular Languages, Regular grammars: right linear and left linear grammars, Equivalence of regular languages and regular grammars.

Context-Free Languages:

Context-Free Grammars, Leftmost and Rightmost derivations, Sentential Forms and Derivation Trees, Parsing and Membership, Parse Trees, Ambiguity in Grammars and Languages, Simplification of Context-Free Grammars, Chomsky Normal Form, Greibach Normal Form, Pushdown Automata, Equivalence of PDA and Context-Free Grammars, Closure Properties of Context-Free Languages, Pumping Lemma for Context-Free Languages, Identification of some Languages that are not Context-Free.

Turing Machines and other relevant Topics:

Turing Machines, Turing Machines as Language Accepters, Church-Turing Thesis, Models of Turing Machines -- Multiple Tape, Multiple Tracks, Non-determinism, etc., Equivalence of TM Models, Recursive and Recursively Enumerable languages, Chomsky Hierarchy of Formal Languages, Computability and Decidability, Halting Problem, Undecidability of the Halting Problem, Examples of some other undecidable problems.

Text Book

1. An Introduction to Formal Languages and Automata, Peter Linz, Jones & Bartlett Publishers

Reference Book

1. Introduction to Automata Theory Languages and Computation, J.E. Hopcroft, R Motwani and J.D. Ullman,Pearson Education.
2. Elements of the theory of computation, Lewis, Harry R. and Christos H. Papadimitriou Prentice-Hall, Englewood
3. The Theory of Computation, Bernard M. Moret, Pearson Education
4. Introduction to the Theory of Computation, Michel Sipser, Thomson Brooks/Cole
5. Theory of Computer Science, K L P Mishra and Chandrasekhran, PHI
6. Introduction to Automata Theory, Formal Languages and Computation, Kamala Krithivasan and R. Rama, Pearson Education

CS 3004 COMPUTER GRAPHICS Cr- 4

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the concepts of computer graphics H/W
CO2. analyze algorithms and their implementation
CO3. understand and apply various multimedia techniques
CO4. implement and know when to apply multimedia techniques standards for use.

Prerequisites : Programming in C (CS 1001) and Mathematics - I (MA 1001)

Introduction:

Introduction to Computer Graphics, Use of computer graphics, Elements of picture creation, Display technologies, Graphics display devices, Graphics input primitives and devices.

Two Dimensional Graphics:

Two dimensional output primitives, Different forms of line drawing algorithms, Circle generating algorithms, Ellipse generating algorithm, Filled area primitives.

Two Dimensional Geometric Transformations:
Translation, Scaling, Rotation , Reflection, Shear, Homogeneous coordinates, Composite transformations

Two Dimensional Viewing:

Window to view port transformations, Line clipping: Cohen Sutherland algorithm; Polygon clipping: Sutherland-Hodgeman algorithm, Projections: Parallel and Perspective projections

3D Geometric Transformations:

Translation, Scaling, Rotation in space

Three Dimensional Graphics:

Three dimensional shapes representations: Splines, Hermite Interpolation, Bezier curves and surfaces, Fractals: Generation, classification, Fractal Dimension, Julia Set, Mandelbrot set Visible surface detection: Back Face detection, Depth Buffer Method, Depth Sorting method.

Illumination model and surface rendering:

Basic illumination models, Goraud shading, Phong shading

Color Models:
RGB, CMY and HSV models

Animation.

Text Book

1. Computer Graphics, C Version, D. Hearn and M. P. Baker, Pearson, 2nd Ed, 2003.

Reference Book

1. Computer Graphics - Principles and Practice, J. D. Foley, A. Van Dam, S. K. Feiner and J. F. Hughes, Second Edition in C, Addison Wesley, 2nd Ed, 2003.
2. Mathematical Elements for Computer Graphics, D. F. Rogers, J. A. Adams, McGraw Hill, 2nd Ed, 2001

CS 3007 HIGH PERFORMANCE COMPUTER ARCHITECTURE Cr 4

Course Outcome: At the end of the course, the students will be able to:

CO1. the main objective of this course is to provide students with an understanding and appreciation of the fundamental issues and tradeoffs involved in the design and evaluation of modern computers.
CO2. through programming and analysis assignments students will build, in stages, a timing simulator for a simplified out-of-order multiple-issue microprocessor in order to examine the impact of various architectural techniques.

Prerequisite: Computer Organization and Architecture (CS 2006)

Introduction:

Review of basic computer architecture, quantitative techniques in computer design, measuring and reporting performance. CISC and RISC processors.

Pipelining:

Basic concepts, instruction and arithmetic pipeline, data hazards, control hazards, and structural hazards, techniques for handling hazards. Exception handling. Pipeline optimization techniques. Compiler techniques for improving performance.

Hierarchical memory technology:

Inclusion, Coherence and locality properties; Cache memory organizations, Techniques for reducing cache misses; Virtual memory organization, mapping and management techniques, memory replacement policies.

Instruction-level parallelism:

Basic concepts, techniques for increasing ILP, superscalar, super-pipelined and VLIW processor architectures. Array and vector processors.

Multiprocessor architecture:

Taxonomy of parallel architectures. Centralized shared-memory architecture: synchronization, memory consistency, interconnection networks. Distributed shared-memory architecture. Cluster computers. Non von Neumann architectures: data flow computers, reduction computer architectures, systolic architectures.

Text Book

1. John L. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann.

References Book

1. John Paul Shen and Mikko H. Lipasti, Modern Processor Design: Fundamentals of Superscalar Processors, Tata McGraw-Hill.
2. M. J. Flynn, Computer Architecture: Pipelined and Parallel Processor Design, Narosa Publishing House.
3. Kai Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw-Hill.

CS 3009 **OPERATING SYSTEMS** **Cr-4**

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the difference between different types of modern operating systems, virtual machines and their structure of implementation and applications.
CO2. understand the difference between process & thread, issues of scheduling of user-level processes / threads and their issues & use of locks, semaphores, monitors for synchronizing multiprogramming with multithreaded systems and implement them in multithreaded programs.
CO3. understand the concepts of deadlock in operating systems and how they can be managed / avoided and implement them in multiprogramming system.
CO4. understand the design and management concepts along with issues and challenges of main memory, virtual memory and file system.
CO5. understand the types of I/O management, disk scheduling, protection and security problems faced by operating systems and how to minimize these problems.

Prerequisite: Data Structure& Algorithms (CS 2001)

Introduction:

Operating system and functions, Evolution of operating system, Batch, Interactive, Time Sharing , Real Time System, Multi-Threading System.

Operating System Structure:

System Components, System structure, Operating System Services.

Concurrent Processes:

Process concept, Principle of Concurrency, Critical Section problem, Semaphores, Classical problems in Concurrency, Inter Process Communication, Introduction to monitor, Process Generation, Process Scheduling.

CPU Scheduling:

Scheduling Concept, Performance Criteria SchedulingAlgorithm, Evolution, Multiprocessor Scheduling.

Deadlock:

System Model, Deadlock Characterization, Prevention, Avoidance and Detection, Recovery from deadlock combined approach.

Memory Management:

Resident monitor, Multiprogramming with fixed partition, Multiprogramming with variable partition, Multiple base register, Paging, Segmentation, Virtual memory concept, Demand paging, Performance, Page replacement algorithms, Allocation of frames, Thrashing.

I/O Management & Disk Scheduling:

I/O devices and organization of I/O function, I/O Buffering, DISK I/O, Operating System Design Issues.

File System:

File Concept, File Organization and Access Mechanism, File Directories, File Sharing, Implementation Issues.

Operating system Protection & Security:

Introduction to distributed operating system, Case Studies - The UNIX operating system

Text Book

1. Operating System Concepts, A. Silverschwatz, P. Galvin & G.Gange , Willey

Reference Book

1. Operating System Concepts, Milenekovic, McGraw Hill
2. An introduction to operating system, Dietel, Addision Wesley
3. Operating system design and implementation, Tannenbaum, PHI

CS 3022 PARALLEL AND DISTRIBUTED COMPUTING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. to learn how to design parallel programs and how to evaluate their execution .
CO2. to understand the characteristics, the benefits and the limitations of parallel systems and distributed infrastructures .
CO3. to expose students to writing code in different parallel programming environments
CO4. build experience with interdisciplinary teamwork

Prerequisites: Operating Systems (CS 3009) and High Performance Computer Architecture(CS 3007)

Introduction to parallel computing:

Motivation, scope and issues.

Parallel Programming Platforms:

Trends in microprocessor Architectures, Dichotomy of parallel Computing platforms, physical Organization of parallel platforms, communication costs in parallel Machines, Routing Mechanisms for interconnection Network, Impact of Process Processors mapping and mapping Techniques.

Principles of parallel Algorithm Design :

Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for load Balancing, Methods for containing interaction overheads, Parallel Algorithm Models.

Basic Communication Operations:

One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and reduction All-Reduce and Prefix sum operations, scatter and Gather, All-to-All personalized communication, circular shift, improving the speed of some communication operation.

Analytical Modeling of Parallel Programs:

Performance Metrics for Parallel systems, Effect of Granularity of Performance, scalability of parallel system, Minimum Execution Time and Minimum Cost-optimal execution Time, Asymptotic Analysis of parallel Programs, other scalability Metrics.

Programming Using the message passing Paradigm:

Principle of Message – Passing Programming, Send and receive Operations, The message passing Interface, Topologies and Embedding, Overlapping communication with computation, collective communication and computation Operations, Groups and Communicators. Dense Matrix Algorithm

Sorting:

Bubble Sort and its variants, Quick Sort.

Graph Algorithms:

Minimum Spanning Tree (Prim's Algorithm) shortest path (Dijkstra's Algorithm)

Text Book

1. Introduction to Parallel Computing, Second Edition, Ananth Gram, Anshul Gupta, George Karypis, Vipin Kumar, Person Education.

Reference Book

1. Parallel Computer Architecture and Programming, D.E.Culler,J.P Singh & A Gupta, Morgan Kaufman.
2. Designing and Building Parallel Programs, I.Foster. Addison-Wesley.
3. Parallel programming in c with MPI and Open MP, M.J. Quinn, TMH.

CS 3026 DISTRIBUTED DATABASE SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. to know the design and system issues related to distributed database systems.
CO2. to learn the usage of different design strategies for distributed databases.
CO3. to study and implement the query processing techniques and algorithms as well as transaction management and concurrency control concepts used in such systems and in real world applications.
CO4. to know the Design and implementation issues related to multi-database systems (MDBS) and applications as well.

Prerequisite: Data Base Management Systems (CS 2004)

Introduction:
Overview of DDS, Features of Distributed versus Centralized Databases ,why Distributed Databases Overview of FQL (of RDBMS) and DDBMS.

Levels of Distribution Transparency:
Reference Architecture for Distributed Databases, Types of data Fragmentations, Distribution Transparency forRead-Only Applications, Distribution Transparency for Update Applications, Distributed Databases Access Primitives, Integrity Constraints in Distributed Databases. [8]

Distributed Databases Design:

Distributed Design Issues, Fragmentation, and Allocation of fragments.

Translation of Global Queries to Fragment Queries:
Equivalence Transformations for queries, Transforming Global Queries into Fragment Queries, Distributed Grouping and Aggregate functions Evaluations and Parametric Queries.

Optimization of Access Strategies:
The Framework for Query Optimization, Join Queries and General Queries

Distributed Transaction Management:

Issues for Transaction Management, Supporting Atomicity of Distributed Transaction , Concurrency Control for Distributed Transaction and Architectural Aspects of Distributed Transaction.

Concurrency Control:
Foundation of Distributed Concurrency Control, Distributed Deadlocks, Concurrency Control based Timestamps and Optimistic Methods Distributed Concurrency Control .

Distributed DBMS Reliability :

Basic concepts, Non blocking Commitment Protocols, Reliability and Concurrency Control, Determining a Consistent View of the Network, Detection and Resolution of Inconsistency and Checkpoints and Cold Restart.

Distributed Databases Administration:

Catalog Management in Distributed Databases and Authorizations and Protections

Multi-database Systems (MDBS) :

Problems in Heterogeneous Multi-database Systems, Database Integration Strategies and Multi-database System Architectures.

Text Book

1. Distributed Databases Principles and Systems, S. Ceri and G. Pelagatti, 2nd Edition McGraw Hill,2006.

Reference Book

1. Distributed Database Management Systems: A Practical approach', S. K. Rahimi & F. S. Haug, 1st Edition, 2011, Wiley.
2. Principles of Distributed Database Systems, M.T. Özsu and P. Valduriez. - Prentice-Hall. 2nd Edition,1999
3. Distributed Database Systems,C. Ray,1st Edition, Pearson, 2015.

CS 3028 ARTIFICIAL INTELLIGENCE Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the modern view of AI as the study of agents that receive percepts from the environment and perform actions.
CO2. demonstrate awareness of the major challenges facing AI and the complex of typical problems within the field.
CO3. exhibit strong familiarity with a number of important AI techniques, including in particular search, knowledge representation, planning and constraint management.
CO4. asses critically the techniques presented and to apply them to real world problems.

Prerequisite: Data Structures & Algorithms (CS 2001)

Introduction:

Overview; Foundation; History; The State of Art.

Intelligent Agents:

Agents and environment; Rationality; The nature of environment; The structure of agents.

Solving Problems by Searching:

Problem-solving agents; Well defined problems & solutions; Formulating problems; Searching for solution; Uninformed search strategies: (BFS, DFS, DLS, IDDFS, Bidirectional Search)

Informed Search and Exploration:

Informed search strategies; Heuristic functions; On-line search agents and unknown environment.

Constraint Satisfaction Problems:

Constraint satisfaction problems; Backtracking search for CSPs; Local search for CSPs.

Adversial search:

Games; Optimal decisions in games; Alpha-Beta pruning.

Logical Agents:

Knowledge-based agents; The wumpus world as an example world; Logic: Propositional logic Reasoning patterns in propositional logic.

First-order Logic:

Syntax and semantics of first-order logic; Use of first-order logic.

Text Book

1. Artificial Intelligence: A Modern Approach – Stuart Russel, Peter Norvig, 3rd Edition, Pearson Education, 2009.

Reference Book

1. Artificial Intelligence - Elaine Rich, Kevin Knight and Shivashankar B Nair, 3rd Edition, Tata McGraw Hill, 2008.
2. Artificial Intelligence: A new Synthesis – Nils J. Nilsson, 1st Edition, Elsevier, 1997.
3. Introduction to Artificial Intelligence and Expert Systems- Dan W. Patterson 2nd Edition, PHI, 2009.

CS 3030 COMPUTATIONAL INTELIGENCE Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify and describe soft computing techniques and their roles in building intelligent machines.
CO2. recognize the feasibility of applying a soft computing methodology for a particular problem.
CO3. apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
CO4. apply genetic algorithms to optimization problems.
CO5. apply neural networks to pattern classification problems.
CO6. evaluate and compare solutions by various soft computing approaches for a given problem.

Prerequisite: NIL

Introduction to Neura Fuzzy And Soft Computing:

Introduction, Soft Computing Constituents and Conventional AI,Neuro-Fuzzy and Soft Computing Characteristics

Fuzzy Set Theory:

Fuzzy Sets, Basic Definition and Terminology, Set-theoretic Operations, Member Function Formulation and Parameterization, Fuzzy Rules and Fuzzy Reasoning, Extension Principle and Fuzzy Relations, Fuzzy If-Then Rules, Fuzzy Reasoning, Fuzzy Inference Systems, Mamdani Fuzzy Models, Sugeno Fuzzy Models, Tsukamoto Fuzzy Models, Input Space Partitioning and Fuzzy Modelling.

Optimization:

Derivative-based Optimization, Descent Methods, The Method of Steepest Descent, Classical Newton's Method, Step Size Determination, Derivative-free Optimization, Genetic Algorithms, Simulated Annealing, Random Search, Downhill Simplex Search.

Neural Networks:

Supervised Learning Neural Networks, Perceptrons, Adaline, Back propagation Mutilayer Perceptrons, Radial Basis Function Networks, Unsupervised Learning Neural Networks, Competitive Learning Networks, Kohonen Self-Organizing Networks, Learning Vector Quantization, Hebbian Learning, Hop-field networks.

Neuro Fuzzy Modelling:

Adaptive Neuro-Fuzzy Inference Systems, Architecture, Hybrid Learning Algorithm, LearningMethods that Cross-fertilize ANFIS and RBFN, Coactive Neuro Fuzzy Modeling, Framework Neuron Functions forAdaptive Networks, Neuro Fuzzy Spectrum. Introduction to Neuro Fuzzy Control.

Text Book

1. Neuro-Fuzzy and Soft Computing, J.S.R.Jang, C.T.Sun and E.Mizutani, PHI/Pearson Education.

Reference Book

1. Fuzzy Logic with Engineering Applications, Timothy J.Ross, McGraw-Hill, 1997.
2. Genetic Algorithms: Search, Optimization and Machine Learning, Davis E.Goldberg, Addison Wesley, N.Y.,1989.
3. Neural Networks: A Comprehensive Foundation, Simon Haykin. Prentice Hall
4. Neural Network Design, M. T. Hagan, H. B. Demuth, Mark Beale, Thomson Learning, Vikash PublishingHouse.
5. Neural Networks, Fuzzy Logic and Genetic Algorithms, S. Rajasekaran and G.A.V.Pai, PHI, 2003

CS 3032 BIG DATA Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify the need for big data analytics for a domain
CO2. hands on R tool.
CO3. use Hadoop, Map Reduce Framework
CO4. apply big data for a give problem
CO5. suggest areas to apply big data to increase business outcome
CO6. contextually integrate and correlate large amounts of information automatically to gain faster insights

Prerequisite: Data Base Management System (CS 2004)

Introduction to Big Data :

Importance of Data, Characteristics of Data Analysis of Unstructured Data, Combining Structured and Unstructured Sources. Introduction to Big Data Platform – Challenges of conventional systems – Web data – Evolution of Analytic scalability, analytic processes and tools, Analysis vs reporting – Modern data analytic tools, Types of Data, Elements of Big Data, Big Data Analytics, Data Analytics Lifecycle.

Big data technology foundations :

Exploring the Big Data Stack, Data Sources Layer, Ingestion Layer, Storage Layer, Physical Infrastructure Layer, Platform Management Layer, Security Layer, Monitoring Layer, Analytics Engine, Visualization Layer, Big Data Applications, Virtualization. Introduction to Streams Concepts – Stream data model and architecture – Stream Computing, Sampling data in a stream – Filtering streams, Counting distinct elements in a stream.

Big data tools :

NOSQL, MapReduce – Hadoop, HDFS, Hive, MapR – Hadoop -YARN - Pig and PigLatin, Jaql - Zookeeper - HBase, Cassandra- Oozie, Lucene- Avro, Mahout. Hadoop Distributed file systems.

Data analysis through

Exploring R: Exploring Basic Features of R, Programming Features, Packages, Exploring RStudio, Handling Basic Expressions in R, Basic Arithmetic in R, Mathematical Operators, Calling Functions in R, Working with Vectors, Creating and Using Objects, Handling Data in R Workspace, Creating Plots, Using Built-in Datasets in R, Reading Datasets and Exporting Data from R, Manipulating and Processing Data in R.

Frameworks and visualization :

Distributed and Parallel Computing for Big Data,Visualizations – Visual data analysis techniques, interaction techniques; Systems and applications.Exploring the Use of Big Data in Business Context, Use of Big Data in Social Networking, Business Intelligence, Product Design and Development.

Text Book

1. Big Data, Black Book, DT Editorial Services, Dreamtech Press, 2015

Reference Book

1. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with advanced analystics, John Wiley & sons, 2012.
2. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007 Pete Warden, Big Data Glossary,O'Reilly, 2011.
3. Jiawei Han, MichelineKamber "Data Mining Concepts and Techniques", Second Edition, Elsevier, Reprinted 2008.
4. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services (Editor), Wiley, 2014
5. Stephan Kudyba, Thomas H. Davenport, Big Data, Mining, and Analytics, Components of Strategic Decision Making, CRC Press, Taylor & Francis Group. 2014
6. Norman Matloff , THE ART OF R PROGRAMMING, No Starch Press, Inc.2011.
7. Big Data For Dummies, Judith Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman, Wiley 2013
8. Big Data and Analytics, Seema Acharya, Subhashini Chellappan, Infosys Limited, Publication: Wiley India Private Limited,1st Edition 2015

CS 3033 PRINCIPLE OF AUTOMATA THEORY Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. apply a number of proof techniques to theorems in language design.
CO2. present the theory of finite automata, as the first step towards learning advanced topics, such as compiler design.
CO3. understand the equivalence between Context – Free Grammars and Non-deterministic Push down Automata.
CO4. develop a clear understanding of the Chomsky hierarchy for language classes.

Pre-requisites : Data structure & Algorithms (CS 2001) and Discrete Mathematics (MA 2003)

Regular Languages
Basic Concepts, Deterministic Finite Automata, Non-deterministic Finite Automata, Equivalence of DFA and NFA, Minimization of number of states in a DFA, Regular Expressions, Equivalence of Regular Expressions and Finite State Automata, Closure Properties of Regular Languages, Pumping Lemma for Regular, Regular grammars: right linear and left linear grammars, Equivalence of regular languages and regular grammars.

Context-Free Languages
Context-Free Grammars, Leftmost and Rightmost derivations, Sentential Forms and Derivation Trees, Parsing and Membership, Parse Trees, Ambiguous Grammars, Simplification of Context-Free Grammars, Chomsky Normal Form, Greibach Normal Form, Pushdown Automata, Equivalence of PDA and Context-Free Grammars, Closure Properties of Context-Free Languages, Pumping Lemma for Context-Free Languages.

Turing Machines and other relevant Topics:
Turing Machines, Turing Machines as Language Accepters, Church-Turing Thesis.

Text Book

1. An Introduction to Formal Languages and Automata, Peter Linz, Jones & Bartlett Publishers

Reference Book

1. Introduction to Automata Theory Languages and Computation, J.E. Hopcroft, R Motwani and J.D. Ullman,Pearson Education.
2. Elements of the theory of computation, Lewis, Harry R. and Christos H. Papadimitriou Prentice-Hall, Englewood
3. The Theory of Computation, Bernard M. Moret, Pearson Education
4. Introduction to the Theory of Computation, Michel Sipser, Thomson Brooks/Cole
5. Theory of Computer Science, K L P Mishra and Chandrasekhran, PHI
6. Introduction to Automata Theory, Formal Languages and Computation, Kamala Krithivasan and R. Rama, Pearson Education

CS3034 SERVICE ORIENTED ARCHITECTURE Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. demonstrate an understanding of software oriented architectures.
CO2. demonstrate an understanding of the service composition..
CO3. demonstrate an ability to manage a modern medium scale software development project using SOA principles.
CO4. demonstrate an understanding of the principles linking business processes, process oriented architectures and service oriented architectures.
CO5. demonstrate and ability to implement a service oriented application.

Prerequisite: Software Engineering (IT 3003)

Introduction to SOA, Evolution of SOA:

Fundamental of SOA; Common Characteristics of contemporary SOA; Common tangible benefits of SOA; An SOA timeline (from XML to Web services to SOA); The continuing evolution of SOA (Standards organizations and Contributing vendors); The roots of SOA (comparing SOA to Past architectures).

Web Services and Primitive SOA:

The Web services framework; Services (as Web services); Service descriptions with WSDL; Messaging with SOAP.

Web Services and Contemporary SOA:

Message exchange patterns; Service activity; Coordination; Atomic Transactions; Business activities; Orchestration; Choreography, Addressing; Reliable messaging; Correlation; Polices; Metadata exchange; Security; Notification and eventing.

Principles of Service – Orientation:

Services-orientation and the enterprise; Anatomy of a service-oriented architecture; Common Principles of Service-orientation; Service orientation principles interrelate; Service-orientation and objectorientation; Native Web service support for service-orientation principles.

Service Layers:

Service-orientation and contemporary SOA; Service layer abstraction; Application service layer, Business service layer, Orchestration service layer; Agnostic services; Service layer configuration scenarios.

Business Process Design:

WS-BPEL language basics; WSCoordination overview; Service-oriented business process design; WSaddresing language basics; WS-ReliableMessaging language basics.

SOA Platforms:

SOA platform basics; SOA support in J2EE; SOA support in .NET; Integration considerations.

Text Book

1. Service-Oriented Architecture Concepts Technology, and Design, Thomas Erl, Pearson Education.

Reference Book

1. Understanding SOA with Web Services, Eric Newcomer, Greg Lomow, Pearson Education.

CS 3040 DATA STRUCTURES USING C Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the concepts of data structure, data type and array data structure.
CO2. analyze algorithms and determine their time complexity.
CO3. implement linked list data structure to solve various problems.
CO4. understand and apply various data structure such as stacks, queues, trees and graphs to solve various computing problems using C-programming language.
CO5. implement and know when to apply standard algorithms for searching and sorting.
CO6. effectively choose the data structure that efficiently model the information in a problem

Prerequisite: Programming in C (CS 1001)

Introduction

Structures and Unions, Pointers, Dynamic Memory Allocation, Algorithm Specification, Space and Time Complexity

Arrays

Arrays, Abstract Data Type, Dynamically Allocated Arrays, Polynomials, Two-dimensional Array, Address Calculation, Matrix Addition and Multiplication, Sparse Matrix

Linked List

Singly Linked Lists and Chains, Representing Chains in C, Polynomials, Sparse Matrix, Doubly Linked Lists, Circular & Header Linked lists,

Stacks and Queues

Stacks, Stacks using Dynamic Arrays and Linked List, Queues, Queue using Linked List, Circular Queues using Dynamic Arrays, Evaluation of Expressions

Trees

Introduction, Binary Trees, Binary Tree Traversals, Threaded Binary Trees, Binary Search Trees, AVL Trees, m-way Search Trees, B-Trees, B+-Trees, Tree Operation, Forests, Tree vs. Graph

Sorting :

Insertion Sort, Quick Sort, Merge Sort, Heap Sort, Bubble Sort, Selection sort

Searching : Linear Search, Binary Search

Text Book

1. Data Structures, Schaum's OutLines, Seymour Lipschutz, TATA McGRAW HILL

Reference Book

1. Fundamentals of Data Structures in C, 2nd edition, Horowitz, Sahani, Anderson-Freed, Universities Press.
2. Data Structures A Pseudocode Approach with C, 2nd Edition, Richard F. Gilberg, Behrouz A. Forouzan, CENGAGE Learning, India Edition
3. Data Structures and Algorithm Analysis in C, Mark Allen Weiss, Pearson Education, 2nd Edition.

CS 3042 COMPUTER ORGANIZATION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand how computer hardware has evolved to meet the needs of multiprocessing systems.
CO2. instruction Set Architecture: Instruction format, types, various addressing modes.
CO3. understand the basic components and design of the CPU: the ALU and control unit.
CO4. understand the memory organization: SRAM, DRAM, concepts on cache memory, Memory.
CO5. interleaving, Associative memory, Virtual memory organization.
CO6. understand the parallelism both in terms of a single processor and multiple processors.
CO7. understand the I/O Organization: Basics of I/O, Memory-mapped I/O & I/O mapped I/O, Types of I/O transfer: Program controlled I/O, Interrupt-driven I/O, DMA.

Prerequisite: NIL

Introduction :

Functional units , Basic operational concepts, Bus structures, Performance and metrics, Instructions and instruction sequencing, Hardware – Software Interface, Instruction set architecture, Addressing modes, RISC & CISC. ALU design, Fixed-point arithmetic: Addition, Subtraction, Multiplication and Division,.

Basic Processing Unit ;

Fundamental concepts, Execution of a complete instruction, Single and Multiple bus organization, Hardwired control & Micro programmed control unit.

Pipelining :

Basic concepts, Flynn's Classification, Types of different hazards, Performance considerations.
Memory System

Basic concepts, Semiconductor RAM – ROM, Speed, Size and cost, Cache memories, Improving cache performance using mapping, Virtual memory, Associative memories, Secondary storage devices.

I/o Organization

Programmed I/O, DMA control and Interrupt based I/O, Serial transmission, Synchronization, Bus arbitration techniques, Bus architectures.

Text Book

1. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, "Computer Organization", Fifth Edition, Tata McGraw Hill, 2002.

Reference Book

1. William Stallings, "Computer Organization and Architecture – Designing for Performance", Sixth Edition, Pearson Education, 2003.
2. John P. Hayes, "Computer Architecture and Organization", Third Edition, Tata McGraw Hill, 1998.
3. V.P. Heuring, H.F. Jordan, "Computer Systems Design and Architecture", Second Edition, Pearson Education, 2004.

CS 3044 RELATIONAL DATABASE MANAGEMENT SYSTEM Cr-3

Course Outcome: At the end of the course, the students will be able to ;

CO1. master the basic concepts and understand the applications of database systems.
CO2. construct an Entity-Relationship (E-R) model from specifications and to perform the transformation of the conceptual model into corresponding logical data structures.
CO3. understand the basic database storage structures and access techniques.
CO4. distinguish between good and bad database design, apply data normalization principles, and be aware of the impact of data redundancy on database integrity and maintainability.
CO5. construct queries and maintain a simple database using SQL.
CO6. apply database transaction management and database recovery.

Prerequisite : NIL

Introduction :

Introduction to Database Systems; Database – DBMSDefinition, Approaches to building Database, Data Models,Three – Level Data Abstraction, Various components of DBMS.

Relational Data Model:

Concept of Relations and its characteristics, Schema – instance, Integrity Constraints, E/R Model, Entities, Entity Types, Attribute Types, Relationship and types, E/R Diagram Notations,Extended E/R Model, Converting E/R Diagram to Relational Schema.

Relational Query Language:

Relational Algebra Operators: Selection, Projection, Cross product, Types of joins, Division. Introduction to SQL, Data definition in SQL, Table, Primary key and Foreignkey definitions, Data manipulation in SQL. Nested queries, Notion of aggregation.

Relational Database Design:

Dependencies and Normal forms – Importanceof a good schema design, Problems encountered with bad schema designs,Motivation for normal forms, Dependency theory – functionaldependencies, Armstrong's axioms for FD's, closure of a setof FD's, Minimal covers, 1NF, 2NF, 3NF and BCNF, Denormalization.

Transaction Processing:

Introduction to transaction, ACID property, Serializability, Concurrency control protocol.

Text Book

1. Database System Concepts by Silberschatz, Korth & Sudarshan (McGraw-Hill Education)
2. Fundamentals of Database System By Elmasari & Navathe- Pearson Education

Reference Book

1. Database Management Systems by RamaKrishna & Gehrke (McGraw-Hill Education)
2. Fundamentals of Relational Database management Systems by Sumathi & Esakkirajan, Springer.

CS 3046 INTRODUCTION TO COMPUTER GRAPHICS Cr 3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the concepts of computer graphics H/W
CO2. analyze algorithms and their implementation
CO3. understand and apply various multimedia techniques
CO4. implement and understand when to apply multimedia techniques standards for use.

Pre-requisites: Programming in C (CS 1001) and Mathematics I (MA 1001)

Introduction

Introduction to Computer Graphics, Use of computer graphics, Elements of picture creation, Display technologies, Graphics display devices, Graphics input primitives and devices**.**

Two Dimensional Graphics

Two dimensional output primitives, Different forms of line drawing algorithms, Circle generating algorithms, Ellipse generating algorithm, Filled area primitives.

Two Dimensional Geometric Transformations

Translation, Scaling, Rotation , Reflection, Shear, Homogeneous coordinates, Composite transformations

Two Dimensional Viewing

Window to view port transformations, Line clipping: Cohen Sutherland algorithm; Polygon clipping: Sutherland-Hodgeman algorithm, Projections: Parallel and Perspective projections

3D Geometric Transformations

Translation, Scaling, Rotation in space

Three Dimensional Graphics

Three dimensional shapes representations: Splines, Hermite Interpolation, Bezier curves and surfaces,

Visible surface detection: Back Face detection, Depth Buffer Method, Depth Sorting method

Text Book

1. Computer Graphics, C Version, D. Hearn and M. P. Baker, Pearson, 2nd Ed, 2003

Reference Book

1. Computer Graphics - Principles and Practice, J. D. Foley, A. Van Dam, S. K. Feiner and J. F. Hughes, Second Edition in C, Addison Wesley, 2nd Ed, 2003.
2. Mathematical Elements for Computer Graphics, D. F. Rogers, J. A. Adams, McGraw Hill, 2nd Ed, 2001

CS 4024 DISTRIBUTED OPERATING SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. understand difference between DOS and COS along with distributed computing environment structure, components and their implementation with applications.
CO2. understand Synchronization, absence of global clock, Lamport's logical clock, distributed mutual exclusion and their issues for synchronizing multiprogramming systems and their implementation.
CO3. understand the concepts of deadlock in distributed systems and how they can be managed/avoided and implement them in hierarchical, distributed and centralize multiprogramming system.
CO4. understand different processor failure, byzantine agreement protocol, issue and implementation of distributed shared memory with distributed load sharing in multiprocessor systems.
CO5. understand election algorithm, implementation of file system and remote procedure call in distributed computing systems.
CO6. understand failure, recovery and fault tolerance implementation in distributed systems.

Prerequisite: Operating Systems (CS 3009)

Introduction:

Operating Systems for parallel computers, Performance Evaluation of parallel computers.

Issues in Distributed Systems:

Characterization of distributed systems, Design goals, Communication and computer networks, Distributed processing, Distributed operating systems, Client Server Communications, Remote Procedure calls, File Service, Name Service, Distributed transactions and concurrency control, fault tolerance and security.

Distributed Algorithms:

Synchronization & Coordination, Distributed Algorithms.

Advance Issue:

Special topics in distributed operating systems.

Text Books:

M. Singhal & N. G. Shivaratri,Advanced Concepts in Operating Systems, McGraw Hill.

CS 4025 MICROPROCESSORS Cr-3

Course Outcome: At the end of the course, the students will be able to ;

CO1. understand the architecture and organization of microprocessor along with instruction coding formats.
CO2. understand, write structured and well-commented programs in assembly language and in a higher-level language with an ability to test and debug them in the laboratory.
CO3. understand the memory and addressing concepts for interfacing I/O devices to the microprocessor.
CO4. understand software/ hardware interrupts and further write programs to perform I/O using handshaking and interrupts.
CO5. understanding of digital interfacing and system connections.

Prerequisite: Digital Electronics (EC 2011)

Introduction:

Overview of Microcomputer Structure and Operation, Microprocessor Evolution and Types, 8086 Internal Architecture. 8086 Instruction Description and Assembler Directives, 8086 Family Assembler Language Programming – Instruction Templates, MOV Instruction Coding Format and Examples, MOV Instruction Coding Examples, Writing Programs for use with an Assembler, Assembly Language Program Development Tools

Implementing Standard Program Structures in 8086 Assembly Language:

Simple Sequence Programs, Jumps, Flags, and Conditional Jumps, If-Then, If-Then-Else, and Multiple If-Then-Else Programs, While-Do Programs, Repeat-Until Programs, Instruction Timing and Delay Loops

Strings, Procedures, and Macros:

The 8086 String Instructions, Writing and Using Procedures, Writing and Using Assembler Macros

8086 System Connections Timing:

A Basic 8086 Microcomputer System, Addressing Memory and Ports in Microcomputer Systems, 8086 and 8088 Addressing and Address Decoding, How the 8088 Microprocessor Accesses Memory and Ports, 8086 Timing Parameters

8086 Interrupts and Interrupt Applications:

8086 Interrupts and Interrupt Responses, Hardware Interrupt Applications, 8259A Priority Interrupt Controller, Software Interrupt Applications

Digital Interfacing:

Programmable Parallel Ports and Handshake Input/output, Methods of Data Transfer, Implementing Handshake Data Transfer, 8255A Internal Block Diagram and System Connections, 8255A Operational Modes and Initialization, Constructing and Sending 8255A Control Words

Text Book

1. Microprocessors and Interfacing, Douglas V. Hall, Revised 2nd Edition, TMH, 2006.

Reference Book

1. Advanced Microprocessors & IBM-PC assembly Language Programming, K.Udaya Kumar & B.S. Umashankar, TMH 2003.
2. The Intel Microprocessors, Barry B. Brey, Pearson/PHI 2006. 7th Edition
3. The Intel Microprocessor Family: Hardware and Software Principles and Applications, James L. Antonakos, Thomson, 2007.
4. Microprocessors and Microcomputer- Based System Design, M. Rafiquzzaman, UBS Publication.
5. 8086 microprocessor & Architecture by Liu, Gibson; PHI.

CS 4027 REAL TIME SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. distinguish a real-time system from other systems
CO2. identify the functions of operating system
CO3. evaluate the need for real-time operating system
CO4. implement the real-time operating system principles

Prerequisite: Operating Systems (CS 3009)

Introduction:

Real-Time systems, applications of Real-Time systems, basic model of Real-Time systems, characteristics of Real-Time systems, types of Real-Time systems: hard, firm, soft, timing constraints, modeling timing constraints.

Real-Time task scheduling:

Basic concepts, clock driven scheduling, table driven scheduling, cyclic, schedulers, hybrid schedulers, event driven scheduling, EDF Scheduling, RMA, DMA, resource sharing among RT tasks, Priority inversion, Priority Inheritance Protocol, Highest Locker Protocol, Priority Ceiling Protocol, Scheduling Real-Time tasks in multiprocessor and distributed systems.

Fault-tolerant :

Fault-tolerant scheduling of tasks, clocks in distributed Real-Time systems, Commercial Real-Time Operating Systems, timers, UNIX and Windows as RT OS, POSIX, PSOS, VRTX, QNX, RT Linux, other RT OS, benchmarking RT OS, RT communications, QoS framework, models.

Real-Time Communication :

Real-Time Communication in a LAN, IEEE 802.4, RETHER, Communication over Packet Switched Networks, Routing algorithms, RSVP, rate control, RT databases, Applications, characteristics of temporal data, Concurrency control, Commercial RT databases.

Text Book

1. Real-Time Systems Design & Analysis, P. A. Laplante, Willey, 3rd Ed, 2004.

Reference Book

1. Real-Time Systems, C. M. Krishna and K. G. Shin, McGraw Hill, reprinted 2004.
2. Real-time Systems, J. W. S.Liu, Pearson Education, 6th impression, 2008.
3. Real-Time Systems, R. Mall, Pearson, 2007.

CS 4029 EMBEDDED SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to ;

CO1. describe the differences between the general computing system and the embedded system, also recognize the classification of embedded systems..
CO2. become aware of the architecture of the ATOM processor and its programming aspects (assembly Level)
CO3. become aware of interrupts, hyper threading and software optimization.
CO4. design real time embedded systems using the concepts of RTOS.
CO5. analyze various examples of embedded systems based on ATOM processor.

Prerequisite: Computer Organization and Architecture (CS 2006)

Embedded Computing:

Introduction, Complex Systems and Microprocessor, Embedded System Design Process, Formalisms for System Design, Design Examples.

The 8051 Architecture:

Introduction, 8051 Micro controller Hardware, Input/Output Ports and Circuits, External Memory, Counter and Timers, Serial data Input/Output, Interrupts.

Basic Assembly Language Programming Concepts:

The Assembly Language, Programming Process, Programming Tools and Techniques, Programming the 8051, Data
Transfer and Logical Instructions, Arithmetic Operations, Decimal Arithmetic. Jump and Call Instructions, Further Details on Interrupts.

Applications:

Interfacing with Keyboards, Displays, D/A and A/D Conversions, Multiple Interrupts, Serial Data Communication.

Introduction to Real-Time Operating Systems:

Tasks and Task States, Tasks and Data, Semaphores, and Shared Data; Message Queues, Mailboxes and Pipes, Timer, Functions, Events, Memory Management, Interrupt Routines in an RTOS Environment

Basic Design Using a Real-Time Operating System:

Principles, Semaphores and Queues, Hard Real-Time Scheduling Considerations, Saving Memory and Power, An example RTOS like uC-OS (Open Source); Embedded Software Development Tools: Host and Target machines, Linker/Locators for Embedded Software, Getting Embedded, Software into the Target System.

Basic Design Using a Real-Time Operating System:

Debugging Techniques: Testing on Host Machine, Using Laboratory Tools, An Example System.

Introduction to advanced architectures:

ARM and SHARC, Processor and memory organization and Instruction level parallelism; Networked embedded systems: Bus protocols, I2C bus and CAN bus; Internet-Enabled Systems, Design Example-Elevator Controller.

Text Book

1. An Embedded Software Primer, David E. Simon, Pearson Education.

Reference Book

1. Embedding system building blocks, Labrosse, via CMP publishers.
2. Embedded Systems, Raj Kamal, TMH.
3. Micro Controllers, Ajay V Deshmukhi, TMH.
4. Embedded System Design, Frank Vahid, Tony Givargis, John Wiley.
5. Microcontrollers, Raj Kamal, Pearson Education.

CS 4031 SOFTWARE TESTING Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. students who complete this course will be able to test software in structured, organized ways.
CO2. programmers will learn effective, practical ways to design and automate high quality tests during unit and integration testing.
CO3. system testers will learn how to efficiently design effective tests. Students will learn how to apply theory in practical ways to design tests based on test criteria.

Prerequisites: Software Engineering (IT 3003) and Object Oriented System Design(IT 3004)

Testing Methodology

Introduction to Effective Software Testing, Evolution of Software Testing, Software Testing Myths, Goals of Software Testing, Psychology for Software Testing, Software Testing Definitions, Model for Software Testing, Software Failure Case Studies.

Software Testing Terminology and Methodology

Definitions, Life Cycle of a Bug, Bug Classification based on SDLC, Testing Principles, Software Testing Life Cycle (STLC), Software Testing Methodology, Software Testing Strategy, Test Strategy Matrix, Verification and Validation, Verification and Validation Activities, How to verify Requirements and Objectives, Verification of High level Design, Verification of Data Design, Verification of Architectural Design, Verification of Low level Design, Unit Verification.

Testing Techniques
Dynamic Testing :

Black Box Testing Techniques, Boundary Value Analysis, Boundary value checking, Equivalence Class Testing, Identification of Equivalence classes, State Table based Testing, Finite State Machine, State table based testing, Decision Table based Testing, Cause Effect Graphing based Testing, Error Guessing

White Box Testing :

Need of White box testing, Logic Coverage Criteria, Basis Path Testing, Control Flow Graph,Flowgraph notations of different programming constructs, Path Testing, Terminology, Cyclomatic Complexity, Formulae based on Cyclomatic complexity. Guidelines for Basis Path Testing, Applications of Path Testing, Graph Matrices Graph Matrix, Connection Matrix, Loop Testing, Data Flow Testing, Static Data flow testing, Dynamic Data flowtesting,MutationTesting,MutationTestingProcess.

Static Testing
Inspections, Inspection Process, Walkthroughs, Technical Reviews, Unit Validation Testing,IntegrationTesting Types of Incremental Integration Testing, Pair-wise Integration, Path Based Integration, Function Testing, System Testing, Performance Testing, Usability Testing, performing the system tests, Acceptance Testing.

Regression Testing

Progressive vs Regression Testing, Regression testing produces quality softwareRegression Testability, Objectives of Regression Testing, Regression Testing TypesRegression Testing Techniques, Selective Retest Techniques,Strategy for Test Case Selection, Regression Test selection Techniques, Evaluating Regression TestSelection Techniques, Minimization Technique, Regression Test Prioritization, Types of Test case Prioritization,Prioritization Techniques, Prioritization Techniques, Codebased test case prioritization Vs coverage based test case prioritization.

Managing the Test Process

Test Management, Test Organization, Test Planning, Test Plan Hierarchy, Master Test Plan, Verification Test Plan, Validation Test Plan, Unit Test Plan, Integration Test Plan, Function Test Plan, System Test Plan, Acceptance Test Plan, Detailed Test Design and Test Specifications, Test Log, Test Reports, Software Metric, Testing Metrics for Monitoring and Controlling the Testing Process, Testing Process Maturity Models.

Test Automation

Automation and Testing Tools, Need of Automation, Categorization of Testing Tools Static and Dynamic Testing Tools, Testing Activity Tools, Selection of Testing ToolsCosts incurred in Testing Tools, Guidelines for Automated Testing, Overview of some commercial Testing Tools.

Testing for Specialized Environment

Testing Object Oriented Software, OOT and Structured Approach, Object Oriented Testing, Differences between Conventional testing and Object oriented Testing Issues in OO Testing, Testing of OO Classes, UML based OOTesting Introduction to Testing Web based Systems and Real Time Systems.

Text Book

1. Software Testing Principles : Practices, Naresh Chauhan, Oxford University Press, New Delhi

Reference Book

1. Foundation of Software Testing, Aditya P Mathur, Pearson Education
2. Software Testing and Analysis Process Principles and Techniques, Mauro Pezze, Michal Young, WiIley India
3. Software Testing Principles and Practices, Srinivasan Desikan, Gopalaswamy Ramesh, 2nd Edition, Pearson.

CS 4037 HUMAN COMPUTER INTERACTION Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. explain the human components functions regarding interaction with computer
CO2. explain Computer components functions regarding interaction with human
CO3. demonstrate Understanding of Interaction between the human and computer components.
CO4. use Paradigms
CO5. implement Interaction design basics
CO6. use HCI in the software process
CO7. apply Design rules
CO8. produce Implementation supports
CO9. use Evaluation techniques

Prerequisite: Artificial Intelligence (CS 3028)

Fundamental to HCI:

Importance of the user interface-definition, importance of good design, brief history. Characteristics of graphical & web user interfaces-GUI and WUI. User interface design process. Knowing the client-understanding how people interact, important human characteristics and human considerations. Principles of good screen design-human considerations in screen design. Develop system menus & navigation schemes-structures, functions, content, formatting, phrasing, choices and graphical menus.

Windows Management:

Select the proper kinds of windows-characteristics, components, presentation styles, types, management, organizing functions, operations. Device based controls-characteristics, selection. Screen based controls- operable, text entry/read-only, selection, combination entry/selection, and other operable controls, presentation controls, selection of proper controls. Write clear Text & Messages.

GUI Issues:

Provide effective Feedback and guidance & Assistance. Provide effective Internationalization and Accessibility. Create meaningful Graphics, icons and images. Choose the proper Colors. Organize and Layout windows and pages.

Interaction Design:

Introduction, goals, conceptualizing usability. Conceptualization of interaction-problem space. Conceptual models, interface metaphors, interaction paradigms. Understand users-Cognition, conceptual frameworks for cognition. Collaboration and communication- social mechanisms.

Principles of Interfaces Design:

Understanding how interfaces affect users- affective aspects, expressive interfaces, user frustration, agents. Process of interaction design- activities, characteristics, practical issues, life cycle models. Design, Prototyping and construction- prototyping. Conceptual design, Physical design. Introducing evaluation- evaluation, frameworks.

Text book

1. Human-Computer Interaction, Third Edition by Alan Dix et al., Prentice Hall.

Reference Book

1. The Essential Guide to user Interface Design, Third Edition by Wilbert O. Galitz, Wiley.
2. Interaction Design: Beyond Human-Computer Interaction, Second Edition by Jenny Preece et al., John Wiley & Sons Ltd.
3. Designing the User Interface: Strategies for Effective Human Computer Interaction, Second Edition by B. Sheiderman et al., Addison Wesley.

CS 4041 PATTERN RECOGNITION Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. apply basic principles and practices of Computer Science and Engineering to productively engage in research.

CO2. design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, ethical, manufacturability, and sustainability.

CO3. identify, analyze, formulate, and solve engineering problems.

CO4. use the techniques, skills, and modern engineering tools necessary for engineering practice.

Prerequisite: Data Structure & Algorithms (CS 2001)

Pattern Classifier

Overview of pattern recognition - Discriminant functions - Supervised learning - Parametric estimation Maximum likelihood estimation - Bayesian parameter estimation - Perceptron algorithm - LMSE algorithm - Problems with Bayes approach - Pattern classification by distance functions - Minimum distance pattern classifier.

Unsupervised Classification

Clustering for unsupervised learning and classification - Clustering concept - C-means algorithm – Hierarchical clustering procedures - Graph theoretic approach to pattern clustering - Validity of clustering solutions.

Structural Pattern Recognition

Elements of formal grammars - String generation as pattern description - Recognition of syntactic description - Parsing - Stochastic grammars and applications - Graph based structural representation.

Feature Extraction and Selection

Entropy minimization - Karhunen - Loeve transformation - Feature selection through functions approximation -Binary feature selection.

Recent Advances

Neural network structures for pattern recognition - Neural network based pattern associators – Unsupervised learning in neural pattern recognition - Self organizing networks - Fuzzy logic - Fuzzy pattern classifiers -Pattern classification using Genetic Algorithms.

Text Books:

1. Richard o. Duda, Peter e. Heart, David g. Stork ,"Pattern Classification", Second Edition, Wiley.

Reference Book

1. Christopher-M-Bishop," Pattern-Recognition-and-Machine-Learning", Springer.

INFORMATION TECHNOLOGY

Program Educational Objectives (PEOs) :

The Program Educational Objectives (PEOs) of B.Tech Program in Computer Science Engineering are established and are listed as follows :

PEO-1. To lead a successful career in industry or pursue higher studies or entrepreneurial endeavors.

PEO-2. To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.

PEO-3. To demonstrate effective communication skill, professional attitude and a desire to learn.

Program Outcomes (POs) :

Ability to apply knowledge of computing, mathematics, science and engineering fundamentals appropriate to the discipline.

(a) Ability to analyze a problem, and identify and formulate the computing requirements appropriate to its solution.

(b) Ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.

(c) Ability to design and conduct experiments, as well as to analyze and interpret data.

(d) Ability to use current techniques, skills, and modern tools necessary for computing practice.

(e) Ability to analyze the local and global impact of computing on individuals, organizations, and society.

(f) Knowledge of contemporary issues.

(g) Understanding of professional, ethical, legal, security and social issues and responsibilities.

(h) Ability to function effectively individually and on teams, including diverse and multidisciplinary, to accomplish a common goal.

(i) Ability to communicate effectively with a range of audiences.

(j) Recognition of the need for and an ability to engage in continuing professional development.

(k) Anderstanding of engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects.

IT 1002 **OBJECT ORIENTED PROGRAMMING** **Cr-3**

Course Outcome: At the end of the course, the students will be able to :

CO1. differentiate between structures oriented programming and object oriented programming.
CO2. use object oriented programming language like C++ and associated libraries to develop object oriented programs.
CO3. understand and apply various object oriented features like inheritance, data abstraction, encapsulation and polymorphism to solve various computing problems using C++ language.
CO4. apply concepts of operator-overloading, constructors and destructors.
CO5. apply exception handling and use built-in classes from STL.

Prerequisite: Programming in C (CS 1001)

Object oriented paradigm:
Evolution of programming paradigm, structured versus object-oriented development, Introduction to Object oriented programming concepts: Objects, classes, encapsulation and abstraction, inheritance, polymorphism, dynamic binding, message passing.

Moving from C to C++:
Introduction to C++, streams based I/O, name space, scope resolution operator (::), variable declaration at the point of use, variable aliases-reference variables, strict type checking, parameter passing by reference, inline function, function overloading, default arguments.

Object and Classes:
Specifying and using classes, access specifies: private, public, functions and data members, default arguments, function overloading, friend functions, static members.
Objects: memory considerations for objects, new and delete operators.

Constructors - default constructor, parameterized constructor, constructor with dynamic allocation, copy constructor, destructors.

Operator overloading- overloading through friend and member functionsBinary operators: arithmetic, relational, assignment , insertion, extractionUnary operators: unary minus , post and pre-increment, post and pre- decrement, Conversion functions : class to basic, basic to class, class to class.

Inheritance:
Derived and base classes, Class hierarchies, public, private, and protected derivations, constructors in derived classes, destructors in derived classes, constructors invocation and data members initialization in derived classes, classes within classes, virtual base class.

Polymorphism:
Pointer to objects, pointer to derived class object, this pointer, run time and compile time polymorphism, virtual functions, pure virtual functions, abstract class, virtual destructor.

Files and Streams:
Introduction to file handling, hierarchy of file stream classes, opening and closing of files, file modes, file pointers and their manipulators, sequential access, random access.

Exception handling and Templates :

Introduction to exception handling, throw point outside try, Multiple catch, Catch-all, throwing objects. Introduction to templates, class templates, function templates

Text Book

1. Object Oriented Programming with C++, E. Balaguruswamy, 6th Edition, 2013 TMG Hill

Reference Book

1. Object Oriented Programming with C++, Reema Thareja, OXFORD University Press, 1st Edition, 2015.
2. C++ completes reference, Herbert Schildt, TMG Hill, 4th Edition, 2002.
3. C++ How to Program, Deitel and Deitel, Pearson Education Asia, 8th Edition, 2011.
4. Object Oriented Programming with Ansi and Turbo C++, Ashok N Kamthane, Pearson Education, 1stEdition, 2003.
5. Object-Oriented Programming in C++, Robert Lafore, CourseSams Publishing, 4th Edition

IT 2003 WEB TECHNOLOGY Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. design good web pages using different tags, tables, forms, frames and style sheets supported by HTML.
CO2. implement, compile, test and run Java programs, comprising more than one class, to address a particular software problem.
CO3. demonstrate the ability to employ various types of selection statements and iteration statements in a Java program.
CO4. be able to leverage the object-oriented features of Java language using abstract class and interface.
CO5. be able to handle errors in the program using exception handling techniques of Java.
CO6. design applets as per the requirements with event handling facility.

Prerequisite: Object Oriented Programming (IT 1002)

Web Development:

HTML, Structure, Tags, Lists, Table, Link and it's types ,Images, Form, Frame, Style sheets and it's type

Introduction to Java:

Java and Java applications, Java Virtual Machine(JVM), Java Runtime Environment(JRE)Java Development Kit(JDK,) Byte code, Java characteristics, Object oriented Programming, Simple java programs, Data types, Operators, Expressions, control statements, Selection statements, Iteration statements, Jump statements

Classes, Inheritance :

Classes in java, Declaring a class, Creating instances of class, Constructors, Argument Passing, use of static keyword, Innner class. Method overloading, Inheritance, use of super keyword ,Method overriding, Abstract class, Dynamic method dispatch, use of final keyword

Interface, Package:

Package, Acesss control mechanism, Interface, Dynamic Method look up

Exception Handling:

Java Exception Handling Mechanism, try, catch, throw, throws and finally, Exception types, Built in Exceptions: checked and unchecked exceptions, User defined Exceptions

String Handling:

String and String Buffer, Constructors, String operations : character extractions, String comparisons, searching strings, modifying a string. To String() and valueOf() methods, String Buffer operations

Java I/O Stream:

I/O basics, Byte stream, Character stream, Reading console input, Writing console output, Reading and writing files

Java Utility package:

Collection overview, Collection interfaces, Collection classes: ArrayList, LinkedList, Accessing a collection using iterator and for-Each statement

Applet:

Applet class, Applet architecture, Applet Skeleton, Life cycle methods, setForeground() and setBachground() methods,Using the status window,HTML Applet tag, Passing parameters to an applet, GetCodebase() and getDocumentbase() methods.

Event Handling and AWT:

Delegation Event Model, Event classes, Sources of Events, Event Listener interfaces,Event handling using adapter class, Inner and anonymous class, AWT classes: Label,Button,TextField etc.

Text Book

1. Java-The Complete Reference,Herbert Schildt, 9^{th} Edition, McGraw Hill Education 2014

Reference Book

1. HTML- Complete Reference,Powell, 3rd Edition, TMH 2007
2. Core Java-An Integrated Approach, Dr. R.Nageswara Rao, Dreamtech 2015

IT 3001 COMPUTER NETWORKS Cr- 4

Course Outcome: At the end of the course, the students will be able to :

CO1. understand different models used for study of computer networks and ability to identify different designs.
CO2. understand how information transforms while moving through network and understand different technologies used to improve efficiency of communication.
CO3. understand how to preserve the integrity of data communication on network.
CO4. design and engineer routes to create interconnect of nodes.
CO5. understand working of World Wide Web and electronic mail technologies.

Prerequisite: NIL

Introduction:

Internet, Protocol, Network edge, Packet and circuit switching, Performance of network, Protocol layers and service model

Application Layer:

Architecture and principles of network applications, Web and HTTP, FTP and Email, DNS, P2P Applications

Transport Layer:

Introduction , Multiplexing and de multiplexing of data, Connection less transport, Principles of reliable data transfer, Go-back-to-N, Selective repeat, Connection oriented transport, Principles of congestion control, TCP congestion control

Routing Algorithms:

Link state, Distance vector , Hierarchical routing, RIP, BGP, Broadcast and multicast routing

Link Layer:

Error detection and correction, Multiple access links and protocols, Switched local area networks, Ethernet, VLAN, MPLS, and Data centre networking, 802.11 MAC

Open Area Research:
Introduction to Data centre networking, software defined networking.

Text Book

1. "Computer Networks: A top-down approach", by Forouzan and Mosharraf, Pearson.

Reference Book

1. "Computer Networking: A top-down approach", by Kurose and Ross, 5th Edition, Pearson.
2. "Computer Networks", by Andrew S. Tanenbaum and David Wetherall, 5th Edition, Pearson.
3. "Computer Networks: A System Approach", Larry L. Peterson and Bruce S. Davie, 5th Edition, Morgan Kaufmann Publishers

IT 3002 DATA ANALYTICS Cr-4

Course Outcome: At the end of the course, the students will be able to :

CO1. identify the need for data analytics for different domains
CO2. performing analysis of data using R tool.
CO3. use of Hadoop, Map Reduce Framework
CO4. apply big data analytics for a give problem
CO5. suggest areas to apply big data to increase business outcome
CO6. contextually integrate and correlate large amounts of information automatically to gain faster insights

Prerequisite: Data Base Management System (CS 2004)

Introduction to Big Data :

Importance of Data, Characteristics of Data Analysis of Unstructured Data, Combining Structured and Unstructured Sources. Introduction to Big Data Platform – Challenges of conventional systems – Web data – Evolution of Analytic scalability, analytic processes and tools, Analysis vs reporting – Modern data analytic tools, Types of Data, Elements of Big Data, Big Data Analytics, Data Analytics Lifecycle. Exploring the Use of Big Data in Business Context, Use of Big Data in Social Networking, Business Intelligence, Product Design and Development

Data analysis :

Exploring R: Exploring Basic Features of R, Programming Features, Packages, Exploring RStudio, Handling Basic Expressions in R, Basic Arithmetic in R, Mathematical Operators, Calling Functions in R, Working with Vectors, Creating and Using Objects, Handling Data in R Workspace, Creating Plots, Using Built-in Datasets in R, Reading Datasets and Exporting Data from R, Manipulating and Processing Data in R, Statistical Features-Analysis of time series: linear systems analysis, nonlinear dynamics – Rule induction – Neural networks: learning and generalization, competitive learning, principal component analysis and neural networks.

Big data technology foundations & mining data streams :

Exploring the Big Data Stack, Data Sources Layer, Ingestion Layer, Storage Layer, Physical Infrastructure Layer, Platform Management Layer, Security Layer, Monitoring Layer, Analytics Engine, Visualization Layer, Big Data Applications, Virtualization. Introduction to Streams Concepts – Stream data model and architecture – Stream Computing, Sampling data in a stream – Filtering streams, Counting distinct elements in a stream.

Frequent itemsets and clustering :

Mining Frequent itemsets – Market based model – Apriori Algorithm – Handling large data sets in Main memory – Limited Pass Algorithm – Counting frequent itemsets in a stream – Clustering Techniques – Hierarchical – K-Means. Analytical Approaches and Tools to Analyze Data: Text Data Analysis, Graphical User Interfaces, Point Solutions.

Frameworks and visualization :

Distributed and Parallel Computing for Big Data, MapReduce – Hadoop, Hive, MapR – Hadoop -YARN - Pig and PigLatin, Jaql - Zookeeper - HBase, Cassandra- Oozie, Lucene- Avro, Mahout. Hadoop Distributed file systems – Visualizations – Visual data analysis techniques, interaction techniques; Systems and applications.

Text Book

1. Big Data, Black Book, DT Editorial Services, Dreamtech Press, 2015

Reference Book

1. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with advanced analystics, John Wiley & sons, 2012.
2. Big Data and Analytics, Seema Acharya, Subhashini Chellappan, Infosys Limited, Publication: Wiley India Private Limited,1st Edition 2015
3. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007 Pete Warden, Big Data Glossary,O'Reilly, 2011.
4. Jiawei Han, MichelineKamber "Data Mining Concepts and Techniques", Second Edition, Elsevier, Reprinted 2008.
5. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services (Editor), Wiley, 2014
6. Stephan Kudyba, Thomas H. Davenport, Big Data, Mining, and Analytics, Components of Strategic Decision Making, CRC Press, Taylor & Francis Group. 2014
7. Norman Matloff , THE ART OF R PROGRAMMING, No Starch Press, Inc.2011.
8. Big Data For Dummies, Judith Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman, Wiley 2013

IT 3003 SOFTWARE ENGINEERING Cr-4

Course Outcome: At the end of the course, the students will be able to :

CO1. gather and specify requirements of the software projects.
CO2. analyze software requirements with existing tools.
CO3. differentiate different testing methodologies.
CO4. understand and apply the basic project management practices in real life projects.
CO5. work in a team as well as independently on software projects.

Prerequisite: Programming Knowledge

Software Process Models:

Software Product, Software crisis, Handling complexity through Abstraction and Decomposition, Overview of software development activities, Process Models, Classical waterfall model, iterative waterfall model, prototyping mode, evolutionary model, spiral model, RAD model, Agile models: Extreme Programming, and Scrum.

Software Requirements Engineering:

Requirement Gathering and Analysis, Functional and Non-functional requirements, Software Requirement Specification(SRS), IEEE 830 guidelines, Decision tables and trees.

Software Project Management:

Responsibilities of a Software project manager, project planning, Metrics for project size estimation, Project estimation techniques, Empirical estimation techniques, COCOMO models, Scheduling, Organization &team structure, Staffing, Risk management, Software configuration management.

Structured Analysis & Design:

Overview of design process: High-level and detailed design, Cohesion and coupling, Modularity and layering, Function–Oriented software design: Structured Analysis using DFD Structured Design using Structure Chart, Basic concepts of Object Oriented Analysis & Design. User interface design, Command language, menu and iconic interfaces.

Coding and Software Testing Techniques:

Coding, Code Review, documentation. Testing: - Unit testing, Black-box Testing, White-box testing, Cyclomatic complexity measure, coverage analysis, mutation testing, Debugging techniques, Integration testing, System testing, Regression testing.

Software Reliability and Software Maintenance:

Basic concepts in software reliability, reliability measures, reliability growth modeling, Quality SEI CMM, Characteristics of software maintenance, software reverse engineering, software reengineering, software reuse.

Emerging Topics:

Client-Server Software Engineering, Service-oriented Architecture (SOA), Software as a Service (SaaS)

Text Book

1. Fundamentals of Software Engineering, RajibMall , PHI, 2014

Reference Book

1.Software Engineering, I.Sommerville, Pearson Education, Asia.

IT 3004 OBJECT-ORIENTED SYSTEM DESIGN Cr-4

Course Outcome: At the end of the course, the students will be able to :

CO1. gather and specify requirements of the software projects and to analyze software requirements with existing UML tools
CO2. design and test software using UML tools
CO3. estimate the project with respect to effort and development time
CO4. take up a software development project and to work in a team as well as independently on software projects.

Prerequisites: Object Oriented Programming (IT 1002) and Software Engineering (IT 3003)

Introduction:

An overview of Object Oriented System Development, Object Basics, Object-Oriented systems, Development of Life Cycle.

Object-Oriented Methodologies:

Rumbaugh methodology, Booch methodology, Jackobson methodology, Object Oriented Programming, Object Oriented Design, Object Oriented Analysis, Elements of Object Model.

UML:

Unified Modeling Language, Conceptual Model of the UML, Iterative development, Unified Approach, Unified modeling language, static and dynamic models, Use-case diagram, class diagram, UML dynamic models, package and model organization, UML meta-model.

Object-Oriented Analysis:
Understanding requirements, Identifying use cases, Use-case driven Object Oriented Analysis, Case studies, Classification, Identifying Object relationships, Attributes and Methods.

Object Oriented Design:

Object Oriented Design, Design models: GRASP, Design Patterns, Framework, Object Oriented Testing, Process and Design Axioms and corollaries, Designing classes, Access Layer, Object Storage, Object Interoperability; Designing Interface Objects.

Object Oriented Data Model:
Quarry Languages, OODBMS, Object Rational Database system, designing access layer.

View Layer:

Designing interface objects, designing view layer classes, macro and micro level process, purpose of a view layer, case studies, Quality assurance test, Testing strategies, Test cases and test plan, continuous testing.

Text Book

1. Object Oriented Systems Development, Ali Bahrami, Tata McGraw-Hill

Reference Book

1. Applying UML and Patterns, CriagLarman, Pearson Education
2. Introduction to Object Oriented Analysis and Design, Stephen R Schach, Tata McGraw-Hill, 2003
3. Unified Modeling Language Reference Manual, James Rumbaugh, Grady Booch, Addison Wesley, 1999
4. Practical Object-Oriented Design with UML, Mark Priestley, 2^{nd} Edition, Tata McGraw-Hill, 2003
5. Object-Oriented Design with UML and JAVA, Kbrclay, Elsevier, 2008

IT 3021 E – COMMERCE Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. understand the E – commerce strategies and value chains
CO2. understand the E-commerce services
CO3. understand E – commerce infrastructure, its applications and Supply Chain Management.
CO4. know the availability of latest technology and applications of E-Payment Mechanism.
CO5. apply E-Commerce in business-to-business application.

Prerequisite : NIL

Electronic Commerce:
Overview, Definition, Advantages & Disadvantages of E-Commerce, Threats of E-Commerce, Managerial Prospective, Rules & Regulation for Controlling Commerce, Relationship Between E-Commerce & Networking, Different Types of Networking for E-Commerce, internet, Intranet, EDI Systems, Wireless Application Protocol: Definition, Hand Held Devices, Mobility & Commerce Model, Mobile Computing, Wireless Web, Web Security, Infrastructure Requirement for E-Commerce, Business Model of E-Commerce; Model Based on Transaction Type, Model Based on Transaction Party- B2B, B2C, C2B, C2C, E-Governance.

E-Strategy:
Overview, Strategic Methods for developing E-Commerce. Four C's (Convergence, Collaborative, Computing, Content Management & Call Center). **Convergence:** Technological Advances in Convergence - Types, Convergence and its implications, Convergence & Electronic Commerce. **Collaborative Computing:** Collaborative Product Development, contract as per CAD, Simulations Collaboration, Security. **Content Management:** Definition of Content, Authoring Tools and Content Management, Content Management, Content - partnership, repositories, convergence, providers, Web Traffic. **Traffic Management:** Content Marketing **Call Center:** Definition, Need, Tasks Handled, Mode of Operation, Equipment, Strength & Weakness of Call Center, Customer Premises Equipment (CPE). [6L]

Supply Chain Management:
E-logistics, Supply Chain Portal, Supply Chain Planning Tools (SCP Tools), Supply Chain Execution(SCE), SCE-Framework, Internet's Effect on Supply Chain Power.

E-Payment Mechanism:
Payment through card system, E-Cheque, E-Cash, E-Payment, Threats & Protections.

E-Marketing:
Home - Shopping, E-Marketing, Tele- Marketing

Electronic Data Interchange (EDI):
Meaning, Benefits, Concepts, Application, EDI Model, Protocols (UN EDI, FACT/ GTDI), ANSIX-12, Data Encryption (DES/RSA)

Risk of E-Commerce:
Overview, Security for E-Commerce, Security Standards, Firewall, Cryptography, Key Management, Password Systems, Digital Certificates, Digital Signatures.

Text Book

1. Electronic Commerce - Technologies & Applications, Bhaskar Bharat, TMH

Reference Book

1. E-commerce, MM Oka, EPH
2. Frontiers of Electronics Commerce, Kalakotia, Whinston, Pearson Education
3. Electronic Commerce, Loshin pete, Murphy P. A., Jaico Publishing Housing
4. E-Commerce, Murthy, Himalaya Publishing.

IT 3022 CLOUD COMPUTING Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. understanding the systems, protocols and mechanisms to support cloud computing.
CO2. develop applications for cloud computing.
CO3. understanding the hardware necessary for cloud computing.
CO4. design and implement a novel cloud computing application.

Prerequisite: Computer Networks (IT 3001)

Introduction

Introduction to Cloud Computing, Roots of Cloud Computing: Fundamental concepts of Distributed Systems, Cluster Computing, Grid Computing, and Mobile Computing.

Cloud Models :

Basics of Cloud Computing Concepts, Characteristics of Cloud Computing, Need for Cloud, Cloud Deployment models: private, public, hybrid and community cloud, Cloud Services: Resource-as-a-Service (RaaS), Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (PaaS), Examples of each services.

Cloud Services:

RaaS: Usage of Physical resources like servers, networks, data centeretc, IaaS: Virtualization, Virtual Machine provisioning and Migration Services, Scheduling techniques of Virtual machines for resource reservation. PaaS: Integrated lifecycle platform: Google App Engine, Microsoft Azure, Anchored life cycle platform: Salesforce platform, SaaS: Characterizing SaaS, Salesforce's software environment.

Cloud Application

Cloud Application, Cloud challenges, Cloud Security and privacy issues, Mobile Cloud, Integration of Cloud with Wireless Sensor Network and its application.

Text Book

1. "Cloud Computing Principles and Paradigms", edited by RajkumarBuyya, James Broberg and Andrzej Goscinski, Wiley Publication.

Reference Books:

1. "Cloud Computing for Dummies", Judith Hurwitz, Robin Bloor, Marcia Kaufman and Fern Halper, Wiley Publication.
2. "New frontiers in information and software as a service", Divyakant Agrawal, K. SelcukCandan, Wen-Syan Li (Eds.), Springer Proceedings.

IT 3023 COMPUTER VISION Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. apply knowledge of mathematics, science, and engineering
CO2. understand the time domain and frequency domain of digital signal
CO3. understand the segmentation and feature extraction of the digital signals
CO4. analyze the different Object Reorganization

Prerequisite: Data Structure and Algorithms (CS 2001)

Image formation

Introduction to Vision, Image Formation:
Geometric Primitivity,2D and 3D transformation, Photometric image formation, Digitization, Sampling and Alising.

Low level processing :

Linear filtering,Smoothing,Sharpening,Shift invariantlinear systems , Spatial Frequency and Fourier Transforms, Im age Gaussian Pyramid.

Feature extraction :

Edges Canny, Sobel, Line detectors (Hough Transform),Corners -
Harris and Hessian Affine, Orientation Histogram, SIFT, SURF,Feature analysis,feature vectors, distance/similarity measures.

Segmentation :

Clustering method, split and merge method ,Graph based
method, Applications: Shot Boundary Detection, Background Subtraction and Skin Finding.

Object recognition :

Object detection: Face detection,Pedestrian detection ,Face recognition: Eigenfaces, Active appearance and 3D shap e models.

Motion analysis :

Motion detection and tracking,Background Subtraction and Modeling, Optical Flow.

Text Book

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

Reference Book

1. Computer and Machine Vision Theory,Algorithms, Practicalities ,E.R Davis,Academic Press,4th Edition
2. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

IT 3025 ENTERPRISE RESOURCE PLANNING Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. comprehend the technical aspects of ERP systems;
CO2. understand concepts of reengineering and how they relate to ERP system implementations;
CO3. map business processes using process mapping techniques;
CO4. understand the steps and activities in the ERP life cycle;
CO5. identify and describe typical functionality in an ERP system;
CO6. practical hands-on experience with one of the COTS ERP Software e.g. SAP, Oracle

Prerequisite: NIL

Introduction to ERP

Enterprise – An Overview Integrated Management Information, Business Modeling, Integrated Data Model, Risks & Benefits of ERP.

ERP and Related Technologies
Business Processing Reengineering(BPR), Data Warehousing, Data Mining, On-line Analytical Processing(OLAP), Supply Chain Management (SCM), Customer Relationship Management(CRM), Management Information System(MIS), Decision Support System(DSS), Executive Information System(EIS).

ERP Implementation

Lifecycle, Implementation Methodology, Hidden Costs, Organizing the Implementation, Vendors, Consultants and Users, Contracts with Vendors, Consultants and Employees, Project Management and Monitoring

ERP Modules
Business modules in an ERP Package- Finance, Manufacturing, Human Resources, Plant Maintenance, Materials Management, Quality Management, Sales and Distribution

ERP Planning

ERP & E-Commerce, Future Directives in ERP, ERP and Internet, Critical success and failure factors, Integrating ERP into organizational culture, Performance measurement of ERP system, Maintenance of ERP system.

ERP Market

ERP Market Place, SAP AG, Peoplesoft, Baan, JD Edwards, Oracle, QAD, SSA

Text Book

1. Alexis Leon ,"ERP Demystified", Tata McGraw Hill

Reference Book

1. Vinod Kumar Garg and Venkitakrishnan N K, "Enterprise Resource Planning – Concepts and Practice",PHI

IT 3026 BIO-INFORMATICS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. have a basic knowledge of modern molecular biology and genomics.
CO2. understand the advantages and disadvantages of different machine learning techniques in bioinformatics and how the relative merits of different approaches can be evaluated by correct benchmarking techniques.
CO3. to understand how theoretical approaches can be used to model and analyse complex biological systems.

Prerequisites :Data Structures and Algorithm (CS 2001)

Molecular Biology Primer:

Genetic Material, Function of Genes, Structure of DNA, transcription and translation, Protein structure, DNA analysis, Gene variation, Need of Bioinformatics.

Exhaustive Search:

Restriction Mapping, Impractical restriction mapping algorithm, A practical restriction mapping algorithm, Regulatory motifs in DNA Sequences, Profiles, The motif finding problem, Search trees, Finding trees, Finding median string.

Greedy Algorithm:

A greedy approach to Motif Finding.

Dynamic Programming Algorithms:

The power of DNA sequence comparison, Edit distance and alignments, Longest common sub sequences, Global sequence alignment, Scoring alignments, Local sequence alignments, Alignment with gap penalties, Multiple alignment, Gene Prediction, Statistical approaches to gene prediction, Similarity based approaches to gene prediction, Spliced alignment.

Combinational Pattern Matching:

Repeat finding, Hash tables, Exact pattern matching, Keyword trees, Suffix trees, Heuristic similarity search algorithms, Approximate pattern matching, BLAST-Comparing a sequence against a database.

Graph Algorithms:

Graphs, Graphs and genetics, DNA sequencing, Shortest super string problem, DNA arrays as an Alternative sequencing technique, Sequencing by hybridization, SBH as an Hamiltonian path problem, SBH as an Eulerian path problem, Fragment assembly in DNA sequencing.

Clustering and Trees:

Gene expression analysis, Hierarchical clustering, k-means clustering, Clustering and corrupted cliques, Evolutionary trees, Distance based tree reconstruction, Reconstructing trees from additive matrices, Evolutionary trees and hierarchical clustering, Character based tree reconstruction, Small parsimony problem, Large parsimony problem.

Text Book

1. An Introduction to Bioinformatics Algorithms, N.C. Jones & P.A. Pevzner, The MIT Press-2004.

Reference Book

1. Introduction to Bioinformatics, A. M. Lesk, Oxford University Press.
2. Fundamental concepts of Bioinformatics, D.E. Karne& M.L. Raymer, BenjaminCummings.

IT 3027 MULTIMEDIA APPLICATIONS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyse the structure of the tools in the light of low-level constraints imposed by the adoption of various QoS schemes (ie bottom up approach)
CO2. analyse the effects of scale and use on both presentation and lower level requirements (ie top down approach)
CO3. plan experiments to test user perception of multimedia tools
CO4. state the properties of different media streams; compare and contrast different multicast protocols
CO5. describe mechanisms for providing QoS guarantees in the network and to propose experiments to analyse their performance.

Prerequisite: Computer Graphics (CS 3004)

Introduction:

Definition, Evolution, Multimedia presentation and production, Characteristics of a multimedia presentation, Components and Structure, Hardware and Software Specifications, Digitization concepts, Application domains.

Text, Image & Graphics:

Types of text, ASCII codes, Unicode standards, Font, Insertion of text, OCR, Text File formats, Image types, Color and color models, Scanner, Digital camera, Interface standards, Specification of digital images, Color management systems, Device independent color models, Gamma and gamma correction, Image processing steps and software, Image File formats, Image output on monitor and printer, Components of a Graphics System.

Audio & Video:

Nature of sound waves, Musical sound and noise, Tone and note, Psycho-acoustics and decibels, Microphone, Amplifier, Speakers, Digital audio specifications, Synthesizers, Musical Instrument Digital Interface (MIDI), Sound card, Audio processing steps and software, Audio File formats, Video frames and frame rate, Analog video camera, Video signal formats, Television broadcasting standards, Digital video, Digital video standards, PC Video, Video processing steps and software, Video File formats.

Compression:

CODEC, Types of compression, Types of redundancies, Lossless compression techniques, Lossy compression techniques, Run length encoding, Huffman coding, Arithmetic coding, Lempel-Ziv-Welsh coding, Differential pulse code modulation, GIF standard, JPEG standard, H.261/H.263/ H.264, MPEG-1, MPEG-2, MPEG-4, MPEG-7, AMR, AAC.

Multimedia Architecture & Transmission:

Windows multimedia support, Windows API, Graphic libraries, DirectX, OpenGL, Distributed multimedia applications, Videoconference, Video on demand, Real time transport protocols, Streaming, Windows Media Framework, Quick time Architecture, Ogg Framework, Temporal relationships, Synchronization.

Multimedia Database:

Limitations of textual descriptions of media, Content based storage and retrieval (CBSR), Image color, Image texture, Image shape, Audio speech and music discrimination.

Text Book

1. Principle of Multimedia – Ranjan Parekh – 2nd Edition, Tata McGraw Hill, India.

Reference Book

1. Fundamentals of Multimedia – Ze-Nian Li & Mark S. Drew – PHI India.
2. Multimedia Computing, Communications & Applications – Ralf Stenmetz&KlaraNahrstedt – Pearson Education.
3. Multimedia Communications: Applications, Networks, Protocols and Standards – Fred Halsall – Pearson India.

IT 3028 INFORMATION AND CODING THEORY Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. know the basic notions of information and channel capacity.
CO2. understand the convolutional and block codes, decoding techniques, and automatic repeat request (ARQ) schemes.
CO3. understand how error control coding techniques are applied in communication systems.
CO4. understand the basic concepts of cryptography.

Prerequisite: Principle of Digital Communication (EC 2004)

Information Theory:

Uncertainty and information, average mutual information and entropy, Perfect secrecy.Source Coding: Source coding theorem, Shannon-Fano coding, Huffman coding, arithmatic coding, Lempel Ziv algorithm, run length coding.

Channel capacity & coding:
Channel models, channel capacity, channel coding, information capacity theorem, random selection of codes.

Error control coding:
Block codes: single parity check codes, product codes, repetition codes, Hamming codes, minimum distance of codes

Linear codes:
Generator matrices, parity check matrices, error syndromes, error detection and correction, shortened and extended linear codes.

Cyclic codes:
Generator polynomials, encoding and decoding cyclic codes, parity check polynomials, dual cyclic codes, generator and parity check matrices of cyclic codes.

BCH Codes:
Galois fields, Definition & construction of BCH codes, error syndromes in finite fields, RS codes, The Berlekemp algorithm, Error evaluator polynomial.

Convolution codes:
Encoding convolution codes, generator matrices for convolution codes, generator polynomials for convolution codes, Theviterbi decoder, Tree codes, Turbo codes, Trellis codes.

Text Book

1. Ranjan Bose, "Information Theory, Coding and Cryptography", TMH

Reference Book

1. Salvatore Gravano "Introduction to Error Control Codes", Oxford
2. Wade Trape, Lawrence C Washington, "Introduction to Cryptography with Coding Theory", Pearson.

IT 3029 SOFTWARE DESIGN AND VALIDATION Cr-3

Course Outcome : At the end of the course, the students will be able to :

CO1. know the software design phases.
CO2. understand the different modeling actions.
CO3. understand validation techniques for software.
CO4. understand the timing analysis and trace analysis.

Prerequisites: **Programming in 'C' (CS 1001) and Data Structures& Algorithms(CS 2001)**

Introduction to Software Design :
Modeling notations:
Model Validation: Model simulation and model-based testing :
Performance validation - Timing analysis and prediction:
Performance validation - Scheduling methods :
Software validation - Trace analysis and Debugging methods :
Software validation - Static property checking of software:
Validation of communication behavior :

Text Book

1. Abhik Roychoudhury, Embedded Systems and Software Validation, Morgan Kaufmann Systems-on-Silicon Series, 2009.

Reference Book

1. Flemming Nielson, Hanne R. Nielson, Chris Hankin: *Principles of Program Analysis*, 2nd ed., Springer, 2005

IT 3030 FORMAL VERIFICATION: THEORY AND PRACTICE Cr-3

Course Outcome : At the end of the course, the students will be able to :

CO1. define Digital Design and verification .
CO2. define and work with different simulators.
CO3. generate Test Scenarios of different case studies.
CO4. solve problems using state machine, equivalence checking, model checking.

Pre-requisite: Software Engineering (IT 3003)

Verification practices for hardware systems:
Introduction, Overview of Digital Design and Verification, Verilog HDL, Simulators, Test Scenarios and Coverage, Assertions, Binary Decision Diagrams (BDD), State Machines and Equivalence Checking, Model Checking, Bounded Model Checking, Counter Example Guided Abstraction Refinement

Software Analysis and Verification:
Type checking and type state verification, Dataflow analysis, Software model checking techniques

Text Book
1. P. Dasgupta, A Roadmap for Formal Property Verification, Springer 2006

Reference Book
1. E. M. Clarke, O. Grumberg and D. A. Peled, Model Checking, MIT Press, 2000
2. M. Huth and M. Ryan, Logic in Computer Science, Modelling and reasoning about systems, Cambridge University Press, 2004
3. Christel Baier and Joost-Pieter Katoen, Principles of model checking, MIT Press, 2008

IT 3032 OBJECT ORIENTED SYSTEM Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. gather and specify requirements of the software projects and to analyze software requirements with existing UML tools
CO2. design and test software using UML tools
CO3. estimate the project with respect to effort and development time
CO4. take up a software development project and to work in a team as well as independently on software projects.

Pre-requisites: Object Oriented Programming (IT 1002) and Software Engineering (IT 3003)

Introduction
An overview of Object Oriented System Development, Object Basics, Object-Oriented systems, Development of Life Cycle.

Object-Oriented Methodologies
Rumbaugh methodology, Booch methodology, Jackobson methodology, Object Oriented Programming, Object Oriented Design, Object Oriented Analysis, Elements of Object Model.

UML

Unified Modeling Language, Conceptual Model of the UML, Iterative development, Unified Approach, Unified modeling language, static and dynamic models, Use-case diagram, class diagram, UML dynamic models, package and model organization, UML meta-model.

Object-Oriented Analysis

Understanding requirements, Identifying use cases, Use-case driven Object Oriented Analysis, Case studies, Classification, Identifying Object relationships, Attributes and Methods.

Object Oriented Design

Object Oriented Design, Design models: GRASP, Design Patterns, Framework, Object Oriented Testing, Process and Design Axioms and corollaries, Designing classes, Access Layer.

Object Oriented Data Model and View Layer

Quarry Languages, OODBMS, Designing interface objects, designing view layer classes, macro purpose of a view layer, case studies, Quality assurance test.

Text Book

1. Object Oriented Systems Development, Ali Bahrami, Tata McGraw-Hill

Reference Book

1. Applying UML and Patterns, CriagLarman, Pearson Education
2. Introduction to Object Oriented Analysis and Design, Stephen R Schach, Tata McGraw-Hill, 2003
3. Unified Modeling Language Reference Manual, James Rumbaugh, Grady Booch, Addison Wesley, 1999
4. Practical Object-Oriented Design with UML, Mark Priestley, 2nd Edition, Tata McGraw-Hill, 2003
5. Object-Oriented Design with UML and JAVA, Kbrclay, Elsevier, 2008

IT 3042 INTRODUCTION TO WEB TECHNOLOGY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. design good web pages using different tags, tables, forms, frames and style sheets supported by HTML.
CO2. implement, compile, test and run Java programs comprising more than one class to address a particular software problem.
CO3. demonstrate the ability to employ various types of selection statements and iteration statements in a Java program
CO4. leverage the object-oriented features of Java language using abstract class and interface
CO5. handle errors in the program using exception handling techniques of Java

Pre-requisite : Object Oriented Programming (IT 1002)

Web Development

HTML, Structure, Tags, Lists, Table, Link and it's types ,Images, Form, Frame, Style sheets and it's type

Introduction to Java

Java and Java applications, Java Virtual Machine (JVM), Java Runtime Environment (JRE), Java Development Kit (JDK,) Byte code, Java characteristics, Object oriented Programming, Simple java programs, Data types, Operators, Expressions, control statements, Selection statements, Iteration statements.

Classes, Inheritance

Classes in java, Declaring a class, Creating instances of class, Constructors, Argument Passing, use of static keyword, Innner class, Method overloading, Inheritance, use of super keyword ,Method overriding, Abstract class, Dynamic method dispatch, use of final keyword .

Interface, Package

Package, Access control mechanism, Interface, Dynamic Method look up.

Exception Handling

Java Exception Handling Mechanism, try, catch, throw, throws and finally, Exception types, Built in Exceptions: checked and unchecked exceptions, User defined Exceptions.

String Handling

String and String Buffer, Constructors, String operations : character extractions, String comparisons, searching strings, modifying a string. To String() and valueOf() methods, String Buffer operations .

Java I/O Stream

I/O basics, Byte stream, Character stream, Reading console input, Writing console output, Reading and writing files.

Java Utility package

Collection overview, Collection interfaces, Collection classes: Array List, Linked List, Accessing a collection using iterator and for-Each statement .

Text Book

1. Java-The Complete Reference, Herbert Schildt, 9th Edition, McGraw Hill Education 2014

Reference Book

1. HTML-Complete Reference, Powell, 3rd Edition, TMH 2007
2. Core Java - An Integrated Approach, Dr. R. Nageswara Rao, Dreamtech 2015

IT 4001 MOBILE COMPUTING Cr-4

Course Outcome: At the end of the course, the student should be able to :

CO1. explain the basics of mobile telecommunication system
CO2. choose the required functionality at each layer for given application
CO3. identify solution for each functionality at each layer
CO4. use simulator tools and design Ad hoc networks
CO5. develop a mobile application.

Prerequisite: Computer Networks (IT 3001)

Introduction:

Mobile Computing – Mobile Computing vs wireless Networking – Mobile Computing Applications – Characteristics of Mobile computing – Structure of Mobile Computing Application. MAC Protocols – Wireless MAC Issues – Fixed Assignment Schemes – Random Assignment Schemes – Reservation Based Schemes.

Mobile internet protocol and transport layer :

Overview of Mobile IP – Features of Mobile IP – Key Mechanism in Mobile IP – route Optimization. Overview of TCP/IP – Architecture of TCP/IP- Adaptation of TCP Window – Improvement in TCP Performance.

Mobile telecommunication system :

Global System for Mobile Communication (GSM) – General Packet Radio Service (GPRS) – Universal Mobile Telecommunication System (UMTS).

Mobile ad-hoc networks :
Ad-Hoc Basic Concepts – Characteristics – Applications – Design Issues – Routing – Essential of Traditional Routing Protocols –Popular Routing Protocols – Vehicular Ad Hoc networks (VANET) – MANET Vs VANET – Security.

Mobile platforms and applications :
Mobile Device Operating Systems – Special Constrains & Requirements – Commercial Mobile Operating Systems – Software Development Kit: iOS, Android, BlackBerry, Windows Phone – M Commerce – Structure – Pros & Cons – Mobile Payment System – Security Issues.

Text Book

1. Rajib Mall, "Fundamentals of Mobile Computing", PHI Learning Pvt. Ltd, New Delhi – 2016, second edition.

Reference Book

1. C.K.Toh, "AdHoc Mobile Wireless Networks", First Edition, Pearson Education, 2002.
2. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "Principles of Mobile Computing", Springer, 2003.

IT 4021 INTERNET OF THINGS Cr-3

Course Outcome : At the end of the course, the students will be able to :

CO1. understand the application areas of IOT.
CO2. realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks.
CO3. understand building blocks of Internet of Things and characteristics.

Prerequisite: Computer Networks (IT 3001)

Introduction:

The Internet of Things: an Overview:
The flavour of the Internet of Things, The "Internet" of "Things", The Technology of the Internet of Things, Enchanted Objects, Who is Making the Internet of Things?

Design Principles for Connected Devices:
Calm and Ambient Technology, Magic as Metaphor, Privacy, Web Thinking for Connected Devices, Affordances.

Internet Principles:
Internet Communications: An Overview (IP, TCP, The IP Protocol Suite (TCP/IP), UDP), IP Addresses (DNS, Static IP Address Assignment, Dynamic IP Address Assignment, IPv6), MAC Addresses, TCP and UDP Ports, Application Layer Protocols.

Prototyping:

Thinking About Prototyping: Sketching, Familiarity, Costs versus Ease of Prototyping, Prototypes and Production, Open Source versus Closed Source, Tapping into the Community.

Prototyping Embedded Devices:
Electronics, Embedded Computing Basics, Developing on the Arduino, Raspberry Pi, Beaglebone Black, Electric Imp, Mobile Phone and Tablets, Plug Computing: Always-on Internet of Things.

Prototyping the Physical Design:
Preparation, Sketch, Iterate, and Explore, Non-digital Methods, Laser Cutting, 3D Printing, CNC Milling, Repurposing/Recycling.

Prototyping Online Components:
Getting Started with an API, Writing a New API, Real-Time Reactions, Other Protocols.

Techniques for Writing Embedded Code:
Memory Management, Performance and Battery Life, Libraries, Debugging.

Prototype to Reality:
Business Models: A Short History of Business Models, The Business Model Canvas, Who Is The Business Model For Models, Funding an Internet of Things Startup, Lean Startups.

Moving to Manufacture:
What Are You Producing?, Designing Kits, Designing Printed Circuit Boards, Manufacturing Printed Circuit Boards, Mass-Producing the Case and Other Fixtures, Certification, Costs, Scaling Up Software,

Ethics:
Characterizing the Internet of Things, Privacy, Control, Environment, Solutions.

Text Book

1. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", Wiley publication, 1st Edition, November 2013.

IT 4022 CYBER LAW AND INTELLECTUAL PROPERTY RIGHTS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. understand the role of intellectual property rights
CO2. identify the main types of intellectual property rights
CO3. understand the steps for successful registration and protection of intellectual property rights at national,regional and international levels
CO4. search patent and trademark databases
CO5. understand the legal aspects for intellectual property protection

Prerequisite: NIL

Cyber World :
An Overview, The internet and online resources ,Security of information, Digital signature

An Overview Cyber Law:

Introduction about the cyber space , Regulation of cyber space – introducing cyber law Scope of Cyber laws – e-commerce; online contracts; IPRs (copyright, trademarks and software patenting); e-taxation; e-governance and cyber crimes, Cyber law in India with special reference to Information Technology (Amendment) Act, 2008

IPR:
Introduction : Origin and Genesis of IPR , Theories of IPR – Locke's, Hegel andMarxian Ethical, moral andhuman rights perspectives of IPR, Intellectual PropertyRights: International Relevance, Internationalization of IP protection – ParisConvention, Berne Convention, TRIPS Agreement – basic principles and minimum standards – limits of one-size-fit for all flexibilities under TRIPS

Intellectual Property: Issues and Challenges:
Geographical Indications, Layout designs of Integrated Circuits and Protection of Plant Varieties and Farmers' Rights. Copyright protection with reference to performers rights and Artist rights, Global governance towards Patents , Trade Marks: Legal recognition, Comparative analysis in India, EU and USA, Trade secrets : Legal recognition, Comparative analysis in India, EU and USA

Intellectual Property: Contemporary Trends
Benefit sharing and contractual agreements – International Treaty on Plant Genetic Resources for Food and Agriculture – issues on patent policy and farmers' rights- CBD, Nagoya Protocol and Indian law, UNESCO – protection of folklore/cultural expressions Developments in WIPO on traditional knowledge and traditional cultural expressions

Text Book

1. Duggal Pavan, Cyber Law - An exhaustive section wise Commentary on The Information Technology Act along with Rules, Regulations, Policies, Notifications etc. UNIVERSAL LAW PUBLISHING CO. PVT. LTD. C-FF-1A, Dilkhush Industrial Estate, (Near Azad Pur Metro Station) G. T. Karnal Road, Delhi - 110033, INDIA2014

Reference Book

1. Intellectual Property Rights in India : General Issues and ImplicationsPrankrishnaPal
2. JonathanRosenoer, "Cyberlaw: the Law of the Internet", Springer-verlag, 1997.
3. W. Cornish & Llewelyn – Intellectual Property: Patent, Copyrights, Trade Marks & Allied Rights", London Sweet & Maxwell.
4. Nard Madison- The Intellectual Property, Aspian Publication.
5. Carlosm Correa- Oxford commentaries on GATT/ WTO Agreements trade Related aspects of Intellectual Property Rights, Oxford University Press.
6. Cornish William – Intellectual Property. Cambridge University Press.

IT 4023 MOBILE COMPUTING Cr- 3

Course Outcome: At the end of the course the student will be able to:

CO1. understand the basic concepts of mobile computing and network protocol stack
CO2. learn the basics of mobile telecommunication system
CO3. explain the basics of mobile telecommunication system
CO4. choose the required functionality at each layer for given application
CO5. identify solution for each functionality at each layer
CO6. develop a mobile application.
CO7. gain knowledge on mobile platforms and application development

Pre-requisite: Computer Networks (IT 3001)

Introduction :

Mobile Computing – Mobile Computing Vs wireless Networking – Mobile Computing Applications – Characteristics of Mobile computing – Structure of Mobile Computing Application. MAC Protocols – Wireless MAC Issues – Fixed Assignment Schemes – Random Assignment Schemes – Reservation Based Schemes.

Mobile internet protocol and transport layer :

Overview of Mobile IP – Features of Mobile IP – Key Mechanism in Mobile IP,. Overview of TCP/IP – Architecture of TCP/IP- Adaptation of TCP Window – Improvement in TCP Performance.

Mobile telecommunication system :

Global System for Mobile Communication (GSM) – General Packet Radio Service (GPRS) – Universal Mobile Telecommunication System (UMTS).

Mobile platforms and applications :

Mobile Device Operating Systems – Special Constrains & Requirements – Commercial Mobile Operating Systems – Software Development Kit: iOS, Android, BlackBerry, Windows Phone

Text book

1. Rajib Mall, "Fundamentals of Mobile Computing", PHI Learning Pvt. Ltd, New Delhi – 2016, second edition.
2. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "Principles of Mobile Computing", Springer, 2003.

Reference Book

1. C.K.Toh, "AdHoc Mobile Wireless Networks", First Edition, Pearson Education, 2002.
2. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "Principles of Mobile Computing", Springer, 2003.

IT 4024 COMPUTER SECURITY Cr-3

Course outcome: At the end of the course, the students will be able to :

CO1. understand the basic concepts and goals of Information security such as Confidentiality, Integrity, authentication, Non-Repudiation, Authorization, and Availability and their relevance in various Contexts.
CO2. understand the mathematics related to Classical cryptosystems.
CO3. understand the classical cryptosystems and techniques used to break them.
CO4. understand the ideas of public key cryptosystems and digital signature schemes.
CO5. understand different network issues and the solutions for them through firewall, intrusion detection system.
CO6. understand and critically evaluate a range of access control and authentication mechanisms.

Pre-requisite: Computer Network(IT 3001)

Introduction to Computer Security:
Security Goals and Principles, Cryptographic Attacks, Substitution Ciphers, Transpositions, Stream and Block Ciphers, Algorithm Modes.

Mathematics of Symmetric Key Cryptography:
Modular Arithmetic, Linear Congruence, GF(2^n) Fields.

Symmetric Key Cryptography:
Modern Block Ciphers, Modern Stream Ciphers, Diffie-Hellman Key Exchange Algorithm, Data Encryption Standard (DES), Blowfish, Advanced Encryption Standard (AES).

Mathematics of Asymmetric Key Cryptography:
Primes, Primality Testing, Factorization, Chinese Remainder Theorem.

Asymmetric Key Cryptography:
Overview, RSA, Cryptographic Hash function: MD5, SHA, MAC, HMAC, Digital Envelope, Digital Signature.

Entity Authentication and Key Management:
Passwords, Challenge-Response, Zero-Knowledge, Kerberos, PKI.

Network Security:
Threats in Network, Network Security Controls, Firewalls, Intrusion Detection Systems, Secure E-mail, Malicious Programs.

Text Book

1. Cryptography and Network Security: Second Edition, Behrouz A. Forouzan, McGraw Hill Education

Reference Book

1. Network Security Essentials : Applications and Standards: Fourth Edition, William Stalling, Pearson Education
2. Cryptography and Network Security: Atul Kahate, 2nd Edition, Tata McGraw-Hill
3. Applied Cryptography: Bruce Schneier, John Wiley & Sons
4. Security in Computing: P. Pfleeger, , PHI

IT 4026 **NETWORK SECURITY** **Cr-3**

Course Outcome: At the end of the course, the students will be able to :

CO1. understand the basic concepts of security such as Confidentiality, Integrity, Authentication, Key management, and their relevance in various Contexts of Network Communication.
CO2. understand the security mechanisms applied to the Application Layer along with their utility in Real time communication.
CO3. understand the various security aspects in Transport Layer along with their protocols and architecture.
CO4. understand the security policies applied to Network Layer along with various protocols used for encryption and key management.

Prerequisite: Computer Network (IT 3001)

Introduction:

Computer Security Concepts, Security Attacks, Security Services, Security Mechanisms, Network Security Models .

Symmetric Key Encryption:
Symmetric Encryption Principles, Symmetric Block Encryption Algorithms, Stream and Block Ciphers, Cipher Block Modes of Operations

Assymetric Key Encryption:
Approaches to Message Authentication, Secure Hash Functions, Message Authentication Codes, Public Key Cryptography Principles, Public Key Cryptography Algorithms, Digital Signatures.

Key Management and Distribution:
Symmetric Key Distribution using Symmetric and Assymetric Encryption, Distribution of Public Keys, Kerberos, X.509 Certificates

Security at Network Layer:
IP Security Overview, IP Security Policy, Authentication Header (AH) and Encapsulating Security Payload (ESP), Internet Key Exchange (IKE)

Security at Transport Layer:
SSL Architecture, SSL Protocols, Transport Layer Security (TLS)

Security at Application Layer:
HTTPS, SSH, Email, PGP, S/MIME

Text Book

1. Network Security Essentials: Applications and Standards: Fourth Edition, William Stalling,Pearson Education

Reference Book

1. Cryptography and Network Security: Second Edition, Behrouz A. Forouzan, McGraw HillEducation
2. Ryptography and Network Security: Principles and Practice: Sixth Edition, William Stalling,Pearson Education
3. Network Security - Private Communication in a Public World: Charlie Kaufman, Radia Perlmanand Mike Speciner, Pearson/PHI.

IT 4027 SOFTWARE PROJECT MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. differentiate between a common and software project. Need to know the business objectives, plans, method and methodology.

CO2. give an idea about the project evaluation along with the financial layout.

CO3. understand Step to step project planning and the execution.

Prerequisite: Software Engineering (IT 3003)

Introduction to Software Project Management:
Software Project Management, Software Project vs other types of Projects, Activities, Plan methods, Methodologies, Categorization, Management control.

Project evaluation and Programme Management:

Project Portfolio Management, Evaluation, Cost-benefit Evaluation, Risk Evaluation, Managing Allocation of Resources, Benefits Management.

An Overview of Project Planning:

Stepwise Project Planning

Selection of Project Approach:

Choosing Methodologies and Technologies, Agile Methods, Dynamic System Development Method, Managing Iterative Process, Selecting Process Model.

Software Effort Estimation:

Estimates, Effort Estimation, top-down, Bottom up, Function Points, COCOMO.

Activity Planning and Resource Allocation:

Project Schedules, Network Planning Models, Sequencing and Scheduling. Resource Allocation, Scheduling Resources, Cost Schedules.

Risk Management, Monitoring and Control:

Risk, Categories of Risk, Identification, Assessment, Planning, Management and Control, Creating Framework, Cost Monitoring, Prioritizing Monitoring, Change Control.

Managing Contracts & People and Team Working:

Types of Contract, Contract Management, Understanding Behaviour, Organization Behaviour, Motivation, Oldham-Hackman Job Characteristics Model, Some Ethical and Professional Concerns, Decision Making, Organization Structure, Dispersed and Virtual Teams, Leadership.

Software Quality:

Defining Software Quality, ISO 9126, Product vs Process Quality Management, Quality Management System, Process Capability Models, Testing, Quality Plans**.**

Text Book

1. Bob Hughes and Mike Cotterell, Rajib Mall, Software Project Management, TMH, 5e, 2011

Reference Book

1. Henry.J ,Addison, Software Project Management – A Real-World Guide to Success, Wesley, 2004.
2. Pankaj Jalote, Software Project Management in Practice, Pearson Education, 4e, 2011.
3. S.A. Kelkar, Software Project Management, A Concise Study, Prentice-Hall India, 3e, 2010.
4. Jerome D. Wiest, Ferdinand K. Levy, A Management Guide to PERT/CPM, PHI, 2e, 2008
5. Ince D., Sharp H. and Woodman M.,Introduction to Software Project Management and Quality Assurance, McGraw-Hill, 1993.

IT 4028 CYBER SECURITY Cr-3

Course Outcome : At the end of the course, the students will be able to :

CO1. understand the concept of cyber security

Pre-requisite: NIL

Introduction:

Cyber Security – Cyber Security policy – Domain of Cyber Security Policy – Laws and Regulations – Enterprise Policy – Technology Operations – Technology Configuration - Strategy Versus Policy – Cyber Security Evolution – Productivity – Internet – E commerce – Counter Measures Challenges. Botnets.

Cyber security objectives and guidance

Cyber Security Metrics – Security Management Goals – Counting Vulnerabilities – Security Frameworks – E Commerce Systems – Industrial Control Systems – Personal Mobile Devices – Security Policy Objectives – Guidance for Decision Makers – Tone at the Top – Policy as a Project – Cyber Security Management – Arriving at Goals – Cyber Security Documentation – The Catalog Approach – Catalog Format – Cyber Security Policy Taxonomy.

Cyber governance issues

Cyber Governance Issues – Net Neutrality – Internet Names and Numbers – Copyright and Trademarks – Email and Messaging - Cyber User Issues - Malvertising - Impersonation – Appropriate Use – Cyber Crime – Geo location – Privacy - Cyber Conflict Issues – Intellectual property Theft – Cyber Espionage – Cyber Sabotage – Cyber Welfare.

Cyber infrastructure issues

Cyber Infrastructure Issue – economics ,finance and banking – Health care – Industrial Control systems. cyber insurance, cyber security in international relations.

Text Book

1. Jennifer L. Bayuk, J. Healey, P. Rohmeyer, Marcus Sachs , Jeffrey Schmidt, Joseph Weiss "Cyber Security Policy Guidebook" John Wiley & Sons 2012.

Reference Book

1. Rick Howard "Cyber Security Essentials" Auerbach Publications 2011.
2. B.G Raggad, " Information Security Management", CRC Press, Taylor Francis, 2015

IT 4029 MANAGEMENT INFORMATION SYSTEM Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1 evaluate the role of the major types of information systems in a business environment and their relationship to each other;

CO2 assess the impact of the Internet and Internet technology on business electronic commerce and electronic business

CO3 identify the major management challenges for building and using information systems and learn how to find appropriate solutions to those challenges;

CO4 define an IT infrastructure and describe its components;

CO5 learn the core activities in the systems development process;

CO6 cultivate skills and experience in the development and implementation of information system projects.

Prerequisite: NIL

Information Systems in Business:

Introduction, The real world of Information Systems, Networks, The fundamental role of IS in business, Trends in IS, Managerial challenges of IT. System Concepts: Foundation, Components of an Information System, Information System Resources, Information System activities, Recognizing Information Systems.

Fundamentals of Strategic Advantages:

Strategic IT, Competitive strategy concepts, The competitive advantage of IT, Strategic uses of IT, Building a customer-focused business, The value chain and strategic IS, Reengineering business processes, Becoming an agile company, Creating a virtual company, Building a knowledge-creating company.

Enterprise Business Systems:

Introduction, Cross-functional enterprise applications, Enterprise application integration, Transaction processing systems, Enterprise collaboration systems. Functional Business Systems: Introduction, Marketing systems, Manufacturing systems, Human resource systems, Accounting systems, Financial Management Systems, overview of ERP and E-Commerce.

Decision support in business:

Introduction, Decision support trends, Decision support systems (DSS),Management Information Systems, On-line analytical processing, Using DSS, Executive information systems, Enterprise portals and decision support, Knowledge management systems, Business and Artificial Intelligence (AI), An overview of AI, Expert systems.

Security, Ethical and societal challenges of IT:

Introduction, Ethical responsibility of business professionals, Computer crime, Privacy issues, other challenges, Health issues, Societal solutions.

Security management of IT:

Overview, Tools of security management, Internetworked security defenses, other security measures, System Controls and audits.

Managing IT:

Business and IT, Managing IT, Business / IT planning, Managing the IS function, Failures of IT management.

Managing global IT:

The International Dimension, Global IT Management, Cultural, Political and Geo – Economic challenges, Global Business/ IT strategies, Global Business / IT applications, Global IT Platforms, Global data access issues, Global Systems development.

Text Book

1. Management Information Systems, James A. O' Brien, George M. Marakas, Tata McGraw Hill.

Reference Book

1. Management Information System, Managing the Digital Firm, Kenneth C. Laudon and Jane P. Laudon, PearsonEducation.
2. Information Systems -The Foundation of E-Business, Steven Alter, Pearson Education.
3. Management Information Systems, W.S. Jawadekar, Tata McGraw Hill.

IT 4031 INFORMATION RETRIEVAL Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1 use different information retrieval techniques in various application areas
CO2 apply IR principles to locate relevant information large collections of data
CO3 analyse performance of retrieval systems when dealing with unmanaged data sources
CO4 implement retrieval systems for web search tasks.

Prerequisites: Data Structures and Algorithm (CS 2001)

Introduction:

Definition, Objectives, Functional Overview, Relationship to DBMS, Digital libraries and Data Warehouses.Information Retrieval System Capabilities: Search, Browse, Miscellaneous. Cataloging and Indexing: Objectives, IndexingProcess, Automatic Indexing, Information Extraction.

Data Structures:

Introduction, Stemming Algorithms, Inverted file structures, N-gram data structure, PAT data structure, Signature file structure, Hypertext data structure.

Automatic Indexing:

Classes of automatic indexing, Statistical indexing, Natural language, Concept indexing, Hypertext linkages, Document and Term Clustering: Introduction, Thesaurus generation, Item clustering, Hierarchy of clusters.

User Search Techniques:

Search statements and binding, Similarity measures and ranking, Relevance feedback, Selective dissemination of information search, Weighted searches of Boolean systems, Searching the internet and hypertext, Information Visualization: Introduction, Cognition and perception, Information visualization technologies.

Text Search Algorithms:

Introduction, Software text search algorithms, Hardware text Search Systems. InformationSystem Evaluation: Introduction, Measures used in system evaluation, Measurement example – TREC results.

Text Book

1.Information Retrieval Data Structures and Algorithms, Frakes, W.B., Ricardo Baeza-Yates, Prentice Hall, 1992.

Reference Book

1. Modern Information Retrieval, Yates, Pearson Education.
2. Information Retrieval Systems: Theory and Implementation, Kowalski, Gerald, Mark T Maybury, KluwerAcademic Press, 1997.
3. Information Storage & Retrieval, Robert Korfhage John Wiley & Sons.

IT 4033 NATURAL LANGUAGE PROCESSING Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. introduce the problems and solutions of NLP, and their relation to linguistics and statistics.
CO2. know how to program and use common data structures.

Prerequisite: Artificial Intelligence (CS 3028)

Introduction:

Basic Probability & Information Theory: Introduction to NLP, Main Issues, Basics on Probability Theory, Elements of Information Theory, Language Modeling in General and Noisy Channel Model, Smoothing and EM Algorithm.

Linguistics:

Phonology and Morphology, Syntax (Phrase Structure vs. Dependency).

Words & Lexicon:

Word Classes and Lexicography, Mutual Information, The t-score, The Chi-square Test, Word Classes for NLP Tasks, Parameter Estimation, Partitioning Algorithm, Complexity Issues of Word Classes, Programming Tricks &Tips.

Hidden Markov Models & Tagging:

Markov Models, Hidden Markov Models (HMMs), Trellis Algorithm, Viterbi Algorithm. Estimating the Parameters of HMMs, The Forward-Backward Algorithm, Implementation Issues, Task of Tagging, Tag sets, Morphology, Lemmatization, Tagging Methods, Manually Designed Rules and Grammars, Statistical

Methods, HMM Tagging (Supervised, Unsupervised), Evaluation Methodology (examples from tagging), Precision, Recall, Accuracy, Statistical Transformation Rule-Based Tagging, Maximum Entropy, Maximum Entropy Tagging, Feature Based Tagging, Results on Tagging, Various Natural Languages.

Grammars & Parsing Algorithms:

Introduction to Parsing, Generative Grammars, Properties of Regular and Context-free Grammars, Overview on Non-statistical Parsing Algorithms, Simple Top-Down Parser with Backtracking, Shift-Reduce Parser, Tree banks and Tree banking, Evaluation of Parsers, Probabilistic Parsing. PCFG: Best Parse, Probability of String.

Statistical Parsing & Machine Translation:

Lexicalized PCFG, Statistical Machine Translation (MT), Alignment and Parameter Estimation for MT.

Text Book

1. Foundations of Statistical Natural Language Processing, Manning, C. D. and H. Schutze, TheMIT Press.

Reference Book

1. Speech and Language Processing, Jurafsky, D. and J. H. Martin, Prentice-Hall.
2. Natural Language Understanding, Allen, J., TheBenajmins/Cummings Publishing Company Inc.
3. Elements of Information Theory, Cover, T. M. and J. A. Thomas, Wiley.
4. Statistical Language Learning, Charniak, E., The MIT Press.
5. Statistical Methods for Speech Recognition, Jelinek, F., The MIT Press.

IT 4035 OPERATION RESEARCH Cr-3

Course Outcome: At the end of the course the student will be able to :

CO1. know different operation research techniques to solve Engineering problems.

Pre-requisite: NIL

Module – I

Formulation of optimization problems: Decision variables, objective function and constraints, Graphical solution and optimization outcomes, Linear and non-linear programs.

Linear Programming Problem: Formulation, Simplex method, Duality theory, Dual simplex method

Module – II

Sensitivity Analysis, Transportation Problem, Assignment Problem, Traveling Salesperson Problem

Network Models: Minimal Spanning Tree Problem, Maximal Flow Problem, Shortest Route Problem, Minimum Cost Flow Problem.

Module – III

Integer Linear Programming Problem, Branch and Bound and Cutting Plane Methods, Zero-one Programming Problem, Knapsack Problem, Set covering Problem, Set Partitioning Problem, Deterministic Dynamic Programming Problems

Module – IV

Game theory, Sequencing Problem, Unconstrained Non linear programming, constrained linear programming

Text Book

1. Ronald R. Rardin - Optimization in Operations Research, Vol. 166, New Jersey: Prentice Hall, 1998.

Reference Book

1. H. A. Taha – Operations Research, Prentice Hall of India, 2007.
2. D. T. Phillips, A Ravindran and J.J. Solaberg - Operation Research: Principles and practice, John Wiley and Sons, 1976.
3. Frederick S. Hillier and Gerald J. Lieberman - Introduction to Operations Research, McGraw-Hill Higher Education, 2010.

IT 4037 DATA MINING AND DATA WAREHOUSING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the basic principles, concepts and applications of data warehousing and data mining.
CO2. introduce the task of data mining as an important phase of knowledge recovery process.
CO3. do Conceptual, Logical, and Physical design of Data Warehouses OLAP applications and OLAP deployment.
CO4. have a good knowledge of the fundamental concepts that provide the foundation of data mining.
CO5. design a data warehouse or data mart to present information needed by management in a form that is usable for management client

Prerequisite: Data Base Management Systems (CS 2004)

Introduction:
Basic Data Mining Tasks, Data Mining Issues, Data Mining Metrics, Data Mining from a Database Perspective, A Statistical Perspective on Data Mining.

Data Warehousing and Preprocessing:
Data Warehousing, Data Warehousing Architecture, OLTP, OLAP, Preprocessing Techniques
A Statistical Perspective on Data Mining, Similarity Measures,

Association Rules :
Basic Algorithms for Association Rule, Incremental Association Rules, Measuring the Quality of Rules, Advanced Association Rule.
Classification :
Statistical-Based Algorithms, Distance-Based Algorithms, Decision Tree-Based Algorithms, Advanced Classification methods (Genetic, Rough Set, Fuzzy Set), Neural Network.

Clustering:
Data Types, Similarity Measure, Hierarchical Algorithms, Partitional Algorithms, Clustering Large Databases, Clustering with Categorical Attributes.

Advanced Techniques :
Web Mining, Spatial Mining, Temporal Mining, Text Mining, Multimedia Mining.

Text Book

1. J. Han and M. Kamber. Data Mining: Concepts and Techniques, 3rd Ed. Morgan Kaufman. 2012.

Reference Book

1. M. H. Dunham. Data Mining: Introductory and Advanced Topics. Pearson Education. 2001.
2. I. H. Witten and E. Frank. Data Mining: Practical Machine Learning Tools and Techniques. Morgan Kaufmann. 2000.
3. D. Hand, H. Mannila and P. Smyth. Principles of Data Mining.Prentice-Hall. 2001.

IT 4039 INFORMATION SECURITY Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. understand what are the common threats faced today
CO2. what are the foundational theory behind information security, what are the basic principles and techniques when designing a secure system,
CO3. how to think adversarially, how today's attacks and defenses work in practice, how to assess threats for their significance, and how to gauge the protections and limitations provided by today's technology.

Prerequisite: Computer Networks (IT 3001)

Introduction:

Principles of Security, Classic Crypto, Modern Crypto History, Taxonomy of Cryptography, Information Hiding.

Symmetric- and Asymmetric- Key Crypto:

Stream Cipher, Block Cipher, Fiestel Cipher, DES and Variations, AES, RSA, Diffie-Hellman Key Exchange, Uses of Public Key Crypto, Public Key Infrastructure.

Hash Functions & Cryptanalysis:

Birthday Problem, Non-Cryptographic Hashes, Tiger Hash, HMAC, Uses of Hash Functions, Linear and Differential Cryptanalysis.

Access Control & Authorization:

Authentication Methods, Passwords, Biometrics, Captcha, Firewall, Intrusion Detection.

Software Flaws & Malwares:

Software Flaws, Malware, Software-based Attacks, Software Reverse Engineering, Software Tamper Resistance, Digital Rights Management.

Network Security:

TCP/IP Vulnerability, Concept of Hacking for Penetration Testing, Port Scanning, Packet Sniffing, MAC Flooding, Session Hijacking, IP Spoofing, Denial of Service Attack, Web Server Vulnerabilities, Network Operating System Vulnerabilities, SQL Injection Techniques, Wireless Network Security.

Text Book

1. Mark Stamp's Information Security, Principles and Practice – Deven N. Shah – 1st Edition, Wiley India.

Reference Book

1. Cryptography and Network Security – Behrouz A. Forouzan, DebdeepMukhopadhyay – 2nd Edition, Tata McGraw Hill Education Private Limited.
2. Cryptography and Network Security, Principles and Practice – William Stallings – 5th Edition, Pearson.
3. Applied Cryptography – Bruce Schnier – 2nd Edition, John Wiley & Sons.

IT 4041 NETWORK SECURITY AND CRYPTOGRAPHY Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. understand the basic concepts of security such as Confidentiality, Integrity, Authentication, Key management, fundamental cryptosystems and their relevance in various Contexts of Network communication.

CO2. able to understand the security mechanisms applied to the Application Layer along with their utility in Real time Communication.

CO3. able to understand the various security aspects in Transport Layer along with their protocols and architecture.

CO4. able to understand the security policies applied to Network Layer along with various protocols used for encryption and key management.

CO5. able to understand the basic concepts of security such as Confidentiality, Integrity, Authentication, key Management, fundamental cryptosystems and their relevance in various Contexts of Network communication.

Prerequisite: Computer Network (IT 3001)

Introduction:
Computer Security Concepts, Security Attacks, Security Services, Security Mechanisms, Network Security Models

Symmetric Key Encryption:
Symmetric Encryption Principles, Symmetric Block Encryption Algorithms, Stream and Block Ciphers, Cipher Block Modes of operations

Assymetric Key Encryption:
Approaches to Message Authentication, Secure Hash Functions, Message Authentication Codes, Public Key Cryptography Principles, Public Key Cryptography Algorithms, Digital Signatures

Security at Network Layer:
IP Security Overview, IP Security Policy, Authentication Header (AH) and Encapsulating Security Payload (ESP), Internet Key Exchange (IKE)

Security at Transport Layer:
SSL Architecture, SSL Protocols, Transport Layer Security (TLS)

Security at Application Layer:
HTTPS, SSH, Email, PGP, S/MIME

Text Book

1. Network Security Essentials : Applications and Standards: Fourth Edition, William Stalling, Pearson Education.

Reference Book

1. Cryptography and Network Security: Second Edition, Behrouz A. Forouzan, McGraw Hill Education.
2. Cryptography and Network Security: Principles and Practice: Sixth Edition, William Stalling, Pearson Education.
3. Network Security - Private Communication in a Public World: Charlie Kaufman, Radia Per Computer Security lmanand Mike Speciner, Pearson/PHI.

ELECTRICAL ENGINEERING

Program Educational Objectives (PEOs) :

PEO-1. To lead a successful career in industry or pursue higher studies or entrepreneurial endeavours.

PEO-2. To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.

PEO-3. To demonstrate effective communication skill, professional attitude, desire to learn and adhere to ethical value.

Program Outcomes (POs) :

a. Ability to apply knowledge of mathematics, science and engineering in domain of Electrical Engineering.

b. Ability to identify, formulate, and solve complex Electrical Engineering problems using first principle of mathematics, basic science & engineering

c. Ability to design Electrical components or systems or processes to meet desired needs within realistic constraints of economics, safety and manufacturability.

d. Ability to design and conduct complex Electrical Engineering experiments as well as to analyze and interpret the experimental data.

e. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

f. Ability to assess impact of contemporary social issues on professional practice.

g. Ability to assess the feasibility of Engineering solutions in the context of environment and sustainability

h. Ability to select and adopt ethical Engineering practices.

i. Ability to function in multidisciplinary teams

j. Ability to communicate effectively in oral and written forms.

k. Ability to engage in life-long learning

l. Ability to identify factors influencing finance and management of a project.

EE 1003 BASIC ELECTRICAL ENGINEERING Cr-3

Course Outcome : At the end of the course, the students will be able to:

- CO1. solve problems of DC and AC Circuits.
- CO2. realize Magnetic and electromagnetic circuits.
- CO3. know the operation and practical application of DC and AC machines
- CO4. get knowledge about the electrical measuring instruments, different lamps and safety in operation of different electrical appliances.

Pre-requisite: Nil

Introduction:
Essence of electricity, different electric wiring techniques, necessity of earthing and fuse, power system layout, electrical safety rules.

DC Circuits :
Active and passive elements, ohm's law, Kirchhoff's law, star-delta transformation, mesh analysis, nodal analysis, Superposition theorem, Thevenin's Theorem, Norton's Theorem (Elementary treatment only), DC transients (RL, RC series circuits).

AC circuits :
Fundamentals of AC circuits: Amplitude, time period, frequency, phase, phase difference, average value, R.M.S value, form factor, peak factor, phasor representation of alternating quantities, Phasor Algebra, Series and parallel A.C circuit, Resonance in series and parallel circuits. Three phase AC circuits: star and delta connections, comparison between Single phase and Three phase supply system, Measurement of power and power factor by two-wattmeter method.

Magnetic circuits :
Basic definitions, magnetizing force, reluctance, permeance, magnetic field, magnetic permeability, self and mutual inductance, leakage flux, Faraday's laws of electromagnetic induction, analogy between electric circuit and magnetic circuits, analysis of series magnetic circuit, B-H curve, hysteresis and eddy current loss.

DC Machines:
Principles of electrical machines, E.M.F equation in a dc generator, Torque production in a DC Motor, Operation of a dc machine as a generator, operation of a dc machine as a motor.

AC Machines and transformer:
Single Phase transformer: principle, construction, Uses, E.M.F equation, Auto transformer, Three Phase Induction Motor: Principle, types and uses and Torque-Slip characteristics.

Basic Instruments :
Classification of electrical instruments, essential features of analog measuring instruments, moving coil instruments (PMMC), moving iron instruments, extension of range , Dynamometer type Watt meter.

Illumination :
Luminous flux, luminous intensity, lumen, candela power, illumination, brightness.

Text Book

1. Basic Electrical Engineering by D.C. Kulshreshtha, Tata Mcgraw publication, 1st Edition 2011.
2. Basic Electrical Engineering, T.K. Nagasarkar and M.S. Sukhija, Oxford University press, 2nd Edition 2011.

Reference Book

1. Basics Electrical Engineering Sanjeev Sharma, I.K. International, New Delhi.(Third Reprint 2010).
2. Principles of Electrical Engineering and Electronics- V K Mehta, Rohit Mehta,S Chand and Company,New Delhi(Revised Edition 2013)
3. Basic Electrical Engineering Abhijit Chakrabarti, Sudip Nath, Chandan Kumar Chnada, Tata McGraw Hill Publishing Limited ,New Delhi,2007

EE 2003 NETWORK ANALYSIS Cr-4

Course Outcome : At the end of the course, the students will be able to:

CO1. analyze DC and AC circuits by different network theorems, properties of coupled circuit and usage of network graph to solve electrical circuits.
CO2. ralize transients in AC and DC circuits.
CO3. solve the two port networks, network functions and their response.
CO4. get knowledge about filter design and network synthesis.

Pre-requisite: Basic Electrical Engineering (EE 1003)

Network Topology:
Concepts of Network graph, Terminology, Element, Tree, Branch, Link, Twigs, formation of incidence matrix, loop matrix, cut-set matrix, Relation between branch voltage and current, loop current network topology analysis.

Network Theorems:
Maximum Power transfer theorem, Millman's Theorem, Tellegen's theorem, Reciprocity Theorem.

Coupled Circuits:
Self and mutual inductance, coefficient of coupling, Dot conventions for coupled circuits, tuned coupled circuits.

Transients Response:
Transient response of RL, RC and RLC circuits with constant and sinusoidal excitation in time domain by Introduction to different Signals, periodic and non periodic function, Laplace transformation method, response to step, impulse and ramp inputs.

Two Port Networks:
Open circuit, Short Circuits, hybrid and transmission parameters, T and Π circuit representation, Interconnection of two port networks (Cascade, Series and Parallel)

Network Function and Responses:
Concept of complex frequency, driving point and transfer Functions of one port and two –port network, Calculation of the network functions, Restrictions on poles and zero location of network function, impulse response, time domain behavior from pole zero plot using Laplace transformation.

Synthesis of Passive Network:
Causality and Stability, Hurwitz polynomial, Positive real Function. properties of Driving point function, synthesis of LC, RC and RL driving point function by Cauer-1 and II, Foster-I and II forms.

AC Circuits With Non-Sinusoidal Waveforms:
Fourier series representation of complex waves, symmetry in Fourier series, Average and RMS values of periodic complex wave.

Filter Design:
Introduction, Active and passive filters, Design of low pass, high pass, band pass and band elimination fillers, Circuit analysis using SPICE and PSPICE.

Text Book

1. Network Analysis 3rd Edition, by M. E. Van Valkenburg, Pearson Education, 2006.
2. Circuit Theory, Analysis and Synthesis, A. Chakrabarti, Dhanpat Rai Publishing Company (P) Limited, 5th Edition,2008.

Reference Book

1. Circuits and Networks Analysis and Synthesis (Second Edition) A Sudhakar Shyammohan S Palli, Tata McGraw-Hill, 2011.
2. Network Analysis and Synthesis, F F Kuo, 2nd edition 2006, Wiley student edition.
3. Basic Circuit Analysis (2nd Edition) John O'Malley ,Schaum's Outlines, Tata McGraw-Hill, 2010 (Reprint).
4. A Course in Electrical Circuit Analysis: with Solved Examples, by M. L. Soni, J. C. Gupta, 3rd edition, D. Rai, 1976.
5. Network Analysis and Synthesis by B R Gupta, S Chand, 4th edition -2013

EE 2005 DC MACHINES AND TRANSFORMERS Cr-4

Course Outcome : At the end of the course, the students will be able to:

CO1. know the basic principle of operation, construction, performance characteristics, starting and testing of DC machines.
CO2. design and applications of DC Machines.
CO3. realise the principle of operation, construction, performance characteristics and testing of transformers.

Pre-requisites: Basic Electrical Engineering (EE 1003) and Physics (PH 1003)

D.C. Machine:
Construction, Principle of operation, Armature winding, Simplex Lap and wave winding. Dummy coil, equalizer rings. EMF equation, Armature reaction, effect of armature reaction upon flux distribution curve, Effect of brush shifts, Demagnetizing and cross magnetizing ampere turns, commutation, Inter-poles and compensating winding.

D.C. Generator:
Types: Separate and self excited generators, no load and load characteristics. Voltage-build up in shunt generator, Critical field resistance and critical speed. Voltage regulation, Applications.

D.C. Motor:
Principle, Back emf, Torque and speed formula. Various types and their characteristics. 3-point and 4-point starters. Grading of starting resistance, speed control of D.C. motor, Losses and efficiency, Testing: Brake test, Swinburn's test and Hopkinson's test.

Single Phase Transformer:
Construction, types, applications, Principle of operation, emf equation, voltage and current ratio, operation at no load and loaded condition. Phasor diagram, equivalent circuit, Voltage regulation. Losses and efficiency, all day efficiency. Testing: Open circuit and short circuit tests, Sumpner test, parallel operation.

Auto Transformer:
Construction, Principle of operation, Copper saving, equivalent circuit, phasor diagram and Applications.

Three-phase Transformer:
Construction, transformer connection and vector group, open delta connection. Phase transformation: 3- phase to 6-phase, 3-phase to 12-phase, 3-phase to 2-phase, phasor diagram and voltage ratio. Three winding transformers. Time harmonics in single phase and 3 phase transformer, Parallel operation. Magnetizing inrush current.

Text Book

1. Electric Machinery, by E. Fitzagerald, C. M. Kingsley (Jr) and S. D. Umans, Tata McGraw Hill, 2003
2. Electrical Machines, by P. K. Mukharjee and S. Chakravorti, Danpat rai Publication, 18th reprint 2013

Reference Book

1. Electrical Machines, Ashfaq Hussain, Dhanpat Rai, Delhi, 2nd Edition, 2008.
2. Electrical Machinery, P. S Bimbhra, 7th Edition, Khanna Publishers, 2008.
3. Electric Machines, C. I. Hubert, , Pearson Education, 2003.
4. Electric Machines, by Kothari. D P and I J Nagrath, , 3rdEdn, Tata McGraw-Hill, New Delhi. 2004.
5. A Text Book of Electrical Technology, Vol. –II, AC & DC Machines, By B. L Theraja, A. K Theraja, S. Chand and Sons, 2006

EE 2007 NETWORK THEORY Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. analyze DC and AC circuit by different network theorems and properties of coupled circuit.
CO2. realize transients in AC and DC circuits
CO3. familiar with the operation of two port networks
CO4. understand the usage of network graph to solve electrical circuits.

Pre-requisite: Basic Electrical Engineering (EE 1003)

Network Theorems:
Review of Kirchoff's current law, Kirchoff's voltage law and Superposition theorem. Thevenin's Theorem Norton's Theorem, source conversion, Maximum Power Transfer Theorem, Millman's Theorem, Tellegen's Theorem and Reciprocity Theorem. Mesh analysis and nodal analysis of DC circuits.

Analysis of AC circuits:
Analysis of R-C, R-L and R-L-C circuits under AC excitation using phasors. Maximum Power Transfer Theorem for AC circuits.

Coupled circuits :
Self and mutual inductance, coefficient of coupling, dot convention and analysis of coupled circuits.

Transient Response:
Transient analysis of R-C, R-L and R-L-C circuits with step excitation. Laplace transform and representation of periodic and periodic signals in Laplace domain. Application of Laplace transform for the analysis of R-C, R-L and R-L-C circuits with step, impulse and ramp input.

Two-port networks :
Open circuit, short circuit, hybrid and transmission parameters, T and π circuit representation, Interconnection of two port networks (Cascade, series and parallel configurations).

Network topology:
Concept of network graph and associated terminologies (node, element, branch, link, tree, twig and path). Representation of network graph using incidence matrix, loop matrix and cut-set matrix. Relation between branch voltage and current, loop current network topology analysis.

Text Book

1. Network Analysis 3rd Edition, by M. E. Van Valkenburg, Pearson Education, 2006.
2. Circuit Theory, Analysis and Synthesis, A. Chakrabarti, DhanpatRai Publishing Company (P) Limited, 5th Edition,2008.

Reference Book

1. Circuits and Networks Analysis and Synthesis (Second Edition) A Sudhakar Shyammohan S Palli, Tata McGraw-Hill, 2011.
2. Network Analysis 3rd Edition, by M. E. Van Valkenburg, Pearson Education, 2006.
3. Basic Circuit Analysis (Second Edition) John O'Malley ,Schaum's Outlines, Tata McGraw-Hill, 2010 (Reprint).
4. A Course in Electrical Circuit Analysis: with Solved Examples, by M. L. Soni, J. C. Gupta, 3rd edition, D. Rai, 1976.
5. Network Analysis and Synthesis by B R Gupta, S Chand, 4th edition -2013

EE 2008 ELECTRICAL MACHINES Cr-4

Course Outcome : At the end of the course, the students will be able to:

CO1 know the basic principle of operation, construction, performance characteristics of DC Machines.
CO2 understand the basic principle of operation, construction and testing of Transformer.
CO3 know the details principle of operation, construction, types, use, starting, testing of three phase, single phase Induction motor and three phase synchronous motor.
CO4 know the basic principle of operation and application of universal motors

Pre-requisites: Basic Electrical Engineering (EE 1003) and Physics (PH 1003)

DC Generator:
Construction, Principle of Operation, emf equation, Types of generators, No-load and load characteristics, Voltage build up of shunt generator, Voltage regulation, Applications.

DC Motor:
Construction, Principle of operation, Back emf, Speed and Ttorque formula, Motor characteristics and performance curve, Speed control of DC shunt and series motor, Necessity of starter, 3-point starter, Losses and efficiency, Industrial Applications.

Transformer:
Single phase transformer, Construction , Principle of operation, emf equation, equivalent circuit and phasor diagram, Open circuit and Short circuit test, Regulation, Losses and Efficiency.

Three-phase synchronous motor:
Construction , Principle of operation, V-curves, method of starting and applications.

Three-Phase induction motor:
Construction, Squirrel cage and Slip ring type, Principle of operation and equivalent circuit and phasor diagram, Torque-Slip characteristics, starting torque and maximum torque, starting and speed control and applications.

Single-phase Induction Motor
Construction, Staring method and applications.

Universal motor:
Construction and principle of operation, Applications.

Text Book

1. Electrical Machinery, P. S Bimbhra, 7th Edition, Khanna Publishers, 2008.
2. Electrical Machines, by P. K. Mukharjee and S. Chakravorti, Danpat rai Publication, 18th reprint 2013

Reference Book

1. Electrical Machines, Ashfaq Hussain, Dhanpat Rai, Delhi, 2nd Edition, 2008.
2. Electrical Technology, Volume -II. B. L. Theraja, S .Chand Publications. 2010.
3. Electric Machines, C. I. Hubert, , Pearson Education, 2003.
4. Electric Machines ,by Kothari. D P and I J Nagrath, , 3rd Edn, Tata McGraw-Hill, New Delhi. 2004.

EE 2009 ELECTRICAL MACHINES AND POWER ELECTRONICS Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. know the basic principle of operation, construction, performance characteristics of DC Machines and alternator.

CO2. understand the basic principle of operation, construction of Transformer.

CO3. understand the details principle of operation, construction, types, use, starting, testing and to draw the performance curve of 3-Ø Induction motor..

CO4. know the basic principle of operation, characteristics of power electronic components.

Pre-requisites: Basic Electrical Engineering (EE 1003) and Physics (PH 1003)

DC Generator:
Introduction, Construction of DC Machines, Types and uses, Principle of operation of DC generator, EMF Equation of DC Generator from 1st principle, Different characteristics.

DC Motor:
Introduction, Principle of operation of DC Motors, Torque equation, Types and uses of DC Motors, Different characteristics, Speed control and Starting of D.C. shunt and series motors.

Induction Motors:
Construction, Types and uses of 3-phase induction motor, principle of operation, torque-slip characteristics, Speed control and Starting of 3-phase induction motor, Principle and Uses of single phase Induction motors, Stepper Motor.

Alternator:
Introduction, Construction, Types and uses, Principle of operation, EMF equation of Alternator, Voltage regulation by synchronous impedance method.

Transformer:
Definition, Types, Construction and uses of transformers, Voltage transformation ratio, Working principle, EMF Equation, No load phasor diagram, Losses and Efficiency, Voltage regulation, Principle and uses of 1-Phase Auto transformer, Connections of 3-phase transformer.

Power Electronics and Applications:
Power Semiconductor Devices: Thyristor, TRIAC, IGBT, Thyristor characteristics, Turn on methods**,** Turn off methods**,** Ratings, Simple Industrial Application.

Text Book

1. Electrical Machinery, P. S Bimbhra, 7th Edition, Khanna Publishers, 2008.
2. Power Electronics By P S Bhimbra**,** Khanna Publishers

Reference Book

1. Induction and synchronous machines, K. Murgesh Kumar Vikash Publishing House Pvt. Ltd, New Delhi
2. Electrical Technology, Volume- II. B. L. Theraja, S .Chand Publications. 2010.

EE 2010 AC MACHINES Cr-4

Course Outcome : At the end of the course, the students will be able to:

CO1. realise on principle of operation, construction, types, uses and voltage regulation of synchronous generator.
CO2. analyse the principle of operation, construction, application and starting of synchronous motor.
CO3. practical implementation of 3-Ø Induction motor and 1-Ø induction motors .
CO4. realise on revolving field theory and construction of different types of1-Ø induction motors.

Pre-requisite: DC Machines and Transformers (EE 2005)

Three-Phase Synchronous Generator:

Definition and Principle of operation of Alternator, Rotating Field, Synchronous Speed and frequency, Construction (stator and Rotor), Armature winding, pitch factor, distribution factor and winding factor, EMF equation from 1st Principle, Armature reaction, Synchronous Impedance, Equivalent circuits, Phasor Diagram of a loaded alternator, Determination of voltage regulation - emf method, mmf method, zero power factor method, short circuit ratio, Parallel operation of Alternators and load sharing, Synchronizing Power, Blondel's two reaction theory, phasor diagram, direct and quadrature axis reactance. power angle equation (for cylindrical and salient pole type), Slip test, Ratings and applications.

Three-Phase Synchronous Motor:

Definition and Principle of operation, Starting methods, Equivalent circuit and phasor diagram of cylindrical rotor, Power flow diagram, Toques equation, Power Developed Equation for both salient and cylindrical rotor machine, Effect of load changes on a Synchronous Motor, Construction of V curves and inverted V-curves, Synchronous condenser and power factor correction, Hunting, Ratings and applications.

Three-Phase Induction Machines:

Definition and Principle of Operation, Construction**:** Squirrel cage and Slip ring type. Rotating Magnetic Field, Slip, equivalent circuit and phasor diagram. Expression for torque, maximum torque, Torque-Slip characteristics, Effect of rotor resistance. Different Power stages, No load and blocked rotor test, Performance calculation by circle diagram. Various methods of starting for squirrel cage and slip ring motors, Speed Control: Voltage control, frequency control, variation of rotor circuit resistance, pole changing, cascade method and slip power recovery scheme, Crawling, Cogging, Ratings and applications, Advantages, Limitations and Applications of 3-Phase Induction Generator.

Single-Phase Motors

Single-phase Induction Motor, Double-field Revolving Theory, Types of Single-phase Motors, capacitor start motor, capacitor start and run motor, shaded pole motor, repulsion motor, A.C. Series Motor, Universal Motor, Reluctance Motor, Hysteresis Motor (Principle and operation), Linear Induction Motor, Ratings and applications.

Text Book

1. Electric Machinery, A. E. Fitzagerald, C. M. Kingsley (Jr) and S. D. Umans, , Tata McGraw Hill, 2003.
2. Electrical Machines, P K Mukharjee and S Chakravorty, Danpatrai Publication, 18th reprint 2013

Reference Book

1. Electric Machinery &Transformers,, B.S.Guru and H.R.Hiziroglu-‘ -3rd Ed-Oxford Press, 2010.
2. Induction and synchronous machines by K. Murgesh Kumar Vikash Publishing House Pvt. Ltd, New Delhi, 2010.
3. Electric Machinery and Fundamentals, Stephen J. Chapman - McGraw Hill International Edition, (Fourth Edition), 2005.
4. Electrical Machines and Power Systems, by Vincent Del Toro, Prentice-Hall, 1985
5. M.G. Say Alternating Current Machines (4th.Edition.) Pitman Publishing Ltd. 1976.
6. Electrical Machine I J Nagrath & D P Kothari, TMH , 4th edition 2012

EE 2011 DC, AC AND SPECIAL ELECTRICAL MACHINES Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. know the basic principle of operation, construction, performance characteristics of DC Machines and Alternator.
CO2. understand the basic principle of operation, construction and testing of Transformer.
CO3. know the details principle of operation, construction, types, use, starting, testing of three phase, induction motor and three phase synchronous machines.
CO4. know the basic principle of operation and application single phase motors

Pre-requisites: Basic Electrical Engineering (EE 1003) and Physics (PH 1003)

DC Machines: DC Generator
Construction, Principle of Operation, emf equation, Types of generators, load characteristics, Voltage buildup of shunt generator, Applications.

DC Motor
Construction, Principle of operation, Back emf, Speed and Ttorque formula, Motor characteristics and performance curve, Speed control of DC shunt and series motor, Necessity of starter, 3-point starter, Losses and efficiency, Industrial Applications.

Transformer
Single phase transformer, Construction, Principle of operation, emf equation, equivalent circuit and phasor diagram, Open circuit and Short circuit test, Regulation, Losses and Efficiency.

Three-phase synchronous Machines
Alternator: Introduction, Construction, Types and uses, Principle of operation, EMF equation of Alternator, Voltage regulation by synchronous impedance method. Synchronous Motor: Construction, Principle of operation, V-curves, method of starting and applications,

Three-Phase induction motor
Construction, Squirrel cage and Slip ring type, Principle of operation and equivalent circuit and phasor diagram, Torque-Slip characteristics, starting torque and maximum torque, starting and speed control and applications.

Single-Phase Induction Motors
Types of Single-phase Motors, capacitor start motor, capacitor start and run motor.

Special Motors
Stepper motor (Principle, operation and application), shaded pole motor, repulsion motor, Universal Motor, Reluctance Motor, Hysteresis Motor, Ratings and applications.

Text Book

1. Electrical Machinery, P. S Bimbhra, 7th Edition, Khanna Publishers, 2008.
2. Electrical Machines, by P. K. Mukherjee and S. Chakravorti, Dhanpat rai Publication, 18^{th} reprint 2013

Reference Book

1. Electrical Machines, Ashfaq Hussain, Dhanpat Rai, Delhi, 2^{nd} Edition, 2008.
2. Electrical Technology, Volume -II. B. L. Theraja, S. Chand Publications. 2010.
3. Electric Machines, C. I. Hubert, , Pearson Education, 2003.
4. Electric Machines, by Kothari. D P and I J Nagrath, , 3^{rd} Edn, Tata McGraw-Hill, New Delhi. 2004.

EE 2012 LINEAR CONTROL THEORY Cr-4

Course Outcome : At the end of the course, the students will be able to:

CO1. design the different types of control systems, characteristics of control system components and the mathematical model of physical systems.
CO2. analyze the time domain response of different systems.
CO3. analyze the different techniques used to find the stability of a system by classical methods.
CO4. understand the use of the classical compensation techniques

Pre-requisites: Network Analysis (EE 2003) and Mathematics-1(MA 1001)

Introduction:
Classification of systems, Causal and non-causal, Basic concept of Control System, Classifications, Differential Equation and Transfer Function, Order and Types of the system.

Feedback Theory:
Feedback and Non-feedback System, Effect of Feedback on Gain, Stability, Sensitivity and Noise of the System.

Control System and Components:
Servo Motors: A.C. Servomotor, D.C. Servomotors – Field Control and Armature Control, Position Control System A.C. and D.C. Regulators, Synchros – Transmitter, Error Detector, Sensors, Encoders, A.C. Tachometer, A.C. Tachogenerator, Potentiometer, Hydraulic Controller, Pneumatic Controller.

Description of Physical System:
Mathematical Modeling of Electrical System and Mechanical System (Translational and Rotational Mechanical System), Analogous System, Block Diagram Algebra, Developing Block Diagram from a Mathematical Model, Signal Flow Graph (SFG), Mason's Gain Formula, SFG from Block Diagram (SFG Terminology, Construction and Procedures, Problems.

Time Domain Analysis:
Standard Test Signals (Step Input, Ramp Input, Parabolic Input and Impulse Input)**.** Time Response of First Order and Second Order System to the Test Signals, Type and Order of the System, Time Response Specifications, Generalized Error Co-efficient, Steady State Error and Design Specifications, Error Constants, Effect of adding Poles and Zeros to Transfer Function, Response with P, PI, PD and PID Controllers.

Concept of Stability:
Concept of Stability, Necessary Condition for Stability, Routh Hurwitz (R-H) Stability Criterion, Relative Stability Analysis, Application of R-H Criterion to Linear Control System.

Root Locus Technique:
Root Locus Concept, Construction of Root Locus, Rules for the Construction of the Root Locus, Effect of adding Poles and Zeros to G(s) H(s), Determination of Gain from Root Locus.

Frequency Domain Analysis:
Introduction, Correlation between Time and Frequency Response, Polar Plots, Bode Plots, Nyquist Stability Criterion, Stability Analysis and Relative Stability.
Compensators:
Realization of basic compensators, Cascade Compensation and Feedback Compensation.

Text Book

1. Modern Control Engineering by K. Ogata PHI publication, 5th Edition,2010
2. Control Systems: Theory and applications by Smarajit Ghosh, Pearson. Publication 2012

Reference Book

1. Automatic control systems by Prof. B.S. Manke and S.N.Verma , Khanna publication, 2012.
2. Automatic control system by Hasan Saeed, 6th revised edition 2008, S.K. Kataria and Sons.
3. Modern Control Engineering. By D.Roy Choudhury PHI publication, 5th Edition,2009.
4. Automatic Control Systems by Benjamin C. Kuo, Prentice-Hall,7th Edition,2009.
5. Control System Engg, by I.J.Nagrath and M Gopal ,New age international publication, 4th Edition,2011.
6. Control System by D N Manik, Cengage Learning India Pvt, 2012

EE 2014 ELECTROMAGNETICS Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. solve the problems in different co-ordinate systems

CO2. realize the Static Electric Field

CO3. realize the steady-state and time-varying magnetic field and usage of Maxwell's equation for both static and time varying fields.

CO4. derive parameters of different shape of current carrying conductors and understanding transmission line equations.

Pre-requisites: Physics (PH 1003) and Mathematics (MA 1001)

Coordinate System and Vector Calculus:

Rectangular, Cylindrical and spherical, Transformation, Gradient, Divergence and curl operation and applications.

Static Electrical Field:

Coulomb's Law, Electric field intensity due to continuous line charge, surface charge and volume charge. Gauss's law Maxwell's equation and its application, Application of Gauss' law. Electric potential, equipotential surface, Boundary value problems, electric dipole.

Electric Field in Different Materials:

Electric properties of material, Convection current, Conduction current, Continuity equation, Poisson's and Laplace's equation

Steady Magnetic Field:

Magnetic forces, Biot-savart's law and application. Ampere's circuital law, Magnetic scalar and vector potential, Energy stored in magnetic field, Boundary value problems.

Time Varying Field:

Charged particles moving in a static magnetic field. Moving conductor in a static magnetic field, Faraday's law, General case of induction, Displacement current, Application of Maxwell's equation.

Electromagnetic Waves and Transmission Line

Helmoltz's Wave equation, wave propagation in lossless dielectric. Plane wave in free space. Pointing vector. Reflection and Refraction in plane wave and normal and oblique incidence. Standing-Wave Ratio, The Transmission-Line Equations, Transmission-Line Parameters, Smith Chart.

Text Book

1. Engineering Electromagnetic by Hayt and Buck, 7th Edition Tata Macgraw Hill,2006.
2. Element of Electromagnetic by M.N.O Sadiku, 2nd edition, Oxford,2010.

Reference Book

1. Electromagnetic waves and Radiating Systems E.C. Jordan & K.G. Balmin, 2^{nd} Edition. PHI Pvt.Ltd,2009.
2. C. R. Paul, K. W. Whites, S. A. Nasor, Introduction to Electromagnetic Fields, 3^{rd} ,TMH,2011.
3. Electromagnetic Field Theory by S. Salivahanan and S Karthie, Vikas Publisher 2016.
4. Electromagnetic Field Theory by Rohit Khurana Vikas Publisher 2015.

EE 2016 ELECTRICAL MEASUREMENTS AND MEASURING INSTRUMENTS Cr-4

Course Outcome : At the end of the course, the students will be able to:

CO1. realize the principles, practical applications of different electrical instruments for measurement.
CO2. measure the unknown electrical circuit elements by different AC/DC bridges.
CO3. use instrument transformers in electrical system.
CO4. operate different transducers and electronic instruments for measurement.

Pre-requisites: Basic Electrical Engineering (EE 1003), Basic Electronics (EC 1001) and Physics (PH 1003)

Measuring Instruments:
Introduction, classification, absolute and secondary instruments, indicating instruments. Control, balancing and damping Torques Characteristics, Errors in measurements, Moving iron: Constructional details, extension ranges (both Moving Iron and Moving Coil).

Wattmeter:
Electrodynamometer type: Single and three phase wattmeter, calibration device, errors in wattmeter, compensation, Measurement of 3- Φ power. Induction type.

DC/AC Bridge:
General equation of bridge balance, Wheatstone bridge, Kelvin's double bridge, measurement of self inductance: Maxwell's inductance, Maxwell's inductance-capacitance bridge, Hay's Bridge, Anderson's bridge, Owne's bridges, Schering bridge, errors, Wagner's earthing device, Megger and Insulation measurements.

Energy Meter:
Induction type single and three phase energy meter, compensation, errors, testing, creping.

Galvanometer:
General principle and performance equation of D'Arsonval Galvanometer, vibration galvanometer and ballistic galvanometer. Under damped, undamped, critically damped motion of galvanometer, measurement of charge and flux by ballistic galvanometer.

Frequency Meter:
Vibration reed type and Electrical resonance type.

Power factor Meter:
Single and three-phase electrodynamometer type power factor meter Advantages and Disadvantages.

Instrument Transformers:
Potential and current transformers: construction, ratio and phase angle errors, phasor diagrams, uses, testing.

Potentiometer:
DC potentiometer- Crompton meter, standardization, applications, AC potentiometer- Drysdale polar meter, Gall Tinsley coordinate type meter, standardization, measurement.

Transducers:
Stain gauge, Thermistors, Thermo couples, LVDT, Capacitance transducers, torque meter, inductive torque transducers, Tachometers.

Electronic Instruments:
Electronic voltmeter, block diagram, principle of operation, accuracy of multimeter, Digital Multi-meter, Digital Frequency meter, block diagram, principle of operation, accuracy of measurement. CRO: Block Diagram, Sweep Generator, Vertical amplifiers, Use of CRO for measurement of frequency, phase, amplitude, rise time.

Text Book

1. Electronic Instrumentation and Measurement Techniques, By William David Cooper, PHI, 2010.
2. Electrical Measurements and Measuring Instruments, By Edward William Golding, F. C. Widdis, 5th edition, Pitman, reprint 2012.

Reference Book

1. Electronics Instruments and Measurements – David A. Bell – PHI,2012.
2. A Course in Electrical and Electronics Measurement and Instrumentation by A.K.Sawhney, 10th edition, Dhanpat Rai,1994.
3. Electrical and Electronics Measurements and Instrumentation by R K Rajput, S Chand, 3rd edition -2013

EE 3002 POWER SYSTEM OPERATION AND CONTROL Cr-4

Course Outcome : At the end of the course, the students will be able to:

CO1. detect and analyse the type of fault
CO2. solve load flow problems and economic operation of power system generation
CO3. realize about generation control and voltage control
CO4. implementation of different techniques for power system stability.

Pre-requisite: Power Transmission and Distribution (EE 3007)

Symmetrical and Unsymmetrical Fault Analysis:

Introduction, Transients in transmission line, Short circuit of synchronous machine, Symmetrical components, Sequence impedance and sequence network of power system, Symmetrical Fault analysis, Unsymmetrical Fault analysis: L-G, L-L, L-L-G.

Load Flow Studies:

Importance of load flow studies, Bus classification, Nodal Admittance matrix, Formulation of load flow problem, Approximate load flow solution by Gauss Siedel Method both PV and without PV (acceleration of convergence), Newton Raphson Method, Decoupled and Fast decoupled method.

Economic Operation of Power System:

Introduction, Optimal operation of generators, Distribution of load on various generating units, Penalty factor and Transmission loss as a function of plant generation, Automatic load dispatch.

Automatic Generation and Voltage Control:

Introduction, Load frequency control, Turbine speed governing system, Modelling of speed governing system, Turbine model, Generator load model, Integrated representation of various models, Steady state analysis, Dynamic response, Control area concept, Proportional plus integral control, Two area load frequency control, Automatic voltage regulator, Excitation system – DC Exciter, AC Exciter and Static Exciter .

Stability Analysis:

Introduction to stability, Dynamics of synchronous machines, Swing equation, Power angle curve and its equation, Steady state stability, Equal area criterion, Effect of clearing time on stability.

Text Book

1. Power System Analysis- By John. J. Grainger & W. D. Stevenson, Jr., TMH, 2003 Edition, (15^{th} Reprint).
2. Modern Power System Analysis, I. J. Nagrath, D. P. Kothari, 3^{rd} Edition, Tata McGraw-Hill Publishing Company Ltd, New Delhi.

Reference Book

1. Power System Analysis by T K Nagsarkar and M S Sukhija, 1st Edition, Eighth impression 2012, Oxford University Press.
2. Power System Analysis Operation and Control, Abhijit Chakrabarti, Sunita Halder, Third Edition, PHI Learning Private Limited.

EE 3005 POWER ELECTRONICS Cr-4

Course Outcome : At the end of the course, the students will be able to:

CO1. design the AC to DC converter and use of power factor improvement techniques.
CO2. realize the modes of operation of DC to DC converters.
CO3. implement the control techniques for operation of DC to AC converters.
CO4. use of resonant converters, soft switching converters and SMPS

Pre-requisites: Basic Electrical Engineering (EE 1003) and Basic Electronics (EC 1001)

Introduction to Power Electronics:
Elements of Power Electronics, Several Applications of Power Electronics.

Power Electronics Devices:
Thyristor characteristics Turn on methods, Dynamic characteristics of thyristors, Ratings, Protection, Two Transistor model of thyristor Characteristics and constructions of power MOSFETs, Comparison between power MOSFET and power BJT, Characteristics and constructions of IGBT forward and reverse blocking capability, Latch up, Switching characteristics, Safe operating area, Snubber protection, GTO - turn on and turn off methods, IGBT characteristics, TRAIC and DIAC characteristics and applications.

AC to DC Converters :
Single phase converters - Half wave with R, R-L, R-L-E load and freewheeling diode, single phase full wave converters with R and RLE load, Line commutated Inverters , Single phase semi converters, 3 - phase converters, Dual converters, 3 phase semi converters, Effect of source Inductance on performance of single phase converters. Thyristor Forced Commutation Circuits.

Inverters:
Single phase Half Bridge and Full bridge inverters, 3 phase inverters, 180^0 and 120^0 conduction, Voltage control of inverters: Single pulse and multiple pulse width modulation, Sinusoidal pulse width Modulation, Concept of current source inverters.

DC to DC Converters:
Step up and step down choppers, 2 and 4 quadrant choppers for control of DC motor.

AC to AC Converters:
Single phase AC to AC converter with R and RL load.

SMPS:
Advantages of switch mode power supply over conventional power supply, Fly back converters.

Text Book

1. Power Electronics By M. H. Rashid, Pearson Education, 3rd Edition, 2009.
2. Power Electronics, by P S Bhimbra, Khanna Publishers, 5th Edition, 2011.

Reference Book

1. Power Electronics, Converters, Applications and Design N. Mohan, Undeland and Robbins, John Wiley and Sons , 3rd Edition ,2009.
2. Modern Power Electronics by P C Sen, S Chand Publisher- 2013

EE 3006 ELECTRIC DRIVES AND CONTROL Cr-3

Course outcome : At the end of the course, the students will be able to:

CO1. select the motor for different type of industrial applications.
CO2. start and control the speed of dc machine by different methods.
CO3. control and to know the different types of braking of 3-phase induction motor.

Pre-requisites: DC Machine and Transformer (EE 2005), AC Machine (EE 2010), Power Electronics (EE 3005) and Linear Control Theory (EE 2012).

Introduction:
Basic elements of an electric drive, Four quadrant operation of an electric drive, Dynamics of motor load combination, Types of loads, Stable operating condition of various motor load combinations.

DC motor:
Review of characteristics of DC motors, Modification of characteristics of DC shunt and series motors. Methods of starting DC motor. Fundamental parameters of speed control. Methods of speed control of DC shunt and series motors. Concept of Electric Braking, Regenerative, Dynamic and Counter current braking of DC motors.

Closed loop control of DC motor drives:
Closed loop Speed control, Closed loop Torque control, Hysteresis control, PI control, PLL control.

Induction Motors:
Review of characteristics of three phase Induction motors. Modification of speed torque characteristics due to variation of: stator voltage, Stator frequency and rotor resistance. Methods of starting, Squirrel Cage and slip ring Induction motors. Methods of speed control of Induction motors: Voltage control, V/f control and Rotor resistance control, Slip Power recovery. Electric Braking of Induction Motors: Regenerative Braking, DC Dynamic braking and Plugging.

Solid State Control of DC drive:
Phase controlled and Chopper controlled DC Separately excited motor and series motor drives. Four quadrants drive using dual converter. Closed loop control scheme for DC motor.

Solid State Control of Induction Motors:
Control of IM by three phase AC-AC Voltage controller. Chopper control of rotor resistance. Speed control using slip power recovery schemes. PWM Inverter fed induction motor drives. Current source inverter fed induction motor drives; Comparison of VSI and CSI fed drives. Closed loop control (V/f control).

Text Book

1. G.K. Dubey, Fundamentals of Electric Drives, Second Edition, Narosa Publishers, 2007.
2. Bimal K. Bose, Power Electronics and Motor Drives: Advances and Trends, Academic Press, 2006.

Reference Book

1. S. K. Pillai : A First Course On Electrical Drives, Second Edition, New Age International Publishers 2007.
2. N. K. De, P. K. Sen: Electric Drives, 7th Edition, PHI Learning Pvt. Ltd., 2004.
3. Modern Power Electronics and AC Drives by Bimal. K. Bose, PHI Publisher, 1st Edition, 2013.

EE 3007 POWER TRANSMISSION AND DISTRIBUTION Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. use of the different power system components.
CO2. realize the effects of corona and different factors effecting corona in transmission line.
CO3. solve the problem in mechanical design of overhead transmission lines under different loading condition.
CO4. application of underground cables.
CO5. solve the different configuration of distribution system.

Pre-requisites: Basic Electrical Engineering (EE 1003), Network Analysis (EE 2003) and Network Theory (EE 2007)

Introduction:
Single and 3-phase transmission, Concept of complex power, Per Unit system, Power System layout.

Supply System:
Comparison of AC and DC transmission, Advantage of high voltage transmission, Advantages and Disadvantage of EHV (AC) and HVDC Transmission.

Line constants:
Resistance, Inductance of Single phase and three phase line with symmetrical and unsymmetrical spacing, GMD and GMR calculation, Transposition of power line, Capacitance of Single phase line, Effect of earth on line capacitance, Charging current due to capacitance effect, Bundle conductors, Skin and Proximity effect.

Performance of Transmission line:
Analysis of short, medium and long Transmission Line, ABCD constants and its calculation for Short, Medium and Long Transmission Line, Ferranti effect, Surge Impedance and Surge Impedance Loading, Line compensators.

Corona:
Critical disruptive voltage, Visual critical voltage, Corona Power losses, Factors affecting corona, Advantages and Disadvantages of Corona, Problem Discussion, Radio Interference between power and communication line.

Mechanical Design of over head transmission lines:
Types of conductor and insulator, Insulating materials, Potential distribution over a string of suspension Insulators, String Efficiency, Methods of equalization of the potentials, Sag and Stress calculation, Effect of ice and wind loading, Vibration dampers.

Underground Cable:
Overhead line verses underground cables, Type and construction, Grading of cables, Insulation resistance of cable, Capacitance of three core cable, dielectric losses.

Distribution Systems:
Classification of distribution system, Types of AC and DC distributors, Feeder, Voltage drop and load calculation for concentrated and distributed loads, Radial and ring main system, Economic choice of conductor, Kelvin's law.

Text Book

1. Electrical Power System, C.L. Wadhwa, New Age International (P) Limited, Publishers, 2009.
2. A Text Book on Power System Engineering, A. Chakrabarti, M.L. Soni, P.V. Gupta and U.S. Bhatnagar, Dhanpat Rai and Co., Reprint 2012.

Reference Book

1. A Course in Power System, J. B. Gupta, S K Kataria and Sons Publishers and Distributors, 2011.
2. Power System Analysis and Design- By B. R. Gupta, S. Chand Publications, 3rd Edition, Reprint, 2003.
3. Principle of Power System by V.K.Mehta, S.Chand Publishers, 2012.
4. Elements of Power System Analysis, W.D. Stevenson Jr, TMH, 1982.
5. Overhead Power lines planning, design and construction, by F Kiessling, P Nefzger, J F Nolasco and U Kaintzyk, Springer- Verlag

EE 3009 PRINCIPLE OF CONTROL SYSTEMS Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. know the different types of control systems, characteristics of control system components and the mathematical model of physical systems.
CO2. analyze the time domain response of different systems.
CO3. analyze the different techniques used to find the stability of a system by classical methods.
CO4. understand the classical compensation techniques, usage and realization.
CO5. know the different types of control systems, characteristics of control system components and the mathematical model of physical systems.

Pre-requisite: Mathematics-I (MA 1001)

Introduction

System concept-types, Basic Concept of Control System, Classifications, Differential Equation and Transfer Function (Open Loop and Closed Loop). Feedback Theory: Feedback and Non-Feedback System, Effect of Feedback on Gain, Stability, Sensitivity and Noise of the System.

Description of Physical System

Mathematical Modelling of Electrical System and Mechanical System (Translational and Rotational Mechanical System), mathematical model of Servo Motors and Synchros–transmitter, Analogous System, Block Diagram Algebra, Developing Block Diagram from a Mathematical Model, Signal Flow Graph, Mason's Gain Formula, Signal Flow Graph from Block Diagram (SFG Terminology, Construction and Procedure).

Time Domain Analysis

Standard Test Signals (Step Input, Ramp Input, Parabolic Input and Impulse Input). Time Response of First and Second Order System to the Test Signals, Type and Order of the System, Time Response Specifications, Generalized Error Co-efficient, Steady State Error and Design Specifications, Error Constants, Effect of adding Poles and Zeros to Transfer Function, Response with P, PI, PD and PID Controllers.

Concept of Stability

The Concept of Stability, Necessary Condition for Stability, R-H Stability Criterion, Relative Stability Analysis, Application of R-H Criterion to Linear Control System. The Root Locus Technique: Root Locus Concept, Construction of Root Locus, Rules for the Construction of the Root Locus, Effect of adding Poles and Zeros to G(s) H(s), Determination of Gain from Root Locus. Frequency Domain Analysis: Introduction, Correlation between Time and Frequency Response, Bode Plots, Polar Plots, Nyquist Stability Criterion, Stability Analysis and Relative Stability.

Introduction to State Space analysis

Concept of State, State Space, Concept of Physical variables and phase variables, Modelling of Mechanical, Electrical, Electro Mechanical Systems in State Space.

Text Book

1. Control System Engg., by I. J. Nagrath and M. Gopal, New Age International Publication
2. Control Systems: Theory and applications by Smarajit Ghosh, Pearson. Publication 2012

Reference Book

1. Modern Control Engg., by D Roy Choudhury, PHI Publication
2. Control Systems by K. R. Varmah, McGraw Hill Publication
3. Control System by Anand Kumar, PHI Publication
4. Control System by J P Navani and Sonal Sapra, S Chand, 2015

EE 3011 POWER ELECTRONICS AND DRIVES Cr- 4

Course Outcome: At the end of the course, students will be able to:

CO1. understand the Power Electronics Devices
CO2. realize the modes of operation of AC to DC and DC to DC converters.
CO3. know the control techniques and operation of DC to DC and DC to AC converters.
CO4. understand the basic concepts of electric drives

Pre-Requisites: Basic Electronics (EC 1001), Basic Electrical Engineering (EE 1003), DC AC and Special Electrical Machines (EE 2011).

Power Switching Devices

Introduction to Power Electronics, Thyristor characteristics, Turn ON methods, Dynamic Characteristics of thyristors, Thyristor Ratings- Average, RMS & surge ratings, Thyristor Protection. Characteristics & construction of Power MOSFETS, Comparison between Power MOSFET & Power BJT, Characteristics & construction of IGBT, Forward & Reverse Blocking Capability, switching characteristics, Safe operating area, snubber protection, GTO – turn on and turn off methods, TRIAC and DIAC Characteristics and applications.

AC to DC Converters

Single Phase Converters – Half Wave, with R, RL load, Single Phase Converters – Half Wave, with RLE load, Single Phase Converters – Half Wave, with RL load & Free Wheeling diode, 1 Phase Full Wave converters with R & RLE Load, concept of Line Commutated Inverters, Single Phase Semi Converters, 3 Phase converters, Single Phase Dual converters.

DC to DC Converters

Step Up & Step Down choppers, Buck-Boost Convertor, 4 Quadrant Choppers. Concept of Switch Mode Power Supply, Flyback Converter.

DC to AC Converters

Single Phase Half Bridge & Full Bridge Inverters, Sinusoidal Pulse Width Modulation

AC to AC Converters

Single phase AC to AC phase control, with R and RL load.

Electric Drives

Basic elements of electric drives, 4 quadrant operation of electric drives. Review of characteristics of DC motors, and induction motors. Calculation of equivalent moment of inertia of a drive system and load equalization. Phase controlled and Chopper controlled DC drive. Control of Induction Motor by AC –AC Voltage controller, PWM Inverter fed induction motor drives. Concept of V/f control. Concept of Stepper motors and control. AC and DC servo motors.

Text Book

1. Power Electronics by P. S. Bimbhra, Khanna Publishers, 4th edition, 2012
2. Fundamentals of Electric Drives by G K Dubey, Narosa Publishers, 2nd edition 2007.

Reference Book

1. Power Electronics by M. H. Rashid, Pearson Education, 3rd Edition, 2014.
2. .Power Electronics, Converters, Applications and Design N. Mohan, Undeland and Robbins, John Wiely and Sons, Edition, 2002.
3. Fundamental of Power Electronics by S K Bhattacharya, Vikas Publishing, 1st edition-2005.
4. S. K. Pillai : A First Course On Electrical Drives, Second Edition, New Age International Publishers 2007.
5. N. K. De, P. K. Sen: Electric Drives, 7th Edition, PHI Learning Pvt. Ltd., 2004.
6. Modern Power Electronics and AC Drives by Bimal. K. Bose, PHI Publisher, 1st Edition, 2013.

EE 3021 PRINCIPLES OF INDUSTRIAL INSTRUMENTATION Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. application of different measurement systems in Industry
CO2. analysis of different quantities and different telemetry techniques.
CO3. explore the different instrumentation usage and analysis in power plant.
CO4. operate data logging systems.

Pre-requisite: Basic Electrical Engineering (EE 1003)

Characteristics of Measurement System:
Functional Units, Classification and Performance characteristics, Dynamic Calibration, Errors: An Overview, Statistical Error Analysis and Reliability**.**

Pressure, Temperature and Flow Measurement:
Pressure Measurement: Electrical types, Vacuum Measurement, Sound pressure level measurement, Temperature Measurement: Electrical Types temperature sensors. Flow Measurement: Electrical type flow meters, Open Channel flow measurement; Level Measurement: Hydrostatic type, Thermal effect type, Solid level measurement.

Instruments for Analysis:
Introduction, Gas Analyzers, Liquid Analyzers, X-ray Methods, Chromatography, Mass spectrograph.

Telemetry:
Introduction, Pneumatic Means, Electrical Means, Frequency Telemetering, Multiplexing, Modulation, Modulation of Digital Data, Transmission Channels, Briefing of a Telemetry System in Operation.
Power Plant Instruments:
Introduction, Power Plant Scheme, Vibration and Expansion, Analysis, Flue Gas Analysis. Turbine–Monitoring and Control: Turbine measurements: electrical, mechanical and process parameters. Turbine control systems: safety and process. Lubrication system for Turbo Alternator and its control. Turbo Alternator cooling system.

Display, Recording, Alarm:
Introduction, Display methods, Recorders, Alarm annunciation, Data logging system.

Text Book

1. Principles of Industrial Instrumentation, D Patranabis, Third Edition, Tata McGraw Hill Education Private Limited, New Delhi
2. Power Plant Instrumentation – K.Krishnaswamy, M.Ponnibala, PHI publications,2009.

Reference Book

1. Power Plant Engineering - P.K Nag, Tata McGraw-Hill,2010.

EE 3023 HIGH VOLTAGE ENGINEERING Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. generate high Voltage and high current.
CO2. measure and test of high voltage electrical equipments.
CO3. perform the Breakdown characteristics of different dielectrics.
CO4. implementation of HVDC Transmission system.

Pre-requisites: Basic Electrical Engineering (EE 1003) and Mathematics-I (MA 1001)

Generation of High Voltage and Currents:
Generation of High Voltage AC – By Tesla coil, Resonant Circuits and Cascade Transformers. Generation of High Voltage DC-voltage Double Circuits, Cockeroft Walton voltage multiplier circuit, Ripple voltage, voltage regulation, Van-de-Graff Generators, principle of series and shunt type voltage stabilizers. Generation of Impulse Voltage – Standard impulse wave shapes, Analysis of impulse Generator Circuit of series R-L-C type, Restriction on the ratio of the generator and load capacitances, Wave shape control. Multistage impulse Generators-Marx Circuit, Constructional details, tripping and synchronization. Generation of switching surge voltage. Generation of Impulse currents.

Measurement of High Voltage and Currents:
Measurement using Electrostatic voltmeters, Generating Voltmeters, Sphere gap, Potential Dividers, cathode Ray Oscilloscope. Peak reading a.c. Voltmeter-Chuub-Frotscue method.

High Voltage Testing of Electrical Apparatus:
Indian Standard Specification for D.C., A.C. and impulse and High frequency testing of Insulators, Bushings, Isolators and Circuit Breakers, Cables Lighting Arrestor, Transformer. Introduction to Non-destructive testing materials and Electrical apparatus.

Conduction and Breakdown in Gases:
Concept of Electrical stags, Ionization process, General Characteristics of Gaseous Insulation, Electrical Breakdown of gases, Townsend current growth Equation. Townsend’s criterion for breakdown. Experimental determination of ionization coefficients, Breakdown in Electronegative gases. Time lags for breakdown. Pashen’s law, Streamer theory of breakdown Introduction to partial discharge phenomenon, lighting phenomenon.

Conduction and Breakdown in Liquid Dielectrics:
Pure and Commercial Liquids, conduction and Breakdown in Commercial liquids, Electronic, Cavitations and suspended particle theory.

Breakdown in Solid Dielectrics:
Intrinsic, Electromechanical, Thermal, Treeing and Tracking, Breakdown in composite dielectrics.

Design of High Voltage Laboratories:
Test facilities provided in High Voltage laboratories, Classification of High Voltage laboratories, selection and rating of HV test equipment, layout and clearance, Shielding and grounding of high voltage Laboratories, Introduction to the problem of Electromagnetic interference.

Introduction to D.C. Power Transmission Technology:
Comparison of AC and DC Transmission, Description and Application of DC Transmission. Planning for HVDC Transmission, Modern Trend in DC Transmission.

Text Book

1. J. Kuffel and W. S. Zaengl, High Voltage Engineering: Fundamentals, Newnes, 2000.
2. M. S. Naidu and V. Kamaraju, High voltage Engineering, Tata McGraw Hill, 1995.

Reference Book

1. C.L. Wadhwa : High Voltage Engineering, 2nd Edition, New Age International, 2007.
2. Ravindra Arora and Wolfgang Mosch: High Voltage Insulation Engineering, New Age International Publishers, 2011.

EE 3025 POWER STATION ENGINEERING Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. realization of different Power Plants
CO2. operate various electrical equipments connected with Power Plant and system parameters.
CO3. realize the economic aspects of the power plants.

Pre-requisite: Basic Electrical Engineering (EE 1003)

Introduction:
Introduction to different sources of Energy. Discussion on application of energy sources to power station.

Thermal Power :
Layout of thermal power plant, Main Equipment, Coal Handling plant, Boiler, Super heater, Reheater, Economizer ,Air Preheater steam turbine, Ash handling plant, condenser, Cooling tower and ponds, Feed water heater, E.S.P, Power supply to auxiliaries**.**

Hydro Power Plant:
Classification according to (i) Water Flow (ii) Load (iii) Head surge tank, Penstock, spillway, Tail Race, Types of turbine (i) Pelton turbine, (ii) Francis turbine, (iii) Kaplan turbine, Governor, specific speed, Plant auxiliaries.

Nuclear Power Plant:
Location, Layout of nuclear power plant, Fission, Fusion, controlled chain reaction, Classification of Nuclear reactors –Advanced Gas cooled Reactor, Pressurized Water Reactor, Boiling Water Reactor, Fast Breeder Reactor, and Reactor Control and Cooling.

Diesel Electric Power plant:
Introduction, Selection of site, Layout and Main components, Applications.

Gas Turbine:
Principle of operation.

Electrical System:
Testing and commissioning of generators and power transformers.HT, EHT and LV Substation arrangements. Station batteries and battery chargers.

Economic Aspects:
Load curve, Load duration curve, Connected load, Maximum demand, Demand factor, Average demand, Load factor, Diversity factor, Plant capacity Factor, Plant Use Factor, Tariffs-Types, power factor improvement.

Text Book

1. M.V. Despande, Elements of electrical power system design, PHI,2010
2. Generation of Electrical Energy, B.R. Gupta, S.Chand Publication, 2009.

Reference Book

1. B. G. A. Skrotzki and W. A. Vopat, Power Station Engineering and Economy, McGraw Hill, Digitized on Dec 2007.
2. P. K. Nag, “Power Plant Engineering”, 3rd Edition, Tata McGraw Hill Publication ,2002

EE 3027 ELECTRICAL ENGINEERING MATERIALS Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. know the use of different of dielectrics, insulators and conductors.
CO2. understand the usage of materials for each electric machine.
CO3. realize various crystal structures.

Pre-requisites: Basic Electrical Engineering (EE 1003) and Physics (PH 1003)

Atoms and Aggregate of Atoms:
Structure of atom, electronic configuration, Bonds and bonding, crystallization of materials. Crystal symmetry and structure. Lattice arrangement of atom in materials, molecules and its structures, metallic and amorphous structures. Insulating materials: Dielectric properties of insulators in static fields. The static dielectric constant, Polarization and dielectric constant. The atomic interpretation of the dielectric constant of monatomic gases. Qualitative remarks on the dielectric constants on polyatomic molecules, Quantitative discussion of the dielectric constant of polyatomic gases, the internal field in solid and liquids, the static dielectric constant of solids, Spontaneous polarization, Piezoelectricity.

Behaviour of Dielectrics in Alternating Fields:
Frequency dependence of the electric polarization, Ionic polarization as function of frequency, the complex dielectric constant of non-polar solids. Dipolar relaxation, Dielectric losses. Magnetic properties of Materials: Summary of concepts pertaining to magnetic fields; The magnetic dipole moment of a current loop, The magnetization from a microscopic view point, Orbital magnetic dipole moment and angular momentum of two simple atomic models, Lenz's Law and induced dipole moments.

Classification of Magnetic Materials:
Diamagnetism, The origin of permanent magnetic dipoles in matter, Paramagnetic spin system, Some properties of ferromagnetic materials, Spontaneous magnetization and the Curieweiss Law, Ferromagnetic domains and coercive force, Anti-ferromagnetic materials, Ferromagnetic materials, Mechanism of Conduction in Semiconductors: Classifying materials as semiconductors, The chemical bond in Si and Ge and its consequences. The density of carriers, intrinsic semiconductors, the energy gap, the conductivity of intrinsic semiconductors, Carrier densities in n-type semiconductors, P-type semiconductors, Hall effect and carrier density.

Conducting Materials:
General properties and specifications of pure copper and aluminium, factors affecting resistivity, wiedemanm Franz law, Materials and alloys for high conductivity, Characteristics of brass and different types of bronzes, Different types of solders, Metals and alloys for different types of fuses, fusing current and fuse ratings. Materials used for highly loaded metal contacts, electrical carbon material, characteristics of different carbon and graphite brushes. Materials of high resistivity, alloys for use in electrical resistance, arc-lamps and electric furnaces, introduction to superconductivity. Nano materials: Introduction, synthesis, and characterization; Description of basic energy carriers and nanostructures.

Text Book

1. Electrical engineering Materials by R. K. Shukla and A. Singh, Tata McGrow-Hill Publishing Company Ltd, New Delhi,2010.
2. A Course in Electrical Engineering Materials by R K Rajput, University Science Press, 1st edition- 2011

Reference Book

1. Electronic Properties of Materials, by Rolf E Hummel, Springer (India) Pvt Ltd, New Delhi,2010.
2. Electrical Engineering Materials, by A.J. Dekker, Prentice-Hall of India Pvt Ltd, New Delhi, 2009.
3. An introduction to Electrical Engineering Materials by C S Indulkar and S . Thiruvengadam, S Chand Reprint-2013.
4. Material Science, by V. Rajendran and A Marikani, Tata McGrow-Hill Publishing Company Ltd, New Delhi, 2009.
5. Material Science, by M.S. Vijay and G. Rangarajan, Tata McGrow-Hill Publishing Company Ltd New Delhi, 2011.

EE 3028 POWER ELECTRONIC CIRCUITS Cr-3

Course outcome : At the end of the course, the students will be able to:

CO1. design the AC to DC converter and to analyse power factor improvement techniques.
CO2. realize the modes of operation of DC to DC converters.
CO3. realize the control techniques for operation of DC to AC converters.
CO4. know the use of resonant converters and soft switching converters, SMPS.

Pre-requisites: Basic Electrical Engineering (EE 1003) andBasic Electronics (EC 1001)

Introduction to Power Electronics:
Advantage of power devices operating in the switch mode to those operating in the active region.

Power Electronic Devices:
Thyristor characteristics, Turn ON methods, Dynamic Characteristics of thyristors, Ratings, Protection, Two Transistor Model of Thyristor, Characteristics and construction of Power MOSFETS, Comparison between Power MOSFET and Power BJT, Characteristics and construction of IGBT, Switching characteristics. GTO – turn on and turn off methods, SiC based power devices, TRIAC and DIAC Characteristics and applications.

AC to DC Converters:
Single Phase Converters – Half Wave, with R, RL, RLE load and Free Wheeling diode, Single Phase Full Wave converters with R and RLE Load, Line Commutated Inverters, Single Phase Semi Converters, 3 Phase converters.

DC to DC Converters:
Step up and Step Down choppers, 2 and 4 quadrant choppers for control of DC motor. Buck- Boost converter

Inverters:
Single Phase Half Bridge and Full Bridge Inverters, 3 Phase Inverters, 180° and 120^0 conduction, Voltage Control Of inverters:, Sinusoidal Pulse Width Modulation, Concept of multi level inverters.

AC to AC Converters:
Single phase AC to AC Controllers with R and RL load, Single Phase cycloconverters with R and RL load.

Switch Mode Power Supply (SMPS):
Advantage of Switch Mode Power Supply over Conventional Power Supply, Fly back converters.

Text Book

1. Power Electronics By M. H. Rashid, Pearson Education, 3rd Edition, 2014.
2. Power Electronics by P S Bhimbhra, Khanna Publishers, 4th edition, 2012.

Reference Book

1. Power Electronics by M. D. Singh and K. B. Khanchandani, Tata McGraw-Hill publishers, Second Edition, 2007.
2. Power Electronics, Converters, Applications and Design N. Mohan, Undeland & Robbins, John Wiley and Sons , Third Edition, 2002.
3. Modern Power Electronics by P C Sen, S Chand Publication 2013
4. Fundamental of Power Electronics by S K Bhattacharya, Vikas Publishing, 1st edition-2005.

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EE 3030 VERHEAD POWER TRANSMISSION LINE CONSTRUCTION AND MANAGEMENT Cr-3

Course outcome : At the end of the course, the students will be able to:

CO1. design different components of transmission and distribution lines.
CO2. perform different testing of transformer and DC Machines.
CO3. maintain different Electrical Machines.

Pre-requisites: Basic Electrical Engineering (EE 1003), Power Transmission and Distribution (EE 3007), and DC Machine and Transformer (EE 2005).

Installation ,Commissioning and Testing of Transmission and Distribution Lines:
Planning the route of H.T. Lines, Planning the route of distribution lines, planning of construction work, erection and setting poles guys, cross arms, insulator and jumpers etc, fixing of guarding, anti-climbing devices and danger plates, concept of right of way, service connection, installation of energy meter.

Installation ,Commissioning and Testing of Cables:
Inspection on arrival of cables, transportation, handling and storage of cables, consideration for selection of cables, current rating of cables, various causes of faults and testing of cables, joints in cable and various method of joining.

Installation, Commissioning and Testing of Transformers and DC Machines:
Inspection of arrival of machine, location for foundation of machine and its switch gear, foundation preparation-levelling, alignment, fittings and IER related to installation. Dispatch, inspection, storage and handling of transformer, civil construction feature regarding connection like ventilation, noise level, space for free movement, foundation, drainage of oil, cabling, cable box, fire protection, provision for bushing supports, location of switch gear ,various steps for commissioning fitting of all accessories, filling of oil, drying out, charging the breather with fresh silica gel, cleaning of bushing, fixing conductor and cables, earthing tank and cover, neutral earthing, fixing of protection circuit, setting of relays.

Installation ,Commissioning and Testing of Sub-station:
Design and planning of indoor substation, layout with key diagram, consideration for safe operation of substation, installation of outdoor substation, testing and commissioning of substation, installation of control and relays panel, installation of outdoor circuit breaker, civil works, various step for installation, pre-commissioning checks/test.

Maintenance:
Fundamental of maintenance, preventive maintenance, maintenance planning, advantage of preventive maintenance-daily, weekly, monthly, half yearly, yearly maintenance. break down maintenance, list of tools/instruments and material used for maintenance, making of maintenance schedule of DC machines, induction machines, synchronous machine, transformer, transmission lines ,distribution lines, underground cables, circuit breaker, switch gear protective relays and substation, batteries in substation.

Text Book

1. Installations, Commissioning and Maintenance of Electrical Equipments by Tarlok Singh, S. K. Kataria and Sons, New Delhi, Reprint,2008.
2. Electrical Power Transmission lines, Tower manufacturing to construction, T Ch Hanuman Rao, 2nd edition, Universal printers-2014.

EE 3032 EHV AC TRANSMISSION Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. learn about the trends in EHV AC Transmission and Calculate Line inductance and capacitance of bundled conductors
CO2. realize the effects of corona like audible noise and Radio Interference
CO3. calculate electrostatic field of EHV AC lines.
CO4. understand the Lightning, Lightning Protection and over voltage in EHV Systems

Pre-requisite: Power Transmission and Distribution (EE 3007)

Introduction to EHV AC Transmission:
Role of EHV AC Transmission, Standard Transmission Voltages, Average Values of Line Parameters, Power-Handling Capacity and Line Loss, Properties of Bundled Conductors, Inductance of EHV Line Configuration, Line Capacitance Calculation, Sequence Inductances and Capacitances, Line Parameters for Modes of Propagation, Electrostatics, Field of Sphere Gap, Field of Line Charges and Their Properties, Charge-Potential Relations for Multi-Conductor Lines.

Corona Effects: Power Loss and Audible Noise:
I^2R Loss and Corona Loss, Corona-Loss Formula, Charge-Voltage (q-V) Diagram and Corona Loss, Attenuation of Travelling Waves due to Corona Loss, Audible Noise: Generation and Characteristics, Limits for Audible Noise, AN Measurement and Meters, Formulae for Audible Noise and Use in Design, Relation between Single-Phase and 3-Phase AN Levels, Day-Night Equivalent Noise Level, Some Examples of AN Levels from EHV Lines.

Corona Effects-II: Radio Interference:
Corona Pulses: Their Generation and Properties, Properties of Pulse Trains and Filter Response, Limits for Radio Interference Fields, Frequency Spectrum of the RI Field of Line, Lateral Profile of RI and Modes of Propagation, The CIGRE Formula.

Lightning and Lightning Protection:
Lightning Strokes to Lines, Lightning-Stroke Mechanism, General principles of the Lightning-Protection Problem, Tower-Footing Resistance, Insulator Flashover and Withstand Voltages, Probability of Occurrence of Lightning – Stroke Currents, Lightning Arresters and Protective Characteristics, Dynamic Voltage Rise and Arrester Rating, Operating Characteristics of Lightning Arresters, Insulation Coordination Based on Lightning.

Over voltage in EHV Systems Caused by Switching Operations:
Origin of Overvoltage and their types, Short-Circuit Current and the Circuit Breaker, Recovery Voltage and the Circuit Breaker, Overvoltage Caused by Interruption of Low Inductive Current, Interruption of Capacitive Currents, Ferro-Resonance Over voltages, Calculation of Switching Surges-Single Phase Equivalents, Distributed-Parameter Line Energized by Source, Generalized Equations for Single-Phase Representation, Generalized Equations for Three-Phase Systems, Inverse Fourier Transform for the General Case, Reduction of Switching Surges on EHV Systems.

Text Book

1. Extra High Voltage AC Transmission Engineering by R.D.Begamudre, New Age International Publication, 4th edition, 2012.
2. EHV-AC and HVDC Transmission Engineering and Practices by S Rao, Khanna Publisher, 3rd Edition-2014

Reference Book

1. Power System Grounding and Transients by APS Meliopoulos, Marcel Dekker Inc, 2012.
2. Overhead Power Lines-Planning Design and Construction by F.Kiessling, P.Nefzger, J.F.Nolasco and U.Kainzyk, Springer-Verlag, Germany, 2003.

EE 3034 NEURAL NETWORK, FUZZY LOGIC AND EVOLUTIONARY ALGORITHM Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. know the Learning Paradigms and ANN Paradigms
CO2. solve nonlinear problems by Neural Network and Fuzzy Controllers
CO3. understand the convergence characteristics of Genetic Algorithms, ANN

Pre-requisites: Basic Electrical Engineering (EE 1003) and Mathematics-I (MA 1001)

Learning Paradigms:
Introduction models of neural Network, architectures, knowledge representation, Artificial Intelligence and Neural Networks, learning process, error correction learning, Hebbian learning, competitive learning, Boltzmann learning, supervised learning, unsupervised learning, reinforcement learning, learning tasks.

ANN Paradigms:
Multi-layer perceptron using back propagation algorithm (BPA), self organizing map (SOM), radial basis function network, Functional Link Network (FLN), Hopfield Network.

Fuzzy Logic:
Introduction, fuzzy versus crisp, fuzzy sets, membership function, basic fuzzy set operations, properties of fuzzy sets, fuzzy Cartesian product, operations on fuzzy relations, fuzzy-logic, fuzzy quantifiers, fuzzy inference, fuzzy rule based system, defuzzification methods.

Genetic Algorithms:
Introduction, encoding, fitness function, reproduction operators, genetic modelling, genetic operators, crossover, single site crossover. two point crossover, multi point crossover, uniform crossover, matrix crossover, crossover rate, inversion and deletion, mutation operator, mutation, mutation rate, bit–wise operators, generational cycle, convergence of genetic algorithm.

Text Book

1. S. Rajasekaran and G. A. V. Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms, PHI, New Delhi, 2003.
2. Computational Intelligence: Synergies of Fuzzy logic, Neural Network and Evolutionary Computing by Nazmul Siddique, Hojjat Adeli, John Wiley and Sons, 2013

Reference Book

1. Zimmermann H.J., “Fuzzy Set Theory and Its Applications”, Allied Publishers Ltd., 1999.
2. Klir G. J., Folger T., “Fuzzy Sets, Uncertainty and Information”, Prentice Hall of India, 5th. Indian reprint, 2002.
3. Zurada J. M., “Introduction to Artificial Neural Systems”, Jaico Publishing House, 2006.
4. Mohammad H. Hassoun, “Fundamentals of Neural Networks”, Prentice Hall of India, 2002.
5. D. E. Goldberg, Genetic Algorithm in search, optimization and machine learning, Addition Wesley Publication, NY.
6. Rober J. Schalkoff, Artificial Neural Networks, Tata McGraw Hill Edition, 2011.
7. LaureneFausett, “Fundamentals of Neural Networks”, Pearson Education, 2004.
8. Timothy Ross, “Fuzzy Logic with Engineering Applications”, McGraw-Hill, 1998.

EE 3036 DISCRETE AND NON LINEAR CONTROL THEORY Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. model the non-linear physical systems by state space techniques.
CO2. formulate, design of digital control systems and represent digital control systems using state space models.
CO3. design the compensator and understand the concepts of discrete Time Control Systems

Pre-requisites: Basic Electrical Engineering (EE 1003), Mathematics-I (MA 1001) and Lineer Control Theory (EE 2012)

State Space and State Solution:
Concept of State, State Space, Concept of Physical variables and phase variables, Modelling of Mechanical, Electrical, Electro-Mechanical Systems in State Space; Transfer Function Decomposition Controllable Canonical Form, Observable Canonical Form, Cascade Form, Parallel Form, Non Uniqueness of State Model, Diagonalization: Similarity Transformation, State Transition Matrix: Concept, Resolvant Matrix Method, Infinite Series (Sylvester) Method, Clayey Hamilton Theorem; State Solution.

State Feedback Design:
Concept of Controllability, Kalman and Gilbert Test, Stability, Concept of Observability: Kalman and Gilbert Test, State Feedback Controller Design: Ackerman's Formula. Observer Design: Separation Principle, Ackerman's Formula, Full Order State Observer.

Compensator Design:
Design of lag, lead, lag-lead compensator in Frequency Domain.

Discrete Time Control Systems:
Sampled Data Control Systems, Concept of Sampling: Impulse Sampling, Shanon's Sampling Theorem, Concept of Hold Operation: Zero Order Hold; Z-Transform: Properties, Inverse-Z Transform; Principle of Discretization: Impulse, Step Invariance Methods, Bilinear Transformation, Relationship Between s-plane and z-plane. Stability: Routh Hurwitz in Discrete Domain and Jury's Test.

Text Book

1. Control System Engg, by I.J. Nagrath and M Gopal, New age International Publication, 4th Edition,2009.
2. Digital Control and State Variable Methods, Gopal, 4th Edition, TMH Publishers, 1st reprint, 2013.

Reference Book

1. Control systems Engineering by R.Ananda Natarajan and P.Ramesh Babu (SCITECH), 2nd Edition, 2009.
2. Discrete time control systems by K. Ogata (PHI), 2nd Edition,2009.
3. Automatic Control Systems by Benjamin C Kuo, Prentice-Hall,7th Edition,2009.
4. Modern Control Engg. by K. Ogata PHI publication, 5th Edition,2010.
5. Automatic control system by Hasan Saeed, S.K. Kataria and Sons, Sixth Revised Edition, 2008,.

EE 3038 UTILIZATION OF ELECTRIC POWER Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. interpret Electric Tariff and its applications.
CO2. study the process of Electrical heating and Electrical welding.
CO3. analyze electrolytic process, Electric Drives, Electric Tractions and Illumination techniques.

Pre-requisites: Basic Electrical Engineering (EE 1003) and Mathematics-I (MA 1001)

Electric Tariff:
Classification of costs, Formulation of Electric Tariff, Various kinds of Tariff, Economics of generation. Effect of load factor, Diversity factor and power factor on tariff, power factor improvement.

Electric Heating :
Advantage of Electric heating, Heating Methods, Resistance furnace, Some heating alloys, Causes of failure of heating elements, Temperature control of resistance furnace, Arc furnace, Induction heating, Dielectric heating, Generation of dielectric heat, Dielectric heating principle, Comparison between dielectric and induction heating.

Electrical Welding:
Electric welding- Arc welding, Resistance welding circuit used in electric welding, Electric welding equipments and arc welding, Welding accessories.

Illumination:
Terms used – Light, luminous flux, luminous intensity, Lumen candle power, Illumination Lux, Lamp efficiency, Brightness Glare, Space height ratio, Co-efficient of utilization, Maintenance factors, Depreciation factors, Laws of Illumination, Solid angle, Sources of light-Arc Lamp, Incandescent Lamp, Sodium Vapour Lamp, Mercury Vapour Lamp, Fluorescent Lamp, Neon Lamp, Types of lighting scheme, Design of lighting.

Electrolytic Process:
Faradays law of electrolysis, Extraction of metals, Electroplating.

Electric Drive:
Types of Drive, Types of load, Selection of Electric Drive.

Electric Traction:

System of Track electrification, typical speed-time curve, Tractive effort calculation, Specific energy consumption calculation, Electric Traction motors, Electric braking, Power Supply for Electric Traction.

Text Book

1. Generation, Distribution and Utilization of Electrical Power by CL Wadhwa, Wiley Eastern Ltd., New Delhi.
2. Utilization of Electric Power and Electric Traction by J B Gupta, S K Kataria and Sons, Delhi, 2011.

Reference Book

1. Utilization of Electrical Power by Er. R K Rajput, Lakshmi Publications pvt ltd, 1st Edition 2006.
2. Art and Science of Utilization of Electrical Energy by H. Pratab, DhanpatRai and Co., 3rd Edition, 2013
3. Electrical Technology Volume-III, by B L Theraja, A K Theraja, S Chand Publisher-2013.

EE 3040 ELECTRIC POWER GENERATION TECHNOLOGIES Cr-3

Course Outcome : Analyse at the end of the course, the students will be able to:

- CO1. the layout of different Power Plants (detailed operation and electrical power generation of the each Power Plant)
- CO2. analyze various electrical components connected with Power Plant and system parameters.
- CO3. understand the different renewable energy generation systems.

Pre-requisite: Basic Electrical Engineering (EE 1003)

Thermal Power :
Layout of thermal power plant, Main Equipment, Coal Handling plant, Boiler, Super heater, Reheater, Economizer, Air Preheated steam turbine, Ash handling plant, condenser, Cooling tower and ponds, Feed water heater, E.S.P, Power supply to auxiliaries.

Hydro Power Plant:
Classification according to (i) Water Flow (ii) Load (iii) Head surge tank, Penstock, spillway, Tail Race, Types of turbine (i) Pelton turbine, (ii) Francis turbine, (iii) Kaplan turbine, Governor, specific speed, Plant auxiliaries.

Nuclear Power Plant:
Location, Layout of nuclear power plant, Fission, Fusion, controlled chain reaction, Classification of Nuclear reactors –Advanced Gas cooled Reactor, Pressurized Water Reactor, Boiling Water Reactor, Fast Breeder Reactor, and Reactor Control and Cooling.

Diesel Electric Power plant:
Introduction, Selection of site, Layout and Main components, Application.

Gas Turbine:
Principle of operation.

Solar Energy:
Theory of solar cells. Solar cell materials, solar cell power plant, limitations. Solar radiation flat plate collectors and their materials, applications and performance, applications, solar thermal power plants, photovoltaic - solar cells and its applications.

Wind Energy:
Origin of Winds, Nature of Winds, Wind Turbine Setting, Major Application of Wind Power, Basics of Fluid Mechanics, Wind Turbine Aerodynamics, Wind Turbine Types and Their Construction, Wind Energy Conversion Systems (WECS).

Biomass Energy:
Photosynthesis Process, Usable Forms of Biomass, their Composition and Fuel Properties, Biomass Resources, Biomass Conversion Technologies, Urban Waste to Energy Conversion, Biomass Gasification, Biomass Liquefaction, Biomass to Ethanol Production.

Geothermal Energy:
Applications, Origin and Distribution of Geothermal Energy, Types of Geothermal Resources, Analysis of Geothermal Resources.

Text Book

1. M.V. Despande, Elements of electrical power system design, PHI,2010
2. B.H.Khan, "Non – Conventional Energy Resources" Tata Mc Graw Hill,2nd edition 2009.

Reference Book

1. P. K. Nag, "Power Plant Engineering", 3rd Edition, Tata McGraw Hill Publication ,2002
2. N. K. Bansal, Manfred Kleemann, Michael Meliss, " Renewable energy sources and conversion technology", Tata Mc Graw Hill, 1990.
3. Generation of Electrical Energy, B.R. Gupta, S.Chand Publication, 2009
4. D.P. Kothari, "Renewable energy resources and emerging technologies", Prentice Hall of India Pvt. Ltd,2006.
5. G.D Rai, "Non-Conventional energy Sources", Khanna Publishers, 4th Edition 2000.

EE 3042 PRINCIPLES OF ENERGY CONVERSION Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. principle of operation, construction, performance characteristics, starting and testing of DC machines.
CO2. know the design and applications of transformers.
CO3. understand the details about different parameters, principle of operation, and construction, types, usage and voltage regulation and starting of synchronous machines.
CO4. understand the principle of operation, construction, types, use, starting, testing and to draw the performance curve of 3-Ø Induction motor.

Pre-requisite: Basic Electrical Engineering (EE 1003)

Electromechanical Energy Conversion:
Principle, Singly Excited Magnetic System and Doubly Excited Magnetic system, Physical concept of torque production, Electromagnetic torque and Reluctance torque.

DC Machines:
DC Generator:Construction features, emf equation of dc generator, methods of excitation, losses, condition for maximum efficiency, armature reaction, interpoles and compensating winding, commutation, characteristics of separately excited and self excited dc generator. DC Motor: Working principle, voltage equation, condition for maximum power, characteristics, operating characteristics of dc motor, torque developed, starting, 3 point and 4 point starter, speed control methods.

Transformers:
Single Phase Transformer: Working principle, Construction, types, EMF equation, Transformer on no load and on load, vector diagram, exact and approximate equivalent circuit, O.C and S.C.test on transformer, regulation of transformer, losses and efficiency, condition for maximum efficiency, Auto transformer, 3 Phase transformers: Construction, connections(Y-Y, Y-Δ, Δ- Δ, Δ-Y).

3 Phase induction motor:
Construction, types, rotating magnetic field, principle of operation, slip, frequency of rotor current, rotor emf, rotor current, expression for torque, conditions for maximum torque, torque slip characteristics, starting torque in squirrel cage and slip ring motors, effect of change in supply voltage on torque, slip and speed , relation between full load torque and maximum torque, Power stages in induction motor, vector diagram and equivalent circuit, speed control of 3 phase motor, starting methods for 3 phase induction motor.

Synchronous Machine:
Alternator: Basic principle, construction, pitches factor, distribution factor, emf equation, alternator on load, voltage regulation, and synchronous impedance method Synchronous motor: Basic principle, methods of starting, application.

Text Book

1. Electrical Machines by Ashfaq Hussain; Dhanpatrai and Co.
2. Text of Electrical Technology; Vol -II; B. L. Theraja, and A. K. Theraja; S. Chand Publication

Reference Book

1. Principles of Electrical power systems by J. B. Gupta
2. Generalised theory of rotating machines By P S Bhimra
3. Text book of Electrical Machine by K R Sidhapura and D B Raval, Vikash, 1st edition-2013.

EE 3044 CIRCUIT THEORY Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. analyze DC and AC circuit by different network theorems, properties of coupled circuit and usage of network graph to solve electrical circuits.
CO2. realize transients in AC/DC circuits
CO3. acquire knowledge of operation of two port networks, network functions and their response.
CO4. learn the concepts of filter design

Pre-requisite: Basic Electrical Engineering (EE 1003)

Network Topology:
Concepts of Network graph, Tree, Co-Tree, Links and Twigs. Formation of incidence matrix [A] and loop matrix [B], Formation of Fundamental Cut-Set Matrix [QF], Tie-Set Matrix, Relation between branch voltage and current, loop current network topology analysis**.**

Network Theorems:
Maximum Power Transfer theorem (Both AC and DC Network), Reciprocity Theorem and Millman's Theorem, Tellegen's theorem.

Couple Circuit:
Self and Mutual Inductance. Dot conventions for couple circuits and coefficient of coupling, Tuned coupled circuits (Double Tune and Single Tune.

Transient Response:
Transient response of RL, RC and RLC circuits with a constant and sinusoidal excitation in time domain by Laplace transformation method, Introduction to different Signals, Periodic and non-periodic function, Response to step, impulse and ramp inputs, S-domain circuits.

Two-Port Networks:
Open Circuit, Short circuit, hybrid and transmission parameters, T and π-Circuit representation, Interconnection of two port networks (Series, Parallel and Cascade**).**

Network Functions and Responses:
Concept of complex frequency, driving point and transfer functions of one and two-port networks, Calculation of the network functions, Restrictions on poles and zero location of network function and impulse responses, Time domain behavior from pole-zero plot using Laplace transform.

Synthesis of Passive Network:
Hurwitz polynomial, Positive real Function and properties of Driving point function, Synthesis of LC, RC and RL driving point function by Cauer-1 and Cauer-II, Foster-I and II forms.

AC circuits with non-sinusoidal wave forms:
Fourier series representation of complex waves and Symmetry in Fourier Series, Average and RMS values of periodic complex wave**.**

Filter Design:
Introduction, Active and Passive filters, Design of low pass and high pass filter, Design of Band-pass and band elimination filters.

Text Book

1. Network Analysis 3rd Edition, by M. E. Van Valkenburg, Pearson Education, 2006.
2. Circuit Theory, Analysis and Synthesis, A. Chakrabarti, Dhanpat Rai Publishing Company (P) Limited, 5th Edition,2008.

Reference Book

1. Circuits and Networks Analysis and Synthesis (Second Edition) A Sudhakar Shyammohan S Palli, Tata McGraw-Hill, 2011.
2. Network Analysis and Synthesis, F. F. Kuo, 2nd edition 2006, Wiley student edition.
3. Basic Circuit Analysis (Second Edition) John O'Malley, Schaum's Outlines, Tata McGraw-Hill, 2010 (Reprint).
4. A Course in Electrical Circuit Analysis: with Solved Examples, by M. L. Soni, J. C. Gupta, Danpat Rai publisher, 3rd edition, 1976.

EE 3046 SOLAR POWER TECHNOLOGIES Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. implement various approaches of utilizing solar energy.
CO2. realize power conditioning and MPPT operation.
CO3. design grid connected PV system.

Pre-requisites: Basic Electrical Engineering (EE 1003) and Physics (PH 1003)

Introduction:
Basics of solar energy, Brief History of solar energy utilization, various approaches of utilizing solar. energy, Blackbody radiation, Relation between radiation field energy density and radiation spectrum, Planck's formula in energy unit, Maximum spectral density, Planck's formula in wavelength unit, Wien displacement law, Stefan Boltzmann law, Photoelectric effect, Einstein's theory of photons, Einstein's derivation of the black-body formula.

Solar Cells :
Formation of a p-n junction, Space charge and internal field, Quasi - Fermi levels, The Shockley diode equation - Structure of a solar cell, The solar cell equation, Fill factor and maximum power, Various electron, hole-pair recombination mechanisms, Crystalline silicon solar cells, Thin film solar cells**.**

Solar Photovoltaic Technology:
Solar PV modules from solar cells, Balance of solar PV system, Inverters (DC/DC, DC/AC), Power conditioning, Maximum power point operation, and Standalone PV system design, Grid-connected PV system, Balance of System (BOS) for PV module installation, Concentrated solar power (CSP) systems.

Energy Storage:
Necessity of storage for solar energy- Chemical energy storage - Thermal energy storage – Thermal Flywheels - Compressed air- Rechargeable batteries.

Text Book

1. Solar Photovoltaics, fundamentals Technoloies and Applications, by Chetan Singh Solanki, PHI, 2nd edition 2012
2. Jui Sheng Hsieh, Solar Energy Engineering, Prentice-Hall, 2007.

Reference Book

1. M. Stix, The Sun, An Introduction, Second Edition, Springer 2002.
2. Nelson, The Physics of Solar Cells. Imperial College Press, 2003.
3. Duffie, J.A., and Beckman, W.A. Solar Energy Thermal Process, John Wiley and Sons, NewYork,
4. Rai, G.D., Solar Energy Utilization, Khanna Publishers, N. Delhi, 2010.
5. Non-conventional Energy Resources, by J P Navani and Sonal Sapra, S Chand, Revise edition-2015

EE 4003 SWITCH GEAR AND PROTECTION Cr-3

Course outcome : At the end of the course, the students will be able to:

CO1. know the basics of the switchgears and current chopping phenomenon.
CO2. understand the working principles of different types of Circuit Breakers.
CO3. understand the requirements of substations and earthing mechanism.
CO4. know the philosophy of protection, construction and operation of protective devices in power system.

Pre-requisites: Power Transmission and Distribution (EE 3007), Electrical Measurement and Measuring Instrumentation (EE 2016) and Microprocessor and Microcontrollers (EC 3003)

Introduction:
Requirement of circuit breakers, characteristics of an electric arc, principle of AC and DC arc interruption, Recovery voltage, re-striking voltage and effect of current asymmetry upon them, current chopping, resistance switching.

Circuit Breakers:
Types of AC and DC circuit breakers in general, oil circuit breaker, plain break and controlled break, minimum oil circuit breaker, air blast circuit breaker, vacuum and SF_6 circuit breaker, introduction to miniature case circuit breaker and moulded case circuit breaker, Calculation of fault MVA for symmetrical short circuits and determination of circuit breaker capacity, circuit breaker ratings.

Substation and Earthing:
Types of substations, arrangement of circuit breakers, isolators and bus bars, limiting reactors in power system, Methods of neutral grounding (solid earthing, resistance earthing and Peterson coil earthing and its effects on fault conditions). H.R.C, Fuse, its construction, capacity and characteristics.

Protective Devices:
Philosophy of protection, requirement of ideal protective scheme, definition of different terms in protective systems, Basic elements in protective scheme, Construction and Principle of operations of Electromagnetic type, induction type: over current, directional, distance relays.

Alternator Protection:
Different types of faults, differential protection with biasing, restricted earth fault protection, negative sequence protection, automatic field suppression and neutral circuit breakers.

Transformer Protection:
Buchholz relay, Biased differential protection, restricted earth fault protection, harmonic restraint, protection of combined alternator and transformer.

Bus Bar Protection: Differential scheme for both phase and line faults, frame leakage scheme, introduction to digital protective relay and microprocessor based relays.

Feeder protection:
Time graded protection: radial, parallel and ring feeders; over current and earth fault protection, calculation of graded time setting, split core protection of feeders, carrier current protection and introduction to microwave pilot system, arrangement of relay contacts.

Pilot Wire Protection:
Circulating current differential protection (Merz-Price protection), Biased or percentage differential protection scheme, opposed (balanced) voltage differential protection system, Translay scheme; static relays.

Protection Against Surges: Ground wire, Surge diverters: rod gap, horn gap lighting arresters; surge absorbers.

Text Book

1. Switchgear Protection and Power Systems, Sunil S. Rao, Khanna Publishers, 2009.
2. Power System Protection and Switchgear by B Rabindranath and M Chander , Wiley Eastern (1977)

Reference Book

1. A Course in Power Systems, J. B. Gupta, S. K. Kataria and Sons Publishers and Distributors, 2009.
2. Principles of Relaying", Van Warrington, Y. G. Paithankar. TMH, 2009.
3. Fundamentals of Power System Protection", Y. G. Paithankar, S. R. Bhide, 2nd edition, Prentice Hall of India Private Limited, New Delhi, 2011.
4. Power system Protection and Switchgear, Badri Ram and D N Vishwakarma Tata McGraw Hill, 2nd reprint 2012
5. Power system Switchgear and Protection N.Veerappan and S R Krishnamurthy, S Chand Publication, Revised edition 2013.

EE 4022 BIO POWER Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. study Composition and Conversion of biomass.
CO2. know various gasification processes of Biomass.
CO3. analyze and understand the various aspects of Bio Fuel.

Pre-requisites: Chemistry (CH 1003) and Environmental Science (CH 1005)

Introduction:
Biomass and solid wastes, Broad classification, Production of biomass, photosynthesis, Separation of components of solid wastes and processing techniques, Agro and forestry residues utilization through conversion routes: biological, chemical and thermo chemical, Bioconversion into biogas mechanism.

Composition and Conversion:
Composting technique, Bioconversion of substrates into alcohols, Bioconversion into hydrogen, Thermo chemical conversion of biomass, conversion to solid, liquid and gaseous fuels, pyrolysis, gasification, combustion, Chemical conversion processes, hydrolysis and hydrogenation, Solvent extraction of hydrocarbons, Fuel combustion into electricity, case studies.

Biomass Gasification:
Bio-methenation technology, Bio-diesel, improved wood stove, Bio-hydrogen generation, Quality of Fuel Gas from Gasification and Bio-Methenation, Electricity from bio-mass.

Bio Fuel:
Solid, liquid and gaseous fuels, Coal as a source of energy and chemicals in India, Coal preparation, Carbonization, Gasification and liquefaction of coal and lignite, Principle of combustion, Petroleum and its derived products, Testing of liquid fuels, Petroleum refining processes, Inter-conversion of fuels, Natural gases and its derivatives, sources, potential, Gas hydrates, Combustion appliances for solid, liquid and gaseous fuels, Introduction to nuclear fuel, RDF, Bio-fuels, etc.

Text Book

1. Non-conventional Energy Systems – Mittal, Wheelers Publication.2003.
2. Understanding Clean Energy And Fuels From Biomass, by H.S. Mukunda, Wiley India Pvt Ltd, 2011

Reference Book

1. Biomass for Renewable Energy, Fuels, and Chemicals, by D Klass, Academic Press, 1st Edition 1998
2. Energy Technology by S. Rao. and B. B Parulekar, Khanna Publisher Delhi, 1999.
3. Non conventional Energy Sources, by G D Rai, Khanna Publisher, 200

EE 4024 WIND POWER Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. know the potential of wind energy worldwide and in India, and to study the aerodynamics of wind turbines.

CO2. understand the classification of wind power plants and to study the different components of wind power plants. To study the power control strategy of wind power plants.

CO3. study the details of the wind energy conversion systems.

Pre-requisites: Basic Electrical Engineering (EE 1003), Basic Electronics (EC 1001), DCMachine and Transformer (EE 2005) and AC Machine (EE 2010)

Wind Power :
Wind Power in India, IEC Standards for Wind Turbines, State Government Policy for Wind Power Project Investment. Wind Characteristics: Power in the wind, Conversion of Wind to Electric Energy.

Wind Power Plant:
Types of Wind Power Plant, Components of Wind Power Plants, Working of Wind Power Plants, Aerodynamic Power Regulation of Wind Power Plants: Specifications of Wind Power Plants, Electrical Power Control Strategies.

Major Power Electronics Components in Wind Power Plants:
Power Electronics in Wind Power Plants, Type-A WPP with Squirrel cage Induction generator,
Type-B WPP with Wound Rotor Induction generator, Type-C WPP with Doubly-fed Induction generator: Type-D WPP with Wound Rotor Synchronous generator, Type-D WPP with Permanent Magnet Synchronous generator.

Economics of Wind Power Plants:
Wind Power Quality and Electrical Generators, Grid Integration of Wind Power Plants, Wind resource Assessment, setting of Wind Power Plants, Economics of Wind Power Plants, Choice of Wind Turbines, Wind Power Project development.

Maintenance of Wind Power Plant components:
Wind Power Policy: Wind Power and the Environment, Wind Power Planning, Public Perception and Acceptance, Operation and Maintenance Issues of Wind power Plants, Maintenance of Wind Power Plant components.

Text Book

1. Wind Power Plants and Project Development by Joshua Earnest, Tore Wizelius, PHI Publication, 2010.
2. Wind Energy Technology – Njenkins, John Wiley and Sons, 1st Edition 1997.

Reference Book

1. Solar & Wind energy Technologies – McNeils, Frenkel, Desai, Wiley Eastern 1990.

EE 4025 ELECTRIC TRACTION AND DRIVE Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. understand the general features of Electric traction and the traction drives.
CO2. fmiliarization with Prevailing Indian standard and vector control techniques of Induction Motor drives.
CO3. understand the parameter sensitivity compensation and vector controllers.

Pre-requisites: DC Machine and Transformer (EE 2005) and Power Electronics (EE 3005)

Introduction to Traction
General features of Electric traction, Measurement of train movement.

Tractive Effort :
Calculation of tractive effort, Electrical Motors for traction, Modern Power Electric converters in modern traction.

AC Drives in Electric Traction
Diesel electric traction, reference of Indian Standards, AC drives in Electric Traction.

Vector Controller Induction Motor Drive:
Dynamic d-q model of 3 phase induction motor d-q equivalent circuit(stator, rotor, synchronously rotating reference frames model), equation of flux linkage, small signal equations of induction motor, dynamic model state space equations, Principles of vector control, direct vector control, implementation with voltage source, Derivation of indirect vector control scheme.

Parameter Compensation :
Parameter sensitivity of the indirect vector controlled induction motor drive, Parameter Sensitivity compensation, Speed- Controller design for an indirect vector controller induction motor drive, Sensorless vector control.

Text Book
1. Fundamentals of Electric Drives by G K Dubey Narosa publishing House , 3rd Edition , 2002
2. Bimal K. Bose, Power Electronics and Motor Drives: Advances and Trends, Academic Press, 2006.

Reference Book
1. S. K. Pillai : A First Course On Electrical Drives, 2nd Edition, New Age International Publishers,2007.
2. N. K. De, P. K. Sen: Electric Drives, 7th Edition, PHI Learning Pvt. Ltd., 2004

EE 4026 SOLAR POWER Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. understand the design and analysis of Solar Cells and sizing of Solar power plant.
CO2. various aspects of solar PV applications.
CO3. gain knowledge on Balance of Solar PV Systems and design of Photovoltaic System .

Pre-requisites: Basic Electrical Engineering (EE 1003), Basic Electronics (EC 1001) Electrical Engineering Material (EE 3027) and Physics (PH 1003)

Design of Solar Cells:
Limits of cell parameter, losses in solar cell, solar cell design, Analytical techniques.

Solar Cell Technologies:
Production of Si, Growth of solar PV industry and Si requirements, Production of MGS and EGS, Si wafer based solar cell technology, thin film solar cell technologies, Concentrator PV cells and Systems, Emerging solar cell technologies and concepts.

Solar PV Application:
Solar radiation, Sun tracking, estimating solar Radiation Empirically, Measurement of solar Radiation, Solar PV modules, Mismatch in series and parallel connection, Design and structure of PV Modules, PV Module power output.

Balance of Solar PV Systems:
Basic of electrochemical cell, Factors affecting the battery performance, Batteries for PV systems, Algorithm of MPPT, Charge controllers.

Photovoltaic System Design:
Introduction to Solar PV systems, Stand alone PV system configurations, Design methodology PV systems, Wire sizing in PV system, Precise sizing of PV systems , Hybrid PV systems, Grid connected PV systems, Simple payback period, Life cycle costing(LCC).

Text Book

1. Solar Photovoltaic's Fundamentals, Technologies and Applications by Chetan Singh Solanki, PHI Publication 2nd Edition 2011.
2. Wind and solar systems by Mukund Patel, CRC Press,2006

Reference Book

1. Terrestrial Solar photovoltaic's by Tapan Bhattacharya, Narosa Publishing House 2010.
2. Energy Technology – S. Rao, and B.B. Parulkar,2009.
3. Non-conventional Energy Resources, by N K Bansal, Vikash publisher, 1st edition-2013

EE 4028 SURGE AND LIGHTNING PROTECTION AND SAFETY DEVICES Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. understand the protection of the system by use of safety devices.
CO2. know the idea of surge and to recover from its impact, how to keep healthy the system from lighting by diversion of the extra energy.
CO3. understand the different Lightning protection and their applications.

Pre-requisites: Power Transmission and Distribution (EE 3007) and Switchgear Protection (EE 4003)

Introduction:
Basics of Lightning - Formation , Types, Magnitudes, Waveshape. World Lightning Map

Damage due to Lightning:
Direct & Indirect damages due to Lightning - Ground Potential rise and induced emf, overview of latest Indian/International Standard for Lightning protection IS/IEC 62305

Equipments:
Lightning protection for equipments inside building, Lightning protection design criteria for Infrastructure / Building, Earthing requirements for lightning protection, Step and Touch Potential.

Lightning/Surge Protection Device -Type 1 (Multiple MOV / Spark Gap), Type 2 (MOV)

Lightning protection Application : for 415V AC 3 Phase /230Vac 1 Phase Power supply, for low voltage (24V DC) instrumentation & industrial automation, for Solar Power Plants - Rooftop KW capacity, for Solar Power Plants - Land based MW capacity, for explosive industrial environment (e.g. Chemicals, Petrochemicals), for Signal & Telecommunication system, CCTV Surviliance system.

Text Book

1. Power System Protection and Switchgear by B Rabindranath and M Chander , Wiley Eastern (1977)
2. Power system Switchgear and Protection N.Veerappan and S R Krishnamurthy, S Chand Publication, Revised edition 2013

Reference Book

1. Fundamentals of Power System Protection", Y. G. Paithankar, S. R. Bhide, Eastern Economy Edition, 2nd edition, Prentice Hall of India Private Limited, New Delhi, 2011.
2. Power system Protection and Switchgear, Badri Ram and D N Vishwakarma Tata McGraw Hill, 2nd reprint 2012
3. A Course in Power Systems, J. B. Gupta, S. K. Kataria and Sons Publishers and Distributors, 2009.

EE 4029 HVDC TRANSMISSION Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. know the applications of HVDC transmission system.
CO2. understand the role of HVDC converters and controls.
CO3. know the effects of harmonics and its suppression using filters.
CO4. understand the converter fault and its protection.

Pre-requisites: Power Transmission and Distribution (EE 3007) and Power Electronics (EE 3005)

HVDC Transmission:
Introduction - comparison of AC and HVDC, HVDC transmission analysis of HVDC converters - pulse number - analysis with and without overlap - converter bridge characteristics - converter.

HVDC System Control:
Principles of dc link control - starting and stopping of dc link, power control - harmonics and filters – introduction- generation of harmonics - types of ac filters. power flow analysis in ac/dc systems - general modeling of dc links, solutions of ac - dc power flow.

REACTIVE POWER CONTROL IN HVDC:
Reactive Power Requirements in steady state-Conventional control strategies-Alternate control strategies-sources of reactive power-AC Filters – shunt capacitors-synchronous condensers.

CONVERTER FAULT & PROTECTION: Converter faults – protection against over current and over voltage in converter station – surge arresters – smoothing reactors – DC breakers –Audible noise-space charge field-corona effects on DC lines-Radio interference.

Text Book

1. K. R. Padiyar: HVDC Power Transmission System, New Age Intl. Co., 2002.
2. EHVAC and HVDC Transmission Engineering and Practice – S.Rao.

EE 4030 ECONOMIC OPERATION OF POWER SYSTEMS Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. implement mathematical optimization techniques to the economic operation of power systems with different constraints.
CO2. understand the concept of Unit Commitment and its Solutions Methods.
CO3. analyse the Hydro Thermal coordination concepts.
CO4. understand the optimal power flow, power system security and control problems.

Pre-requisites: Power Transmission and Distribution (EE 3007), Power System Operation and Control (EE 3002)

Economics Operation:
Economic dispatch problem of thermal units without and with losses –Gradient Method –Newton's Method – Base point and participation factor method.

Unit Commitment Solutions Methods:
Introduction to unit commitment, method of unit commitment: Priority –List Methods, Dynamic Programming Solution, Forwards DP Approach, Lagrange relaxation solution.

Hydro-Thermal Co-Ordination:
Hydroelectric plant models –Short Term Hydroelectric scheduling problem–gradient approach.

Optimal Power Flow:
Solution of OPF, gradient method, Newton's method, linear programming method with only real power variables, linear programming with AC power flow variables, security constrained optimal power flow.

Power System Security: Contingency analysis –linear sensitivity factors –AC power flow methods contingency selection –concentric relaxation –bounding-security constrained optimal power flow.

The Control Problem: The two-area system, Tie-line Bias control; steady state instabilities: Torsional Oscillatory Model-Damper windings and negative damping, effect of AVR loop: AGC Design using Kalman method-state variable form of the dynamic model, optimum control index.

Text Book

1. Allen J.Wood and Wollenberg B.F., "Power Generation Operations and Control", John Willey and Sons, second edition, 1996.
2. Electric Energy Systems Theory and Introduction , Olle I Elgard, TMH second edition.

References Book

1. Kirchmayer L. K. Economic Control of Interconnected systems", John Willey and Sons, 1959.
2. Nagrath, I.J. and Kothari D. P., "Modern Power System Analysis", TMH, New Delhi, 2006

EE 4031 NUMERICAL RELAYS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. know the digital system for relaying and signal processing
CO2. understand the principle and communication protocol of numerical relay
CO3. know different monitoring protocols and architecture of relay
CO4. understand different techniques of numerical relay testing

Pre-requisites: Switchgear and Protection (EE 4003), Microprocessor and Microcontroller (EC 3003)and Digital Electronics (EC 2011)

General Introduction to Numerical Relays
Digital / Numerical Relay, Number Systems, Digital Systems, Denary to Binary Equivalents, Microprocessors, Microprocessor Principles, Microprocessor Architecture, Microprocessor Memories. Analog to Digital Converter (ADC), Multiplexers, Sample and Hold(S/H) Circuits, Operational Amplifiers.

Digital Signal Processing
Logic Devices and Systems Signal Processing Filters, Conversion from Time Domain to Frequency Domain Analysis.

Principles of Numerical Relays:
Definition of a Numerical Protection System, Advantages of Numerical Relays, Procession Unit, Man-Machine Interface(MMI), Communication in Protection Relays, Information Handling with Sub-station Monitoring System (SMS), Digital / Numerical Relays, Different Types of Numerical Relays. Principles of Fault Locators, Calculation of Algorithm, Solution of Fault Locator Equation.

Protection and Coordinated Control
Protection and Coordinated Control, Place of Personal Computer, Self-Monitoring and Post Fault Analysis, Workstations and Remote Communication, Alstom EPA Computer (Publication N.1.6918 B), PSCN 3020 Bay Module: Integrated Digital Sub-station Control System, Architecture, Interface to SCADA, Local Control Point: Man-Machine Interface, SPACE 2000-System for Protection and Automatic Control.

Reliability, Testing, and Maintenance for Numerical Relays
Reliability, Software Considerations, Scheduling Problems, Redundancy, Relay Testing, Privatization and Deregulation of Electrical Industry, Protective Relaying Capabilities, Maintenance, Opto-electronic Sensors

Text Book:
1. Digital/Numerical Relays by T S M Rao**,** Tata McGraw-Hill Education, 2005
2. Protective Relaying: Principles and Applications, Fourth Edition,By J. Lewis Blackburn, Thomas J. Domin, CRC Press, Taylor and Francies

EE 4037 ADVANCED POWER ELECTRONICS Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. design the AC to DC and DC to DC power electronics converters
CO2. understand the working and application of PWM inverters.
CO3. usage of resonant converter and SMPS
CO4. understand the FACTS devices and the gate drive circuits.

Pre-requisite: Power Electronics (EE 3005)

AC – DC Converters:
Rectifier Circuit Design, L and C filter design, Design of Heat Sinks. Power factor improvement of rectifier circuits.

DC to DC Converters:
Continuous and Discontinuous conduction of buck and boost converters. Buck -boost and Cuk converters. Chopper Circuit Design.

PWM Inverters:
Review of Inverter circuits. Bipolar and Unipolar switching scheme. Modulation Strategies, Performance of 3 phase Sinusoidal PWM Inverters. Trapezoidal modulation.

Resonant Converters:
Hard switching and Soft switching. Series resonant Inverter, Series Resonant Inverter with bidirectional switches, frequency response. ZCS and ZVS resonant converters. Electronic Ballasts.

SMPS:
Flyback Converters, Forward Converter, Current Mode Control. Magnetic Materials suitable for high frequency transformers, Design of High Frequency transformers and Inductors.

FACTS:
Review of the principles of power transmission. Shunt compensation. Thyristor controlled reactor. Static VAR compensator. Principles of series compensation. Thyristor controlled series capacitor. Series static VAR compensator. Unified Power Flow Controller.

Gate drive Circuits :
Gate drive circuits for Thyristor, MOSFET, IGBT, BJT, GTO

Static Switches:
AC switches and DC switches

Text Book
1. Power Electronics By M.H. Rashid Pearson Education , 3rd Edition,2009.
2. Power Electronics , Converters , Applications and Design, by N . Mohan, Underland and Robbins , John Wiely and Sons, 3rd Edition,2011.

Reference Book
1. Power Electronics By M.D . Singh and K.B. Khanchandani, Tata McGraw - Hill publishers, 2nd edition,2008.
2. Modern Power Electronics, by P.C Sen, Wheeler publishing Co, First Edition,2009.
3. Elements of Power Electronics, by Philip T. Krein, Oxford University Press,25 Sept 1997.

EE 4039 **Cr-3**

POWER QUALITY

Course Outcome : At the end of the course, the students will be able to:

CO1. know power quality problems and their Constraints for mitigation.
CO2. analyze the transients generated and the sources and effects of harmonics in power quality problems.
CO3. understand the different power quality compensation techniques.

Pre-requisites: Power System Operation and Control (EE 3002) and Power Electronics (EE 3005)

Introduction:
Importance of power quality, terms and definitions of power quality as per IEEE std. 1159. such as transients, short and long duration voltage variations, interruptions, short and long voltage fluctuations, imbalance, flickers and transients. Symptoms of poor power quality. Definitions and terminology of grounding. Purpose of groundings.

Flickers & Transient Voltages:
RMS voltage variations in power system and voltage regulation per unit system, complex power. Principles of voltage regulation. Basic power flow and voltage drop. Various devices used for voltage regulation and impact of reactive power management. Various causes of voltage flicker and their effects. Short term and long term flickers.

Voltage Sag, Swells and Interruptions:
Voltage sags versus interruptions. Economic impact of voltage sag. Major causes and consequences. Characteristics, assessment. Influence of fault location and fault level on voltage sag. Areas of vulnerability. Assessment of equipment sensitivity to voltage sags, CBEMA, ITIC, SEMI F 42 curves. Representation of the results of voltage sags analysis. Voltage sag indices.

Waveform Distortion:

Definition of harmonics, Causes and effect of harmonics. Voltage versus current distortion. Harmonic indices. A.C. quantities under non-sinusoidal conditions. Triplen harmonics, characteristics and non characteristics harmonics. Harmonics series and parallel resonances. Consequences of harmonic resonance. Principles for controlling harmonics. Reducing harmonic currents in loads. K-rated transformer. IEEE Harmonic standard 519-1992.

Power Quality Monitoring

Need of power quality monitoring and approaches followed in power quality monitoring. Power quality monitoring objectives and requirements. Initial site survey. Power quality Instrumentation. Selection of power quality monitors, selection of monitoring location and period. System wide and discrete power quality monitoring.

Text Book

1. Electric Power Quality by Heydt, G T, Stars in a circle publications, Indiana 2^{nd} edition-1994
2. Electrical Power System Quality , by R C Dugan, M.F Mcgranaghan, S. Santoso and H W Beaty, 2^{nd} Edition TMH publication- 2008.

Reference Book

1. Arrillaga J and Watson RN, Chen S, Power system Quality Assessment, Wiley New York-2000.
2. Bollen M H J, Understanding Power Quality Problems,: Voltage Sag and interruptions, IEEE press NY-2000.

EE 4041 ALTERNATE ENERGY SOURCES Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. recognize the need of renewable energy technologies and Global and National scenarios of energy.
CO2. understand the principles of renewable energy production from various renewable sources.
CO3. know about Electrical Energy Storage System.

Pre-requisite: Physics (PH 1003)

Introduction:
Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of alternate energy sources.

Hydrogen Energy:
Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles.

Fuel Cells:
Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, Applications for power generations.

Ocean Energy:
Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.

Geothermal Energy:
Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma, advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.

Magneto Hydro Dynamic (MHD) Power Generation:
Principle of MHD power generation, MHD system, design problems and developments, gas conductivity, materials for MHD generators and future prospects.

Energy Storage System:
Batteries, types, working principles, role of carbon nano tubes in electrode, super conducting magnetic energy storage (SMES) systems, Capacitor and super capacitor.

Text Book

1. N. K. Bansal, Manfred Kleemann, Michael Meliss, " Renewable energy sources and conversion technology", Tata McGraw Hill, 1990.
2. B.H.Khan, "Non – Conventional Energy Resources" Tata McGraw Hill, 2nd edition 2009.

EE 4042 SENSOR TECHNOLOGIES Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. understand various transducers and sensors
CO2. analyze various logic gates
CO3. analyze various Adaptive control mechanisms
CO4. understand the signal conditioning and Data Acquisition system.

Pre-requisite: Electrical Instrumentation (EE 4047)

Introduction to Sensors and Transducers:
Classification of Transducers, Capacitive and Resistive Transducers, Magnetic Transducers, Hall-effect Transducers, Piezoelectric transducers, Proximity Sensors, Pneumatic Sensors, Light Sensors, Digital Optical Encoders. Sensor Characterisation and Calibration:Introduction, Classification, Performance Characteristics, Calibrations, Errors and Reliability.

Rotational Motion Transducers:
Rotational Displacements: Circular& Helical Potentiometers, Rotational Differential Transformer, Incremental Shaft encoders, Coded-disc shaft encoders, Resolver, Synchros, Induction Potentiometer, Rotary Inductosyn, Gyroscopes.

Rotational Velocity: Digital Tachometers, Stroboscopic Methods, Analog Tachometer, Mechanical Flyball, The rate gyrosocope, fibre-optic gyroscope, accelerometer, Inertial Measurement Unit, Inertial Navigation System.

Automation :PLCs:
Introduction, Logic Gates, PLC System, PLC Programming, Case Studies

Adaptive Control:
Introduction, Feedback Linearization, Model Reference Adaptive Control, System Identification and Generalized Predictive Control in Self-Tuning Mode, Sliding mode Control, Overview of Intelligent Control in a generalized manner.

Signal Conditioning & Data Acquisition System:
Introduction, Functions of Signal Conditioning Equipment, Amplification, Type of Amplifiers, Mechanical Amplifiers, Fluid Amplifiers, Optical Amplifiers, Electrical and Electronic Amplifiers, Attenuators, Filters. Objectives and Configuration of Data Acquisition System, Different types of Data Acquisition Systems and their applications, Data Conversion.

Text Book

1. Electronic Measurements and Instrumentation by R.K Rajput (S.Chand 2nd revised edition 2011)
2. Measurement and Instrumentation Principles by Alan S Morris (Elsevier 1st edition,2006)

Reference Book

1. Instrumentation & Control Systems by W. Bolton (Newnes-*An imprint of Elsevier,* 1st edition, 2011)
2. Digital Control and State Variable Methods: Conventional and Intelligent Control Systems by M. Gopal (4th Edition, 2012)

EE 4043 ELEMENTS OF POWER ELECTRONICS Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. understand the power electronics devices
CO2. realize the modes of operation of DC to DC and AC to DC converters.
CO3. know the control techniques and operation of AC to AC converters.
CO4. understand the concepts of Inverters and SMPS.

Pre-requisites: Basic Electronics (EC 1001) and Basic Electrical Engineering (EE 1003)

Introduction to Power Electronics:
Advantage of power devices operating in the switch mode to those operating in the active region.

Power Electronic Devices:
Thyristor characteristics, Turn ON methods, Dynamic Characteristics of thyristors, Ratings, Protection, Characteristics and construction of Power MOSFETS, Comparison between Power MOSFET and Power BJT, Characteristics and construction of IGBT, Switching characteristics. GTO – turn on and turn off methods, SiC based power devices, TRIAC and DIAC Characteristics and applications.

AC to DC Converters:
Single Phase Converters – Half Wave, with R, RL, RLE load and Free Wheeling diode, Single Phase Full Wave converters with R and RLE Load, Line Commutated Inverters, Single Phase Semi Converters.

DC to DC Converters:
Step up and Step Down choppers, 2 and 4 quadrant choppers for control of DC motor. Buck- Boost converter

Inverters:
1 Phase Half Bridge and Full Bridge Inverters, 3 Phase Inverters, 180° and 120^0 conduction, Sinusoidal Pulse Width Modulation.

AC to AC Converters:
Single phase AC to AC Controllers with R and RL load, Single Phase Cycloconverters with R and RL load.

Switch Mode Power Supply SMPS :
Advantage of Switch Mode Power Supply over Conventional Power Supply, Flyback converters.

Text Book

1. Power Electronics By M. D. Singh and K. B. Khanchandani, Tata McGraw-Hill publishers, Second Edition, 2007.
2. Power Electronics By P S Bhimbhra, Khanna Publishers, 4th edition, 2012

Reference Book

1. Power Electronics By M. H. Rashid, Pearson Education, 3rd Edition, 2014.
2. Power Electronics, Converters, Applications and Design by N. Mohan, Undeland and Robbins, John Wiely and Sons , Third Edition, 2002.
3. Fundamental of Power Electronics by S K Bhattacharya, Vikas Publishing, 1st edition-2005.

EE 4044 ENERGY AUDIT AND MANAGEMENT Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. understand the concept of energy conservation ,management and audit
CO2. analyze combined power and heating systems
CO3. analyze various applications and types of energy audit

Pre-requisites: Basic Electrical Engineering (EE 1003) and Physics (PH 1003)

General Aspects:
Definition of energy efficiencies, estimation of energy efficiencies in supply side and demand side, definition of energy conservation, management and audit, similarities and dissimilarities in financial audit and energy audit, approach, data collection and data analysis methodologies, demand and supply matching methodologies, energy sources, energy management system, types of energy policy, energy conservation, energy efficiencies.

Energy Utilization and Conversion Systems:
Furnaces: classification of furnaces; controlled atmospheres in furnaces; furnace fuels; efficient of energy in furnaces; thermal efficiency; heat losses; reducing heat losses hydraulic power systems compressed air; heat recovery; drying and leaks; operating conditions, steam turbines as alternatives to electric motors combined power and heating systems; characteristics of prime movers; heat and power requirements; economics of a c.h.p. system; energy conversion; distinct heating; factors affecting the choice of heating; distinct generation.

Application of Energy Audit
Definition of energy audit, need for energy audit, types of energy audit, energy audit reporting format, financial audit, energy audit :- peak load, average load, firm power, dump power, secondary power, load curve, energy load curve, load distribution curve, plant capacity factor, energy index, cost index, budgeting and standard costing, representation of energy consumption, energy economics, financial appraisal and profitability with problems.

Text Book
1. "Energy Management", by W.R.Murphy and G. McKay, Butterworth and co Publishers, Oxford, UK, 2003
2. Energy audit of Building systems: an Engineering approach by Moncefkrati, CRCPRESS, Second Edition,2009.

Reference Book
1. A workbook for Energy Management in building by Tarik Al-Shemmeri,Wilay-Blackwell,2011.
2. Energy audit: Thermal power, combined cycle and co-generation plants by Y.P.Abbi, TERI, 2012

EE 4045 NON-CONVENTIONAL ENERGY SYSTEMS Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. understand the various non-conventional sources of energy like wind, biomass etc and its applications.
CO2. describe the various renewable energy sources and the possible conversion paths to a useful form of energy.
CO3. explain the physical principles of wave energy, the generation of tides and how to harness their power; describe the physics of geothermal resources and energy from biomass.
CO4. understand other direct energy conversion systems and fuel cells.

Pre-requisites: Basic Electrical Enginering (EE 1003), Physics (PH-1003) and Chemistry (CH 1003)

Introduction
Various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits. Salient Features of Non-Conventional Energy Sources, Environmental Aspects of Energy, World Energy Status, Energy Scenario in India.

Solar Energy
Theory of solar cells. Solar cell materials, solar cell power plant, limitations. Solar radiation flat plate collectors and their materials, applications and performance, applications, solar thermal power plants, photovoltaic - solar cells and its applications.

Wind Energy:
Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind turbines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output.

Geothermal Energy:
Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma, advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.

Ocean Energy:
Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.

Bio-mass Energy:
Availability of bio-mass and its conversion theory.

Fuel Cells:
Principle of working of various types of fuel cells and their working, performance and limitations.

Text Book

1. N. K. Bansal, Manfred Kleemann, Michael Meliss, “Renewable energy sources and conversion technology", Tata McGraw Hill, 1990.
2. B. H. Khan, “Non – Conventional Energy Resources” Tata McGraw Hill, 2nd edition 2009.

References Book

1. Kothari D.P., “Renewable energy resources and emerging technologies”, Prentice Hall of India Pvt. Ltd, 2006.
2. Rai G.D, "Non-Conventional energy Sources", Khanna Publishers, 4th Edition 2000.
3. Ashok V. Desai, "Nonconventional Energy", New Age International Publishers Ltd, Reprint 2003.
4. Non-conventional Energy Sources and Utilization by R K Rajput, S. Chand, revised edition-2015.

EE 4046 FUNDAMENTALS OF ELECTRICAL DRIVES Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. select the motor for different types of industrial applications.
CO2. start and control the speed of dc machine by different methods.
CO3. control and to know the different types of braking of 3-phase induction motor.

Pre-requisites: Electrical Machines and Power Electronics (EE 2009) or Principles ofEnergy Conversion (EE 3042) and Elements of Power Electronics (EE 4043)

Introduction: Basic elements of an electric drive, four quadrant operation of an electric drive, dynamics of motor load combination, types of loads, stable operating condition of various motor load combinations.

DC motor: Review of characteristics of DC motors, Modification of characteristics of DC shunt and series motors. Methods of starting DC motor. Fundamental parameters of speed control. Methods of speed control of DC shunt and series motors. Concept of Electric Braking, regenerative, Dynamic and Counter current braking of DC motors.

Induction Motors: Review of characteristics of three phase Induction motors. Modification of speed torque characteristics due to variation of Stator voltage, Stator frequency and rotor resistance. Methods of starting, Squirrel Cage and slip ring Induction motors. Methods of speed control of Induction motors: Voltage control, V/f control & Rotor resistance control, Slip Power recovery. Electric Braking of Induction Motors: Regenerative Braking, DC Dynamic braking and Plugging.

Solid State Control of DC drive: Phase controlled and Chopper controlled DC separately excited motor and series motor drives. Four quadrants drive using dual converter. Closed loop control scheme for DC motor.

Solid State Control of Induction Motors: Control of IM by three phase AC-AC Voltage controller. Chopper control of rotor resistance. Speed control using slip power recovery schemes. PWM Inverter fed induction motor drives. Current source inverter fed induction motor drives; Comparison of VSI and CSI fed drives. Closed loop control (V/f control).

Text Book

1. G.K. Dubey, Fundamentals of Electric Drives, Second Edition, Narosa Publishers, 2007.
2. Bimal K. Bose, Power Electronics and Motor Drives: Advances and Trends, Academic Press, 2006.

Reference Book

1. S. K. Pillai, A First Course On Electrical Drives, Second Edition, New Age International Publishers 2007.
2. N. K. De, P. K. Sen, Electric Drives, 7th Edition, PHI Learning Pvt. Ltd., 2004.

EE 4047 ELECTRICAL INSTRUMENTATION Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. know the classification of measuring instruments, their applications and minimize the error sources in measuring instruments.
CO2. understand the operation and measure the resistance, inductance and capacitance by AC/DC bridges.
CO3. understand the different measuring techniques and operation of the different meters.
CO4. know the operation of different transducers and electronic instruments for measurement.

Pre-requisite: Basic Electrical Engineering (EE 1003)

Measuring Instruments

Introduction, classification, absolute and secondary instruments, indicating instruments, Control, balancing and damping, characteristics, Errors in measurements, MI: Constructional details, extension range (both MI and MC).

DC/AC bridge

General equation of bridge balance, Wheatstone bridge, Kelvin's double bridge, Maxwell's inductance - capacitance bridges, Hay's Bridge, Anderson's bridge, Owen's bridge, Schering bridge, errors.

Wattmeter

EDM type, Induction type, single and three phase wattmeter, calibration device, error's in wattmeter, compensation, Measurement of 3-phase power.

Energy Meter

Induction type single and three phase energy meter, compensation, creep errors, testing.

Galvanometer
General principle and performance equation of D'Arsonval Galvanometer, vibration galvanometer and ballistic galvanometer, measurement of charge and flux by ballistic galvanometer.

Frequency meter
Vibration reed type and Electrical resonance type.

Power factor meter
Single phase electrodynamometer type power factor meter, advantages and disadvantages.

Instrument Transformers:
Potential and current transformers, construction, ratio and phase angle errors, phasor diagrams, uses, testing.

Potentiometer
Dc potentiometer- Crompton meter, standardization, Ac potentiometer- Drysdale polar meter, Gall Tinsley coordinate type meter.

Transducer
Stain gauge, Thermistors, Thermocouples, LVDT, Capacitance transducers, torque meter, inductive torque transducers, Tachometers.

Electronic instruments
Electronic voltmeter, block diagram, principle of operation, accuracy of measurement, Digital Multi-meter, Digital Frequency meter, block diagram, principle of operation, accuracy of measurement.

CRO
Block Diagram, Sweep Generator, Vertical amplifiers, Use of CRO for measurement of frequency, phase, amplitude, rise time.

Text Book

1. Electronic Instrumentation and Measurement Techniques, By William David Cooper, PHI,2010.
2. Electrical Measurements and Measuring Instruments, By Edward William Golding, F. C. Widdis, 5th edition, Pitman, 1951.

Reference Book

1. A Course in Electrical and Electronics Measurement and Instrumentation by A.K.Sawhney, 10th edition, Dhanpat Rai,1994.Electronics Instruments and Measurements – David A. Bell – PHI, 2012.
2. Electrical and Electronic Measurements and Instrumentation by R K Rajput, S Chand- 4th edition, 2015

EE 4049 CONTROL SYSTEMS Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. know the different types of control systems, characteristics of control system components and the mathematical model of physical systems.
CO2. analyze the time domain response of different systems.
CO3. analyze the different techniques used to find the stability of a system by classical methods.
CO4. understand the concept of frequency domain analysis and usage of control system components.

Pre-requisites: Circuit Theory (EE 3044) and Mathematics-I (MA 1001)

Introduction:
System concept-types, Basic Concept of Control System, Classifications, Differential Equation and Transfer Function (Open Loop and Closed Loop).Feedback Theory:Feedback and Non-feedback System, Effect of Feedback on Gain, Stability, Sensitivity and Noise of the System.

Description of Physical System:
Mathematical Modelling of Electrical System and Mechanical System (Translational and Rotational Mechanical System), Analogous System, Block Diagram Algebra, Developing Block Diagram from a Mathematical Model, SFG, Mason's Gain Formula, Signal Flow Graph from Block Diagram (SFG Terminology, Construction and Procedure), Problem Practice based on application of SFG to Control System.

Time Domain Analysis: Standard Test Signals (Step Input, Ramp Input, Parabolic Input and Impulse Input)**.** Time Response of First and Second Order System to the Test Signals, Type and Order of the System, Time Response Specifications, Generalized Error Co-efficient, Steady State Error and Design Specifications, Error Constants, Effect of adding Poles and Zeros to Transfer Function, Response with P, PI, PD and PID Controllers.

Concept of Stability: The Concept of Stability, Necessary Condition for Stability, R-H Stability Criterion, Relative Stability Analysis, Application of R-H Criterion to Linear Control System.
The Root Locus Technique: Root Locus Concept, Construction of Root Locus, Rules for the Construction of the Root Locus, Effect of adding Poles and Zeros to G(s) H(s), Determination of Gain from Root Locus.

Frequency Domain Analysis: Introduction, Correlation between Time and Frequency Response, Polar Plots, Bode Plots, Nyquist Stability Criterion, Stability Analysis and Relative Stability.

Control System and Components:
Servo Motors: A.C. Servomotor, D.C. Servomotors – Field Control and Armature Control, Position Control System : A.C. and D.C., Regulators, Synchros – Transmitter, Error Detector, Sensors, Encoders, A.C. Tachometer, A.C. Tachogenerator, Potentiometer, Hydraulic Controller, Pneumatic Controller.

Text Book

1. Control System Engg., by I. J. Nagrath and M. Gopal, New Age International Publication
2. Control Systems: Theory and applications by Smarajit Ghosh, Pearson. Publication 2012

Reference Book

1. Modern Control Engg., by D Roy Choudhury, PHI Publication
2. Control Systems by K. R. Varmah, McGraw Hill Publication
3. Control System by Anand Kumar, PHI Publication
4. Control System by J P Navani and Sonal Sapra, S Chand, 2015

EE 4051 ACTIVE AND PASSIVE FILTERS Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. learn the concept and characteristics of Filters.
CO2. design of Passive Networks.
CO3. synthesize the Active filter.

Pre-requisites: Circuit Theory (EE 3044) and Basic Electronics (EC 1001)

Filter Preliminaries:
Terminology; Magnitude and Phase responses; Classification (LPF, HPF, BPF, APF etc.)

Approximation Theory:
Low pass approximations methods, Butterworth response, Butterworth pole locations, Butterworth filter design from specifications, Chebyshev and inverse Chebyshev characteristics, Network functions and pole zero locations, Characteristics of Cauer (elliptic) response, Bessel-Thomson approximation of constant delay, Delay Equalization.

Frequency Transformation :
Frequency transformation and its importance in filter design, Low pass to high pass transformation, Low pass to band pass transformation and Low pass to band stop transformation

Properties and Synthesis of Passive Networks:

One-port passive circuits , Properties of passive circuits, Positive real functions, Properties of lossless circuits, Synthesis of LC one-port circuits, Foster and Cauer circuits, Properties and synthesis of RC one-port circuits , Two-port Passive Circuits, Properties of passive two-port circuits, Residue condition, Transmission zeros . Synthesis of two-port LC and RC ladder circuits based on zero shifting by partial pole removal.

Sensitivity:

Basic concepts; Application to filters- Q sensitivity, WP sensitivity, Elements of passive network synthesis, Properties and synthesis of LC, RC driving point and transfer functions, Singly- and Doubly-terminated ladder networks.

Active Filter Synthesis:

Active filter and passive filter, Ideal and real operational amplifiers, Gain-bandwidth product, Active building blocks: Amplifiers, Summers, Integrators, First order active sections using inverting and non-inverting Op-amp configuration, Second order active sections (biquads), Tow-Thomas biquad circuit, Design of active filter using Tow- Thomas space biquad, Sallen-Key biquad circuit and Multiple-feedback biquad (MFB) circuit, Gain reduction and gain enhancement ,RC-CR transformation

Text Book

1. G. Daryanani, Principles of Active Networks Synthesis and Design, John Wiley and Sons, 1976.
2. A.S. Sedraand P.O. Brockett, Filter Theory and Design: Active and Passive, Matrix Publishers, 1978.

Reference Book

1. M.E. Van Valkenburg, Analog Filter Design, Holt, Rinehart and Winston, 1982.
2. G.S. Moschytz and P. Horn, Active Filter Design Hand-Book, John Wiley and Sons, 1981.
3. G.S. Moschytz: (Ed.), MOS Switched Capacitor Filters: Analysis and Design, IEEE Press, 1981.

EE 6121 COMPUTER APPLICATION IN POWER SYSTEM Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. design mathematical models for power system components using graph theory
CO2. understand the 3-phase network and the formulation of Z bus.
CO3. know the representation of 3-phase network for fault study using Zbus.
CO4. understand Transient stability Analysis with Modified Euler's and RK 4^{th} order method.

Pre-requisites: Power Transmission and Distribution (EE 3007), Power System Operation and Control (EE 3002)

Introduction to Computer Method:

Network matrices, Reference frame, Network graph, Tree, branch, Basic loop and Cut sets, Basic Incidence matrices, Augmented matrices, Primitive networks, Network matrices by Singular and Non-singular transformation with Bus frame of reference, Branch frame of reference, Loop frame of reference.

Three Phase Network:

Elements in impedance and admittance form, Balance excitation, Un-balance excitation, Transformation matrices for symmetrical components, Incidence and network matrix for 3-phase elements, Formation of Z bus, Addition of branch, Addition of link problems.

Representation of Three Phase Elements in Short Circuit Study:

Short circuit study of balanced network by Z bus, LG fault, L-L fault, 3-ph fault with and without fault impedance, Problems.

Transient stability Analysis:
Load representation**,** Network performance equation, Swing equation, Machine equation, Solution techniques in transient stability study, Modified Euler's method, RK 4^{th} order method, Problems.

Text Book

1. Computer Methods in Power System Analysis by Glenn W. Stagg, Ahmed H. El-Abiad, McGraw-Hill Book Company, International Editions,2009.
2. Power System Dynamics and Stability By Jan Machowski, James Richard Bumby Wiley Publications 1998.

Reference Book

1. Advanced Power System Analysis and Dynamics by L. P. Singh, New Age International (P) Limited, Publishers, Revised 4th Edition,2011.
2. Power System Dynamics and Stability by Jan Machowski, James Richard Bumby, Wiley Publications 1998.
3. Power System Analysis by N.V.Ramana, Pearson Publication,2011
4. Computer application techniques in Power System by M.A.Pai, TMH, 2006.

EE 6123 POWER MARKET REFORMS Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. gain information about Indian power sector, utilities and their roles.
CO2. realise the power sector restructuring and market reform, their benefits and challenges in Genco, transco, and Disco.
CO3. design the electricity market pricing.
CO4. realize the different methods of transmission planning, congesion and pricing in electricity market.

Pre-requisite: Power System Operation and Control (EE 3002)

Power Sector in India:
Introduction to various institutions in Indian Power sector such as CEA, Planning Commissions, PGCIL, PFC, Ministry of Power, State and central governments, REC, Utilities and their roles. Critical issues / challenges before the Indian power sector, Salient features of Electricity act 2003, Various national policies and guidelines under this act.

Power Sector Restructuring and Market Reform:
Different industry structures and ownership and management models for generation, transmission and distribution. Competition in the electricity sector- conditions, barriers, different types, benefits and challenges, Latest reforms and amendments. Different market and trading models / arrangements, Open access, Key market entities- ISO, Genco, Transco, Disco, Retailco, Power market types, Energy market, Ancillary service market, Transmission market, Forward and real time markets, Market power.

Electricity Markets Pricing and Non-Price Issues:
Electricity price basics, Market Clearing price (MCP), Zonal and locational MCPs, Dynamic, spot pricing and real time pricing, Dispatch based pricing, Power flows and prices. Optimal power flow, Spot prices for real and reactive power, Unconstrained real spot prices, Constrains and real spot prices. Non price issues in electricity restructuring (quality of supply and service, standards of performance by utility, environmental and social considerations) Global experience with electricity reforms in different countries.

Transmission Planning and Pricing:

Transmission planning, Different methods of transmission pricing, Different transmission services, Congestion issues and management, Transmission cost allocation methods, Locational marginal price, Firm transmission right. Transmission ownership and control, Transco and ISO, Transmission pricing model in India, Availability based tariff, Role of load dispatch centers (LDCs), Salient features of Electricity act 2003, Price based Unit commitment, Concept of arbitrage in Electricity markets, Game theory methods in Power System, Security constrained unit commitment, Ancillary services for restructuring, Forward ancillary service auction, Power purchase agreements.

Text Book

1. Kankar Bhattacharya, Math H.J. Boller, JaapE. Daalder, 'Operation of Restructured Power System' Klumer Academic Publisher,2010.
2. Mohammad Shahidehpour, and Muwaffaqalomoush, - "Restructured electrical Power systems" Marcel Dekker, Inc., 2009.

Reference Book

1. Loi Lei Lai; "Power System Restructuring and Deregulation", John Wiley & Sons Ltd., England.
2. "Know Your Power", A citizens Primer On the Electricity Sector, Prayas Energy Group, Pune.
3. Sally Hunt, "Making Competition Work in Electricity", 2002, John Wiley Inc.

EE 6139 ILLUMINATION ENGINEERING Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. analyze different radiation techniques and the laws of thermal radiation.
CO2. study and realize the colorimetric and photometry techniques.
CO3. study the characteristics and application different types of lamps.
CO4. acquire knowledge of the basic concepts of lighting design and maintenance of lighting system

Pre-requisites: Basic Electrical Engineering (EE 1003) and Physics (PH 1003)

Introduction:

Light and electromagnetic radiation, Sources of light, Thermal radiator, Blackbody radiator, Laws of thermal radiation, Daylight and artificial light, Spectral power distribution (SPD) of light sources.

Visual system:

Structure, External factors of vision, Continuous adjustment- photopic, scotopic and mesopic capabilities, Perception, CIE standard observer, Glare- discomfort and disability glare.

Colorimetric:

Dichromatic vision, RGB colour specification system, CIE 1931 XYZ colour specification system, Source colour and object colour specification, CIE standard illuminant, Radiometric and photometric quantities, Relation between Lumen and Watt, Photometric standards.

Photometry:

Measurement of luminous flux, Illuminance, Luminance, Luminous intensity distribution, Computation of lumen output from luminous intensity distribution of a source, Computation of CCT and CRI from CIE 1931 chromaticity diagram.

Different Types of Lamps :
Its characteristics and Applications, Luminaire- its function and classification, Lamp and luminaire specifications.

Basic Concepts of Lighting Design :
Design objectives, Design parameters, Qualitative and quantitative evaluation of lighting systems, Energy management in illumination, Energy efficient illuminating system components, Energy oriented new and retrofit installations, Power Quality, Demand side management (DSM).

Maintenance of Lighting System :
Indoor and outdoor, Maintenance schedule, scheme, Relamping-spot and group, Equipment and materials used for maintenance job, General guidelines on disposal of burnt out lamps

Text Book

1. Energy Management in Illumination Systems – Kao Chen,CRC Press,2009.
2. Lamps and Lighting – Edited by J.R.Coaton and A.M.Marsden, 2010.

Reference Book

1. Lighting for energy efficient luminous environments- Ronald N.Helms& M Clay Belcher. Prentice Hall,2012.
2. Fundamentals of Illumination Engineering – V.V.Meshkov , Mir Publication, Russia, 2008.
3. The Scientific Basis of Illuminating Engineering – P.Moon Dover Publications, 2008.

EE 6336 SMART GRID Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. understand Smart Grid Architecture
CO2. analyze different optimization techniques
CO3. control smart grid system

Pre-requisite: Power System Operation and Control (EE 3002)

Introduction to Smart Grid:
Definition of smart grid.

Smart Grid Architecture:
Components and architecture of smart grid design, Review of the proposed architectures for smart grid. The fundamental components of smart grid designs, Transmission automation, Distribution automation, Renewable integration.

Tools and Techniques for Smart Grid:
Computational techniques, Static and dynamic optimization techniques, Computational intelligence techniques, Evolutionary algorithms, Artificial intelligence techniques.

Distribution Generation Technologies:
Technologies, Electric vehicles and plugged – in hybrid vehicles, Environmental impact and climate change, Economic issues.

Communication Technologies and Smart Grid:
Introduction to communication technology, Synchro Phasor Measurement Units (PMUs)

Control of Smart Power Grid System:
Load Frequency Control (LFC) in micro grid system, Voltage control in micro grid system, Reactive power control in smart grid, Case studies and test beds for the smart grids.

Text Book

1. Stuart Borlase, "Smart Grids, Infrastructure, Technology and Solutions", CRC Press, 2013.
2. A. G. Phadke and J. S. Thorp, “Synchronized Phasor Measurements and their Applications”, Springer Edition, 2010.

Reference Book

1. Gil Masters, "Renewable and Efficient Electric Power System", Wiley–IEEE Press, 2004.
2. T. Ackermann, "Wind Power in Power Systems", Hoboken, NJ, USA, John Wiley, 2005.
3. Clark W Gellings P.E. "The Smart Grid enabling energy efficiency and demand response", CRC Press, 2013.

ELECTRONICS & TELECOMMUNICATION ENGINEERING

Program Educational Objectives (PEOs)

The Program Educational Objectives (PEOs) of the B.Tech Program in Electronics & Telecommunication Engineering are as follows :

PEO-I. To lead a successful career in industry or pursue higher studies or entrepreneurial endeavours.

PEO-II. To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.

PEO-III. To demonstrate effective communication skill, professional attitude and a desire to learn.

Program Outcomes (POs)

The Program Outcomes of the B.Tech Program in Electronics & Telecommunication Engineering are:

a) Ability to apply knowledge of mathematics, science and engineering to solve complex problems.

b) Ability to identify, formulate and solve electronics and communication engineering related problems using first principles.

c) Ability to design, implement and evaluate electronics and communications systems to meet the societal and environmental needs.

d) Ability to design and conduct complex experiments and interpret data.

e) Ability to use techniques, skills and modern engineering necessary for engineering practices.

f) Ability to assess the impact of contemporary social issues on professional practice.

g) Ability to recognize the sustainability and environmental impact of the engineering solutions.

h) Ability to follow prescribed norms, responsibilities and ethics in engineering practices.

i) Ability to work effectively as an individual and in a team.

j) Ability to communicate effectively through oral, written and pictorial means with engineering community and the society at large.

k) Ability to recognize the need for and to engage in life-long learning.

l) Ability to understand and apply engineering and management principles in executing projects.

EC 1001 **BASIC ELECTRONICS** **Cr-3**

Course Outcome: At the end of the course, the students will be able to :

CO1. differentiate between conductors, insulators and different types of semiconductormaterials.
CO2. identify different types of diodes, transistor configurations, FETs and poweramplifiers; analyze simple electronic circuits using diodes and BJTs.
CO3. identify different types of feedback and condition for oscillation.
CO4. analyze simple electronic circuits with op-amp using either inverting or noninverting configurations.
CO5. identify different types of digital gates, flip-flops and analyze and build registersand asynchronous counters using gates and flip-flops.
CO6. identify different components of a CRO and Signal Generator.

Prerequisite: NIL

Semiconductors: Energy band concept of materials, difference between metal, insulator and semiconductor, Intrinsic and extrinsic semiconductors (n-type & p-type), current conduction in semiconductor, Photodiode, photo-transistor, LED and seven-segment display.

Junction Diodes: Operation of p-n junction diode, diode characteristics, half-wave, full-wave and bridge rectifiers, rectifiers with C, LC and LC π filter, clipper and clamper circuits, breakdown mechanisms, Zener diode and voltage regulator.

Bipolar Junction Transistor (BJT): Transistor operation and current components in p-n-p and n-p-n transistors, CE, CB, CC configurations and characteristics, biasing, load line analysis.

Field Effect Transistors (FET): Operations of p-channel and n-channel JFETs, characteristics of JFET, operation of MOSFET and its characteristics.

Power Amplifiers: Class A, B, C and push-pull amplifiers.

Feedback Concept: General feedback structure, properties and advantages of negative feedback, Barkhausen criteria for oscillation.

Operational Amplifiers (OPAMP): Ideal OPAMP, CMRR, virtual ground, Inverting and non-inverting OPAMPs, summing amplifiers, Differential amplifier, integrator & differentiator.

Digital Electronics: Number systems, conversions and codes, Logic gates & Truth tables (OR, AND, NAND, EX-OR), flip-flops (RS flip-flop, D flip-flop, JK flip-flop and MS flip-flop). Shift register, Asynchronous (ripple) counter.

Electronic Instruments: Operation of CRO and its applications, Signal Generator.

Text Book

1. Electronic Devices and Circuits – D. A. Bell - 5th Edition (Oxford)
2. Electronics –Fundamentals & Applications –D. Chattopadhyay and P. C. Rakshit – 11th Edition (New Age International)

Reference Book

1. Electronic Devices & Circuits – R. L. Boylestad & L. Mashelsky – 10th Edition (Pearson)
2. Electronic Principles – A. Malvino & D. J. Bates – 7th Edition (TMH)
3. Digital Principles and Applications– A. Malvino and Leach – 7th Edition (TMH)
4. Integrated Electronics – J. Millman, Halkias & Parikh – 2nd Edition (TMH)

EC 2001 ANALOG ELECTRONIC CIRCUITS – I Cr–4

Course Outcome: At the end of the course, the students will be able to :

CO1. design biasing circuits using BJTs and FETs and analyze their stability.
CO2. analyze amplifier circuits using BJTs and FETs with help of their small signal model.
CO3. analyze and determine the bandwidth of different video amplifiers using frequency response method and step response method.
CO4. design and analyze compound circuit configurations used in operational amplifiers with BJTS and FETS.
CO5. differentiate between different negative feedback and sinusoidal oscillators.
CO6. analyze different types of power amplifier circuits using BJTs.

Prerequisite: Basic Electronics (EC 1001)

Transistor Biasing Circuits: Different types of biasing circuits for BJT & FET, Stability factors & Bias compensation.

Small Signal Analysis of BJT: The transistor model-hybrid model, Graphical determination of h-parameters. Low frequency small signal analysis of CE, CC and CB configurations without feedback, Simplified CE & CC hybrid model, CE amplifier with an emitter Resistance.

Small Signal Modeling and Analysis of FETs: Signal Model of JFET, Analysis of JFET CS & CD configuration, Analysis of Enhancement and Depletion MOSFET amplifiers, small signal low frequency model of MOSFET, mid-frequency and low frequency analysis of CS, CG and CD amplifiers.

BJT and JFET Frequency Response: Classification of Amplifiers, Distortion in amplifiers, Frequency response of an amplifier, Lower Cut Off frequency and higher Cut Off frequency of an amplifier, Step response of an amplifier, Band pass of cascade stages, Low frequency response of RC coupled BJT and FET amplifier, High frequency modeling and analysis of BJT and FET amplifiers, Miller effect capacitance.

Compound Configurations: Differential amplifier, Differential amplifier circuit configurations, DC Analysis, AC Analysis, Constant current bias, current mirror, level translator, Cascade, Cascode and Darlington connections.

Feedback and Oscillator Circuits: Feedback concept, Feedback amplifier topologies, General characteristics of negative feedback amplifier, input and output resistance with negative feedback, Method of analysis of feedback amplifiers with practical examples, Positive feedback, Barkhausen Criterion of Oscillation, Sinusoidal Oscillator, LC Oscillators, RC phase shift oscillator, Crystal Oscillator.

Power Amplifiers: Definition of class A, B and C power amplifiers, Distortion analysis, Series fed and transformer coupled power amplifier, Push-pull amplifiers, Conversion efficiency

Text Book

1. Integrated Electronics- Analog and Digital Circuits and Systems – J. Millman & Halkias, C.D. Parikh- 2nd/ 2013 (10th Reprint)– Mc-Graw Hill India

Reference Book

1. Electronics Devices and Circuit Theory – Robert L. Boylestad and Lewis Nashelsky – PHI (9th Edition)

EC 2003 SIGNALS AND SYTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. differentiate between various types of signals and operate on signals.
CO2. classify various types of systems and differentiate between convolution, de-convolution and correlation of arbitrary signals.
CO3. analyze LTI systems and signals using Laplace transforms and Fourier transforms.
CO4. differentiate between Laplace transforms and Fourier transforms.
CO5. define and classify analog filters and find the frequency plots of various filters.
CO6. differentiate between Z-transforms and Fourier transforms.

Prerequisite: Mathematics-II (MA 1002)

Signals: Introduction, Classification, Signals and vectors analogy, Concept of Vector space and Orthogonality, Sampling and reconstruction of band limited signals, Representation of analog and discrete time signals in terms of impulses, Representation of discrete time signals and Basic operation on signals.

Sequences: Classification based on length, symmetric, periodicity, energy power, special sequences, arithmetic operations on sequences.

Systems: Introduction, Classification, LTI systems, Linear Convolution, Causality and stability of LTI systems, Representation of causal LTI systems, Order of systems, IIR and FIR systems, Correlation.

Fourier Analysis: Significance of Fourier series in LTI systems, Continuous time Fourier series formula and derivation, Dirichlet conditions & properties, Approximation of Fourier series to Fourier transform for aperiodic signals, Properties, examples ,amplitude and power spectra, Analysis of LTI systems using Fourier Transform.

Laplace Transform: Introduction, Properties with examples, Relationship between Fourier and Laplace transform, Pole-Zero plot, Analysis of LTI systems, Transfer function.

Z-transform: Introduction, Definition, ROC of the Z – Transform, System Transfer Function, Poles and zeros, Properties of Z – Transform, Inverse Z – Transform, Solution of difference equations using one sided Z – Transform, Response of pole-zero systems with Non-Zero initial conditions, Causality and stability of LTI systems in the Z-domain.

Text Book

1. Signals & Systems – Alan V Oppeinhem, Alan S Willsky– 2nd/ 2011–PHI

Reference Book

1. Signals & Systems – P. Ramesh Babu –Scitec,4th Edition.

EC 2004 PRINCIPLE OF DIGITAL COMMUNICATION Cr-4

Course Outcome: At the end of the course, the students will be able to :

CO1. characterize signals in time and apply Fourier Transform for signals.
CO2. differentiate between different Analog Modulation Schemes analytically as well as graphically.
CO3. analyze different Analog to Digital Conversation techniques and multiplexing techniques like TDM and FDM.
CO4. analyze the working principles of Digital Modulation Techniques & Data Transmission.
CO5. differentiate between different channel coding techniques.

Prerequisite: Mathematics-II (MA 1002)

Signal:
Signals in time domain, Fourier transform, Periodic and non periodic signal Analysis, spectral density.

Analog Modulation:
Types of analog modulation, Need for modulation, principles of AM, Types of AM (DSB, SSB, VSB), power relationship, principle of FM & PM, Types of FM, spectrum of FM, Bandwidth of FM (Carson's rule).

Pulse Modulation:
Sampling Theorem, PAM, PWM, PPM, TDM, FDM.

PCM & Delta Modulation:
Quantization process, PCM, Noise consideration in PCM system, Delta and Adaptive Delta modulation.

Digital Modulation Techniques & Data Transmission:
ASK, FSK, PSK, DPSK, QPSK, probability of error, BER calculation, matched filter, relationship between Bit error rate and symbol error rate, comparison of modulation system, Data Communication systems, parity, Asynchronous and Synchronous transmission, low speed, medium speed and high speed modems.

Basic Information theory:
Information and Entropy, Binary symmetric channel and Binary error channel, Shannon's channel capacity theorem, capacity of Gaussian channel, Basics of source and channel coding (Huffman, Cyclic codes).

Text Book

1. Communication Systems – Simon Haykin, 4th Edition, John Wiley

Reference Book

1. Principle of Communication System – H. Taub & D. Schlling, TMH, 3rd Edition.
2. Data & Computer Communication – W. Stallings, Pearson, 9th Edition.

EC 2005 SEMICONDUCTOR DEVICES Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. differentiate the conduction techniques in semi-conductor materials.
CO2. analyze characteristics of Semi-conductor diodes and solve problems.
CO3. analyze characteristics of Bi-polar Transistors and solve problems.
CO4. analyze characteristics of MOS Transistors and solve problems.
CO5. differentiate between different Opto-electronic devices.

Prerequisite: Basic Electronics (EC 1001)

Energy bands & Current Carriers in Semiconductors: Bonding Forces in Solids, Energy Bands theory in crystals (Qualitative Analysis), Metals, Semiconductors, & Insulators, Fermi-Level, Intrinsic and Extrinsic Semiconductors, Concept of Holes, Carrier Concentration. and Mobility, diffusion and drift of carriers, continuity equation, Injected minority carrier charge, Recombination and generation of charge carriers.

P- N Junction: Physical Description of p-n junction, Basic device technologies for fabrication of a p-n junction current flow at a junction, homojunction and heterojunctions, equilibrium band diagram, charge, field and potential profiles in p-n junctions, depletion region, biased P-N junctions, diode equation and diode characteristics, equivalent circuit, temperature dependence, Capacitance of p-n junction diode (transition & storage), junction Breakdown (Avalanche & Zener), Step and linearly graded junction, diode switching characteristics, Metal – Semiconductor junction (Schottky barrier, Ohio contact and rectifying contact).

BJT: Junction transistors, Charge transport in BJT, base narrowing (Early effect), Avalanche breakdown & Punch Through, transistor switching, Coupled-Diode model, Ebers-Moll equations.

MOSFET: MOS structure, Basic operation of Enhancement & Depletion mode MOSFET, MOS capacitance (Operation with band diagram, threshold voltage & Characteristics), CCD and applications.

Opto–Electronics: Optical absorption in semiconductors, photovoltaic effects, solar cells (p-n junction), Photoconductors, Photodiode, PIN photodiode, Avalanche photodiode, Phototransistor, LED, Semiconductor Laser (p-n junction)

Text Book

1. Solid State Electronic Devices by Streetman & Banerjee, 6^{TH} Edition/2013, PHI.

Reference Book

1. Semiconductor Devices: Basic Principles by Jasprit Singh, John Wiley & Sons, 2000.
2. Integrated Electronics: Analog and Digital Circuits and Systems by Jacob Millman, Christos Halkias, ChetanParikh , Second Edition, TMH 2010.
3. Semiconductor Physics and Devices: Donald Neaman and Drubesh Biswas, TMH,4^{TH} Edition, 2012
4. Semiconductor Physics: Device & Technology: S. M. Sze& M-K Lee, John Wiley & Sons, 2012

EC 2008 MEASUREMENTS & INSTRUMENTATION Cr–4

Course Outcome: At the end of the course, the students will be able to :

CO1. estimate the error and interpret the instrument datasheet.
CO2. derive the balance equations to analyze the unknown electrical quantities.
CO3. select the appropriate instrument for measuring A.C & D.C currents and voltages.
CO4. select the appropriate sensor to measure physical parameters.
CO5. differentiate between digital measuring instruments, function generators, spectrum analyzers and analytical instruments.

Prerequisites: Basic Electrical Engineering (EE 1003) and Network Theory (EE 2007)

Measurement & Error: Calibration of Instruments, Accuracy, Precision & Resolution, Types of Errors, Statistical analysis, Probability of error, Limiting error.

A.C. & D.C. bridges: General equation for bridge balance, DC bridges: Wheatstone bridge, Kelvin's double bridge; General form of AC bridge; Maxwell's inductance-capacitance bridge, Anderson's bridge, Schering bridge, Wien's bridge; Sources of error in bridge measurement, Wagner's earthing device.

Electrical measuring instruments: Classification of instruments, Overview of PMMC, Moving iron, Dynamometer type instruments, Overview of Ammeter, Voltmeter, Multimeter, True RMS voltmeter, Potentiometer, Current transformer, Potential transformer, Strip chart recorders.

Transducers: Strain Gauges, LVDT, Thermistor & Thermocouples, Piezo – electric transducer and Bourdon tube.

Electronic measuring instruments & CRO: Q-meter, Digital Voltmeter, Digital frequency meter, CRO: construction, Time base circuit, measurements with CRO, CRO probes.

Signal generator & waveform analyzing instruments: Function generator: Square, triangular & sinusoidal waveform generator & Spectrum analyzer.

Analysis instruments: Principle of operation of pH meter, Liquid chromatograph, Spectrophotometer

Text Book

1. Electrical and Electronic Measurements & Instrumentation By A.K. Sawhney – Dhanpat Rai,2013.
2. Electronic Measurement & Instrumentation By H. Cooper – PHI, 2nd Edition.

Reference Book

1. Electronics Instruments & Measurement by David A. Bell –Oxford, 3rd Edition.

EC 2010 ANALOG ELECTRONIC CIRCUITS – II Cr–3

Course Outcome: At the end of the course, the students will be able to :

- CO1. analyze the response of different linear wave shaping circuits and attenuators.
- CO2. determine the different DC and AC parameters of op amp; identify type of feedback and analyze its stability.
- CO3. analyze different circuits using op-amps. (closed loop: negative and positive feedback or open loop)
- CO4. design and analyze multi vibrator with its different applications using IC 555 timer.
- CO5. analyze the performance of negative resistance devices.

Prerequisite: Analog Electronic Circuits-I (EC 2001)

Op-amps and its Parameters: Block diagram representation, Analysis of equivalent circuit, Types of IC Op-amp, Power Supply for IC Op-amp, Input offset voltage, Input Bias current, Input offset current, total output offset voltage, Thermal drift, PSRR, Common mode configuration and CMRR, Noise in Op-amp, Slew rate.

Op-amp with Negative Feedback: Op-amp circuits using negative feedback (voltage series, voltage shunt feedback), Differential amplifiers.

Frequency Response of an Op-amp : Frequency response, Compensating Networks, Frequency response of compensated and non-compensated Op-amp, high frequency Op-amp equivalent circuit, open loop voltage gain as a function of frequency, Closed loop frequency response, Circuit stability, high frequency effects of op-amp gain and phase.

Op-amp Applications: Linear and non-linear circuit operations of op-amps like adder, substractor, multiplier circuits, SPICE analysis of op-amp circuits, instrumentation amplifiers, Voltage to current converter and vice versa, Integrator, Differentiator, first and second order active filter, triggerable and non-trigerrable multivibrator, triangular and sinusoidal wave generator, Precision rectifier, Peak detector, Phase shift oscillator, Wien bridge oscillator, voltage to frequency converter, comparator : Zero crossing detector & Schmitt Trigger, Sample and Hold circuit, the 555 timer as Monostable and Astable mode, PLL and its applications, IC voltage regulators.

Linear Wave Shaping Circuits: High pass and low pass circuit, Response of RC circuit to various inputs such as sinusoidal, step, pulse, square wave, exponential and ramp. High pass RC circuit as a differentiator. Low pass RC circuit as an integrator, Attenuator and its application.

Negative Resistance Devices: Tunnel diode & UJT, their V – I characteristics and performance analysis.

Text Book

1. Op-amp & LIC – R. K. Gayakwad – PHI,4th Edition.
2. Pulse, Digital and Switching waveforms –J. Millman & H. Taub – TMH, 3rd Edition.

Reference Book

1. Linear Integrated Circuits – D. Ray Choudhury & Shail Jain (New Age), 4th Edition.
2. Pulse Digital Circuit – Anand Kumar - PHI , 3rd Edition.

EC 2011 DIGITAL ELECTRONICS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. simplify and realize Boolean expression.
CO2. design combinational circuits and various asynchronous & synchronous sequential circuits using FLIP-FLOPs.
CO3. design & implement Mealy and Moore model FSM for different synchronous sequential circuits.
CO4. differentiate between different logic families and analyze TTL & CMOS chips.
CO5. differentiate between different types of D/A and A/D converters.

Prerequisite: Basic Electronics (EC 1001)

Introduction to Boolean Algebra: Signed binary number, Binary arithmetic, Codes—BCD, Gray, Excess-3, Error detection & Correcting code-Hamming code, Universal gates, Boolean Algebra, Basic theorems & properties of Boolean Algebra, De-Morgan's theorem, Minterms & Maxterms, K-map representation, simplification and realization with logic gates.

Combinational Circuits: Adders (Half and Full adders, parallel binary adders, look ahead carry adder generator), Subtractors (Half and Full Subtractors, 4-bit Adder/Subtractor), Magnitude comparator, decoders (3 to 8, BCD to Decimal decoder, BCD to SSD) and Encoders, Priority Encoder, Multiplexer and Multiplexer-tree, De-multiplexer.

Sequential Logic: Shift Register (SISO, SIPO, PIPO, PISO, Bidirectional), Counter (Ripple and Synchronous), Ring and Johnson Counters.

Finite State Machine (FSM): Model of Finite State Machine---State diagram, Mealy and Moore models, Logic diagrams, State table, State reduction, State assignment, Excitation table. Realization of memory elements (S-R, J-K, T, Master-Slave), State diagram, state table, Excitation table, Synthesis of Synchronous sequential circuits (Sequence detector)

Logic Families: Transistor as a switch, Characteristics (Propagation delay, Speed-power product, Noise margin, Fan-in, Fan-out), Standard logic families (TTL, ECL, CMOS), Digital ICs TTL (74 Series) and CMOS (4000 Series).

D/A and A/D: Digital to Analog converter (Binary weighted resistor network & R-2R ladder network), Analog to Digital converter (Flash type, Counter type & Successive approximation type).

Text Book

1. Fundamentals of Digital Logic – Anand Kumar - PHI, 2nd Edition, 2011
2. Digital Logic and Computer Design – M. Morris Mano – PHI,2011

Reference Book

1. Digital Principles and Applications – Malvino & Leach –TMH, 7th edition, 2011
2. Digital Fundamentals – T. L. Floyd & Jain – Pearson Education, 10th edition, 2011

EC 2012 ANALOG COMMUNICATION TECHNIQUES Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze amplitude modulation and demodulation techniques with applications.
CO2. differentiate between FM and PM techniques with methods of generation and detection.
CO3. analyze super heterodyning, AM Receiver and FM receiver.
CO4. analyze sampling theory and pulse modulation techniques.
CO5. differentiate between types of noise in communication systems.
CO6. analyze the noise performance of different types of AM and FM systems.

Prerequisite: Signals and Systems (EC 2003)

Introduction: Introduction to communication system, dB, dBm, Concept of bandwidth, spectral efficiency, Hilbert Transform, Pre-envelope, base-band and band-pass signals

Amplitude Modulation and Demodulation: AM DSB , DSB-SC, SSB,Modified SSB,Calculation of transmitted power, Efficiency, SSB-SC, VSB, method of recovery of the base signal, Square law demodulator, Envelop detector,Superheterodyne AM receiver, FDM

Angle Modulation and Demodulation: Phase and frequency modulation, Relationship between PM & FM, Threshold in FM**,** Phase and frequency deviation, Spectrum of an FM signal, Some features of Bessel's coefficient, Effect of modulation index on Bandwidth, Phasor diagram for FM signals, FM generation, parameter variation method, Armstrong system for NBFM, Frequency multiplier. An example of an Armstrong FM system, FM Demodulators, FM detection using PLL, Pre-emphasis and De-emphasis ,FM Radio receiver.

Pulse Modulation and Demodulation : Sampling theorem (low pass and Band pass signals), Natural sampling, Flat – top sampling, signal recovery through holding, Pulse Amplitude modulation, Channel bandwidth for PAM signal, TDM, PWM, PPM.

Noise in Communication Systems: Sources of noise, Types of Noise, Frequency domain representation of noise, Effect of filters on the PSD of noise, SNR of DSB/FC, DSB/SC, SSB/SC system, Comparison of AM, SSB, DSB, VSB modulation schemes. Calculation of output SNR of FM system, Comparison between FM and PM,

Text Book

1. Communication Systems – Simon Haykin, John Wiley,4th edition,2011.
2. Modern Digital and Analog Communications Systems **-** B.**P.** Lathi & Z.Ding - Hardcover, Oxford Univ Pr,4th edition,2011

Reference Book

1. Principles of Communication System – H. Taub & D.L.Schilling – TMH,3rd edition,2011

EC 2013 ANALOG ELECTRONICS Cr-4

Course Outcome: At the end of the course, the students will be able to :

CO1. differentiate between different biasing for BJTs and FETs and analyze their stability.
CO2. analyze amplifier circuits using BJTs and FETs with help of their small signal model.
CO3. analyze compound circuit configurations with BJTs and FETs.
CO4. design electronic circuits using BJTs or FETs for different negative feedback topologies depending on applications.
CO5. analyze different types of Power amplifier, Differential amplifier and Current mirror circuits.
CO6. analyze Operational amplifiers and its applications including 555 timer.

Prerequisite: Basic Electronics (EC 1001)

Bipolar junction transistor and its circuits: Review of transistor, Biasing of BJT, Concept of stability and compensation of biasing circuits, Simplified small signal hybrid modeling of BJT, Analysis of transistor amplifiers (CB, CE and CC) using BJT simplified small signal model, Applications of Miller's theorem.

Field effect transistor and its circuits: Review of FET (JFET & MOSFET), Biasing of FET (JFET & MOSFET), Small signal modeling of FET, Analysis of CS and CD amplifiers using FET small signal model, MOS as switch and CMOS as inverter.

Feedback Amplifier and Oscillator Circuits: Types of amplifiers and their equivalent circuits, Feedback concept, Feedback amplifier topologies, General characteristics of negative feedback amplifier, input and output resistance with negative feedback, Method of analysis of feedback amplifiers with practical examples, Frequency response of amplifiers with and without feedback, Positive feedback, Barkhausen criterion, RC and LC phase shift oscillators, Crystal Oscillator.

Power amplifiers: Definition of class A, B and C power amplifiers, Distortion analysis, Series fed and transformer coupled power amplifier, Push-pull amplifiers, Conversion efficiency.

Differential amplifier and current mirror circuits: Differential amplifiers under balanced and unbalanced conditions, differential and common mode gain, Constant current bias, Current mirror, Level Translator.

Operational amplifiers: Op Amp and its block diagram, Characteristics of ideal and non-ideal op amp, Equivalent circuit for op amp, AC and DC parameters, Inverting and non-inverting op amp with and without feedback, Basic and practical differentiator circuit, Basic and practical integrator circuit, Instrumentation amplifier and its applications, V-I converter and vice versa with its applications, Op amp as comparator, zero crossing detector and Schmitt trigger, Triangular and rectangular wave generator using op amp, 555 timer and its application.

Text Book

1. Integrated Electronics- Analog and Digital Circuits and Systems – J. Millman & Halkias, C.D. Parikh- 2nd/ 2013 (10th Reprint)– Mc-Graw Hill India.
2. Op-Amps and LIC- Ramakant A. Gayakward -4th Edition- Pearson.

Reference Book

1. Microelectronics circuits- A. S. Sedra and K. C. Smith- 5th Edition, 2011 - Oxford University Press.
2. Linear Integrated Circuits- D. Roy Choudhury and Shail B. Jain- 4th Edition- New Age International Publishers.

EC 2014 ELECTROMAGNETIC THEORY Cr-3

Course Outcome: At the end of the course, the students will be able to :

- CO1. identify the appropriate coordinate system for a particular vector based problem, and the laws of vector calculus.
- CO2. solve numerical problems involving static charges and constant currents.
- CO3. analyze and differentiate between Maxwell's equations for electromagnetism.
- CO4. analyze wave behavior during its propagation through multiple media in presence of different boundary conditions.
- CO5. differentiate between transmission lines and waveguides
- CO6. design transmission line sections or waveguides (length and other dimensions) along with feeding mechanism for realizing impedance matched conditions.

Prerequisite: Mathematics-II (MA 1002)

Static Electric and Static Magnetic Fields: Orthogonal Co-ordinate systems, statements of Coulomb's and Gauss's laws, boundary conditions for electrostatic fields, electrostatic energy density, Poisson's and Laplace's equations, Statement of Ampere's circuital law, Lorentz's force equation, vector magnetic potential, Biot-Savart law and applications, Boundary conditions for magentostatic fields.

Time Varying Fields and Maxwell's Equations: Faraday's law, Maxwell's Equations in point form and integral form, displacement current, electromagnetic boundary conditions, interface between a dielectric and a perfect conductor, wave equations and their solutions, source-free wave equations, Helmholtz's wave equation in free space, principle of duality.

Plane Electromagnetic Waves: Plane waves in lossless media, polarization of plane waves, plane waves in lossy media, low-loss dielectrics, skin depth, group and phase velocities, flow of electromagnetic power and Poynting vector, normal and oblique incidences of electromagnetic waves (parallel & perpendicular polarized) at plane perfect conducting and dielectric boundaries, Brewster's angle.

Theory and Applications of Transmission Lines: General transmission-line equations, wave characteristics on an infinite transmission line, transmission line parameters, attenuation constant from power relations, wave characteristics of finite transmission lines, transmission lines as circuit elements, transmission lines with resistive termination and arbitrary termination, transmission line circuits, transients on transmission lines, voltage reflection and current reflection diagrams, *S*mith chart, quarter wave transformer, single stub and double stub matching.

Text Book

1. Elements of Electromagnetics (Fourth Edition) by Matthew N.O Sadiku, Oxford University Press, 2009.
2. Field and Wave Electromagnetics (Second Edition) By David K. Cheng, Pearson Education, 1989

Reference Book

1. Engineering Electromagnetics (Seventh Edition) by William H. Hayt, Jr and John A. Buck, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.
2. Electromagnetic Waves and Radiating Systems by Edward C. Jordan and Keith G. Balmain, Prentice Hall of India, New Delhi, 2^{nd} Edition.

EC 2015 ANALOG CIRCUITS Cr-3

Course Outcome: At the end of the course, the students will be able to:

- CO1. design biasing circuits using BJTs and analyze their stability.
- CO2. analyze amplifier circuits using BJTs with help of their small signal model.
- CO3. design and analyze compound circuit configurations with BJTS used in operational amplifiers.

CO4. design electronic circuits for different negative feedback and sinusoidal oscillators depending on applications using BJTs or MOSFETs.
CO5. design and analyze different types of power amplifier circuits using BJTs.
CO6. design Differential amplifier and Operational Amplifiers.

Prerequisite: Basic Electronics (EC 1001)

Bipolar junction transistor and its circuits: Review of transistor theory, transistor characteristics. early effect and punch through,Baising of BJT(Fixed, collector to base, emitter baising),stability & compensation of baising circuit (Qualitative only), Analysis of transistor amplifier(CB,CC,CE) using BJT small signal model.

MOS Device & Circuit: MOS structure & characteristics, MOS as switch CMOS as inverter, MOSFET biasing circuit(CS & CD),Analysis of MOSFET amplifier using small signal model.

Amplifier & feedback circuit: types of amplifier & their equivalent circuit (VA, CA, Transconductanc & Transresistance amplifier), Concept & types of feedback topology, Analysis of practical feedback amplifiers, frequency response of amplifier with & without feedback, Barkhausen criterion, RC & LC phase shift oscillator(qualitative description),output frequency of the oscillator.

Power amplifier: Class A,B,AB,C amplifier & their distortion.

Differential & Operational Amplifier: Differential & common mode gain, Characteristics of ideal & non ideal OP-AMP, Equivalent circuit forOP-AMP, inverting non inverting OP-AMP, basic & practical differentiator & integrator circuit, OP-AMP as comparator, triangular & square wave generator using OP-AMP, Zero crossing detector, Schmitt trigger, 555 timer, voltage controlled oscillator.

Text Book

1. Integrated Electronics- Analog and Digital Circuits and Systems – J. Millman & Halkias, C.D. Parikh- 2nd/ 2013 (10th Reprint)– Mc-Graw Hill India.
2. Op-Amps and Linear Integrated Circuits - Ramakant A. Gayakward -4th Edition- Pearson.

Reference Book

1. Microelectronics circuits- A. S. Sedra and K. C. Smith- 5th Edition, 2011 - Oxford University Press.
2. Linear Integrated Circuits - D. Roy Choudhury and Shail B. Jain- 4th Edition- New Age International Publishers.

EC 2016 COMMUNICATION ENGINEERING Cr-4

Course Outcome: At the end of the course, the students will be able to :

CO1. determine the statistical behavior of signals and noise, and their modeling.
CO2. differentiate different analog modulation and digital modulation techniques.
CO3. analyze different AM and FM radio receivers.
CO4. analyze different Digital modulation techniques.
CO5. differentiate between different Modern Communication Systems: Satellite, Fiber and Mobile Communication.

Prerequisites: Signals and Systems (EC 2003) and Priniciple of Digital Signal Processing (EC 3013)

Introduction: Brief Idea of Probability, Random Variable, Random Process, Cumulative Distributive Function, Probability Distributive Function, Mean, Variance, Gaussian and Rayleigh PDF, White Noise, Colored Noise, Signal to Noise Ratio.

Signals: Signals in time domain, Fourier transform and Series, properties of FT and FS, Unit impulse and unit step function

Amplitude Modulation: Principle of AM, side bands, Power Relationship, Assignable Frequency spectrum, Sideband Transmission, DSB, SSB, VSB, Balanced Modulator.

AM Radio Receiver: Super heterodyne Principle, Block Diagram, Typical features, Front end output S/N, Sensitivity, Selectivity, Fidelity.

Angle Modulation: Principle of FM,Frequency Deviation, Spectrum of FM wave, Power in Modulated wave, Narrow band FM, Pre-emphasis, De-emphasis, Block Diagram of FM Transmitter, Reactance modulator, Typical Characteristic features.

FM Radio Receiver: Block Diagram of FM Receiver, Noise in RF Amplifier, FM Detector: Slope Detector, Discriminator, Phase-locked loop, Selectivity, sensitivity of FM Receiver.

Pulse Modulation and Demodulation: Sampling Process, Pulse Amplitude Modulation, Time Division Multiplexing, Frequency Division Multiplexing, The Quantization Process, Pulse Code Modulation, Noise consideration in PCM systems.

Digital Modulation: Data Form, Principles involved in ASK, PSK (BPSK, QPSK, π/4 QPSK), FSK.

Modern Communication Systems: Introduction to Modems, Block diagram Description of satellite communication, Fiber optic communication and Mobile communication.

Text Book

1. Introduction to Analog & Digital Communication System – Simon Haykins, Wiley Student edition 2011 – John Wiley.

2. Modern Digital and Analog Communications Systems -B.P. Lathi - Hardcover, Oxford Univ Press, 4th Edition.

Reference Book

1. Principles of Communication System – H. Taub& D.L.Schilling – TMH, 3rd Edition.

EC 2017 ELECTRONICS DEVICES AND CIRCUITS Cr-4

Course Outcome: At the end of the course, the students will be able to :

- CO1. **d**ifferentiate between different biasing for BJTs and FETs and analyze their stability.
- CO2. analyze amplifier circuits using BJTs and FETs with help of their small signal model.
- CO3. analyze compound circuit configurations with BJTs and FETs.
- CO4. design electronic circuits using BJTs or FETs for different negative feedback topologies depending on applications.
- CO5. analyze different types of Power amplifier, Differential amplifier and Current mirror circuits.
- CO6. analyze Operational amplifiers and its applications including 555 timer.

Prerequisite: Basic Electronics (EC 1001)

Bipolar junction transistor and its circuits: Review of transistor, Biasing of BJT, Concept of stability and compensation of biasing circuits, Simplified small signal hybrid modeling of BJT, Analysis of transistor amplifiers (CB, CE and CC) using BJT simplified small signal model, Applications of Miller's theorem.

Field effect transistor and its circuits: Review of FET (JFET & MOSFET), Biasing of FET (JFET & MOSFET), Small signal modeling of FET, Analysis of CS and CD amplifiers using FET small signal model, MOS as switch and CMOS as inverter, Basic steps for fabrication of BJT and MOSFET.

Feedback Amplifier and Oscillator Circuits: Types of amplifiers and their equivalent circuits, Feedback concept, Feedback amplifier topologies, General characteristics of negative feedback amplifier, input and output resistance with negative feedback, Method of analysis of feedback amplifiers with practical examples, Frequency response of amplifiers with and without feedback, Positive feedback, Barkhausen criterion, RC and LC phase shift oscillators, Crystal Oscillator.

Power amplifiers: Definition of class A, B and C power amplifiers, Distortion analysis, Series fed and transformer coupled power amplifier, Push-pull amplifiers, Conversion efficiency.

Differential amplifier and current mirror circuits: Differential amplifiers under balanced and unbalanced conditions, differential and common mode gain, Constant current bias, Current mirror, Level Translator.

Operational amplifiers: Op Amp and its block diagram, Characteristics of ideal and non-ideal op amp, Equivalent circuit for op amp, AC and DC parameters, Inverting and non-inverting op amp with and without feedback, Basic and practical differentiator circuit, Basic and practical integrator circuit, Instrumentation amplifier and its applications, V-I converter and vice versa with its applications, Op amp as comparator, zero crossing detector and Schmitt trigger, Triangular and rectangular wave generator using op amp, 555 timer and its application.

Text Book

1. Integrated Electronics- Analog and Digital Circuits and Systems – J. Millman & Halkias, C.D. Parikh- 2nd/ 2013 (10th Reprint)– Mc-Graw Hill India.
2. Op-Amps and LIC- Ramakant A. Gayakward -4th Edition- Pearson.

Reference Book

1. Microelectronics circuits- A. S. Sedra and K. C. Smith- 5th Edition, 2011 - Oxford University Press.
2. Linear Integrated Circuits- D. Roy Choudhury and Shail B. Jain- 4th Edition- New Age International Publishers.

EC 3003 MICROPROCESSORS & MICROCONTROLLERS Cr-4

Course Outcome: At the end of the course, the students will be able to :

CO1. acquire in-depth knowledge of the 8 bit and 16 bit Microprocessors (like 8085 and 8086) and 8 bit Microcontrollers (such as MCS – 8051) including the peripheral chips.

CO2. design a Microprocessor / Microcontroller based system for industrial or any other control applications.

Prerequisite: Digital Electronics (EC 2011)

8085 Microprocessor Architecture: Introduction, 8085 Architecture, Pins & signals.

Instruction Set Of 8085 And Software Development: Addressing Modes, Timing Diagrams, 8085 Instructions, Assembler Directives, Sample programs, Software development tools.

8085 Interrupts: Hardware Interrupts, Selective masking, Interrupt structure.

Memory Interfacing: Memory chips (27 series EPROM and RAM chips), Memory interfacing.

Interfacing Chips: Programmable peripheral Interface (8255), Priority Interrupt Controller (8259), Concepts of serial communication and USART (8251).

16 bit processor (intel 8086): Introduction, Architecture, Pins & Signals, Interrupts, Memory interfacing.

8051 Family Of Microcontrollers : Introduction, Overview of 8051 family, Architecture & Memory organization, Pins & signals, Addressing Modes, 8051 Instructions & sample programs, Timers, Counters and serial communication.

Text Book

1. Microprocessor architecture, Programming and Applications with the 8085 – Ramesh S. Goankar – Penram International Publishing (India) 6th edition,
2. Microprocessors and Interfacing, Programming & Hardware – Douglas V. Hall – TMH 3rd edition, 2012
3. Microcontroller Theory & Applications – Deshmukh – TMH, 2005

Reference Book

1. Introduction to microprocessors – A. P. Mathur – eTMH Publication – 3rd edition, 2011
2. Microprocessors & Microcomputer based System Design – Md. Rafiquzzaman, 2nd edition
3. Advanced Microprocessor & Microcontrollers – Prof. S. K. Venkat Rama - Laxmi Publications- 1st edition
4. 8051 Microcontroller - Hardware, Software & Applications – V Udayashankara&M Mallikarjunaswamy– TMH – 1st edition
5. The 8051 Microcontroller & Embedded Systems – M. A. Mazidi – Pearson – 2nd edition, 2011

EC 3005 DIGITAL COMMUNICATION TECHNIQUES Cr-4

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze random processes and probability distribution functions.
CO2. differentiate between PCM and DM technique.
CO3. analyze the noise performance of different waveform coding techniques.
CO4. analyze and differentiate between different digital modulation techniques.
CO5. analyze performance analysis of different modulation techniques.

Prerequisite: Analog Communication Techniques (EC 2012)

Introduction: Brief Idea of Probability, Random Variable, Random Process, Cumulative Distributive Function, Probability Density Function, Mean, Variance, Power spectral density, Gaussian, Rayleigh, Exponential and Poisson PDF.

PCM, Delta Modulation and Demodulation: Pulse Code Modulation, Electrical representation of Binary Digit, PCM system, companding, Multiplexing of PCM signals, Differential PCM, Delta Modulation, Adaptive Delta Modulation, Linear predictive coder, Comparison of PCM and DM, Delta Sigma modulation.

Noise in PCM and Delta – Modulation: Quantization noise, output signal power, output SNR in PCM, quantization noise in DM, output SNR in DM and DPCM.

Multiplexing: Introduction, frequency division multiplexing (FDM), time division multiplexing (TDM), Introduction to Code division multiplexing**.**

Digital Modulation and Demodulation Techniques: Band-pass transmission system, Gram-Schmidt orthogonalization, BPSK, DPSK (Differential Encoded PSK), QPSK, π/4 QPSK, OQPSK, M-ary PSK., BFSK, M-ary FSK, Minimum shift keying (MSK), GMSK, Comparison of BPSK, QPSK, π/4 QPSK, OQPSK, BFSK, GMSK,QAM. Comparison of modulation schemes in terms of probability of error and spectral efficiency .

Data Transmissions: Base-band Signal Receiver, Probability of Error, The Optimum Filter, White noise, the Matched filter, Probability of Error of Matched Filter, Coherent Reception: PSK, FSK, Non-coherent Detection of FSK, Differential PSK and QPSK, Error probability of BPSK, BFSK & QPSK, MSK & GMSK, QAM. Bit encoding, Symbol-by-symbol encoding, Relationship between bit error rate and symbol error rate.

Text Book

1. Principles of Communication Systems – H. Taub& D.L. Schilling, G.Saha – 4^{th} edition,2013- McGrawHill

Reference Book

1. Communication System – Simon Haykin, John Willey - 4^{th}edition,2011
2. Modern Analog & Digital Communication System – B.P.Lathi Oxford University Press- 4^{th} edition,2011

EC 3007 DIGITAL SIGNAL PROCESSING Cr-4

Course Outcome: At the end of the course, the students will be able to :

CO1. select appropriate transformation technique for signal analysis.
CO2. apply the knowledge of analog filters to digital filters, design a digital filter and physically realize any digital filter.
CO3. analyze multi-rate systems and filter banks.
CO4. apply the adaptive filters for system identification, channel equalization and noise cancellation.

Prerequisite: Signals and Systems (EC 2003)

Fourier Transforms: Brief idea about the DSP, Review of Fourier Transform and Z-transform**,** Discrete Time Fourier Transform, Conditions and properties of DTFT, Discrete Fourier Transform, Properties of DFT, Inverse Discrete Fourier Transform, Circular Convolution, Properties of Circular Convolution, Sectioned convolution, Fast Fourier Transform, Properties of FFT, Radix 2 Decimation in Time (DIT), Radix 2 Decimation in Frequency (DIF), Chirp-Z transform algorithm.

Digital filters: Introduction to Digital Filter, Design of IIR filters: Butterworth, Chebyshev and elliptic analog filter design, Conversion to digital IIR Filter using impulse invariance technique, Bilinear Transformation, and approximation of derivatives, Realization of Digital Filters, Direct form – I realization Direct form – II realization, Design of FIR Filter: Rectangular, Berlitt, Blackmann Hamming, Hanning and Kaiser window, Frequency Transformations in the Analog domain, Frequency Transformations in the Digital domain.

Multi-rate DSP: Introduction to multi-rate DSP, Decimation and interpolation, Polyphase decomposition, Uniform DFT filter banks, Quadrature mirror filters and perfect reconstruction, Introduction to finite register length effects on digital filter performance, Introduction to spectral density and spectral estimation.

Adaptive filters: Introduction to Adaptive Filters, Application of Adaptive Filters: System Identification or System Modeling, Adaptive Channel Equalization, Adaptive Line Enhancer, Adaptive Noise Cancelation.

Text Book

1. Digital Signal Processing – J. G. Proakis& D. G. Manolakes, 4th edition – PHI

2. Adaptive Signal Processing – B. Widrow& S. D. Sterns – Pearson, 2002.

Reference Book

1. Digital Signal Processing – Oppenheim & Schafer, PHI, 1st Edition.

2. Digital Signal Processing – P. Ramesh Babu, Scitech Publication,4th Edition.

EC 3011 VLSI DESIGN Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. select appropriate method to design using VLSI design flow and implementation using FPGA.
CO2. analyze basic working principle and process of manufacturing of a MOSFET.
CO3. depict the stick diagram of any circuit and produce its corresponding layout by using layout rules.
CO4. analyze the working of any analog and digital circuit using MOS.
CO5. apply circuit partitioning methods on given circuit.
CO6. design circuits using low power methods.

Prerequisite: Analog Electronics Circuit-I (EC 2001),Analog Electronics (EC 2013), Analog Circuits (EC 2015) and Digital Electronics (EC 2011)

VLSI Methodologies: Introduction to VLSI design, Moore's Law, VLSI Design flow, Design hierarchy, VLSI Design style: Full custom, Gate array, standard-cell, Macro cell based design, Field programmable devices, design quality.

MOSFET: Electrical characteristics of MOSFET, Threshold voltage, Body effect, current expression (gradual channel approximation method), Channel length modulation, MOSFET scaling: constant field and constant voltage scaling, Short-channel effects.

Unit process in VLSI and IC fabrication: Unit process in VLSI: Wafer preparation, Oxidation, Diffusion, Ion implantation, Deposition, Metallization, Etching and Lithography. nMOS fabrication, n-well and p-well process .

CMOS Logic Circuits: General CMOS logic structure, VTC of inverter, noise margin, Different types of inverter (resistive load, enhancement and depletion nMOS load and CMOS), Switching characteristic (propagation delay and parasitic capacitance estimation), NAND, NOR and other complex CMOS logic circuits, Sizing of CMOS logic circuits, CMOS Power: static and dynamic power dissipation, latch-up, sizing for large capacitive load,. Dynamic CMOS logic circuits, charge leakage and charge sharing problem, dynamic gate cascading problem, Domino and NORA logic, Introduction of sequential CMOS logic circuits, Stick diagram. Layout and Layout design rules.

Physical Design Automation: Objectives and goals of partitioning, floor planning and placement, Global routing.

Text Book

1. CMOS Digital Integrated Circuits – S. Mo. Kang and Yusuf Leblebici, 3rd Ed, TMH

Reference Book

1. Digital Integrated Circuits A Design Perspective -Jan M. Rabaey, Prentice-Hall Publication, 2nd Edition.
2. Basic VLSI Design – D. Pucknell&Eshraghian _PHI, 3rd Edition.
3. Principle of CMOS VLSI Design – Neil H. E. Weste – Pearson Edition, 2nd Edition.
4. CMOS Circuit Design – R. Jacob Baker, Harry W. Li, David E. Boyce –PHI,2003.

EC 3012 ANTENNA AND RADIO WAVE PROPAGATION Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. differentiate between various parameters of antenna and will be able to evaluate the radiation pattern of metallic and aperture type antenna.
CO2. analyze the radiation pattern of a uniform linear array and synthesize a linear array from given radiation pattern.
CO3. evaluate the radiation pattern and input impedance of biconical, helical, loop, V, rhombic, parabolic, offset parabolic, cassegrain, slot, horn, planar log-spiral, log periodic, Yagi-Uda, Microstrip antenna having 4 different feeding structure.
CO4. analyze the propagation mechanism of signal in earth's atmosphere.

Prerequisite: Electromagnetic Theory (EC 2014)

Radiation and Thin Linear Antennas: Vector magnetic potential, retarded potential, radiation from an oscillating electric dipole, radiation resistance of quarter-wave monopole and half-wave dipole.

Basic Antenna Parameters and Theorems: Radiation patterns, E-plane & H-plane, directivity, gain, efficiency, effective length, effective aperture, wave polarization & cross-polarization, LHCP & RHCP, FRISS transmission formula, antenna noise temperature, applications of reciprocity theorem and other theorems in antennas.

Antenna Arrays: Uniform n-element linear array, broadside & end-fire arrays, grating lobes, principle of pattern multiplication, design of linear array using Tchebyscheff distribution, phased array, adaptive array, basic concept of smart antennas.

Wire Antennas: V-antenna, Rhombic antenna, Loop antenna, Helical antenna

Reflector Antennas: Parabolic disc antenna, losses in disc antenna, tilted & off-set fed discs, Cassegrain reflector antenna.

Slot, Horn and Complementary Antennas: Slot antenna feedings and radiation pattern of slot antennas, Babinet's principle and complementary antennas, impedance of complementary screens & slot antennas, Horn antennas, radiation from horn antenna.

Broadband and Frequency-Independent Antennas: Broadband antennas, Rumsey's principle, frequency-independent planar log-spiral antenna, log-periodic antenna array, Yagi-Uda array .

Microstrip Antennas: Radiation mechanism of microstrip antenna, advantages & disadvantages, bandwidth enhancement of microstrip antennas using stacked, proximity-coupled and aperture-coupled microstrip antennas.

Radio Wave Propagation : Surface wave, space wave, tropospheric wave propagation, tropospheric scatterer, ducting, ionospheric layers, ionospheric wave propagation, critical frequency, MUF, skip distance, millimeter wave propagation, absorption of millimeter wave by rain and atmospheric gasses.

Text Book

1. Antennas for All Applications - J. D. Kraus & R. J. Marhefka, Tata McGraw Hill,4th Edition.
2. Electromagnetic Waves and Radiating Systems - E. C. Jordan & K. G. Balmain, PHI, 2nd Edition.

Reference Book

1. Antenna Theory - Analysis and Design - C. A. Balanis, John Wiley & Sons, Inc, 3rd Edition.
2. Antennas and Radio Wave Propagation - R. E. Collin, McGraw Hill,1985.

EC 3013 PRINCIPLE OF DIGITAL SIGNAL PROCESSING Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. select appropriate transformation for signal analysis.
CO2. analyze importance and utility of DFT filter banks.
CO3. solve Laplace Transforms and Z-Transforms.
CO4. apply the knowledge of analog filters to digital filters, design a digital filter and physically realize any digital filter.

Prerequisite: Mathematics-II (MA 1002)

Introduction

Brief idea about analog and digital signals, Definition of signal and systems, Signal Processing (ASP and DSP), Advantages and Disadvantages of DSP, Application of DSP.

Discrete time Signals & Systems

Discrete Time Signals and its classification , Discrete Time Systems and its classification, Operation on Discrete Time Signals , LTI systems Linear convolution sum and de-convolution, Properties of convolution, Applications of convolution, Interconnection of LTI systems , Correlation of two sequences & its Properties

Fourier Transform, DTFT, DFT, IDFT and FFT

Introduction to Fourier Transform, Discrete Time Fourier Transform, DTFT of discrete time signal and its properties, Discrete Fourier Transform and its Properties, Inverse Discrete Fourier Transform , Circular convolution and its properties , Long duration sequences by digital filter method (Over-lap save and Over-lap add method) , Fast Fourier Transform and its properties.

Z-Transform

Introduction to Z-Transform , Definition of Z-Transform , ROC of the Z-Transform , Properties of ROC, Properties of Z-Transform , Inverse Z-Transform , Long division method, Convolution Method, Partial Fraction Expansion Method, Residue method, Solution of difference equations using one sided Z-Transform, Stability analysis of Discrete Time Systems.

Digital filters (IIR & FIR FILTERS)

Introduction to Digital Filter, Design of IIR filter using Approximation of Derivatives method, Design of IIR filter using impulse invariance technique, Design of IIR filter using Bilinear transformation , Design of FIR Filter using Rectangular, Hamming Window. Blackmann window, Kaiser window, and Bartlett window.

Text Book

1. Digital Signal Processing by T. K. Rawat, Oxford Publication 1 st Edition
2. Principle of Signal Processing and Linear System: B.P.Lathi, First Edition ,Oxford University Press

Reference Book

1. Digital Signal Processing – J.G.Proakis and D.G.Manolakis , 4th Edition-PHI
2. Signals & Systems: Alan V. Oppenheim & Schafer-2nd Edition 2011 Pearson
3. Digital Signal Processing: P. Ramesh Babu: Scitech,2nd Edition

EC 3016 RF COMMUNICATION Cr - 4

CO1. comprehend the Maxwell's equations and their applications.
CO2. describe and explain the working of transmission lines, waveguides and passive microwave components.
CO3. describe and explain the working of RF amplifiers and oscillators.
CO4. classify, describe and compare different antennas and antenna arrays.
CO5. explain the different mechanisms of wave propagation through the atmosphere.
CO6. describe different multiplexing techniques and RF communication links.

Prerequisite:Physics (PH 1003)

Maxwell's equations, electromagnetic plane waves and microwave systems

Maxwell's equations in integral form, differential form, and their physical interpretation. Electromagnetic plane waves, polarization and electromagnetic power, IEEE microwave frequency bands, Microwave communication system (block diagram and description).

Transmission lines and waveguides

Fundamentals of transmission lines, types of transmission lines, traveling and standing waves on transmission lines, transmission line parameters, reflection coefficient and VSWR, impedance matching of transmission lines.

Introduction to rectangular waveguides, propagating modes in rectangular waveguides (qualitative only) , dominant and degenerate modes , waveguide parameters, methods of excitation, losses in waveguides.

Qualitative descriptions and applications of waveguide tees, resonators, directional coupler, isolator, circulator , duplexer and mixer using magic tee.

RF amplifiers and oscillators

Qualitative description and applications of klystron amplifiers and oscillators, magnetrons and traveling wave tubes, GUNN and PIN diodes.

Antennas

Hertzian dipole antenna, wire radiation in to space, resonant and non –resonant antennas, antenna terms and definitions (input impedance, antenna losses, radiation efficiency, radiation pattern, half power beam widths, first null beam widths, directivity, gain, effective aperture area and polarization), FRISS transmission formula, qualitative descriptions and applications of half wave dipole and quarter wave monopole antennas, antenna arrays, effect of ground, turnstile antenna, loop antenna, helical antenna , Yagi-Uda antenna array, Log-periodic dipole antenna array, aperture antennas, horn and dish antennas, microstrip antenna, adaptive and smart antennas.

Propagation of waves

Effect of environment on wave propagation, Modes of wave propagation, ground waves, sky waves, space waves, Tropospheric scatter phenomenon.

RF communications links

Overview of multiplexing techniques (FDM and TDM), microwave communication link, general satellite communication and block diagram, uplink and downlink frequencies, satellite sub systems, link budget calculation.

Textbook

1. 'Electronic Communication Systems' by G. Kennedy, B. Davis and S. R. M. Prasanna, TataMcGraw Hill Education Pvt Ltd, 5th Edition.

Reference Book

1. 'Electronic communication: Modulation and Transmission' by R. J. Scheoenbeck, PHI, 2nd Edition
2. 'Electromagnetic waves and radiating systems' by E.C. Jordan and K. G. Balmain, Pearson, 2nd Edition.

EC 3022 ADVANCED MICROPROCESSORS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze the operation of 8086 Processor in minimum and maximum mode configurations.

CO2. analyze advanced concepts of different higher level processors (from 80286 to Pentium) such as virtual memory, memory management, multi-tasking, protection capabilities, paging, cache concepts in 486 and Pentium.

CO3. analyze RISC features and parallel processing of instructions through U and V pipelines, incorporated in the design of Pentium processors

Prerequisite: Microprocessors and Microcontrollers (EC 3003)

8086 Microprocessor: Review of 8086 Architecture, Pins and Signals, Minimum and maximum mode configurations, Interrupts and Memory Interfacing.

8086 Addressing modes and Instructions, Multiprocessor configurations, 8086 Coprocessor.

Intel 80286: Introduction, Multiuser and Multitasking concepts, Virtual memory, Memory management, Architecture, Pins and signals, Real and protected modes of operation, Limitation of 80286.

Intel 80386 : Introduction, Register organization, Pins & signals, Real and protected modes, Virtual – 86 mode, 80386 privilege levels and protection, Call gates, Task switching, Memory management, Segmentation, Paging, TLB.

Intel 80486: Introduction, Enhanced features .

Pentium Processor: RISC features, Architecture, Pipelining, Superscalar execution, Branch prediction & handling.

Text Book

1. Microprocessors & Interfacing, Programming & Hardware by D. V. Hall-TMH – 3rd edition, 2012
2. The Intel Microprocessors 8086/8088, 80186/80188, 80386, 80486, Pentium and Pentium Pro-Processor by B. B. Brey – PHI – 8th edition
3. The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware and Applications by Triebel and Singh- Pearson Edn. – 4th edition

Reference Book

1. Microprocessors & Microcomputers based System Design by Md. Rafiquzzaman– UBS – 2nd edition.
2. Advance Microprocessor and Peripherals – Architecture, Programming and Interfacing by A. K. Ray and K. M. Bhurchandi – TMH – 3rd edition
3. Microcomputer System: The 8086/8088 family: Architecture, Programming and Design by Liu & Gibson- PHI – 2nd edition
4. An Introduction to the Intel Family of Microprocessors by James L. Antonakos - Pearson Education – 3rd edition

EC 3024 EMBEDDED SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. differentiate the design constraints of embedded systems.
CO2. design the algorithm for various models of embedded system.
CO3. design the algorithm based on differentiating the hardware requirements.
CO4. analyze the design constraints of System on chip using different IP Cores and Protocols.
CO5. write code for embedded system.

Prerequisite: Microprocessors and Microcontrollers (EC 3003)

Overview of Embedded System: Embedded System, Embedded Processor in System, Components of Embedded System, Brief introduction to Embedded software in system, Design Process in Embedded System.

Embedded Hardware:
Processor & Memory: Brief overview of 8051 Architecture and real world interfacing, Introduction to advanced Processor Architectures-ARM, Processor and Memory organization, Parallelism in instruction level, Processor and memory selection.

I/O Types: Serial and Parallel communication Ports, Timer and Counting devices, Watchdog timers, real time clock, Serial bus Communication Protocols- I2C, CAN, and Parallel Communication Protocol-ISA.

Interrupt Service Mechanism: Concept of ISR, different interrupt sources, Interrupt handling Mechanism, Multiple Interrupts, Interrupt Latency and deadline.

Embedded Software Development-
Software Development: Programming concept in ALP (assembly language programming) and High level language-C, Processor directives, functions and macros and other programming elements, Embedded C++ concept only.

RTOS(Real time operating System)- OS overview, Process, Interrupt and memory management, RTOS overview, Basic Design rule using RTOS, Task scheduling using Priority based scheduling, cyclic scheduling and round robin scheduling.

Embedded system Design using PIC microcontroller: Introduction toMicrochip PIC16 family, PIC16F873 processor architecture- features, memory organization, on chip peripherals, Watchdog timer, ADC, Data EEPROM, Asynchronous serial port, SPI mode, I2C mode, Interfacing with LCD, ADC, sensors, stepper motor, key board, DAC.

Case study of different types of Embedded System: Design of Automated Chocolate Vending Machine, Digital Camera.

Text Book

1. Microcontrollers Theory and Application, Ajay V. Deshmukh, TMH, 2011.
2. Embedded Systems: Architecture, Programming & Design, Raj Kamal, TMH, 2011

Reference Book

1. Embedded System Design: A unified Hardware/ Software Introduction, by Frank Vahid, Willey, 2011.
2. Design with PIC Microcontrollers , J. B. Peatman, Pearson India,2008

EC 3025 COMPUTATIONAL INTELLIGENCE Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. apply the concepts of fuzzy set theory to model different inference schemes using fuzzy rules.
CO2. implement different derivative free optimization techniques for solving engineering problems.
CO3. design engineering systems by using adaptive networks, neural networks and adaptive neuro-fuzzy inference systems.
CO4. utilize Neural Network Systems for different processes and perform optimization on these neural models for designing high performance systems.

Prerequisite: Mathematics-I (MA 1001)

Introduction to Soft Computing:
Soft computing constituents and conventional Artificial Intelligence, Neuro-Fuzzy networks.

Fuzzy Sets Theory and applications:
Introduction, Basic definitions and terminology, Set-theoretic operations, MF Formulation and parameterization, More on fuzzy union, intersection, and complement. Extension principle and fuzzy relations, Fuzzy if-Then rules, Fuzzy reasoning, Mamdani fuzzy models, Sugeno Fuzzy Models, Tsukamoto fuzzy models, other considerations.

Derivative-free optimization:
Genetic algorithm, simulated annealing, random search, Downhill simples search.
Adaptive Networks:
Architecture, Back propagation for feed forward networks, Extended back propagation for recurrent networks, Hybrid learning rule.

Neural Networks:
Supervised learning neural networks: Perceptions, Adaline, Back propagation multi layer perceptions, Radial Bias Function networks, modular network.Unsupervised learning and other neural networks: Competitive learning networks, Kohonen self organizing networks, learning vector Quantization, Hebbian learning, principal component networks, and The Hopfield network. Reinforcement learning.

Adaptive Neuro-Fuzzy Inference Systems:
ANFIS architecture, Hybrid learning algorithms, Learning methods that cross-fertilize ANFIS and RBNF, Simulation examples.

Text Book
1. Neuro Fuzzy and Soft Computing by J. S. R. Jang, C.T. Sun, E. Mizutani, PHI, 1st Edition.
2. Neural Networks and Learning Machines by Simon Haykin, PHI, 3rd Edition.

Reference Book
1. Genetic Algorithms in search, Optimization and Machine learning by David E. Goldberg, 1st Edition, PEARSON

EC 3027 OPTICAL & SATELLITE COMMUNICATION Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze the principle of light propagation through optical fiber, advantages and types of material used for fabrication of fiber.
CO2. differentiate between different types of modes.
CO3. analyze various types of losses, dispersion, bandwidth requirement and repeater spacing for optical communication system.
CO4. analyze the structure, principle of operation and characteristic of optical sources and detectors.
CO5. differentiate between different types of noises at the receivers and calculate SNR and NEP.
CO6. prepare optical link budget and explain concept of WDM.
CO7. analyze satellite orbits, calculate orbital parameters, launching of satellites and satellite subsystems.
CO8. differentiate between various types of losses in satellite communication and make link budget design taking those into consideration.

Prerequisites : Physics (PH 1003) & Analog Communication Techniques (EC 2012), Introduction to Communication Engineering (EC 3044) & Communication Engineering (EC 3009)

Introduction: Optical Frequencies, Principle of Light Propagation in a fiber, Advantages of optical fiber communication.

Wave Propagation in optical fiber: Relation between refractive index and velocity of light, basic structure and ray diagram of optical path in an optical fiber, Acceptance cone, Numerical aperture. Concept of modes, Different types of mode in optical fibers, Cut-off condition for guided modes, Boundary conditions, single mode / multi mode fiber, Concept of V number and its importance.

Losses in fiber: Material or impurity losses, Rayleigh scattering loss, Absorption loss, Bending loss, Concept of dispersion, Intermodal dispersion, Intramodal dispersion, Wave guide and material dispersion, Minimization of dispersion.

Optical sources: Characteristics of good optical source, Principle of operation of LED, Principle of operation of laser diode, Intensity modulation using both LED and Laser diode.

Optical detectors: Principle of operation of PIN diode, Principle of operation of APD, Comparison of PIN / APD, Noises at optical receiver, Thermal noise, Short noise, SNR and Noise equivalent power.

Fiber link: Optical link budget, Concept of WDM

Satellite Communications Introduction : Frequency spectrum for satellite communication, Types of orbits, Kepler's Laws of planetary motion, Orbital perturbations, geostationary orbit, Satellite launching , General satellite communication, Block diagram uplink, Downlink frequencies, Types of modulation techniques used, Common Satellite applications.

Losses / Attenuation: Signal loss on transmission through earth's atmosphere, Atmospheric losses, Ionospheric effects, Rain attenuation.

Satellite link budget: Transmission losses, Interference, System noise temperature, Link power budget**.**

Satellite sub-systems: Antenna sub-systems, Attitude and orbit control sub-system, Power sub-system, Communication sub-system, TTC&M sub-systems.

Text Book

1. Optical Fiber Communication - G. Kaiser –5th edition, 2013- Tata Mc-Graw Hill
2. Satellite Communication – Pratt, Bostien, Allnut – 2nd edition, 2013 - John Willey Publications

Reference Book

1. Optical Fiber Communication – J. C. Palais – Pearson Education
2. Satellite Communication – Denish Rsode - Tata Mc-Graw Hill

EC 3028 DATA COMMUNICATION AND NETWORKING Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze the function of OSI model and Layered Architecture and Compare and contrast different analog and digital data transmission protocols in LAYER-I.
CO2. analyze algorithms and calculate parameters associated with Flow Control, Error control and Media Access Control (MAC) techniques used in LAYER-II.
CO3. analyze and calculate parameters related to Routing Algorithms and protocols and design network with different IPv4 addressing scheme used in LAYER-III.
CO4. compare different Transport layer protocols and calculate parameters used in LAYER-IV.
CO5. formulate different mathematical models based on queuing theory and traffic models.
CO6. differentiate between different QoS approach and calculate parameters associated with it.

Prerequisites: Analog Communication Techniques (EC 2012), Digital Communication Techniques (EC 3005) & Communication Engineering (EC 3009)

Introduction: Overview of analog and digital data transmission, Historical background of data network, Protocol and their function, OSI model and layering.

Physical Layer Issues: Transmission impairments, transmission media: twisted pair, coaxial cable, optical fiber and wireless transmission. Line coding formats, typical feature and performance. Types of data and corresponding signal with examples: digital data-analog signal, analog data-digital signal, digital signal-digital data and analog data-analog signal, Asynchronous and synchronous transmission, transmission topology, MODEM, Time division and statistical multiplexing.

Link Layer Protocols: Circuit switching and packet switching. Framing, Error detection and correction, Retransmission Mechanisms (ARQ), Go Back N, Selective Repeat, Sliding window Protocol.

Multiple Access Protocols: Aloha System, Carrier Sensing (CSMA, CSMA/CD, CSMA/CA), Examples of Local area networks: Ethernet (IEEE 802.3), Wi-Fi (IEEE 802.11), IEEE 802.11ac .

Internetworking: Bridging, Global Internet, IP protocol and addressing (IP V4), Subnetting and supernetting, Classless Inter-domain Routing (CIDR), IP address lookup, Domain Name Systems (DNS), Network Address Translator (NATs), Unicasting, broadcasting and multicasting, Routing in Internet: Link-state, RIP, OSPF, ICMP

End-to-End Protocols: TCP and UDP, Congestion Control, Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit/ Fast Recovery.

Quality of Services(QoS): Introduction to Quality of Services(QoS), Integrated and Differentiated Services.

Text Book

1. Data Communications and Networking, B A Forouzan, McGraw-Hill, 4thEdition, 2011.
2. Computer Networking – A top-down approach featuring the Internet, James F. Kurose and Keith W. Ross, 2nd Edition, Pearson Education, Asia, 2004.

Reference Book

1. Internetworking with TCP-IP: Principles, Protocols and Architecture, D. E. Comer, Vol I, 2nd Edition, Prentice Hall, 1991.
2. Data and Computer Communications, William Stalling, 10thEdition, Prentice Hall, 2013.
3. Communication Networking – An analytical Approach, Anurag Kumar, D Manjunath and Joy Kuri,Morgan Kaufmann, 2004.

EC 3030 ADAPTIVE SYSTEMS & SIGNAL PROCESSING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. solve problems in various discrete random processes.
CO2. differentiate between different Linear predictive Filters.
CO3. design Wiener Filter and apply it for practical applications.
CO4. design Adaptive Filters.

Prerequisite: Digital Signal Processing (EC 3007)

Discrete random processes: Random variables, random processes, filtered random processes. Ensemble averages, correlation, covariance, power spectrum, cross power spectrum. Ergodicity, time averages, biased & unbiased estimators, consistent estimators.

Linear prediction: Direct form linear prediction filtering, Normal equations for linear prediction filtering, Levinson algorithm, linear prediction lattice filtering.

Digital Wiener filtering: Wiener smoothing and prediction filters, Application of Wiener smoothing to noise cancelling, Application of Wiener prediction filters, Constrained, linear MMSE filtering, Minimum variance beam-forming.

Adaptive filtering: LMS adaptive algorithm. Properties of LMS adaptive filter, Normalized forms, Finite precision effects, Adaptive beam-forming, Frequency domain adaptive filters, Adaptive lattice filters, Godard algorithm, Neural networks and multi-layer perceptrons, Adaptive IIR filtering.

Text Book

1. Adaptive Filter Theory, S. Haykin, Prentice-Hall, 4-th edition, 2001.

Reference Book

1. Fundamentals of Adaptive Filtering, Ali H. Sayed, John Wiley, 2003.
2. Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing, D. Manolakis, V. Ingle, S. Kogan, McGraw Hill, 1999.
3. Adaptive Signal Processing, B. Widrow, S. Stearns, Prentice-Hall, 1985.

EC 3032 TELEMETRY AND REMOTE CONTROL Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze principles of Telemetry, functional blocks of telemetry systems and different types of telemetry.
CO2. differentiate between different modulation and multiplexing techniques in telemetry.
CO3. analyze the concepts and applications of remote sensing.
CO4. analyze the fundamental operating blocks and applications of fiber optic telemetry systems.

Prerequisite: Communication Engineering (EC 3009)

Fundamental concepts– Significance, Principle, functional blocks of Telemetry and Telecontrol system- Methods of telemetry –Electrical, Pneumatic, Hydraulic and Optical Telemetry – State of the art-Telemetry standards. basic scheme, voltage, current and frequency telemetry, line length limitations, wired and wireless types, Concepts of Information transfer, Coding – Overview of source coding and channel coding.

Modulation codes: PAM, PFM, PTM, PCM, Bit error rate, Inter symbol, noise, parity checking, Review of modulation and multiplexing: FM-AM, FM-FM, PAM-AM, PAM-FM, PCM-AM, etc, Quantization and conversion methods, error in quantization, bandwidth consideration.

FDM and TDM systems, IRIG standards in FDM systems in FDM telemetry, SCO's, Mux and Demux circuits, Detectors and Demodulators, Pulse averaging, Quadrature FM and PLL, Mixers, TDM systems (architecture)-TDM- PAM, PAM- PM, TDM- PCM systems.

Overview of Digital modulation, Modem Protocols, Synchronous protocols, Satellite telemetry, TT and C services, Subsystems, Earth station, Global Positioning System, Overview of wave propagation, Basics of remote sensing, Concept of GIS.

Fiber optic Telemetry- The Fibre as transmission medium, Interconnections, Repeaters, Sources, Detectors, WDM, Remote control: concept and example from a typical industrial situation.

Text Book

1. Handbook of telemetry and remote control, Gruenberg. L, McGraw Hill ,New York, 1987.
2. Telemetry and data transmission, Baral R. N. ,S K Kataria and Sons, 2nd Edition, 2009.

Reference Book

1. Telemetry Engineering, Young R.E, Little Books Ltd, London 1988.
2. Data communication and teleprocessing system, Housley T, Prenctice Hall International, Englewood Cliffs, New Jersey, 1987.
3. Communication Systems, Bruce Carlson A, 3rd edition, McGraw Hill, New York 1987.
4. Telecommunication and Switching systems and Networks, Viswanathan T, Prentice Hall, New Delhi, 1992

EC 3034 INDUSTRIAL DATA NETWORKS Cr-3

Course Outcome: At the end of the course, the students will be able to :

- CO1. differentiate between RS-232 and RS-485, EIA-232, EIA-422 interface standards based on ISO/OSI Model
- CO2. apply MODBUS protocol structure, its function codes and troubleshooting. Further they will have insight to Data Highway (plus) protocols, HART Protocol.
- CO3. analyze Physical layer, Data Link Layer and Operating Characteristics of AS interfaces and Device net.
- CO4. identify different operational aspects of ProfiBus including the protocol stack, communication object and model.
- CO5. identify, compare and contrast different industrial Ethernet standards and Wireless communication, components of radio link, radio spectrum and frequency allocationaspects.

Prerequisites: Communication Engineering (EC 3009) and Data Communication & Networking (EC 3028)

Rs – 232 and Rs – 485:
ISO-OSI model – EIA 232 Interface standard – EIA 422 interface standard – 20mA current loop – Serial interface converters.

Modbus Data Highway (Plus) And Hart Protocols :
MODBUS protocol structure – Function codes – Troubleshooting – Data highway (plus) protocols – Review of HART Protocol.

As – Intreface And Devicenet:
AS interfaces:- Introduction, Physical layer, Data link layer and Operating characteristics.
Device net: - Introduction, Physical layer, Data link layer and Application layer.

Profibus PA/DP/FMS and FF:
Profibus:- Introduction, Profibus protocol stack, Profibus communication model, Communication objects, System operations and Troubleshooting – Foundation fieldbus versus Profibus.

Industrial Ethernet and Wireless Communication :
Industrial Ethernet:- Introduction, 10Mbps Ethernet and 100Mbps Ethernet – Radio and wireless communication:- Introduction, Components of radio link, radio spectrum and frequency allocation and radio modems – Comparison of various industrial networks.

Text book

1. Computer Buses, Buchanan, W, 2000, CRC Press
2. Computer Networks, Tanenbaum, 5th Edition, PEARSON

Refrence book

1. Practical Industrial Data Networks Design, installation and Troubleshooting, Steve Mackay, 1st Edition, 2004.
2. Wireless Communication and networks, Stallings, 2nd Edition, 2007, PHI

EC 3042 MEDIA & APPLICATIONS Cr-3
(Industry sponsored Elective)

Course Outcome : At the end of the course, the students will be able to achieve the following :

VAS, M2M (Machine to Machine) and TV & Media are Cutting Edge Domains and knowing these domains will keep the students market ready with respect to knowledge.

Prerequisite :

Topic 1:General
OOPS & Programming concepts, Operating System Concepts & basic knowledge of Linux, Scripting knowledge - Unix Shells Scripting, Java Scripting, Perl Scripting, Data structure /Algorithm, DBMS, Networking Concepts

Topic 2: Technology Specific
Basic knowledge of JAVA, Servlets, JSP and XML processing with JAVA, Spring /Hibernate, JBoss(App Server), Messaging (JMS), Restful web service, AV formats (HD ..), Video codecs
(MPEG…), IP Multicast

Topic 3: Domain Specific
Telecommunication Overview, Telecom Ecosystem (North / South Bound, GSM Concepts), VAS and Media as a function overview (EGI team would support), Basic concepts of Protocols (HTTP, TCP, UDP, STPP, SMPP, RTSP, IGMP)

MAIN SYLLABUS

MODULE - 1: TVM

Topic 1:TVM Overview
Introduction to TV and Media & Industry overview, Cable, DTH, IP network, IPTV concepts, Video Standards, Video Codecs, OTT, Catch up TV

Topic 2: Multiscreen TV, Middleware, DRM, VOD
Multiscreen TV - Live TV, Multiscreen TV Platforms, Multiscreen converged TV services & Middleware platform
Middleware - Multiscreen converged TV services & Middleware platform, DRM, Encryption, Access control and Authentication, DRM implementations and various players, Digital rights management and digital Copy Protection,
VOD
Video on Demand (VOD)
Subscription VOD (SVOD)

Topic 3: Content Delivery & Video optimization , CDNs
Content delivery & Video optimization - Diagnostics and monitoring systems, User authentication systems, Content delivery & optimization
CDN/ MDN
Encoders , streamers , Receivers
LTE Broadcast Overview

Topic 4: End User devices & UI, Content management, DVR, Broadcast services
End user devices & UI - Electronic Program Guide, Digital TV Consumption Devices, STB Architectures, Mobile clients, Tablets, Personal Computers, Digital home networking
Content management - Video on Demand (VOD) asset preparation, Content management systems (CMS), Analytics and Reporting systems, Content lifecycle
DVR - PVR/DVR, nPVR, Cloud
Broadcast services

MODULE - 2: VAS

Topic 1: VAS & M2M Overview
Overview of Service Delivery Platform, Overview of Service Enablement framework, Overview to Service Exposure & M2M, Overview of Device Connectivity Platforms & Remote Device Management, VAS & M2M Global Market trend, Evolution of VAS domain wrt Cloud /Virtualization , 4G & LTE, Overview of Service Delivery Platform (video)

Topic 2: Service Enablement
SDP Architecture Overview, Network Enablers Protocol (Native) SMPP, MM7 Architecture
Network Enablers Protocol (Web 2.0) Parlay X, Business Integration Protocol (Network Management) SNMP,
Content delivery concepts: OMA / Non OMA & HTTP - Premium messages, Infotainment Services, Caller/Hello Tunes, Wallpaper, Ringtones, Polytunes, Gifting services, Referrals services etc, Concept Handling using DRM, Application to peer messaging(A2P) & Peer to Application messaging (P2A)
Role of Operators, Service Provider and Subscribers, Subscriber provisioning, enable and access services, Use case Simulation, M2M Enablement Framework

Topic 3: Service Applications - (IP/Messaging)
SS7 and SIGTRAN: SS7 Overview, SIGTRAN Overview, MTP Links and Link-set, Low Speed and High Speed Links, MTP Route and Route-Sets, MTP Routing, MTP Connectivity Setup, SCCP, SCCP Connection Less Services, SCCP GT Translation, SCCP GT Based Routing, SIGTRAN SCTP and M3UA, SCTP Connectivity Setup, M3UA Connectivity Setup, TCAP, TCAP Dialog and Component Primitives, TCAP Session Examples, Messaging specific Protocols etc
Legacy Messaging – SMS, MMS, VMS: GSM overview, GSM Architecture Overview, GSM Nodes (Radio, MSC, HLR, VLR), SMS Flow, MMS Flow, VMS Flow
IP Messaging - RCS, EM (Rich communication Suit & Enriched Messaging): IP Messaging overview (SIP Messaging, RCS, etc), IP Messaging Gateway overview

Topic 4: Service Applications - (IN Applications)
IN and NGIN Architecture: Overview of Intelligent Networks (IN), IN and NGIN Architecture, IN BCSM, INAP Releases and Features, INAP Operations, CAP Releases and Features, CAP Operations, CAP and TCAP packets. CAP Application Example

NGIN Applications: Basic Telephone Call, Basic GSM Call, NGIN Application Overview, Toll-free, Universal Access Number, Premium Rate, Collect Call, VPN, Tele-Voting Services and Features. Custom NGIN Applications

NGIN Platforms: SS7 Cards, SS7 Hardware, SS7 FE and BE Architecture, NGIN Platform based on Java, Oracle OCCAS, JAIN SLEE, Open Cloud Rhino, Other NGIN Service Development Platforms, Traditional IN App Development, NGIN Application Development.

EC 3046 FIBER TECHNOLOGY Cr-3

(Industry Sponsored Elective)

Course Outcome : At the end of the course, the students will be able to achieve the following :

CO1. Fiber technology is rapidly changing technology that can support enormous Internet traffic growth required by bandwidth intensive applications of this century. This course offers comprehensive coverage of the Optical networking technologies, Architectures and its Applications and fiber planning best practices, industry use cases to give student the real feel of the Optical networks deployed in industry and ways of working.

CO2. This course is an attempt to bridge the gap between Industry and academia by empowering Student with knowhow on the best practices followed in industry and updates on emerging technologies that will shape the deployment of optical networks for years to come.

Prerequisites: Analog Communication Techniques(EC 2012) and Communication Engineering (EC 3009)

Optical Fiber Cables & System
Introduction to Fiber optic communication; Principal of Fiber propagation; Structure of Fiber; Characteristics of Fiber

Active and Passive Components
Light Sources and Detectors ;Attenuator ;Couplers ;Splitters Gratings; Isolators; Circulators; Filters; Amplifier; OADMs ROADM; Photonics Cross connect; Transponder

Optical Splice Connectors and Passive Nodes
Fiber Splicing; Connectors; Fiber Testing

Optical Fiber Link Design
Link Budget Considerations; Power Budget; Power Budget Requirement; Examples, Case Studies

Optical Fiber Installation
Cable installation in underground Ducts; Guiding System and cable bending; Installation of aerial cables

PDH SDH and OTN Overview
PDH Overview; SDH Overview; OTN Overview

Optical Networks
Access Network; Metro Network; Core Network

FTTX Overview
FTTH; FTTP; FTTC; FTTB, Design Tools (AutoCAD, ArcGIS)

GPON Fundamentals
GPON - Principle; OLT / ONU; GPON Frame structure; Tripple Play Services; Case Studies and Examples

WDM Overview
DWDM Component - - MUX/ DEMUX, AMPLIFIER, OADM; DWDM Non Linear Effects; DWDM vs CWDM; DWDM Link Design

Maintenance and Safety Aspect
General support system architecture; Testing and Maintenance principle; Optical fiber and cable restoration; optical Monitoring parameters

EC 4001 RF AND MICROWAVE ENGINEERING Cr-4

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze microwave vacuum tube amplifier and signal source.
CO2. design semiconductor microwave source and amplifier.
CO3. design various microwave components using simulation software.
CO4. design & implement various transmission lines.
CO5. analyze microwave filter design and implement in simulation software.
CO6. measure characteristics of microwave component and devices.

Prerequisite: Electromagnetic Theory (EC 2014)

Waveguide and Cavity Resonator: Transverse electric and transverse magnetic wave propagations in rectangular and circular waveguides, wave impedances, rectangular cavity resonator, quality factor of the rectangular cavity resonator.

Microwave Vacuum Type Amplifiers and Sources: Limitations of conventional vacuum tubes, Klystron amplifier, Reflex Klystron oscillator, Travelling Wave Tube (qualitative), Backward Wave Oscillator (qualitative), Magnetron Oscillator.

Microwave Solid State Devices & Sources: TED, RWH theory, Gunn Effect, two-valley model theory, modes of operation of Gunn, READ diode, PIN diode, IMPATT diode, TRAPATT diode and BARITT diode.

Microwave Components: Scattering matrix representation, variable attenuators, linear and rotary phase shifters, E-plane, H-Plane and Magic Tees, rat race power divider, two-hole and Bethe hole directional couplers, slotted section, matched terminations, coupling probes, crystal detector, Faraday rotation in ferrites, Faraday rotation isolator, Faraday rotation 3-port and 4-port circulators.

Microwave Integrated Circuits: Introduction to microwave integrated circuits, strip line, microstrip line, slot line, CPW, coupled microstrip lines.

Microwave Measurements: Power, frequency and impedance measurements. Gain and radiation pattern measurement of antennas.

Text Book

1. Microwave Devices & Circuits – S. Y. Liao, 3rd edition, 2013 - PHI
2. Microwaves: Introduction to Circuits, Devices and Antennas – M. L. Sisodia and V. L. Gupta, New Age International, 1st Edition.

Reference Book

1. Microwaves– K. C. Gupta, Wiley Eastern Limited, 1st Edition.
2. Basic Microwave Techniques and Laboratory Manual - M. L. Sisodia and G. S. Raghuvanshi, Wiley Eastern Limited, 2nd Edition.
3. Microwave Engineering – D. M. Pozar – John Wiley & Sons, Inc, 4th Edition.

EC 4003 WIRELESS & MOBILE COMMUNICATION ENGINEERING Cr-4

Course Outcome: At the end of the course, the students will be able to :

- CO1. analyze basic Cellular Architecture and practical mobile communication strategies.
- CO2. solve basic propagation models and understand signal degradation in a wireless channels.
- CO3. differentiate between various modulation schemes used in present day mobile communication.
- CO4. apply channel equalization and diversity techniques in wireless systems.
- CO5. distinguish between the different types of multiple access schemes and GSM technology.
- CO6. differentiate between CDMA and OFDMA modulation.

Prerequisites: Analog Communication Techniques (EC 2012),Digital Communication Techniques (EC 3005) and Communication Engineering (EC 3009)

Mobile Communication Principle: Cellular Concept System Architecture, Spectrum Allocation, Frequency Reuse, Channel Assignment Strategies, Co-channel Interference & System Capacity, Hand off, Hand off structure, Practical Hand off consideration, Prioritizing Hand off, Power Control, Near – Far Problem, System capacity, Improvement Techniques: Cell splitting, Sectoring, Micro cell Zone concept.

RF Propagation & Multi-path Model: Free space propagation model, propagation mechanism, Large Scale fading, Diffraction & Scattering by high – raise structures, shadowing and path loss, Small Scale Fading, Doppler and time-delay spread, coherence Bandwidth and coherence-Time, Types of Small – Scale Fading.

Equalization and Diversity Techniques: Fundamentals of Equalization, Adaptive equalizer, Concept of diversity, Types of diversity (space, time, frequency, polarization, Rake receiver .

Spread Spectrum modulation: Spread Spectrum Modulation and principle, PN sequence and its properties, Direct sequence SS and frequency – hopped SS (DS – SS and FH – SS), TH – SS.

Multiple Access Techniques: Multiplexing and multiple access, TDD and FDD techniques, Description of FDMA, TDMA, CDMA systems, Description and special features of GSM and IS – 95, WCDMA, Wireless data communication and services, Mobile communication standards, Transmitting and Receiving Antenna Systems.

Multicarrier Modulation: Data transmission using multiple carriers, OFDM, Multi carrier CDMA.

Multiple Antennas and space time communications: Concept of Multi Input Multi Output Antenna system, Narrow band MIMO model, MIMO channel capacity, MIMO Diversity gain, Space time Modulation.

Text Book

1. Wireless Communication Principle & Practice – T.S.Rappaport – 2nd edition 2012 - Pearson Education.
2. Wireless Communication – Andrea Goldsmith – Cambridge Press, 1st Edition, 2005.

Reference Book

1. Wireless and Cellular Communication – C. Y. Lee – McGraw Hill, 3rd Edition, 2006.
2. Mobile Communication – Schillar – Pearson Education, 2nd Edition,2010.
3. Communication System – Simon Haykin – John Willey , 4th Edition
4. Fundamentals of Wireless Communication – Tse&Viswanath –Cambrige,2010.

EC 4021 RADAR & TELEVISION ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze video bandwidth of monochrome signal and the different sync pulse with the video signal to from composite video signal.
CO2. analyze signal transmission, channel bandwidth and types of antenna used for reception of TV signal.
CO3. differentiate between different constituents of TV Receiver.
CO4. analyze the concepts related to color television.
CO5. analyze the principle of radar operation and distinguish between pulse and CW radars.

Prerequisites: ACT (EC 2012) and DCT (EC3005) and Communication Engineering (EC 3009)

Basic Television System, Scanning Principle & Composite Video Signal: Principle of Television, Aspect ratio & flicker, Concept of scanning & No. of scanning lines, Interlaced scanning, Video Bandwidth, Video signal & DC component, Blanking pulse, Horizontal & Vertical sync/ pulse, Equalizing pulse

Signal Transmission, Channel Bandwidth & TV Transmitting & Receiving Antenna: Need of vestigial Transmission, Channel Bandwidth for monochrome, transmission, Transmitting (Turnstile) & receiving, Antenna (Yagi), Co-axial & twin wire cable &Balun transformer.
Monochrome Television Reciever: Monochrome TV receiver: Block diagram, RF tuner, Video amplifier, Video detector, inter carrier sound detection, Sync separator, AGC, SMPS Power Supply.

Colour Television Principle: Luminance & chrominance signals, Channel bandwidth & frequency interleaving, Color subcarrier and modulation of R-Y, B-Y and signals, color burst signal, Color TV receiver block diagram.

Principle of Radar System: Radar block diagram, its operation & radar range equation, Pulse repeating frequency and range ambiguities.

CW & CW-FM Radar: Doppler Effect, CW radar & block diagram, FM-CW radar principle & CWFM altimeter.

MTI & PULSE Doppler Radar: MTI radar block diagram & its operation, delay line canceller, blind speed & its minimization.

Tracking Radar: Principle of Tracking radar, sequential lobing, conical scanning &Monopulse tracking radar.

Text Book

1. Introduction to Radar system by M.I. SKOLNIK – 3rd edition , 2013 McGrawHill
2. Monochrome & colour Television by R. R. GULATI – 3rd edition, 2014 – New Age.

Reference Book

1. Microwave & Radar Engineering by M. KULKARNI
2. T. V & Video Engg. by A. M. Dhake, 2nd Edition,2006.

EC 4031 MOBILE COMMUNICATION ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze the concepts of Cellular System.
CO2. model RF Propagation and Multi-path propagation.
CO3. differentiate between QPSK, Offset QPSK, π/4 QPSK, MSK, GMSK, and QAM.
CO4. differentiate between various Equalization and Diversity Techniques.
CO5. characterize various Spread Spectrum modulation.
CO6. differentiate between various Multiple Access Techniques like TDMA, FDMA and CDMA.

Prerequisites: Communication Engineering (EC 3009) and Introduction to Communication Engineering (EC 3044).

Mobile Communication Principle: Cellular Concept System Architecture, Spectrum Allocation, Frequency Reuse, Channel Assignment Strategies, Co-channel Interference & System Capacity, Hand off, Hand off structure, Practical Hand off consideration, Prioritizing Hand off, Power Control, Near – Far Problem, System capacity, Improvement Techniques: Cell splitting, Sectoring, Micro cell Zone concept.

RF Propagation & Multi-path Model: Free space propagation model, propagation mechanism, Large Scale fading, Diffraction & Scattering by high – raise structures, shadowing and path loss, Small Scale Fading, Doppler and time-delay spread, coherence Bandwidth and coherence-Time, Types of Small – Scale Fading.

Modulation Techniques: Overview of QPSK, Offset QPSK, π/4 QPSK, MSK, GMSK, QAM.

Equalization and Diversity Techniques: Fundamentals of Equalization, Adaptive equalizer, Concept of diversity, Types of diversity (space, time, frequency, polarization, Rake receiver .

Spread Spectrum modulation: Spread Spectrum Modulation and principle, PN sequence and its properties, Direct sequence SS and frequency – hopped SS (DS – SS and FH – SS), TH – SS.

Multiple Access Techniques: Multiplexing and multiple access, TDD and FDD techniques, Description of FDMA, TDMA, CDMA systems, Description and special features of GSM and IS – 95, Wireless data communication and services, Mobile communication standards, Transmitting and Receiving Antenna Systems.

Text Book

1. Wireless Communication – T.S.Rappaport – Pearson Education, 2nd Edition, 2012.

Reference Book

1. Wireless Communication – Andrea Goldsmith – Cambridge Press, 1st Edition,2005.
2. Wireless and Cellular Communication – C. Y. Lee – McGraw Hill, 3rd Edition,2006.
3. Mobile Communication – Schillar – Pearson Education, 2nd Edition, 2010.
4. Wireless Communication – Tse &Viswanath – Cambrige Press, 2010.

EC 4033 SMART ANTENNAS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze the basic working of different array antennas and also adaptive and smart antennas.
CO2. differentiate between different direct domain least square approaches to adaptive processing in adaptive array antennas.
CO3. analyze the mutual coupling between different array elements and their compensation techniques.
CO4. analyze the direction of arrival estimation techniques and adaptive signal processing techniques for smart antennas.

Prerequisite: Antenna and Radio wave propagation (EC 3012)

Introduction: Basics of linear antenna arrays, circular antenna arrays and phased array antenna, concept of adaptive antennas and smart antennas, adaptive processing using minimum variance distortionless technique.

Direct Data Domain Least Square Approaches to Adaptive Processing: Direct data domain least square procedures, eigenvalue method, forward method, backward method, forward-backward method, main beam construction for prevention of signal cancellation.

Mutual Coupling in Adaptive Smart Antennas: Mutual coupling among an array of dipoles (qualitative), compensation using open-circuit voltages and minimum norm formulation, effect of mutual coupling for constant jammers and constant signals, compensation for mutual coupling for constant jammers and constant signals.

Direction of Arrival (DOA) Estimation and Adaptive Signal Processing for Smart Antennas: Problem formulation, transformation matrix to compensate undesired electromagnetic effects, DOA estimation for a semicircular array, adaptive processing using a single snapshot from a non-uniformly spaced array in presence of mutual coupling and near-field scatterers, DOA estimation using a phased array on a conformal hemispherical surface, DOA estimation using cyclostationarity, Optimization of base station location for indoor wireless communication.

Text Book

1. Smart Antennas – T. K. Sarkar, M. C. Wicks, M. Salazar-Palma and R. J. Bonneau, Wiley-Interscience, 1st Ed., 2003.

Reference Book

1. Smart Antenna Engineering - Ahmed El-Zooghby, Artech House, 1st Ed., 2005.
2. Smart Antennas for Wireless Communication: With MATLAB- F. Gross, McGraw Hill, 1st Ed., 2005.

EC 4041 MICROPROCESSOR, MICROCONTROLLER & APPLICATIONS Cr–3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze Architecture and operation of 8 bit Microprocessor (like 8085) and 8 bit Microcontroller (such as 8051) including the peripheral chips.

CO2. design applications using Microprocessors and Microcontrollers.

Prerequisite: Digital Electronics (EC 2011)

8085 Microprocessor Overview : Introduction, Architecture, Pins & signals, Addressing Modes & Instructions, Timing Diagrams, Assembler Directives, Sample programs.

8085 Interrupts & Memory Interfacing : 8085 Interrupts, Memory chips and Memory interfacing.

Interfacing Chips: Programmable Peripheral Interface (8255), Priority Interrupt Controller (8259) and USART (8251).

8051 Family Of Microcontrollers : Introduction, Overview of 8051 family, Architecture & Memory organization, Pins & signals, Addressing Modes, 8051 Instructions & sample programs, Timers, Counters and serial communication.

Text Book

1. Microprocessor architecture, Programming and Applications with the 8085 – Ramesh S. Goankar – Penram International Publishing (India) 6th edition,
2. Microcontroller Theory & Applications – Deshmukh – TMH, 2005

Reference Book

1. 8051 MICROCONTROLLER - Hardware, Software & Applications – V Udayashankara&M Mallikarjunaswamy–TMH – 1st edition

EC 4044 INFORMATION THEORY & CODING Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. differentiate between different forms source information and coding techniques.
CO2. analyze channel coding schemes and shannon's information theory.
CO3. distinguish between various error decoding schemes.
CO4. analyze and design cyclic codes, CRC codes and BCH codes
CO5. analyze the recent coding schemes.

Prerequisite: Digital Communication Techniques (EC 3005)

Source Coding: Introduction to information theory, definitions of self-information and mutual information, conditional self-information, average mutual information and entropy, binary entropy function, FLC & VLC, prefix code and Kraft inequality, source coding theorem, code efficiency, redundancy, Shannon-Fano algorithm, discrete memory less source and Markov source, Huffman coding.

Channel Capacity & Coding: DMC, BSC, BEC & other special channels, channel capacity, channel coding, code rate, channel coding theorem, Information capacity theorem, Shannon limit.

Speech Coding: Characteristics of speech signals, frequency domain speech coding, sub-band coding, adaptive transform coding, Vocoders (channels vocoders, formant vocoders, cepstrumvocoders).

Error Control Coding : Code, codeword, weight of a codeword, generator polynomial, vector, matrices, Galois field, liner code, linear block code, matrix description of linear block code, parity check matrix, systematic code, decoding of a linear block code, standard array, syndrome decoding, error probability after coding, Hadamard code & Hamming code, optimal linear code, maximum distance separable code.
Cyclic codes: Method for generating cyclic codes, burst error correction, Fire code, Golay code, CRC codes, circuit implementation of cyclic codes.

BCH Codes: Primitive element, minimal polynomial, method of generating BCH code, examples of BCH codes, decoding of BCH code, Reed-Solomon code.

Convolutional Codes: Tree & Trellis codes, Convolutional codes, Viterbi decoding,

Text Book

1. Information Theory, Coding and Cryptography – Ranjan Bose, Tata McGraw Hill – 2nd edition 2011
2. Principles of Digital Communication – J. Das, P. K. Chatterjee& S. K. Mullick, New Age Internationals, 2008

Reference Book

1. Elements of Information Theory- T. M. Cover & J. A. Thomas, Wiley-Interscience – 2nd edition, 2010
2. Digital Communications – J. G. Proakis, McGraw Hill Education – 4th edition.

EC 4046 MODERN DIGITAL COMMUNICATION TECHNIQUES Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze random processes for the design of digital communication systems.
CO2. differentiate between different digital modulation schemes.
CO3. design an optimum receiver for AWGN channels.
CO4. estimate the channel with distortion.
CO5. analyze different types of adaptive equalization methods and related issues.

Prerequisite: Digital Communication Techniques (EC 3005)

Introduction: Review of probability theory and stochastic process in digital message transmission, Principles of detection theory: Binary and m-ary hypothesis testing, Multi-hypothesis testing, sufficient statistics, Bay's likelihood ratio test.

Digital Modulation Schemes: Memory-less modulation method, QAM signaling with memory, Continuous –Phase frequency Shift Keying (CPFSK), Continuous –Phase Modulation (CPM), Power Spectral Density (PSD): digital signal with memory, linearly modulated signal with finite mean, PSD of CPFSK and CPM signals.

Optimum Receiver for AWGN Channels: Correlation Receiver, Matched filter receiver, optimal detection, error probability for band limited signal, optimal detection, detection of signaling schemes with memory (maximum likelihood sequence detection, optimum receiver for PCM signals).

Synchronization: Carrier phase estimation (maximum likelihood, phase lock looped, decision-directed loop), symbol time estimation (maximum likelihood, non-decision-directed timing estimation).

Digital Communication through Band-Limited Channels: Band-limited channel: Characterization, optimal receiver for band-limited channels with ISI and AWGN, Linear equalization (peak distortion criterion, Mean Square Error (MSE) criterion), decision feedback equalizer.

Text Book

1. Digital Communication, John G. Proakis and MasoudSalehi, 5th Edition, McGrahill International, 2008
2. A Foundation in Digital Communications, Amos Lapidoth, Cambridge University Press, 2009

Reference Book

1. Communication Systems, Carlson A. and Paul Crilly, 5th Edition. McGraw Hill, 2009.
2. Digital Communications, Simon Haykin, John Wiley & Sons, 2000

EC 6102 TELECOMMUNICATION SWITCHING NETWORKS & PROTOCOLS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze the switching technique in telecommunication system.
CO2. analyze the concept of telecommunication traffic management.
CO3. design and implement switching system.
CO4. differentiate between different telephone exchanges.
CO5. analyze various signaling systems and its architecture.

Prerequisites: Digital Communication Techniques (EC 3005) and Communication Engineering (EC 3009)

Introduction: Evolution of Telecommunication, Switching system, Classification of switching, Elements of Telecommunication, Telecommunication standard

Telephone System: PSTN, Modern Telecom System, Telephone Network, Telephone numbering plan, Central battery system, Transmission impairments, two/four wire transmission, subscriber loop design.

Telecommunication Traffic: Telecommunication traffic, Grade of service, Traffic measurement, Mathematical model for telecommunication traffic.

Switching Systems : Switching, Types of switching, Circuit switching, Message/Packet switching, Functions of switching system, Electronics switching system, Multiplexing, TDM (E1/E2, T1), FDM, Implementation of switching system, Blocking and Non-blocking Switches, Single stage and Multistage switches, Space switching, Time switching, Hybrid switching, Path finding, Complexity, Blocking probability of switch.
Telephone exchange: Stored program controlled exchange, Electronic exchange, Example of modern exchange (C-DOT exchange), availability of parallel exchange.

Signaling systems: Types of signaling information, forms of signaling, Channel Associated Signaling (CAS), Common Channel Signaling, CCITT No-7 system, SS 7 Signaling Architecture .

Text Book

1. Telecommunication Switching, Traffic and Networks – J. E. Flood –1st edition, 2011 Pearson LPE.
2. Digital Telephony – John C. Bellamy, John Wiley, 3rd Edition, 2000.

Reference Book

1. Telecommunication Switching Systems and Networks – T. Viswanathanam – PHI Publication, 2011
2. Signaling in Telecommunication Networks, - John G. van Bose and Fabrizio U. Devetak, Wiley Interscience, 2nd Edition, 2007

EC 6108 DIGITAL IMAGE PROCESSING Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze different image processing technique to retrieve image information.
CO2. differentiate between different image transformation techniques.
CO3. analyze different image enhancement techniques.
CO4. analyze the concept of color image processing.
CO5. analyze the concept of image restoration.
CO6. differentiate between different image compression and segmentation techniques.

Prerequisites: Digital Signal Processing (EC 3007) & Principle of Digital Signal Processing (EC 3013)

Introduction: Historical Background of image processing, fundamental steps in image processing elements of digital image processing systems. Digital image representation, Different image processing tasks: Image enhancement, Image restoration, Image compression and image analysis.

Digital Image Fundamentals: Elements of visual perception, A simple image model, sampling and quantization, relationship between pixels, image geometry: translation, rotation, perspective transformation, camera model, camera calibration, stereo imaging.

Image Transforms: Review of mathematical preliminaries : matrix theory results: Toeplitz and circulant matrices, orthogonal and unitary matrices, positive definiteness and quadratic forms ,block matrices and Kronecker products, separable operators, introduction to image transforms, Two dimensional orthogonal and unitary transforms, properties of unitary transforms, 2-D DFT, Walsh Transforms, Hadamard transform, Discrete Cosine Transform (DCT), Discrete Sine Transform (DST), Haar Transform, Slant Transform, Brief introduction to wavelet transform and multi-resolution analysis, Karhunan-Lauve (K-L) Transform, SVD Transform.

Image Enhancement : Introduction spatial domain methods, frequency domain method, enhancement by point processing : Histogram equalization, spatial filtering : Low pass median, Sharpening filter, High boost filters, derivative filters, enhancement in frequency domain, Homomaorphic filtering.

Color Image Processing: RGB, CMY and YIQ color models conversion from RGB to HIS and HIS to RGB.

Image Restoration : Introduction, degradation model, algebraic approach to restoration, inverse filtering, Weiner filter, constrained least squares restoration, restoration in spatial domain.

Image Compression : Introduction and motivation, fundamental concepts : Data redundancy (coding redundancy, interpixel redundancy and psycho visual redundancy), fidelity criteria, image compression models, elements of information theory, image compression techniques: pixel coding (PCM run-length – coding, bit-plane coding), Predictive coding, Delta modulation, DPCM etc., Transform coding (Zonal coding, Thresh holding, coding with different transforms), Other techniques such as vector quantization and hybrid coding, Image compression standards.

Morphological Image Processing: Dilation and erosion, Opening and closing, some basic morphological algorithms.
Image Segmentation: Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region based segmentation.

Text Book

1. Digital Image Processing - R.C.Gonzalez and R. E. Woods – Prentice Hall,3rd Edition,2008.

Reference Book

1. Fundamentals of Digital Image Processing- A. K. Jain – Prentice Hall
2. Digital Image Processing- S.Jayaram, S.Esakkirajan, T.Veerakumar – TMH,2009.

EC 6112 COMMUNICATION & NETWORK SECURITY Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze different security threats and attacks with reference to ISO/OSI model security.
CO2. differentiate between various cryptography, watermarking, steganography methods.
CO3. analyze different Symmetric and Asymmetric cryptographic algorithms.
CO4. differentiate various key distribution and Digital Signature.
CO5. analyze the working of various communication security protocols with respect to OSI layer.
CO6. analyze different network security systems implementation in Wireless systems.

Prerequisite: Data Communication and Networking (EC 3028)

Introduction: Cryptography, Watermarking, Steganography, Escrow & Crypt Analysis, ISO/OSI reference model & security, Security threatening attacks & actions, Reviews of mathematical foundations (Logarithms, Prime Number, GCD, Groups, Rings, Fields, Fermat's Theorem, Euler's Theorem, Exclusive-Or, Random Numbers).

Ciphers &Algorithm: Symmetric Ciphers, Asymmetric Ciphers systems, Elliptic Curve Crypto systems, RSA Algorithm.
Cryptographic Key distribution system: Key Distribution, Merkle's Puzzle Method, Shamir's Key Distribution Method, Digital Signature.

Communication Security layer classification: A synergistic security frame work, Firewalls & Gateways, Security Cross- portfolios, attacks and security in the internet, TACACS.

Network security: Wireless system: WLAN security, IEEE 802.11i robust security network and vulnerabilities, GSM Security, B3G/4G Security Concerns, Wimax Security, and Communication Satellite network security, Wireless Adhoc Network Security.

Text Book

1. Cryptography & Network Security by B A Forouzan and D Mukhopadhyay, Mc-Graw Hill, India, 2nd Edition, 2010..
2. Security of Information and Communication Network by S V. Kartalopoulos, Wiley-IEEE Press., 2009.

Reference Book

1. Handbook of Information and Communication Security by Stavroulakis, Peter; Springer, 2010
2. Secure Broadcast communication in Wired and Wireless Communication. By Adrian Perrig& Doug Tygar, Kluwer Publication, 2002.
3. Modern Cryptography: Theory and Practice by W Mao, Pearson Education, India, 1st Edition, 2003.

EC 6114 SPREAD SPECTRUM TECHNIQUES AND MULTIPLE ACCESS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze different Spread Spectrum Techniques such as DSSS and FHSS.
CO2. analyze different Spreading Sequences: Correlation functions, Binary linear feedback Shift register sequence for spread spectrum.
CO3. analyze the concept of jamming in Spread spectrum communication model.
CO4. analyze the process of Code acquisition and Tracking Loops.
CO5. differentiate between multiple access such TDMA, FDMA and CDMA.
CO6. differentiate between various CDMA –SS application like of CDMA digital cellular systems.

Prerequisites: Digital Communication Techniques (EC 3005) and Wireless & Mobile Communication Engineering (EC 4003)

Spread Spectrum Techniques: Introduction, Basic communication problems, Pulse noise jamming, Low probability of detection, Signal structure secrecy, Direct sequence spread spectrum, Frequency hopping spread spectrum: Coherent slow frequency hopping spread spectrum, Non Coherent slow frequency hopping spread spectrum, Non coherent fast frequency hopping spread spectrum, Hybrid direct sequence and frequency hopping spread spectrum, Time hopping and Multicarrier Systems.

Spreading Sequences: Correlation functions, Binary linear feedback Shift register sequence for spread spectrum, Definitions, mathematical background and sequence generator fundamentals, Maximal length sequences, Gold Sequences.

Communicating through fading Channels: Performance of spread spectrum system in Jamming environments, Spread spectrum communication model, performance in jamming environment without coding. Fading Channels: statistical model of fading, Characterization of mobile radio channel, Requirement of diversity in fading channel.

Code acquisition and Tracking Loops: Introduction, Optimum tracking of wideband signal, Baseband delay-lock tracking loop, Non coherent delay lock tracking loop, Code tracking loop for frequency hop system.

Multiple Access-multi-user interferences and multi-user Detection: Multiuser systems and multiple access problems, FDMA, TDMA, Code division multiple access, Synchronous CDMA, Asynchronous CDMA, and Asynchronous CDMA in cellular networks.

Applications: Multicarrier CDMA, MC-DS-CDMA, Ultra-Wideband (UWB) systems, Mobile communications and wireless networks: CDMA digital cellular systems, Specific examples of CDMA digital cellular systems.

Text Book

1. Introduction to Spread Spectrum Communication, by Roger L. Peterson, Rodger E Ziemer and David E. Borth, Prentice hall 1995,ISBN:0024316237
2. Spread Spectrum and CDMA Principle and applications, by Valery P. Ipatov ,John wiley& sons,Ltd,ISBN:0470091789, 2005.

Reference Book

1. Spread Spectrum Systems by R.C.Dixon**,** John wiley& sons,Ltd,ISBN:0471539427,1984.
2. Principle of Spread Spectrum Communication, A. J. Viterbi, CDMA, Addison-Wesley ,1995,ISBN:0201633744

EC 6128 WIRELESS SENSOR NETWORK Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze the architecture of wireless sensor networks and the factors influencing WSN architecture design.
CO2. analyze the physical and MAC Layer issues in WSN.
CO3. analyze the basic principles of Routing Mechanisms in WSN.
CO4. analyze the localization and time synchronization problems with reference to WSN.

Prerequisite: Data Communication and Networking (EC 3028)

Introduction: Basic Concepts, Platforms, Standardization, architecture and protocols, Applications in military, environment, healthcare, industry and energy, factors influencing WSN Design.

Physical & MAC Layer: PHY layer standard (IEEE 802.15.4), MAC challenges, MAC protocols for Sensor Network - Contention based (S-MAC, B-MAC, CC-MAC), reservation based-(TRAMA) & Hybrid MAC (Zebra MAC).
Network & Transport layer: Routing challenges, Data Centric and Flat- architecture protocol(SPIN), Hierarchical protocol (LEACH),Geographical routing protocol (MECN), QoS based Protocol(SAR).Challenges of Transport layer ,Transport Layer protocols (PSFQ & CODA).

Cross Layer Solutions: Interlayer Effects, Cross layer Interactions (MAC-Network, MAC-Application, Network and PHY, Transport –PHY), cross layer module.

Localization: Challenges in localization, Ranging Techniques, Range based Localization protocols, Range-Free Localization Protocol.

Time Synchronization: Challenges for Time synchronization, Timing Sync protocol for sensor network (TPSN), Time Diffusion Synchronization protocol (TDP), Rate based diffusion protocol (RDP).

Text Book

1. Wireless Sensor Networks – Ian F. Akyildiz and Mehmet Can Vuran -John Wiley and Sons Ltd, Publication,2010.

Reference Book

1. Wireless Sensor Network - a networking perspective, Jun Zhny and Abbos Jama Lipcar,Wiley 2009.
2. Wireless Sensor Network, Springer, C. Raghavendram, K Sivalingam and T. Znati, ISBN:1-4020-7883-8, August 2005.

EC 6224 LOW POWER VLSI DESIGN Cr- 3

Course Outcome: At the end of the course, the students will be able to :

CO1. design different MOS Logic circuits
CO2. analyze different types of power dissipation in CMOS circuits
CO3. differentiate between different scaling techniques
CO4. optimize the power dissipation in CMOS circuits through switched capacitance minimization approach
CO5. optimize the power dissipation in CMOS circuits through different lower power minimization techniques.

Prerequisite: VLSI Design (EC 3011)

Basics of MOS circuits: MOS transistor structure and device modeling, MOS inverters, MOS combinational circuits - different logic families.

Sources of power dissipation in CMOS circuits: static power dissipation - diode leakage power, subthresholdleakage power, gate and other tunnel currents; dynamic power dissipation - short circuit power, switching power, gliching power; degrees of freedom, energy delay product, power delay product.

Supply voltage scaling approaches: technology Level - feature size scaling, threshold voltage scaling; logic level - gate sizing for voltagearchitecture level - parallelism and pipelining; algorithm level - transformations to exploit concurrency; dynamic voltage scaling. Switched capacitance minimization approaches: system level - power down, system partitioning;algorithm level - concurrency, locality, regularity, data representation; architecture level - concurrency, signal correlation; logic level - gate sizing, logic styles; layout level - layout optimization; technology level - advanced packaging, SOI.
Leakage power minimization techniques: threshold voltage scaling: MTCMOS, VTCMOS and Multiple-

Vt CMOS circuits; gate sizing. Low power memory design: ROM, SRAM (4T, 6T), DRAM.

Text Book

1. CMOS Digital Integrated Circuits, Sung-Mo Kang and Yusuf Leblebici, 3rd edition, TMH,2011
2. Digital Integrated Circuits: A Design Perspective, J. M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, 2nd Edition, PHI,2001

Reference Book

1. CMOS VLSI Design: A circuits and Systems Perspective, West, Harris and Banerjee, 3rd edition, Pearson Education,.
2. Low Power VLSI CMOS Circuit Design, A. Bellamour, and M. I. Elmasri, Kluwer Academic Press.
3. Low Power Digital CMOS Design, Anantha P. Chandrakasan and Robert W. Brodersen, Kluwer Academic Publishers,2002.
4. Low-Power CMOS VLSI Design, Kaushik Roy and Sharat C. Prasad, Wiley-India,2011.
5. Essentials of VLSI Circuits and Systems, Eshraghian, Puckness and Eshraghian, 2nd edition, Pearson Education,

EC 6313 OPTIMIZATION TECHNIQUES IN ENGINEERING Cr–3

Course Outcome: At the end of the course, the students will be able to :

CO1. formulate fitness functions and cost functions for engineering optimization problems and specify the constraints as required.
CO2. implement different single variable optimization algorithms including the gradient based methods.
CO3. analyze and implement different multi variable optimization algorithms and a multi objective optimization techniques based on Parento-Fronts.
CO4. implement Bio-inspired optimization algorithms for solving complex engineering problems.

Prerequisites: Mathematics-I (MA 1001) and Mathematics-II (MA 1002)

Introduction: Optimal problem formulation, Design variables constraints, Objective function, Variablebounds, Engineering optimization problems, Optimization algorithms.

Single-variable Optimization Algorithm: Optimality Criteria, Bracketing methods: Exhaustive search methods, Region-Elimination methods; Interval halving method, Fibonacci search method, Point estimationmethod; Successive quadratic estimation method.

Gradient-based Methods: Newton-Raphson method, Bisection method, Secant method, Computer programmes.

Multivariable Optimization Algorithm: Optimality criteria, unidirectional search, Direct search methods: Evolutionaryoptimization method, Simplex search method, Hooke-Jeeves pattern search method, Cauchy's (Steepest descent) method, Newton's method, multi-objective optimization, Pareto optimization.

Constrained Optimization Algorithm: Characteristics of a constrained problem. Direct methods: The complex method, Cuttingplane method, Indirect method: Transformation Technique, Basic approach in thepenalty function method, Interior penalty function method, Convex method.

Advanced Optimization Algorithms: Genetic Algorithm (GA), working principles, GAoperators, selection methods, advanced GAs, computerprogrammes, simulated annealing. Particle swarm optimization (PSO), differential evolution (DE) algorithm, bacterial foraging algorithm, ant colony optimization algorithm.

Text Book

1. Optimization for Engineering Design-Algorithms & Examples – K. Deb, PHI, 2nd Ed., 2012.
2. Multi-objective Optimization Using EvolutionaryAlgorithms-K. Deb, John Wiley & Sons, 1st Ed., 2001.

Reference Book

1. Optimization: Theory and Applications - S.S. Rao, Wiley Eastern Ltd, 2nd Ed., 1979.

EC 6316 MICROWAVE INTEGRATED CIRCUITS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. analyze the fabrication techniques of MIC and MMIC , use of active devices with MIC and MMIC, differentiate between MIC and MMIC.
CO2. analyze and design strip lines and micro strip lines, and model the discontinuities in those lines.
CO3. analyze and design slot lines, fin lines, coplanar lines and coplanar wave-guides
CO4. design parallel coupled lines for couplers and power divider circuits.
CO5. differentiate between various measurement techniques associated with planar transmission lines.

Prerequisites: Analog Electronic Circuits-I (EC 2001) and RF & Microwave Engineering (EC 4001)

Introduction: Introduction to Microwave Integrated Circuits (MIC) and Monolithic Microwave Integrated Circuits (MMICs), their advantages over discrete circuits, MMIC fabrication techniques, Thick and Thin film technologies and materials, encapsulation and mounting of active devices in MIC and MMIC.

Planar Transmission Lines-I: Strip line & microstrip line, field configurations, quasi-TEM mode in microstrip line, analysis of microstrip transmission line, concept of effective dielectric constant, impedance of Strip line & microstrip line, dispersion and losses in microstrip line, discontinuities in microstrip.

Planar Transmission Lines-II: Slot Line, approximate analysis and field distribution of slot line, transverse resonance method and evaluation of slot line impedance, comparison with microstrip line. Fin lines & Coplanar Lines, analysis of Fin lines by transverse resonance method, conductor loss in Fin lines, coplanar wave guide (CPW).

Parallel-coupled Microstrip Lines and Power Dividers: Coupled microstrip lines, even mode and odd mode characteristic impedances, semi-empirical formulae for coupled line parameters, coupled-region length, coupler directivity, crosstalk between microstrip lines, design of microstrip branch-line power divider and rat-race ring power divider.

MIC Measurement, Testing and Applications: MIC measurement system, microwave test fixtures and probes, measurement techniques of S- parameters, noise measurement.

Text Book

1. Microstrip Lines and Slot Lines - K.C. Gupta, R. Garg. , I. Bahl, P. Bhartia, Artech House, 2nd Ed., 1996.
2. Foundation for Microstrip Circuit Design-T. C. Edwards, John Wiley & Sons Ltd, 2nd Ed., 1992.

Reference Book

1. Stripline-like Transmission lines for Microwave Integrated Circuits, B. Bhat, S. K. Koul, Wiley Eastern Ltd, 1st Ed., 1989.
2. Microwave Integrated Circuits, K.C. Gupta and A. Singh, Wiley Eastern Limited, 1st Ed., 1975.

ELECTRONICS
&
ELECTRICAL
ENGINEERING

Program Educational Objectives (PEOs)

The Program Educational Objectives (PEOs) of the B.Tech Program in Electronics & Electrical Engineering are as follows :

PEO-I. To lead a successful career in industry or pursue higher studies or entrepreneurial endeavours.

PEO-II. To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.

PEO-III. To demonstrate effective communication skill, professional attitude and a desire to learn.

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The Program Outcomes of the B.Tech Program in Electronics & Electrical Engineering are:

a) Ability to apply knowledge of mathematics, science and engineering to solve complex problems.

b) Ability to identify, formulate and solve electronics and electrical engineering related problems using first principles.

c) Ability to design, implement and evaluate electrical and electronics systems to meet the societal and environmental needs.

d) Ability to design and conduct complex experiments and interpret data.

e) Ability to use techniques, skills and modern engineering necessary for engineering practices.

f) Ability to assess the impact of contemporary social issues on professional practice.

g) Ability to recognize the sustainability and environmental impact of the engineering solutions.

h) Ability to follow prescribed norms, responsibilities and ethics in engineering practices.

i) Ability to work effectively as an individual and in a team.

j) Ability to communicate effectively through oral, written and pictorial means with engineering community and the society at large.

k) Ability to recognize the need for and to engage in life-long learning.

l) Ability to understand and apply engineering and management principles in executing projects.

EL 3001 CONTROL SYSTEMS Cr-4

Course Outcome : At the end of the course, the students will be able to :

CO1. determine the transfer function.
CO2. calculate the effect of feedback on gain, time constant, bandwidth, noise etc.
CO3. analyze the working and importance of control components in a control loop.
CO4. define performance characteristics.
CO5. define type and order and then calculate rise time , peak time, steady state error for standard test inputs.
CO6. determine the stability from characteristic equation using Routh stability criterion.
CO7. draw the root locus to determine the system stability.
CO8. draw the bode and nyquist plots and determine the system stability

Prerequisite: Signals and Systems (EC 2003)

Introduction:
Basic concepts of Control Systems, Classifications, Servomechanism and Regulators.

Depreciation of Physical System:
Differential Equation of Physical System,Transfer function, Block Diagram Algebra, Signal flow graph, Mason's gain formula, application of signal flow graph to control system.

Feedback Theory:
Feedback and non feedback systems, Reduction of parameter variation by use of feedback, Control of the Effects of Disturbance Signals by use of feedback, Regenerative Feedback.

Control Systems & Components:
Electrical Systems: A. C. Servomotor, D.C. Servomotor, A.C. Tachometer, Potentiometers, Sychoros, A.C. and D.C. position control system, hydraulic Systems, Preumatic Systems.

Time domain Analysis, Design Specification & Performance Indices:
Standard Test Signal: Step, Ramp, Parabolic, Impulse.

Time Response of First-order System:
Response of the Unit step Input, Response to the Unit Ramp Input.

Time Response of second-order System:
Response to the Unit Step Input, Time Response specifications, Steady state Error and Design specification, Error constant of 2nd order system, Derivative and Integral control PID control, Design consideration for higher order systems, Performance indices, Optimization using ITAE.

Concept of Stability:
The concept of stability, necessary conditions for stability, Hurwitz Stability Criterion, Routh Stability Criterion, Application of Routh Stability Criterion to Linear Feedback Systems.

Root of Stability:
Root Locus Concept, Construction of Root Loci, Construction Rules, Determination of gain from Root Locus.

Frequency Domain Analysis:
Introduction, Bode diagram, Polar Plots, Log magnitude versus Phase Plots, Nyquist stability criterion, Stability Analysis, Relative stability, Closed Loop Frequency Response: Constant M-Circles, Nichols Chart, Use of MATLAB for performance studies.

Text Book

1. Control System Engg. I. J. Nagrath & M. Gopal, 5th edition New Age International (P) Ltd

Reference Book

1. Modern Control Engg, K. Ogata, PHI, 3rd Edn, 1997
2. System Dynamics & Control: Eronini Umez-Eronini, 1999 Edn, PWS Publishing International Thompson Publishing Company
3. Control Systems Engineering, Norman Nise, Wiley, 3rd Edn.

EL 3022 ADVANCED CONTROL SYSTEMS Cr-3

Course Outcome : At the end of the course, the students will be able to :

CO1. design cascade and feedback compensation using Bodes Plot.
CO2. design PID Controllers.
CO3. analyze State-Space Analysis for Linear Continuous time.
CO4. solve of stage equations, State Transform matrix
CO5. test for Controllability & Observability.
CO6. analyze various mathematical analysis for Nonlinear System and Discrete-Time System.

Prerequisite: Control Systems (EL 3001)

Introduction to Design:
Cascade and feedback compensation, Lead and Lag compensation design using Bodes plot.

Cascade Compensation in Frequency Domain:
Correlation of time and frequency domain specifications, Lead and Lag compensation design using Bode plot, Comparison of Lead & Lag Compensation, Feedback compensation in Frequency domain.

PID and Robust Control System Design:
Zigler Nichols rules for Turning PID controllers, Modifications of PID control Scheme. Robust control System Design Examples.

State-space Analysis :
(Linear Continuous time) Concept of state variables and state model State representation using physical variables and using phase variables & canonical variable.

Solution of stage equations, State Transform matrix:
Properties, Computation by Laplace Transform and using Caley-Hamilton Theorem. Transfer function from state equations. Characteristics equation eigen values & eign vectors. Digitalization using similarly Transform, Vander monde Matrix and Modal matrix.

Controllability & Observbility Test:
Pole placement using stage feedback for Regulator Type Systems, Full order state observer design, Ackermann's formula, Effect of observer on classed loop system.

Nonlinear Systems:
Definitions, examples, Vander Pole's equations
Linearization of nonlinear system, Around equilibrium points, Phase plane method, Singular points, Method of Isoclines, Stability of nonlinear systems, Limit cycles, Phase plane trajectories of simple nonlinear control system.

Discrete-Time System:
Sampled data digital control system, Uniform periodic sampling, Mathematical description of sampling process, Spectrum analysis, sampling theorem, aliasing, signal reconstruction, using zero order hold.
Z transform of signals and discrete sequences Z transform theorems Conversion of G (&) to G(Z), Difference equation, Inverse Z-transform methods. The Z transfer function (pulse transfer function)
Difference equation Solution, Z & S domain relationship, Impulse response and step transient response, Error constants, steady state error.

Text Book
1. Control System Engg, J. Nagrath & M. Gopal 3rd Edition New Age International Publisher
2. Modern Control Engg., By K. Ogata 3rd Edition PHI

Reference Book
1. Discrete Time Control System, K. Ogata 2nd Edition Pearson Education

EL 3024 INDUSTRIAL AUTOMATION AND CONTROL Cr-3

Course Outcome : At the end of the course, the students will be able to :

- CO1. select suitable sensor to measure industrial parameters and the different types of actuators and its working. They will be able to design proper signal conditioning circuit to the transducer.
- CO2. determine the effect of proportional gain, integral time, derivative gain constant on the system performance and will be able to tune the controller using tuning methods, implement PID using electronic , digital, pneumatic and hydraulic methods.
- CO3. design the ladder logic to implement any process with given problem statement.
- CO4. analyze DCS hardware and its merits/demerits in an industrial automation
- C05. analyze SCADA hardware and software and its merits/demerits in industrial automation.
- CO6. design the complex control scheme to a particular process.

Prerequisites : Control Systems (EL 3001) and Introduction to Control Systems (EC 3045)

Sensors, Actuators and Signal conditioning:
Sensors: Displacement sensors, Force sensors, Ultrasonic sensors, Temperature sensors, Pressure sensors etc
Actuators: Dc motors, Servo motors, Stepper motors, Piezo electric actuators, Pneumatic actuators etc.
Signal Conditioning: Filtering, Amplifying, Isolation, ADC, DAC, Sensor protection circuits, Signal transmission and noise suppression, Estimation of errors and calibration.

Controller tuning:
PI controller, PD controller, PID controller and tuning methods: *Ziegler-Nichols tuning method, Cohen coon tuning method,* Implementation of PID controllers (digital and analog).

Automation:
PLC (Programmable logic controllers): Overview, operation and architecture, PLC programming, Application examples.
DCS (Distributed control systems): Overview, Advantages, Functional requirements of Distributed control systems, Communication for distributed control, Application examples.
SCADA (supervisory control and data acquisition): Introduction to SCADA, SCADA system components, architecture and communication, SCADA applications.
Advanced control techniques:
Feed forward control, Ratio control, Cascade control, Adaptive control, Duplex or split range control, Override control, internal mode control.

Text book
1. Computer-Based Industrial Control, Krishna Kant,2nd edition Prentice Hall of India Ltd.
2. Chemical Process Control – Theory and Practice, Stephanopoulous, Prentice Hall of India Ltd, 1984.
3. Fundamentals of Industrial Instrumentation and Process Control, William C. Dunn, TataMcGrawHill, 2009.

Reference book
1. Modern Automation Systems, Muhammad Abdelati, University Science Press, 2009.
2. Modern Control Engineering, 4th edition, Ogata, Prentice Hall of India

ELECTRONICS & INSTRUMENTATION ENGINEERING

Program Educational Objectives (PEOs)

The Program Educational Objectives (PEOs) of the B.Tech Program in Electronics & Instrumentation Engineering are as follows :

PEO-I. To lead a successful career in industry or pursue higher studies or entrepreneurial endeavours.

PEO-II. To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.

PEO-III. To demonstrate effective communication skill, professional attitude and a desire to learn.

Program Outcomes (POs)

The Program Outcomes of the B.Tech Program in Electronics & Instrumentation Engineering are:

a) Ability to apply knowledge of mathematics, science and engineering to solve complex problems.

b) Ability to identify, formulate and solve electronics and instrumentation engineering related problems using first principles.

c) Ability to design, implement and evaluate electronics and instrumentation systems to meet the societal and environmental needs.

d) Ability to design and conduct complex experiments and interpret data.

e) Ability to use techniques, skills and modern engineering necessary for engineering practices.

f) Ability to assess the impact of contemporary social issues on professional practice.

g) Ability to recognize the sustainability and environmental impact of the engineering solutions.

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i) Ability to work effectively as an individual and in a team.

j) Ability to communicate effectively through oral, written and pictorial means with engineering community and the society at large.

k) Ability to recognize the need for and to engage in life-long learning.

l) Ability to understand and apply engineering and management principles in executing projects.

EI 2005 ELECTRICAL & ELECTRONIC MEASUREMENTS Cr-4

Course Outcome: At the end of the course, the students will be able to :

CO1. differentiate between different measurement methods and universal instruments.
CO2. differentiate between measurement techniques for measuring the value of different electrical and electronic components.
CO3. analyze internal construction of instruments used for measuring current, voltage, power, energy, frequency and spectrum.

Prerequisites: Basic Electrical Engineering (EE 1003) and Basic Electronics (EC 1001)

Introduction:
Measurement and its significance, Methods of measurement, Classification of instruments, Errors in measurement, Types, Accuracy and Precision, Significant figures, Units and standards of measurement, classification, Electrical standards, IEEE standards.

Measurement of Resistance, Inductance and Capacitance:
Resistance: Measurement of low and medium resistance, DC bridges - Wheatstone bridges, Limitations of Wheatstone bridge, Kelvin's double bridge, Measurement of high resistance-Megohm bridge. Megger, Inductance: Maxwell's, Hay's, Anderson and Owen's bridge.

Capacitance: Schering &Wein's bridge. Errors in bridge measurement and Wagner's earthing device.

Measurement of voltage and current:
Galvanometer: Construction, principle of operation of D'Arsonval and Ballistic, sensitivity and Galvanometer constants.

Ammeter and Voltmeter: Construction, theory and principle of operation of PMMC, MI, Electro dynamometer, Inductive, Electrostatic type.

DC Potentiometer: Construction, theory and Principle of Basic slide wire DC potentiometer, Crompton and Vernier potentiometers. AC potentiometers: Drysdale , Gall – Tinsley.

Sensitivity, Loading effect on measurements, Range extension and calibration of Voltmeter and Ammeter.

Measurement of Power, Energy and Power factor:
Power: Construction, Theory and principle of operation of electro dynamometer, electrostatic Wattmeter, Measurement of 1Φ and 3 Φ power by Wattmeter.

Energy: Construction, Theory and principle of operation of 1Φ and 3Φ Induction watt-hour meter, Errors and compensation.

Theory and operation of frequency, power-factor meters, calibration of Wattmeters and Energymeters.

Current Transformers and Potential Transformers:
Construction, Theory, characteristics and testing of CTs and PTs.

Electronic Instruments for measurement of basic parameters:
Introduction, Electronic DC & AC Voltmeters, Chopper amplifier type, True RMS Voltmeter, Peak response Voltmeter, Q-meter, Digital Voltmeters (Block diagram only).

Oscilloscope:
CRO, Block diagram, sweep circuits, Delay line, multiple trace, and oscilloscope probes. Introduction to analog and digital storage oscilloscope, Measurement of frequency, phase angle and time delay using oscilloscope.

Frequency Counters, Function Generators and Spectrum analyzers:
Frequency Counters, Function generators, spectrum analyzers: Block diagram, working, types.

Text Book

1. A Course in Electrical and Electronic Measurements and Instrumentation, A K Sawhney, Dhanpat Rai & Co, Reprint, 2013.
2. Modern Electronic Instrumentation and Measurement Techniques, Helfrick & Cooper, 2nd Edition. PHI,

Reference Book

1. Electrical Measurements and Measuring Instruments, Golding & Widdis , 5th edition, Reem Publication,
2. Electronic Instrumentation, H S Kalsi , 3rd Edition, TMH.
3. Electronic Instrumentation &Measurements, David A. Bell, 3rd Edition, Oxford University press.
4. Elements of electronic instrumentation and measurement, Joseph J. Carr, 3rd Edition.

EI 2006 INSTRUMENTATION – I Cr-4

Course Outcome : At the end of the course, the students will be able to :

- CO1. differentiate between various transducers, sensors and their brief performance specifications
- CO2. analyze the principle of working of various transducers used to measure temperature, level and pressure.
- CO3. analyze various signal conditioning techniques.
- CO4. analyze applications of various transducers in industry.

Prerequisites: Basic Electrical Engineering (EE 1003) and Analog Electronics (EC 2013)

Introduction: Instrument and measurement system and its functional elements
Input – Output configuration, correction methods

Performance characteristics of Instrumentation system:
Static and dynamic characteristics, loading effect, Impedance concept.

Statistical analysis:
Statistical concepts, probability distribution function, chi-square test, curve fitting techniques, Reliability.

Primary sensing elements and Transducers:
Primary sensing elements: Mechanical, Pressure and flow sensing elements.
Transducers: Introduction, classification, characteristics and selection
Resistive transducers – Potentiometers, strain gauge, RTD, Thermistor, Photo Conductive cell, pirani gauge.
Inductive transducers: Variable inductance, LVDT, RVDT, Synchro, Resolver.
Capacitive, Hall-effect, Proximity sensors, opto-electronic, ultrasonic and fibre-optic transducers.Voltage generating transducers – thermocouple, piezoelectric and pyroelectric transducers, moving coil generator.
Magnetic type transducers – eddy current, magnetostrictive and magneto resistive types Digital transducers.

Signal conditioning:
Introduction, signal conditioning circuits using DC bridges (Wheatstone bridge), AC bridges with push-pull transducer - Blumlein bridge, Diode circuits, Op-Amps, Attenuators, Filtering, Modulation and Demodulation techniques, A/D and D/A conversion in measurement.

Measurement of non-electrical quantities:

Measurement of force, weight, stress and strain, velocity and acceleration and torque, Shock measurement, Introduction to vibration measurement and monitoring.

Text Book

1. Transducers and Instrumentation – D. V. S. Murthy, 2nd edition, 2013 - PHI Learning.
2. Principle of Measurement Systems – J. P. Bentley 4th edition, Pearson Education.

Reference Book

1. Measurement System Application and Design – E. O. Doeblin,5th edition, TMH
2. Sensors & Transducers - D. Patranabis, 2nd edition, PHI
3. Introduction to Measurement and instrumentation – A.K. Ghosh, 2012, PHI.
4. The Measurement, Instrumentation and Sensors Hand book – John G Webster, CRC press.

EI 2008 INTRODUCTION TO INSTRUMENTATION ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the standard errors in instrument and its classification.
CO2. understand the mechanical measurements necessary for engineering applications and development.
CO3. measure the unknown resistance, inductance and capacitance.
CO4. work with electrical instruments to measure current and voltage of different ranges.
CO5. understand the principles of digital voltmeters, signal generators and CRT.

Pre-requisite: Analog Electronics (EC 2013)

Measurement System and Metrology

Measurement and its significance, Methods of measurement, Classification of instruments, Errors in measurement, Types, Accuracy and Precision, Significant figures. Units and standards of measurement. Limit gauges, slip gauge. Comparators: Mechanical, electronic, optical and pneumatic. Angular measurement: sine bar, autocollimator. Measurement of straightness: Flatness, squareness, roundness and Rotation.

Mechanical measurements

Measurement of surface finish: Terminology, roughness, waviness, analysis of surface finish, stylus probe instrument-Talysurf. Screw thread metrology: Errors in thread-Pitch error-drunkenness-measurement of various elements thread-two and three wire method-floating carriage micrometer. Measurement of gears: tooth thickness, constant chord and base tangent method, Parkinson gear tester.

Electrical Measurements

Resistance Measurement of low and medium resistance, DC bridges - Wheatstone bridges, Limitations of Wheatstone bridge, Kelvin's double bridge, Measurement of high resistance-Megohm bridge. Inductance: Maxwell's, Hay's, Anderson and Owen's bridge. Capacitance: Schering & Wein's bridge.Errors in bridge measurement, Wagner's earthing device.

Electrical Instruments

Ammeter and Voltmeter: Construction, theory and principle of operation of PMMC, MI, Electro dynamometer rectifier type, True RMS meters. Sensitivity, loading effect on measurements. Range Extension of meters: Ammeter shunts, multiplier and instrument transformers (CT and PT).

Electronic Instruments

Introduction, Digital Voltmeters: Ramp type, dual slope and successive approximation type. Signal generators. Cathode ray oscilloscope: Block diagram, CRT.

Text book

1. Engineering Metrology, R.K.Jain, 2005, khanna Publishers.
2. A course in Electrical and Electronic Measurements and Instrumentation, A K.Sawhney, 2001, Dhanpat Rai & Sons.

Reference book

1.Modern electronic instrumentation and measurement techniques, Helfrick & Cooper, 2nd edition, PHI.

2. Engineering metrology, I.C.Gupta, 7th edition , Dhanpat Rai & Sons.

EI 3004 PROCESS CONTROL-I Cr-4

Course Outcome : At the end of the course, the students will be able to :

CO1. design active and passive compensators and also able to perform the state-space representation.
CO2. analyze different physical controlling processes mathematically and compensator design for the same.
CO3. differentiate between different controllers and control schemes.

Prerequisites: Instrumentation-I (EI 2006) and Control Systems (EL 3001)

Introduction to design:

Cascade and feedback compensation, PI, PD, AND PID Controller design, Lead, Lag and Lag-Lead compensators design . Comparison of Lead - Lag compensation. Feedback compensation.

State-space analysis:

Modelling-Concept of state variables and state model (Linear continuous time), State representation using physical variables, phase variables & canonical variable. Solution of state equations, State transform matrix-Properties, Computation by Laplace Transform and using Caley-Hamilton Theorem. Transfer function from state equations. Characteristics equation Eigen values & Eigen vectors. Vander monde matrix and modal matrix. Controllability & Observability test.

Process dynamics and modeling:

Need for process control. Mathematical model of flow, Level, Pressure and Thermal Processes, CSTR. Interacting and non-interacting systems, Degrees of freedom, Continuous and batch processes, MIMO processes. Transient response of control systems, servo and Regulatory operations, Proportional control of single capacity, two-capacity, three-capacity processes.Linearization of nonlinear systems.

Basic control schemes:

On-off control, proportional control, PI,PD,PID Control, Frequency response of controllers, Comparison of control actions. Pneumatic, Hydraulic, Electronic controllers.

Controller tuning:

Performance criteria Tuning methods: Process Reaction Curve method, Continuous cycling method and Damped oscillation method, Zeigler-Nichols method, Cohen - Coon method.

Complex control schemes:

Ratio control, Split range control, Cascade control, Feed forward control, selector control, Inverse derivative control, Antireset control. Multivariable control systems Dead time compensation-Smith predictor, selective and Adaptive control systems.

Text Book

1. Process Dynamics & control – Dale E-Seborg, Duncan A. Mellichamp, Thomas F. Edger, Francis J. boyle, John wiley& sons, 3rd Edition
2. George Stephanopoulos, Chemical Process control, An Introduction to Theory and Practice, 1st Edition, PHI.

Reference Book

1. Harriott Peter, Process control, 1st Edition, 2009, Tata Mc GrawHil.
2. Principles of Process Control –, D Patrnabis, 3rd Edition, TMH.
3. Process control principle and Application- SurekhaBhanot, 1st Edition, Oxford.
4. Process Control: Concepts, Dynamics and Applications – SK Singh, 2009 PHI.

EI 3005 INSTRUMENTATION – II Cr-4

Course Outcome : At the end of the course, the students will be able to :

- CO1. analyze the construction and working principle of Industrial Instruments for Temperature, Level, Pressure, Flow and Viscosity.
- CO2. identify sensor, transducer and their performance specifications for measurement of different process variables.
- CO3. apply specific instrument for the measurement of different process variable.
- CO4. analyze the industrial application and calibration of Industrial Instruments.
- CO5. analyze the use of Industrial Instruments in hazardous locations.

Prerequisite: Instrumentation-I (EI 2006)

Temperature measurement:
Temperature scales, ITS90.Filled in systems, Bimetal elements, RTD, Thermocouple, Semiconductor temperature sensors, Radiation pyrometers.

Pressure & vacuum measurement:
Manometer types, Elastic type, D/P Transmitters. Electronic type: capacitive, piezoresistive and resonator type, Installation of pressure measuring devices, accessories.
Vacuum: McLeod gauge, thermal conductivity gauge, ionization gauge.

Level measurement:
Gauge glass, float, displacers and hydrostatic types, D/P type, capacitive type, conductive type, ultrasonic type, microwave type, radiation type, vibration type.

Flow measurement:
Basic principles of flow measurement, Differential pressure devices: orifice, venturi, flow nozzle, pitot tube, annubar, Area flow meter: Rotameter and piston type. Mass flow meter: Coriolis, thermal & impeller types. Electromagnetic type, ultrasonic type, vortex type, turbomagnetic type, target type, positive displacement type, open channel flow measurement, solid flow rate measurement.

Viscosity, density, conductivity and humidity measurements:
Capillary Viscometer, Saybolt viscometer, float viscometer, plastometer, vibrating type, oscillating type, ultrasonic type. Measurement of density: liquid density measurement, gas densitometers, Conductivity measurement.Humidity measurement.

Instrumentation in hazardous locations:
Area, material & temperature, classification, explosion proof enclosures, intrinsic safety, Pressurization, non incendive systems, Combustible gas detectors, Enclosure classification: IP & NEMA standards.

Text book

1. Industrial instrumentation & control, S. K. Singh , 3rd Edition, TMH.

2. Industrial instrumentation, K.Krishnaswamy, S.Vijayachitra, 2nd Edition, New age international.

Reference book

1. Instrument engineers handbook, Vol-1, B.G Liptak, CRC press

2. Measurement System Application and Design – E. O. Doeblin,5th edition, TMH

EI 3007 SENSORS AND ACTUATORS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. understand components of sensor and selection criteria.
CO2. select suitable sensor for measuring displacement and velocity.
CO3. select suitable sensor for force, weight and pressure measurement.
CO4. select suitable sensor to measure temperature in different applications.
CO5. select suitable sensor to measure level and flow.
CO6. understand the working of micro sensor and micro actuators and its applications.

Pre-Requisite: Introduction to Instrumentation Engineering (EI 2008)

Introduction
Definition of sensor and transducer, classification, characteristics. Selection criteria of transducers. Smart sensor: Block diagram, features.

Displacement and velocity Measurement
Linear and rotary displacement sensors: Potentiometer, capacitive, inductive. Position measurement: Optical Encoder, proximity sensors. Velocity measurement: Tachometer types, Stroboscope, Encoder.

Measurement of Force, Weight and Pressure
Force and weight measurement: Strain gauge, types, load cell.Pressure measurement: Manometer types, Strain gauge, diaphragm gauge, capsule, bellows, bourdon tube, piezoelectric sensor.

Temperature measurement
Temperature scales. Mechanical thermometers: Filled in systems, Metallic expansion. Electrical thermometers: RTD, Thermocouple, Semiconductor temperature sensors, Radiation pyrometers.

Level measurement
Mechanical methods: float and displacer. Electrical methods: Resistance, inductive, capacitance type. Gamma radiation method. Ultrasonic level gauging.

Flow measurement
Basic principles of flow measurement. Differential pressure devices: orifice, venturi, flow nozzle, pitot tube, annubar. Area flow meter: Rotameter. Mass flow meter: Coriolis, thermal & impeller types. Electromagnetic type, ultrasonic type, vortex type, turbomagnetic type, target type, positive displacement type.

Micro sensors and actuators
Micro sensors : Principles and examples, force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors , chemical sensors, bio sensors, temperature micro sensors and flow micro sensors. Micro actuators: Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of micro actuators: Electrostatic, magnetic, fluidic, inverse piezo effect.

Text book

1. Industrial instrumentation and control, S.K.singh, 3rd Edition, TMH

Reference book

1. Transducers and Instrumentation, Murthy.D.V.S, 2001, Prentice Hall of India.
2. Sensors and transducers, Patranabis.D, 2003, PHI.
3. Microsystem Technology and Microrobotics, Sergej Fatikow and Ulrich Rembold , 1st edition , Springer-Verlag Berlin Heidelberg.
4. Shape memory actuators, Manfred Kohl, first edition, Springer.

EI 3021 MATERIAL SCIENCE Cr-3

Course Outcome : At the end of the course, the students will be able to :

- CO1. apply knowledge of mathematics, science and engineering (to solve problems related to materials science and engineering)
- CO2. design and conduct experiments, as well as to analyze and interpret data (using statistical, computational or mathematical methods)
- CO3. differentiate between different materials for a wide range of applications in engineering.
- CO4. realize the professional and ethical responsibilities of a materials scientist and engineer.
- CO5. develop skills and techniques of modern materials engineering practice.

Prerequisite: Physics (PH 1003)

Classification of engineering Materials :

Crystal Structures:
Types of crystal, Unit Cells and Basis Vectors, Miller Indices, Crystal Structure of materials (SCC, BCC, FCC, HCP), Classification of crystals – ionic, covalent and molecular crystals.

Crystal Defects: Point defects, Line Defects, Planar or Surface defects.

Dielectric Materials and Insulators:
Polarization, Dielectric constant of mono-atomic and polyatomic gases; Dielectric constant of solids, spontaneous polarization, ferroelectric materials, Curie-Weiss Law, Dielectrics in ac fields, complex polarizability and complex dielectric constant, Dielectric Losses.

Magnetic Properties of materials:
Dia, Para, ferro, anti-ferro and ferrimagnetism, Magnetic hysteresis, Ferrites and their applications, Hard and soft magnetic materials.

Piezoelectric Materials:
Electrostriction, Displacement strain and stressin solids, Quartz- Its piezoelectric properties, applications, Pyroelectric.

Superconductivity:
Review of superconductivity, Application of superconductivity- SQUID, Cryotron.

Advance Materials:
Brief description of other materials such as Corrosion Resistant materials, Nano-phase materials, Shape Memory Alloys, SMART materials, Biomaterials.

Text Book

1. Electrical Engineering Materials: A.J. Dekker, 1st Edition,PHI,2013
2. Material Science: V. Rajendra and A. Marikani,1st Edition, TMH,

Reference Book

1. Material Science and Engineering: W.D. Callister, 2nd Edition , WILEY
2. Material Science and Engineering: V. Raghavan,5th Edition, PHI
3. Material Science and Engineering : M.S. Vijaya and G. Rangarajan, 1st edition, TMH
4. Material Science for Engineers, James F. Shackelford and M.K. Muralidhara,6th edition, PEARSON

EI 3022 BIOMEDICAL INSTRUMENTATION Cr-3

Course Outcome : At the end of the course, the students will be able to :

- CO1. identify various bio-medical signals and instruments, transducers , sensors and their brief performance specifications.
- CO2. analyze the principle of various bio-medical instruments, transducers used to measure temperature, level, pressure.
- CO3. differentiate between various bio-medical instruments.
- CO4. analyze applications of various bio-medical instruments in medical purposes.

Prerequisite: Chemistry (CH 1003)

Fundamentals of Biomedical Instrumentation:
Sources of Biomedical Signals, Basic Medical Instrumentation System, Intelligent Medical Instrumentation Systems, PC Based Medical Instrumentation Systems, General Constraints & Regulations of Medical Devices.

Biomedical Signals & Electrodes:
Origin of Bioelectric Signals-Repolarization, Depolarization, Resting Potential Recording Electrodes – Ag-AgCl Electrodes, Electrodes for ECG, EEG, EMG, Microelectrodes, Skin Contact Impedance, Motion Artifacts, Transducers used in biomedical applications.

Blood pressure measurements:
Manual / automatic systems, invasive and non invasive types, Sphygmomanometer, Blood flow measurements using ultrasonic and electromagnetic flowMeters.

Heart:
Engineering analog of heart, model of heart, electrocardiograph-principle of instrument, detail instrumentation, noises and interference in the measurement, its solutions, other systems of diagnosing the heart.
Pacemaker – general description and instrumentation details, Defibrillator.

X-ray imaging:
Range for medical use, principle of X-ray generation, instrumentation of X- ray image.

Computer aided tomography (CAT):
Basic principle, image acquisition, mathematical modeling for reconstruction of image, block diagram representation of the instrument and detailing of some parts.

Biotelemetry:
Techniques and Applications.

Patient Safety:
Electric Shock Hazards, Leakage Currents, Safety Codes for Biomedical Equipment.

Text Book

1. Hand Book of Biomedical Instrumentation- by R. S. Khandpur, 2nd Edition, Tata McGraw Hill.
2. Biomedical Instrumentation and Measurements- by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, 2nd Edition, PHI learning Pvt. Ltd.

Reference Book
1. Introduction to Biomedical Equipment Technology- by Joseph J. Carr, John M. Brown, 4th Edition.
Pearson Education.

EI 3023 NEURAL NETWORK AND FUZZY LOGIC CONTROL Cr-3

Course Outcome : At the end of the course, the students will be able to :

CO1. analyze and classify neural networks and its implementation algorithms.
CO2. apply suitable algorithms on different cases.
CO3. apply fuzzy logic and neural networks.
CO4. analyze the applications of Neural Network and Fuzzy logic in image processing.

Prerequisites: Mathematics-I (MA 1001), Mathematics-II (MA 1002) and Control Systems (EL 3001)

Neural Networks and Pattern Association:
Differences between biological and artificial neural networks – Typical architecture – Common activation functions – McCulloch – Pitts neuron – Simple neural nets for pattern classification – Linear separability – Hebb net – Perceptron – Adaline – Madaline – Architecture – Algorithm and simple applications – Training algorithms for pattern association – Hebb rule and delta rule – Hetero associative – Auto associative and iterative auto associative net – Bidirectional associative memory – Architecture – Algorithm – Simple applications.

Neural Netwroks based on Competition:
Kohonen self organising maps – Learning vector quantization – Counter propagation – Architecture – Algorithm and applications

Adaptive Resonance and Backpropagation Neural Networks:
ART1 and ART2 – Basic operation and algorithm – Standard back propagation architecture –
Derivation of learning rules – Boltzmann machine learning – Architecture – Algorithm and simple applications

Fuzzy sets and Membership Functions:
Properties and operations on classical and fuzzy sets – Crisp and fuzzy relations – Cardinality – properties and operations – Composition – Tolerance and equivalence relations – Simple problems –Features of membership function – Standard forms and boundaries – Fuzzification – Membership value assignments – Fuzzy to crisp conversions – Lambda cuts for fuzzy sets and relations –Defuzzification methods.

Applications of Neural networks and Fuzzy logic:
Applications of neural networks – Pattern recognition – Image compression – Communication – Control systems – Applications of fuzzy logic – Fuzzy pattern recognition – Fuzzy image compression – Fuzzy logic controllers

Text Book

1. Fundamentals of Neural Networks, LaureneFausett, 2004, Pearson Education.
2. Fuzzy Logic with Engineering Applications, Timothy Ross, 1998, McGraw-Hill.

Reference Book

1. Introduction to Neural Networks Using Matlab 6.0, Sivanandam, S.N., Sumathi, S. and Deepa, S.N, 2005, TMH.
2. Fundamentals of Artificial Neural Networks, Mohammad H. Hassoun, 1st edition,2010, PHI
3. Neural Networks and Fuzzy Systems, Bark Kosko, 1st edition, PHI

EI 3024 VIRTUAL INSTRUMENTATION Cr-3

Course Outcome : At the end of the course, the students will be able to :

CO1. analyze the virtual instrumentation and programming techniques.
CO2. differentiate between different data acquisition techniques on virtual instrumentation.
CO3. implement different controllers and testing using industry standard software.
CO4. differentiate between various Industrial network components and protocols.

Prerequisites: Instrumentation-I (EI 2006) and Digital Electronics (EC 2011)

Introduction:
Virtual Instrumentation – Definition, flexibility – Block diagram and Architecture of Virtual Instruments – Virtual Instruments versus Traditional Instruments Data flow techniques-graphical programming in dataflow– Review of Popular softwares in virtual Instrumentation.

VI Programming Techniques:
VI- sub VI- Loops-structures-charts- arrays- clusters –graphs- formulae nodes –math script- local and global variable- strings- file I/O-execution control- Instrument drivers.

Data Acquisition in VI:
Introduction to data acquisition-signal conditioning-classes of signal conditioning-field wiring and signal measurement-ground loops-A/D, D/A converters, plug-in DAQ boards- Analog input/output cards -Digital Input/Output cards-counter and timer I/O boards-Isolation-techniques- Opt isolation -Data acquisition modules with serial communication.

Communication networked modules:
Introduction to PC Buses – Local bus: ISA – PCI –RS232 – RS422 – RS485 – Interface Bus – USB, PCMCIA, VXI, SCXI, PXI. Instrumentation buses: Modbus – GPIB – Networked bus – ISO/OSI Reference model, Ethernet, and VISA.

Real time control and Applications:
Design of ON/OFF controller- PID controller –electronic prototyping and testing with ELVIS- real-time data acquisition-transducer analysis-signal processing with DSP module-real-time embedded control with CRIO.

Text Book

1. Virtual Instrumentation Using LabView, Jerome, 1st Edition, PHI
2. LabView Graphical Programming, Gary W. Johnson, Richard Jennings, 4th Edition, TMH

Reference Book

1. Practical Data Acquisition for Instrumentation and Control Systems, John Park and Steve Mackay, 2003, Newnes
2. labview based advanced instrumentation system, psumathi, 1st edition,2007, springer science Elsevier

EI 3025 PRINCIPLE OF ANALYTICAL INSTRUMENTATION Cr-3

Course Outcome : At the end of the course, the students will be able to :

CO1. differentiate between various techniques involved to determine the concentration of each component from a mixture.
CO2. analyze different parameters of liquid used for industrial and biomedical application.
CO3. analyze the operating principle of instruments used for radiation detection and pollution monitoring.

Prerequisite: Chemistry (CH 1003)

Fundamentals of Analytical Instruments:
Introduction, Elements of an Analytical Instrument.

Spectrophotometry:
Ultraviolet and Visible Absorption Spectroscopy. Different types of Spectrophotometers. Sources of Errors and Calibration. Infrared Spectrophotometers, Basic Components and Types, Sample Handling Techniques. Flame Photometers, Principle, Constructional Details, Types and accessories. Atomic Absorption Spectrophotometers and their instrumentation.

Chromatography:
Gas Chromatograph, Basic Parts of a Gas Chromatograph, Methods of Measurement of Peak Areas. Liquid Chromatography, principle, construction.

pH Meters And Ion Analyzers :
Principle of pH Measurement, Electrodes for pH Measurement, pH Meters, Ion Analyzers.

Analyzers:
Blood gas analyzers, Measurement of Blood pCO_2 and pO_2. Industrial Gas Analyzers, Paramagnetic Gas Analyzer, The Electrochemical methods, Infrared Gas Analyzers, Analyzers based on Gas density, Method based on Ionization of gases.

Spectrometers:
X-RAY Spectrometer: X-Ray Diffractometers, Electron Probe Microanalyzer. Massspectrometer: Principle, construction NMR &ESR Spectrometer: Principle, construction

Radiochemical Instruments:
Radiation Detectors, Liquid Scintillation Counters, Gamma Spectroscopy.

Pollution Monitoring Instruments:
Air pollution due to carbon monoxide, sulphur dioxide, Nitrogen oxides, Hydrocarbons, Ozone, Water pollution monitoring instruments.

Text book
1.Handbook of Analytical Instruments – by R.S. Khandpur, 2nd edition, TMH

Reference book
1.Instrumental Methods of Analysis ,Hobart H. Willard, 2012, 7th edition, CBS publisher
2.Principles of Industrial Instrumentation, D. Patranabis, 3rd edition, TMH.

EI 3026 FIBER OPTIC INSTRUMENTATION Cr-3

Course Outcome : At the end of the course, the students will be able to :

CO1. differentiate between various optical sources and detectors used for communication.
CO2. analyze various phenomenons of transmission media and its performance calculation.
CO3. differentiate between various sensors and amplifiers used in optical transmission for performance calculation.

Prerequisite: Physics (PH 1003)

Optical Sources:
Light Emitting Diodes (LEDs), LED Structures, Light Source Materials, Quantum Efficiency and LED Power, Modulation of an LED.

LASER diodes:
Principle of Operation, Modes and Threshold Conditions, Optical output power and drive current, Quantum efficiency, Resonant frequencies, Radiation Pattern, Single Mode Lasers, Modulation of Laser diode.

Optical Detectors:
P-n junction Photo diodes, Power relationship, Responsivity Versus wavelength, Equivalent Circuit of a p-n Photo diode, Bandwidth, p-i-n photo diode and APD, Principle of operation, Sources of noise, Noise Equivalent Circuits, Signal to noise ratio for p-i-n and APD.

Optical Fiber:
Fiber Materials, Ray Propagation in Step-Index Fibers, Total internal reflection, Ray Propagation in Graded Index Fibers, Mode Theory, Monomode Fibers, Attenuation in Optical Fibers – absorption, scattering and bending losses

Power Launching and Coupling:
Source-to- Fiber Power Launching, Power-coupling calculation, Equilibrium Numerical Aperture, Lensing Schemes for coupling Improvement.

Fiber-Optic Sensors:
Intensity Modulated Sensors, Phase Modulated Sensors, Fiber-optic Mach-ZehnderInterferometric sensor, Fiber-optic Gyroscope, Spectrally Modulated Sensors, Distributed Fiber Optic Sensors,Fiber optic Bragg grating senor.

Optical Amplifiers:
Semiconductor Optical amplifiers (SOA), Erbium Doped Fiber amplifiers,Fiber Raman ampliflier.

Text Book
1. Optical Fiber Communication by Gerd Keiser, 4th Edition ,McGraw Hill International Edition
2. Fiber Optics and Opto electronics by R. P. Khare, 1st Edition, Oxford University Press

Reference Book
1. Optical Fiber Communications Principles and Practice by John M. Senior, 3rd Edition Pearson Education
2. Optoelectronics and Fiber Optics Communication by C.K.Sarkar and D.C Sarkar, 2nd Edition. New Age International

EI 3027 INDUSTRIAL INSTRUMENTATION Cr-3

Course Outcome : At the end of the course, the students will be able to :

CO1. analyze the construction and working principle of Industrial Instruments for measurement of different process variable like Temperature, Level and Pressure.
CO2. identify sensor, transducer and their performance specifications for measurement of different process variable.

CO3. analyze various Instrumentation and control used in power plant.
CO4. analyze Spectrophotometry and chromatography techniques.

Prerequisite: Electrical & Electronic Measurements (EI 2004)

Temperature measurement :
Bimetal elements. RTD, Thermocouple, Semiconductor temperature sensors, Radiation pyrometers, thermistor.

Pressure & vacuum measurement:
Manometer types, Elastic type, D/P Transmitters. Electronic type: capacitive
Vacuum: McLeod gauge, thermal conductivity gauge, ionization gauge**,** Bourdon tube.

Level measurement:
D/P type, capacitive type, ultrasonic type, microwave type, radiation type**.**

Analytical measurements :
Spectrophotometry: Ultraviolet and Visible Absorption Spectroscopy, Infrared Spectrophotometers.
Mass Spectrometer: Principle, Types, Components of a mass spectrometer.
Chromatography: Gas chromatograph, Basic parts of gas chromatograph, Methods of measurements of peak areas.
Pollution Monitoring Instruments: Air pollution due to carbon monoxide, sulphur dioxide, Nitrogen oxides, Hydrocarbons, Ozone, Water pollution monitoring Instruments.

Power Plant Instrumentation :
Over view Of Power Generation: Introduction, Basic overview of power generation in thermal power plants, P & I diagram, Cogeneration of Power, Importance of Instrumentation and control in power generation.
Instrumentation and Control In Water Circuit: Introduction, Measurements in Water Circuit Water flow, steam flow, water and steam pressure, water and steam temperature, boiler drum water level, Measurement of impurities in water and steam.
Controls in water circuit: Boiler, drum level, superheated steam temperature, steam pressure.
Turbine – Monitoring and Control: Introduction, Turbine Measurements Electrical, Mechanical and Process parameters, Turbine control systems Safety and process, Lubrication system for Turbo Alternator and its control, Turbo Alternator cooling system.

Text book
1. Industrial instrumentation & control, S. K. Singh , 3rd Edition, TMH.
2. Power plant Instrumentation-K .Krishnaswamy, M. Ponnibala, 2ndedition,PHI publication

Reference book
1. Industrial instrumentation, K. Krishnaswamy, S. Vijayachitra, 2nd edition, New age international.
2. Instrument engineers handbook, Vol-1, B.G Liptak, CRC press
3. Handbook of Analytical Instruments- by R. S. Khandpur, 2nd edition, TMH

EI 4003 PROCESS CONROL-II Cr-3

Course Outcome : At the end of the course, the students will be able to :

CO1. analyze digitize the system output and apply controllers whenever needed.
CO2. analyze various different hardware used in industry for programming and controlling purposes.
CO3. differentiate between control elements and their application in industry.

Prerequisites: Control System (EL 3001) and Process control-I (EI 3004)

Computer Aided Process Control:
Introduction, Overview on computer control of process plants.

Digital control systems:
Sampled data digital control system, sampling theorem, signal reconstruction. Z-plane analysis of discrete time control systems, stability analysis in Z-plane, steady state error analysis of sampled data digital control systems. Direct Digital Control, structure, Digital implementation of PID controller, Controller design by S-Z plane transformation. Microprocessor based DDC structure.

Programmable Logic Controller:
Introduction, Architecture, relay ladder logic, programming, software, configuration and applications.

Distributed control system and SCADA:
Introduction.DCS system architecture and elements, configuration and applications, The basic SCADA structure, hardware and software.

Final control elements:
Actuators: Pneumatic Actuators, Electrical Actuators and drive circuit, Control valves: Ball valve, Butterfly valve, Globe valve, Saunders valve. Valve characteristics, Quick opening, Linear, and Equal percentage, Valve sizing and selection, Valve positioners, P-I and I-P converters. Connecting elements in Flow, Level, Pressure and Temperature control loops. Introduction to P&I diagram.

Plant process control:
Boiler control- Control schemes, combustion control, optimizing air-flow, feed water control, furnace pressure control, and steam temperature control. Distillation column- Control schemes, Batch process control-Control schemes.

Industrial control applications:
Cement plant, Thermal power plant, and Steel plant- objectives, automation strategy, and their DCS structure.

Text Book

1. Digital control systems, Benjamin C. kuo, OXFORD,1st Edition.
2. Process control principles and applications, SurekhaBhanot, OXFORD, 1st Edition.

Reference Book

1. Instrument Engineers Handbook , B. G. Liptak, Volume-II & III, Chilton Book Co., Philadelphia.
2. Computer Aided Process Control, S.K.Singh, 2005, PHI.
3. Programmable Logic Controllers : Programming Methods and Applications (With CD) (English) , Hackworth, 1st Edition.

EI 4023 PROCESS DYNAMICS AND CONTROL Cr-3

Course Outcome : At the end of the course , the students will be able to :

CO1. develop the mathematical model of process.
CO2. design various complex control schemes for SISO and MIMO systems.
CO3. tune the PID controller to improve the performance.

Pre-Requisite: Control Systems (EL 3001)

PROCESS DYNAMICS AND MODELLING

Need for process control. Mathematical model of flow, Level, Pressure and Thermal Processes, CSTR. Interacting and non-interacting systems, Degrees of freedom, Continuous and batch processes.

DYNAMIC RESPONSE OF PROCESSES

Transient response of control systems, servo and Regulatory operations, Proportional control of single capacity, two-capacity, three-capacity processes.Linearization of nonlinear systems.

BASIC CONTROL SCHEMES

On-off control, proportional control, PI,PD,PID Control, Frequency response of controllers, Comparison of control actions. Implementation of controllers: Pneumatic, Hydraulic, Electronic Methods.

CONTROLLER TUNING

Performance criteria. Tuning methods: Process Reaction Curve method, Continuous cycling method and Damped oscillation method, Zeigler-nichols method, Cohen - Coon method and 3-C, method of parameter adjustment.

COMPLEX CONTROL SCHEMES

Ratio control, Split range control, Cascade control, Feed forward control, selector control, Inverse derivative control, Antireset control. Multivariable control systems Dead time compensation-Smith predictor, selective and Adaptive control systems.

CONTROLLER DESIGN FOR MULTIVARIBLE PROCESS

Synthesis of alternative control configuration**.** Interaction and Decoupling of control loops: Relative gain array, Control loop selection.Design of noninteracting control loops. Design of control systems for complete plant : Case study.

Text Book

1. Chemical Process control, An Introduction to Theory and Practice, George Stephanopoulos , PHI, 2008.
2.Process Control: Principles and Applications, Surekha Bhanot, Oxford , 2008.

Reference Book

1. Process Dynamics & control – Dale E-Seborg, Duncan A. Mellichamp, Thomas F. Edger, Francis J. boyle, 3rd Edition, John wiley& sons.
2. Modern Control Engineering , K. Ogata, 5th Edition, PHI.
3. B. G. Liptak, Instrument Engineers Handbook, Chilton Book Co., Philadelphia.
4. P. Harriott, Process control, Mc Graw Hill, New York.
5. Process Control , Dynamics Concepts and Applications – SK Singh, PHI ,2007.

EI 4028 POWER PLANT INSTRUMENTATION Cr-3

Course Outcome : At the end of the course, the students will be able to :

CO1. Differentiate between various components of thermal power plants in brief and their operations.
CO2. Differentiate between the sensors used in power plants for various applications.
CO3. Differentiate between controlling strategies used in power plant for error corrections and efficiency enhancing.

Prerequisite: Instrumentation-II (EI 3005)

Overview of Power Generation:
Introduction, Basic overview of power generation in thermal power plants, P& I diagram, Cogeneration of power, Importance of instrumentation and control in power generation.

Instrumentation and Control in Water Circuit:
Introduction, Measurements in water circuit: water flow, steam flow, water and steam pressure, water and steam temperature, boiler drum water level, Measurement of impurities in water and steam, Controls in water circuit: boiler drum level, superheated steam temperature, steam pressure.

Instrumentation and Control in Air-Fuel Circuit:
Introduction, Measurements in air-fuel circuit: flow, pressures, temperatures and level. Controls in air-fuel circuit: combustion and furnace draft. Analytical measurements in air-fuel circuit: oxygen and carbon dioxide in flue gas, combustibles analyser, and infrared flue gas analyser, smoke detector, dust monitor, fuel analysers and chromatography, Pollution monitoring instruments.

Turbine–Monitoring and Control:
Introduction, Turbine measurements: electrical, mechanical and process parameters. Turbine control systems: safety and process, Lubrication system for Turbo Alternator and its control, Turbo Alternator cooling system.

Text Book

1. Power Plant Instrumentation – K.Krishnaswamy, M.Ponnibala, 2nd Edition, PHI publications.
2. Power Plant Engineering - P.K Nag, 3rd Edition, Tata McGraw-Hill.

Reference Book

1. Standard Boiler Operations - S.M. Elonka and A.L Kohal, Tata McGraw-Hill.
2. Mechanical and Industrial Measurements - R.K Jain, 2008, Khanna Publishers.
3. Power Plant Engineering – EL. Wakil, Tata McGraw-Hill.

EI 4029 INSTRUMENTATION FOR OIL & GAS INDUSTRIES Cr-3

Course Outcome : At the end of the course, the students will be able to :

CO1. differentiate between various processes involved in petrochemical industry.

CO2. differentiate between various sensors used in petrochemical industry and their working mechanism, limitations, range of operation.

CO3. differentiate between various controlling schemes involved in petrochemical industry.

Prerequisite: Instrumentation-II (EI 3005)

Overview of petrochemical processes:

Introduction, Petroleum Feedstocks: exploration, recovery, composition, Oil and Gas separation, Refining of crude oil, Processes, Products from crude oil: Methane, Acetylene, Ethylene, Propylene – derivatives etc., Unit operations: Distillation etc.

Measurements:

Pressure, Temperature, Flow, Level sensors; Analytical Instruments: Chromatography, Gas analyzer etc.; Special types of sensors: Soft-sensors in distillation columns, magnetostrictive and magnetic float for level measurement etc.

Control of refinery processes:

Process control in refinery and petrochemical industry: Control of distillation column, Control of catalytic crackers and pyrolysis unit, Automatic control of polyethylene production, Control of vinyl chloride and PVC production; Controls for Safety.

Text book

1. Chemicals from Petroleum, L. Waddams,2^{nd} edition, Chemical Publishing Company
2. Process Control Structures and Applications, Balchan.J.G., and Mumme K.I., Van 1988, Nostrand Reinhold Company, New York

Reference book

1. The Refinery of the Future, James G. Speight, 2010. William Andrew Publishing
2. Instrumentation in Process Industries, B. G. Liptak 2005, CRC Press

EI 4033 NONLINEAR CONTROL THEORY Cr-3

Course Outcome : At the end of the course, the students will be able to :

CO1. analyze various applications of nonlinear control in practical applications.
CO2. analyze various types of phase plane and describing function analysis.
CO3. analyze various types of stability on different types of system.

Prerequisite: Control Systems (El 3001)

Introduction to nonlinear phenomena:
Nonlinear systems-introduction-behavior of nonlinear systems-jump resonance-limit cycles, Common physical nonlinearities-saturation-friction-backlash-dead zone-relay, Multivariable nonlinearities (definition).

Phase plane analysis:

The phase-plane method-basic concepts-singular points-nodal point-saddle point-focus point-vortex point, Construction of phase trajectories-analytical method-graphical methods-isocline method, delta method, Example problems.

Describing function analysis:

Describing function method-basic concepts, derivation of describing functions-dead zone and saturation, relay with dead-zone and hysterisis, backlash, Stability of nonlinear systems- analysis bydescribing function-using Nyquist stability criterion- limit cycles-Reliability of describing function analysis.

Lyapunov Stability Theory:

Stability of nonlinear systems-Lyapunov theory (review)- autonomous and non-autonomous systems ,equilibrium points, Stability in the sense of Lyapunov, asymptotic stability and exponential stability, Linearization and local stability, Lyapunov's direct method, positive definite functions and Lyapunov functions, Lyapunov theorem for local stability and global stability, Analysis based on Lyapunov's direct method-LTI systems-Krasovskii's method, Variable gradient method for constructing Lyapunov functions-simple examples, Popov's stability criterion. Stability of non-autonomous systems (basic concepts only)-Lyapunov's direct method –simple problems.

Text Book

1. Systems and control, Stanislaw H. Zak, 1st Edition, oxford university press
2. Control System Engg. I. J. Nagrath& M. Gopal, 5^{th}edition ,New Age International (P) Ltd

Reference Book

1. Nonlinear Systems Analysis, M. Vidyasagar, Englewood Cliffs. 2nd edition 1993, Prentice Hall
2. Nonlinear Systems, H. K. Khalil, Englewood Cliffs, N.J ,3rd edition, 2001 Prentice Hall
3. Nonlinear Control of Engineering Systems: W. E. Dixon, A. Behal, D.M. Dawson, and S. Nagarkatti A Lyapunov-Based Approach, Birkhäuser, Boston, 2003

MECHANICAL ENGINEERING

Program Educational Objectives (PEOs):

The Program Educational Objectives (PEOs) of B.Tech Program in Mechanical Engineering are established and are listed as follows :

PEO-1. To lead a successful career in industry or pursue higher studies or entrepreneurial endeavors.

PEO-2. To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.

PEO-3. To demonstrate effective communication skill, professional attitude and a desire to learn.

Program Outcomes (POs):

The Program Outcomes of UG in Mechanical Engineering are:

a) Ability to apply knowledge of mathematics, science and engineering in domain of mechanical engineering

b) Ability to identify, formulate, and solve complex mechanical engineering problems using first principle of mathematics, basic science & engineering

c) Ability to design a mechanical component or system or process to meet desired needs within constraining realistic factors including economy, safety and manufacturability.

d) Ability to design and conduct complex mechanical engineering experiments as well as to analyze and interpret the experimental data.

e) Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

f) Ability to assess impact of contemporary social issues on professional practice

g) Ability to recognize the sustainability and environmental impact of the engineering solutions.

h) Ability to follow prescribed norms, responsibilities and ethics in engineering practices.

i) Ability to work effectively as an individual and in a team.

j) Ability to communicate effectively through oral, written and pictorial means with engineering community and the society at large.

k) Ability to recognize the need for and to engage in life-long learning

l) Ability to understand and apply engineering and management principles in executing projects.

ME 1001 ENGINEERING MECHANICS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. identify and formulate elementary level engineering problems related to particle mechanics,in conceptual form as well as in terms of mathematical and physical models and to solve problems dealing with forces in a plane or in space and equivalent force systems.

CO2. solve real life problems by using mathematics, physical laws and theorems.

CO3. utilize scalar and vector analytical techniques for analyzing forces in statically determinate structures and to analyze and design a bridge in a safe and economical way using the knowledge gained from trusses and frames.

CO4. aapply the basic principles ofenergy methodsto theanalysis of particlessubjected toforces.

CO5. apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems.

Prerequisite : Nil

Concurrent Forces in a Plane:

Introduction to Engineering Mechanics, Free-body diagrams, Composition and resolution of forces, Equilibrium of concurrent forces in a plane, Methods of projections, Methods of moments

Friction:

Static friction, Laws of dry friction, Applied of friction in inclined plane, Wedge friction, Belt friction

Parallel Forces in a Plane:

Parallel forces acting in the same and opposite directions, General case of parallel forces in a plane, Centre of parallel forces, Centroid and Centre of gravity, Theorem of Pappus, Centre of composite plane figures and Curves, Distributed forces in a plane.

Moment of Inertia:

M I of plane figures, Parallel Axis Theorem, Perpendicular axis theorem and MI of composite figures.

Force analysis of Plane Trusses and Frames:

Methods of joints, Method of Sections and Method of members.

Principle of Virtual work:

Equilibrium of Ideal Systems, Virtual work.

Kinematics of Rectilinear Motion:

Differential equations of rectilinear motion, Force proportional to displacement, Free vibration, D' Alembert's Principle, Momentum and Impulse, Work & Energy, Conservation of energy, Impact.

Kinematics of Curvilinear Motion:

Normal and Tangential acceleration, Motion of a Projectile, Work and Energy in curvilinear motion.

Rotation of a rigid body:

Kinematic s of rotation, Rotation under the action of a constant moment.

Text Book

1. Engineering Mechanics – S Timoshenko, D. H Young & J.V. Rao-TMH

Reference Book

1. Engineering Mechanics (Statics and Dynamics) - Bear and Johnson, TMH
2. Engineering Mechanics –S.S. Bhavikatti, New Age International

ME 2001 ENGINEERING THERMODYNAMICS Cr-4

Course Outcome: At the end of the course, the students will be able to :

CO1. comprehend terminology related to thermal engineering.
CO2. recognize the need of learning thermodynamics.
CO3. appreciate the 1^{st} law in cyclic and acyclic processes.
CO4. iinterpret the 2^{nd} law in applications related to heat engine, heat pump and refrigerators.
CO5. read and comprehend steam table and Mollier chart in solving complex thermal problems.
CO6. compute availability.

Prerequisite : Mathematics-I (MA 1001)

Basic concepts and definitions:

Scope of thermodynamics, Macroscopic and microscopic approaches, Definition of fixed mass (closed system) and control volume (open system), Properties (extensive and intensive), State and representation on a property diagram, process and its representation, cyclic process (or cycle) and its representation, Characteristics of properties (point and path function), Reversible and irreversible processes, Thermal, mechanical and chemical equilibrium, thermodynamic equilibrium, Zeroth law of thermodynamics, Forms of energy, energy transfer by heat, forms of work (electrical and mechanical), energy transfer by work, conservation of mass in a control volume.

First law of thermodynamics:

Moving boundary work (PdV work), PdV work for different processes, First law for closed systems (for cyclic and non-cyclic processes), introduction of internal energy as a thermodynamic property, flow work and energy of a flowing fluid, first law for control volumes (open systems) and introduction of enthalpy as a thermodynamic property, Application of first law to different processes of fixed masses (closed systems) and control volumes.

Second law of thermodynamics:

Kelvin-Planck and Clausius statements of second law, Reversible and irreversible processes, Irreversibilities, Carnot principles, Clausius inequality, definition of entropy and its evaluation for various processes of pure substances, principle of increase of entropy, Entropy generation.

Pure substances:
Definition of pure substance, p-V and T-v diagrams for pure substances, specific volumes of saturated liquid, wet vapor and superheated vapor. Use of steam tables in finding internal energy and enthalpy of steam at different conditions.

Thermodynamic property relations:
Ideal gases and their p-V-T relation, The Maxwell relations, The Clapeyron's equation, Change in internal energy, Change in internal enthalpy, the T-ds relations, Relation between specific heats, isothermal compressibility and volume expansivity, the Joule-Thomson coefficient.
Exergy:
Available energy or Exergy, Useful work, availability for closed systems, flow availability, irreversibility, Second law efficiency.

Text Book

1. Thermodynamics, An Engineering Approach, Yunus A Cengel and Michael A. Boles, Mc Graw Hill Education, 7^{th} Edition, 2011 (reprint 2013)

Reference Books

1. Fundamentals of Classical Thermodynamics, Gordon J. Van Wylen , Richard E. Sonntag, Claus Borgnakke, John Wiley, Fifth Edition
2. Engineering thermodynamics, P. K. Nag, McGraw Hill Education, Fifth Edition
3. Engineering Thermodynamics, Gordon Rogers and Yon Mayhew, Pearson Education Ltd
4. Engineering Thermodynamics ,Krieth, CRC Press
5. Engineering Thermodynamics , Jones and Dugan, PHI Learning Pvt. Ltd.

ME 2002 MACHINE DYNAMICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. classify various simple mechanisms and explain their inversions.
CO2. analyze velocities and accelerations of mechanisms.
CO3. iillustrate Hook's joint, Davis and Ackerman Steering gears. Compound pendulum, Bifilar and Trifler suspension.
CO4. assess the effect of friction on mechanisms and the kinematics of cam and followers.

Prerequisite : Kinematics & Kinetics of Machines (ME 2009)

Force analysis:

Analytical method of finding acceleration of a piston and connecting rod. Inertia force, Torque. Inertia forces in the Reciprocating Engines, Turning Moment diagrams, Flywheel.

Gyroscope:

Gyroscopic couple of plane disc. Analysis of the forces on bearings due to the forced processing of rotating disc mounted on shafts. Gyroscopic effects on a two wheel and four wheel vehicle. Gyroscopic stabilization with reference to practical application.

Governors:

Centrifugal Governor: Watt and Porter Governors, Spring loaded Governor-Hartnell Governor,Sensitiveness,Stability,Isochronous,Hunting,Governor Effort and Power, curves of Controlling force, Effects of frictions.

Balancing:

Balancing of revolving masses in the same planes and different planes. Partial balance of Locomotives. Variation of tractive efforts, swaying couple. Primary and Secondary balance of multicylinder engines.

Free Vibration:

Free vibration of single degree system without and with damping, Equilibrium Method, Energy method, stiffness of spring elements, viscous damping, Logarithmic decrement.

Forced Vibration:

Equation of motion, Dynamic amplifier, Vibration isolation and transmissibility, transverse vibration of shafts carrying a point load, uniformly distributed load and several loads. Dunkerly's method and energy method, whirling of shafts, Two rotor systems.

Toothed Gears: Theory of shape and action of tooth properties and methods of generation of standard tooth profiles, Standard proportions, Interference and under cutting, methods of elimination of interference, minimum number of teeth to avoid interference.

Lower Pairs:

Hook's joint, Davis and Ackerman Steering gears.

Text Book

1. Theory of Machines, Sadhu Singh, Pearson

Reference Book

1. Theory of Machines, Shigley J, TMH
2. Mechanism and Machine Theory, J.S.Rao and R.V.Dukkipati, New Age
3. Theory of Mechanism and machines, Sharma & Purohit, PHI
4. Theory of Machines and Mechanisms, John Joseph Uicker, Gordon R. Pennock, Joselph E.Shigley, Oxford Univ Pr (Sd), 2010
5. Theory of mechanisms and machines, A. Ghosh and A. K. Mallik, 2nd Edn., 1988

ME 2003 FLUID MECHANICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. explain fluid properties and determine hydrostatic pressure using manometric data
CO2. determine the total pressure and centre of pressure
CO3. demonstrate stability of floating bodies and types of flow. visualize different motion.
CO4. apply Bernoullis equation in moving fluids to find flow rate.
CO5. solve hydraulic pipe flow problems and hence calculate hydraulic and energy grade lines.
CO6. solve complex problem for flow of viscous fluid.

Prerequisite : Mathematics-I (MA 1001)

Fundamental Concepts:
Definition of a fluid, Macroscopic and Microscopic view points, the concept of continuum, concept of pressure and stress in a fluid, Properties of a fluid.

Fluids under Rest:
Fundamental equation and its solution (constant density and constant temperature solutions), Units and scales of pressure measurement, Manometers, Hydrostatic thrusts on submerged surfaces (plane and curved), Buoyancy, Stability of unconstrained bodies in fluids, Fluids under relative equilibrium.

Kinematics of Fluid Flow:
Scalar and vector fields, Description of fluid motion, variation of flow parameters in time and space, Material derivative and acceleration, Stream lines, path lines and streak lines, Translation, Rate of deformation and Rotation. Derivation of Continuity Equation in Cartesian coordinates (Control mass system approach and Control volume approach). Stream function, constancy of stream function on a streamline, physical significance, Velocity Potential, Relationship between velocity potential and stream function.

Dynamics of Inviscid Flows:
Equation of motion for inviscid flow in Cartesian coordinates, Pressure differential between two points (steady, unsteady along a streamline and irrotational flow). Euler's equation o motion in streamline coordinates. Mechanical energy conservation and its application to vortex flow (free and force vortex flow), pressure distribution in free and forced vortex flow, Derivation of Bernoulli' equation from Euler's equation, Applications of Bernoulli's equation for measurement of flow rate through venturimeter, orificemeter, and flow nozzles, concept of static and stagnation pressures and application of pitot tube in flow measurements.

Dynamics of Viscous Flows:
Conservation of linear momentum in differential form, viscous flows through pipes: concept of friction factor in a pipe flow, variation of friction factor, losses due to geometric changes (sudden enlargement, exit loss, sudden contraction, and entry loss), concept of flow potential and flow resistance, flow through branched pipes (pipes in series and parallel), losses in pipe bends, losses in pipe fittings, power transmission by a pipeline.

Text Book

1. Introduction to Fluid Mechanics and Fluid Machines, S. K. Som, G. Biswas & S. Chakraborty, McGraw Hill Education (India) Pvt. Ltd, New Delhi, 3rd Edition, 2014.

Reference Book

1. A Text Book of Fluid Mechanics, R. K. Rajput, S. Chand Limited, 2008.
2. Hydraulics and Fluid Mechanics Including Hydraulics Machines, P.N. Modi, Standard Publishers Distributors, 19th Edition, 2013.
3. Fluid Mechanics, A. K. Mohanty, PHI Learning Pvt. Ltd., 2001.
4. Engineering Fluid Mechanics, K. L. Kumar, S. Chand Limited, 2008.
5. Fluid Mechanics, Y. Cengel and J. Cimbala, McGraw Hill Education (India) Pvt. Ltd, New Delhi, 2rd Edition, 2010.

ME 2007 MATERIAL SCIENCE AND ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. recognize appropriate material for a particular engineering application.
CO2. develop and change the chemical, physical and mechanical properties of steel and its alloys for different structural applications.
CO3. select different no ferrous materials for different industrial and day to day life application.
CO4. change the mechanical properties of steel with or without change in chemical compositions.
CO5. use the technique to prevent corrosion of different ferrous and non ferrous alloys

Prerequisite : Chemistry (CH 1003)

Introduction of Engineering Materials:
Materials Classification, Engineering requirements of materials, recent development in metallic and non metallic materials.

Structure of Materials:
Fundamental concepts, bonding forces and energies, unit cells, crystal structures, crystal systems, Crystallographic plane and directions, single and poly-crystalline materials, non-crystalline materials.

Structure property relationship:
Defects in crystals – point defects, line defects (dislocations), surface defects and volume defects, mechanical properties of materials (tensile, hardness, creep and fatigue), strengthening mechanism of metals, electrical properties, thermal properties, magnetic properties and optical properties.

Phase Diagram and Phase transformation of metals and alloys:
Basics of phase diagram, Gibb's phase rule, Lever rule, Isomorphous, Eutectic and Peritectic alloy system, Iron-carbon equilibrium diagram, Isothermal decomposition of austenite (TTT curve), transformation of austenite upon continuous cooling, Principles of heat treatment, basics of heat treatment furnaces, Annealing, Normalizing, Hardening, Tempering, Martempering, Age hardening, Surface hardening, Case hardening, Hardenability of steel and Jominey end quench test.

Metallic and non-metallic Materials:
Alumium, Magnesium and Titanium alloys and their application, Structural classes of alloy steels, Ordinary, improved and quality carbon structural steels, alloy structural steels, tool steels, wear-resistant steels, stainless and acid resistant steels, corrosion resistant steels, Magnetic steels. Pig iron, Grey cast iron, White cast iron, malleable cast iron, SG (spheroidal graphite) iron, ceramics, polymers and composites.

Materials Selection and Design Considerations:
Introduction, case studies to select material for Torsionally-stressed cylindrical shaft, Automotive valve spring, Anatomy of Hip joint, Integrated circuit and etc.

Economic, Environmental, and societal issues in materials Science and Engineering:
Corrosion & its Prevention, Component design, materials, manufacturing techniques, recycling issues.

Text Book
1. Materials Science and Engineering, Willium D. Callister, Jr. John Wiley & Sons publications
2. Callister's Materials Science and Engineering Adapted By R. Balasubramaniam, Wiley India, Edition - 2010

Reference Book
1. Material Science and Engineering, V. Ragvan, Prentice Hall of India, 4th Edition.
2. Engineering Metallurgy: Applied Physical Metallurgy, R. A. Higgins, 6th Edition
3. Engineering Materials Technology, W. Bolton, 3rd Edition, Butterworth & Heinemann, 2001.

ME 2008 FLUID DYNAMICS AND HYDRAULIC MACHINES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. differentiate Boundary layer thickness, displacement thickness, Momentum thickness, and energy thickness.
CO2. explicate pressure drag and friction drag on stream lined and bluff bodies.
CO3. aapply Raleigh's method and Buckingham theorem for dimensional analysis and model study.
CO4. find out efficiency of Pelton, Francis, Kaplan turbines using velocity triangle.
CO5. describe the characteristics curves of centrifugal pump and reciprocating pump.
CO6. enumerate hydraulic ram, hydraulic accumulator, intensifier, fluid drives, and their applications.

Prerequisite : Fluid Mechanics (ME 2003)

Boundary Layer Theory:

Boundary layer growth over a flat plate, Boundary layer thickness, displacement thickness, Momentum thickness, and energy thickness, Laminar and Turbulent boundary layer, Separation of boundary layer.

Drag and Lift:

Drag and Lift coefficient, pressure drag and friction drag on stream lined and bluff bodies, Drag over flat plate, Local and average skin friction drag coefficient. Profile drag, Circulation, Lift and Magnus effect.

Dimensional Analysis and Model study:

Dimensional homogeneity, dimensional analysis, Raleigh's method and Buckingham theorem. Superfluous and Omitted Variables, Similarity laws and model studies, Distorted models.

Forces on vanes:

Dynamic pressure on fixed and moving flat plates and curved vanes, work done and efficiency.

Turbines:

Classification, Impulse and reaction type, Outward and inward flow, mixed and axial flow turbines, Study of Pelton, Francis and Kaplan turbines, Blade angle, velocity triangle. Specific speed, and unit quantities, Governing of turbines, Draft tubes, Cavitations in reaction turbines, Principles of similarity applied to turbines.

Centrifugal Pump :

Principles, classifications, Blade angle, velocity triangle, efficiency of centrifugal pump, specific speed, Characteristics, curves, Multistage pumps- pumps in series and parallel, Principle of similarity applied to pumps , cavitations in pumps, NPSH.

Reciprocating pump:

Principle of working, slip, work done effect of acceleration and frictional resistance, separation, air vessels.

Text Book

1. A Text Book of Fluid Mechanics and Hydraulic Machines, R. K. Bansal . Laxmi Publications(p) Ltd. 2010, 9th Edition.

Reference Book

1. Hydraulics and Fluid Mechanics (including Hydraulic Machines in SI Units), P. N. Modi, S. M. Seth.,Standard Book House, 1991, 10th Edition
2. Fluid Mechanics and Hydraulics(Including Fluidics), Jagdish Lal, MPP (Metropolitan Book co. Pvt .Ltd, New Delhi.), 1994, 9th Edition
3. Fluid Mechanics,A. K. Mohanty,Prentice-Hall of India Private Limited, New Delhi, 2006, 2nd Edition(10th Printing)

ME 2009 KINEMATIC AND KINETICS OF MACHINES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. classify various simple mechanisms and explain their inversions.
CO2. analyze velocities and accelerations of mechanisms.
CO3. illustrate Hook's joint, Davis and Ackerman Steering gears. Compound pendulum, Bifilar and Trifler suspension.
CO4. assess the effect of friction on mechanisms and the kinematics of cam and followers.

Prerequisite : Mathematics-I (MA 1001)

Simple Mechanisms:

Classification of links and pairs, kinematics chains, degrees of freedom, Grashof's law, Grubler's criterion for plane mechanism. Four bar mechanism and its inversions. Single slider crank chain and its inversions. Double slider crank chain and its inversions.

Velocity Analysis:

Velocity of a point in a link by relative velocity methods and instantaneous center method, Numbers and types of instantaneous centers in a mechanism. Location of instantaneous centers. Kennedy's theorem, Velocities of four-bar and slider crank mechanisms.

Acceleration Analysis:

Acceleration of point on a link, Acceleration diagram of a link, Acceleration in the slider crank and four bar mechanism .Klein's construction, Coriolis' components of acceleration.

Friction:

Friction of a square threaded screw and V-threads, Friction of journal, pivot and collar bearings, single plate, multi plate , conical clutches ,Centrifugal clutch.

Brakes and Dynamometer:

Block, internally expanding and Disc Brakes, Absorption and Transmission Dynamometers, Pony Brakes, Rope Brake, Belt Transmission and torsional Dynamometer.

Belt and Rope and Chain Drive:

Velocity ratio, Effect of belt thickness and slip on velocity ratio, Length of belt, Ratio of driving tensions, Power transmitted by belt ,Centrifugal tension .Maximum power transmitted by belts, Creep and initial tension, V-belt. Ratio of tensions in rope drive. Chain length, angular speed ratio and Classification of chains.

Gear Trains: Simple, compound, Riveted and Epicyclic Gear Trains, Calculation of velocity ratio.

Cams:

Types of cams and followers, Displacement velocity and acceleration-time curves for uniform velocity, uniform acceleration and deceleration, simple harmonic motion and cycloid motion, Graphical construction of cam profiles for different types of followers, Cams with specified contours.

Text Book

1. Theory of Machines, S. Ratan, TMH, 4^{th} Edition

Reference Book

1. Theory of Machines, J. Shigley, TMH
2. Machines and Mechanisms: Applied Kinematics Analysis, David H Myszka, PHI
3. Kinematics of Machinery through Hyper Works, J.S.Rao, Springer, 1st Edition

ME 2010 BASIC MANUFACTURING PROCESSES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand and select the casting process for a particular industrial product.
CO2. identify the suitable forming process for different material and product.
CO3. identify the best welding technique for joining of various components and to produce defect free products.
CO4. apply powder metallurgy process to produce powder of various materials and to manufacture new composite material.

Prerequisite : Chemistry (CH 1003)

Foundry Process:

Pattern making, pattern materials, allowances, types of pattern, sand casting types, sand cast, moulding procedure, types of sand, gates and riser (basic design considerations) essential properties of moulding sand, core making, types of cores. Essential qualities, core mixtures and binder sand testing, Mould and core hardness test, fineness test, clay content test, permeability test, moisture content test, sand conditioning. Cleaning of casting and defects in casting, die casting. Precision investment casting, shell moulds, centrifugal casting processes, permanent moulds casting, dies casting.

Metal Working Process: Hot and cold working of Metals: Basic Principles of hot and cold working of metals.

Rolling: Types of Rolling, Rolling equipments hot and cold rolling, General deformation pattern, Pressure and forces in rolling. Distribution of roll pressure, angle of bite, effect of rolling on microstructure, Rolling defects, Numerical on rolling load and power required for reduction, Thread rolling.

Forgings: Smith forging, Drop forging, press forging & Machine forging, Description of Presses and hammers, forging defects.

Extrusion: Direct, Indirect and impact extrusion and their applications, Extrusion defects. Determination of extrusion force.

Drawing: Wire and rod drawing, Tube drawing, Process variables in drawing process. Deep drawing. Determination of drawing force.

Sheet metal working:

Blanking. piercing, coining, embossing, bending, deep drawing ans spinning.

Powder Metallurgy:

Preparation of powder, properties of powder, fabrication methods & procedure, applications, advantages.

Fabrication Processes:

Classification, types of welding joints, Gas welding: principles, types of flames, equipment, techniques of gas cutting. Electric Arc Welding: Principles of electric welding equipments and electrodes. Principles of Inert Gas Welding: TIG, MIG, sub-merged arc welding. Atomic hydrogen welding, plasma are welding. Resistance Welding: Principle of forge welding, spot welding, seam welding, projection welding, Upset-butt welding, flash welding. thermit welding, electro-slag welding, friction welding. Brazing and Soldering. Welding defects and inspection.

Text Book

1. Manufacturing Technology (Part I), P.N. Rao (Tata Mc-Graw Hill, Publication. Co.Ltd.)
2. Manufacturing Processes, J. P. Kaushish, PHI (2nd Edition)

Reference Book

1. Manufacturing Technology: Materials, Processes and Equipment: Helmi A. Youssef, Hassan A. El. Hofy and M.H. Ahmed, CRC Press, 2015
2. Principle of Manufacturing Materials and Processes: J.S. Cambell, TMH
3. Welding & Welding Technology - R. Little, TMH, 43rd reprint, 2014
4. Manufacturing Science: A. Ghosh & A.K. Mallick, EWP

ME 2011 THERMODYNAMICS AND HYDRAULICS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. develop an intuitive fundamental understanding of thermal-hydraulic systems
CO2. determine the thermodynamic and physical properties of numerous substances
CO3. apply the first and second laws of thermodynamics to several engineering devices
CO4. develop fundamental understanding of fluid machineries.
CO5. apply fluid dynamics principles to numerous fluid mechanical systems

Prerequisite : Mathematics-I (MA 1001)

Thermodynamics:

First law of thermodynamics, internal energy, enthalpy, different thermodynamic processes, Second law of thermodynamics, entropy, carnot cycle, properties of steam, use of steam table and Mollier chart, Rankine cycle, reheat and regeneration.

Steam turbine:

Types, working principle of impulse and reaction turbines, work done and efficiencies.

Gas turbine:

Classification, working principle of gas turbine, Brayton cycle, gas turbine cycle with intercooling, reheat and regeneration.

IC engines:

Otto, Diesel & Dual cycle, S. I. and C. I. engines, 2 stroke & 4 stroke engines, indicator diagram and power measurement.

Fluid dynamics:

Introduction, Euler's equation, Bernoulli's equation. Practical applications of Bernoulli's equation- Venturimeter, Orificemeter, Pitot tube.

Hydraulic turbines:

Types, working principle of Pelton, Francis, Kaplan and Propeller turbines, different heads and efficiencies, work done & efficiency of turbines. Specific speed equation and specific discharge equation.

Centrifugal pump:

Classification, construction, work done, efficiencies, cavitation.

Reciprocating pump:

Classification, construction, working, work done, slip and coefficient discharge.

Text Book

1. Thermal Engineering, A. S. Sarao, Satya Prakashan, New Delhi, Eighth Edition.
2. Fluid Mechanics and Hydraulics Machines: R.K. Rajput, S. Chand

Reference Book

1. Engineering thermodynamics, P K Nag, McGraw Hill Education, Fifth Edition
2. Hydraulics and Fluid Mechanics, P.N. Modi and S.M. Seth
3. Introduction to Thermal and Fluid Engineering, Allan D Kraus, James R Welty, Abdul Aziz, CRC Press

ME 2013 KINEMATICS AND DYNAMICS OF MACHINES Cr-4

Course Outcomes: At the end of the course, the students will be able to:

CO1. classify various simple mechanisms and explain their inversions.
CO2. analyze velocities and accelerations of mechanisms.
CO3. select best drive for machinery.
CO4. assess the effect of dynamic forces on mechanisms and the kinematics of cam and followers.

Pre-requisite: Engineering Mechanics (ME 1001)

Simple Mechanisms

Classification of links and pairs, kinematics chains, degrees of freedom, Grashof's law, Grubler's criterion for plane mechanism. Four bar mechanism and its inversions. Single slider crank chain and its inversions. Double slider crank chain and its inversions.

Velocity Analysis

Velocity of a point in a link by relative velocity methods and instantaneous center method, Numbers and types of instantaneous centers in a mechanism. Location of instantaneous centers. Kennedy's theorem, Velocities of four-bar and slider crank mechanisms.

Acceleration Analysis

Acceleration of point on a link, Acceleration diagram of a link, Acceleration in the slider crank and four bar mechanism. Klein's construction, Coriolis' components of acceleration.

Belt and Rope and Chain Drive

Velocity ratio, Effect of belt thickness and slip on velocity ratio, Length of belt, Ratio of driving tensions, Power transmitted by belt, Centrifugal tension. Maximum power transmitted by belts, Creep and initial tension, V-belt. Ratio of tensions in rope drive. Chain length, angular speed ratio and Classification of chains.

Gear

Simple, compound, Riveted and Epicyclic Gear Trains, Calculation of velocity ratio. Theory of shape and action of tooth properties and methods of generation of standard tooth profiles, Standard proportions, Interference and under cutting, methods of elimination of interference, minimum number of teeth to avoid interference.

Cams

Types of cams and followers, Displacement velocity and acceleration-time curves for uniform velocity, uniform acceleration and deceleration, simple harmonic motion and cycloid motion, Graphical construction of cam profiles for different types of followers, Cams with specified contours.

Force analysis

Analytical method of finding acceleration of a piston and connecting rod. Inertia force, Torque. Inertia forces in the Reciprocating Engines, Turning Moment diagrams, Flywheel.

Gyroscope

Gyroscopic couple of plane disc. Analysis of the forces on bearings due to the forced processing of rotating disc mounted on shafts. Gyroscopic effects on a two wheel and four-wheel vehicle. Gyroscopic stabilization with reference to practical application.

Governors: Centrifugal Governor: Watt and Porter Governors, Spring loaded Governor-Hartnell Governor, Sensitiveness, Stability, Isochronous, Hunting, Governor Effort and Power, curves of Controlling force, Effects of frictions.

Balancing

Balancing of revolving masses in the same planes and different planes, Partial balance of Locomotives. Variation of tractive efforts, swaying couple. Primary and Secondary balance of multi cylinder engines.

Vibration

Free vibration of single degree system without and with damping, Equilibrium Method, Energy method, stiffness of spring elements, viscous damping, Logarithmic decrement. Equation of motion, Dynamic amplifier, Vibration isolation and transmissibility, transverse vibration of shafts carrying a point load, uniformly distributed load and several loads. Dunkerly's method and energy method, whirling of shafts, Two rotor systems.

Text Book

1. Theory of Machines, S. Ratan, TMH, 4th Edition

Reference Book

1.Theory of Machines, J. Shigley, TMH

2.Machines and Mechanisms: Applied Kinematics Analysis, David H Myszka, PHI

3.Kinematics of Machinery through Hyper Works, J.S.Rao, Springer, 1st Edition

ME 2014 ENGINEERING METROLOGY AND MEASUREMENTS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. explain limit, fit & tolerance and design gauges using Taylor's Principle.
CO2. envisage the principle of comparators, sine bar & slip gauges and perform angle measurement using standards of measurement.
CO3. identify statistical quality control using control charts and acceptance sampling.
CO4. analyze reliability data and different hazard models

Prerequisites : Kinematics & Kinetics of Machines (ME 2009) and Fluid Mechanics (ME 2003)

Metrology:
Basics Concepts:
Metrology Defined, Needs of inspection, Principle and methods of measurements, Sources of error, precision and accuracy, Objectives of Metrology and Measurements, Standards of measurement: - Line, End and Wave length standards. Limits, Fits and Tolerances: Interchangeability, selective assembly, limits, tolerances and fits (Indian standard), Fundamental deviation, Hole & Shaft basis systems, limit gauges, Taylor's principles of designs of limit gauges.

Comparators:
Needs of comparator, Basic principle, use, classification and characteristics of comparators, Mechanical, electrical & electronic comparator, pneumatic comparator and comparator sensitivity. Angle Measurements: Sine bar; its use, limitations, errors. Slip gauges and its use. Auto-collimator: - principle, construction and application. Measurement of taper angle.

Inspection of Screw Thread Elements:
Measurement of effective diameter using 2- wire and 3- wire methods of measurement. Geometric Shapes: Measurement of straightness, flatness, parallelism, squareness and roundness (circularity) testing. Surface Texture: Elements of surface texture, order of surface irregularity, methods of measurement of surface finish.

Statistical Quality Control:
Frequency distribution, process capability, control charts, X charts, R Charts, P-charts, C- chart. Acceptance sampling, O. C. curves, Sampling plan & acceptability, Design of Experiment. **Reliability:** Definitions & field data analysis, Hazard models: Constant hazard & linearly increasing hazard models, Bath-Tub Curve, System reliability and reliability improvement, Availability, Maintainability.

Measurement:

Basic Concepts:
Hysteresis, Linearity, Resolution, Threshold, Drift, Transducers classification, Quality attributes of transducers, Mechanical amplification.

Measurement of Force, Torque and Strain:
Direct methods of force measurement, Elastic members: Load cells, Cantilever beams, Proving rings, Differential transformers, Torsion bar dynamometer, Servo controlled dynamometer, Absorption dynamometer, Mechanical strain gages, Theory of strain gage, Gage factor, Methods of strain measurements, Strain gauge bridge arrangement.

Measurement of Temperature and Pressure:
Methods of measuring temperature, Thermocouples, Law of thermocouples, Thermistor, Pyrometry, IR Thermography, Methods of pressure measurement, Static pressure measurement, Elastic pressure transducers, Dead weight pressure gauges, Measurement of vacuum, Measurement of high pressure.

Modern Measurement Techniques:
Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), X-ray Diffraction Systems (XRD).

Text Book

1. Engineering Metrology and Measurements, N.V. Raghavendra & L. Krishnamurthy, Oxford Publ., 2013.

Reference Book

1. Reliability Engineering, L. S. Srinath, East West Press.
2. Statistical Quality Control, M Mahajan, Dhanpat Rai & Co, 2010
3. Mechanical Measurements, R. S. Sirohi, H. C. Radha Krishna, New Age International, 1991
4. Mechanical and Industrial Measurements, R.K. Jain, Khanna Publ., 12th Ed.

ME 2015 MANUFACTURING TECHNOLOGY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand and select the casting process for a particular industrial product.
CO2. identify the suitable forming process for different material and product.
CO3. identify the best welding technique for joining of various components and to produce defect-free products.
CO4. understand the different basic machining processes and machine tools.
CO5. apply the different non- traditional machining processes for up growing high strength materials with complicated and miniaturized product manufacturing.

Prerequisite : Chemistry (CH 1003)

CASTING
Introduction to casting - Patterns - Types - Pattern materials - Allowances. Moulding - types - Moulding sand - Gating and Risering - Core making. Special Casting Process – Shell- Investment - Die casting - Centrifugal Casting - Design of Casting, defects in casting.

MECHANICAL WORKING OF METALS
Hot and Cold Working: Rolling, Forging, Wire Drawing, Extrusion - types – Forward backward and tube extrusion. Sheet Metal Operations: Blanking - blank size calculation, draw ratio, drawing force, Piercing, Punching, Trimming, Stretch forming, Shearing, Bending - simple problems - Bending force calculation, Tube forming - Embossing and coining, Types of dies: Progressive, compound and combination dies, defects in forming.

MACHINE TOOLS
Turning, Drilling, Milling Machine - Types, Types of cutters, operations, Indexing methods. Shaping, Planing and Slotting Machine – Operations and quick return mechanisms, Work and tool holding devices. Boring machine - Operations, Jig boring machine. Broaching machine - operations, Tool nomenclature-Simple Problems.

THEORY OF METAL CUTTING
Orthogonal and oblique cutting - Classification of cutting tools: single, multipoint - Tool signature for single point cutting tool - Mechanics of orthogonal cutting - Force relations : Merchant circle – Determination of Shear angle - Chip formation-Cutting tool materials - Tool wear and tool life - Machinability - Cutting Fluids – Economics of machining. Non conventional machining processes such as AJM, EDM, USM, ECM, PAM, LBM and EBM.

GEAR MANUFACTURING AND SURFACE FINISHING PROCESS

Gear manufacturing processes: Extrusion, Stamping, and Powder Metallurgy. Gear Machining: Forming. Gear generating process - Gear shaping, Gear hobbing. Surface Finishing Process: Grinding process, various types of grinding machine, Grinding Wheel - types - Selection of Cutting speed and work speed, dressing and truing. Fine Finishing - Lapping, Buffing, Honing, and Super finishing.

Text Book

1. Sharma.P.C, "Production Technology : Manufacturing Processes", 7th Edition, S. Chand Publisher, 2008.
2. Rao.P.N, "Manufacturing Technology, Vol I and II", Tata McGraw Hill Publishing Co., 2nd edition, 2009.

Reference Book

1. Hajra Choudhary.S.K and Hajra Choudhary.A.K, "Elements of Manufacturing Technology", Vol II, Media Publishers, Bombay,
2. Jain.R.K, "Production Technology : Manufacturing Processes, Technology and Automation", 17th Edition, Khanna Publishers, 2011.
3. Kalpakjian, "Manufacturing Engineering and Technology", 4th edition, Addison Wesley Congmen Pvt. Ltd., Singapore, 2009.
4. Chapman.W.A.J, "Workshop Technology Vol. I and II", Arnold Publisher, New Delhi, 2001.

ME 2017 THERMODYNAMICS & FLUID MECHANICS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. develop an intuitive fundamental understanding of thermo-fluid systems
CO2. determine the thermodynamic and physical properties of numerous substances
CO3. apply the first and second laws of thermodynamics to several engineering devices
CO4. apply control volume analysis to numerous fluid mechanical systems
CO5. analyse simple, incompressible and inviscid fluid flows, such as pipe and pump flow systems
CO6. develop basic understanding of fluid machineries.

Prerequisite : Mathematics-I (MA 1001)

The Thermal/Fluid Sciences: Introductory Concepts

Thermodynamics, Fluid Mechanics, Importance and Applications of Thermodynamics and Fluid Mechanics in Electronic Product Design, Thermal/Fluid Sciences and the Environment.

Thermodynamics

Preliminary Concept:

Temperature and the Zeroth Law of Thermodynamics,The First Law of Thermodynamics, Second law of thermodynamics: Entropy, Work done, heat added and entropy changes in simple processes, Laws of perfect gas in Engineering Units. Relationship between CP, CV, R and J, Constant Pressure, Constant Volume, isothermal and adiabatic process.

Steam Properties:

Constant pressure formation of steam, Enthalpy and specific volume of dry, wet and super heated steam. Use of Mollier chart.

Gas Power Systems:
The Internal Combustion Engine, The Air Standard Otto Cycle, Design Example, The Air Standard Diesel Cycle, Air standard efficiency of Dual combustion cycle, The Gas Turbine, Simple open and closed cycles.

Vapor Power and Refrigeration Cycles:
The Ideal Rankine Cycle, The Effect of Irreversibilities, The Rankine Cycle with Superheat and Reheat, Design Example, The Ideal Rankine Cycle with Regeneration, The Ideal Refrigeration Cycle, The Ideal Vapor Compression Refrigeration Cycle, Departures from the Ideal Refrigeration Cycle, Solution of Engineering Problems using Psychrometric Chart.

Fluid Mechanics

Fluid Properties:

Physical properties of fluids, Types of fluid, Hydrostatic Law, Measurement of pressure by manometers. Total pressure and centre of pressure on horizontal, vertical and inclined surfaces submerged in liquid.

Buoyancy and Floatation:
Centre of buoyancy, Meta center & meta-centric height, Analytical method for metacentric height, Stability of floating and submerged bodies, Oscillation of a floating body.

Dimensional Analysis and Model study:
Dimensional homogeneity, dimensional analysis, Raleigh's method and Buckingham theorem. Superfluous and Omitted Variables, Similarity laws and model studies, Distorted models.

Flow in Pipes and Pipe Networks:
Frictional Loss in Pipes, Dimensional Analysis of Pipe Flow, Fully Developed Flow, Friction Factors for Fully Developed Flow, Friction Factor and Head Loss Determination for Pipe Flow, Design Examples, Multiple-Path Pipe Systems.

Fluid Machineries:
The Principles of Centrifugal Pump, The Net Positive Suction Head,Combining Pump and System Performance**,** Scaling Laws for Pumps and Fans**,** Axial and Mixed Flow Pumps**,** Turbines.

Text Book
1. Introduction to Thermal and Fluid Engineering, Allan D. Kraus, James R. Welty, Abdul Aziz, CRC Press, 2011.

Reference Book
1. Introduction to Thermal and Fluids Engineering, D. A. Kaminski, M. K. Jensen, Wiley, 2011.
2. Engineering Thermodynamics, Parthasarthi Chattopadhyay, 1st Ed., Oxford Univ. Press
3. A Textbook of Thermal Engineering: (SI Units), R.S. Khurmi, J.K. Gupta, 15th Ed., S. Chand
4. A Textbook of Fluid Mechanics and Hydraulic Machines, R.K. Bansal, 9th Ed., Laxhmi Publ.
5. Fluid mechanics: Fundamentals and Applications, Y.A.Cengel, J.N.Cimbala, 3rd Ed., Tata McGraw Hill Education P. Ltd.

ME 2019 MECHANICS OF SOLIDS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. analytically evaluate various types of stresses in different structural element
CO2. estimate two dimensional stresses and strains analytically
CO3. draw shear force and Bending Moment diagram in simply supported and cantilever beams subject to various loads
CO4. evaluate the bending stress in simple and composite beams.
CO5. calculate the stresses in thin shells and circular shafts subjected to combined bending and twisting
CO6. find out the Slope and deflection of simply supported beams and cantilevers.

Prerequisite : Engineering Mechanics (ME 1001)

Simple stress and strain:
Concept of stress: Definition, Reason of stress phenomenon, normal stress and shear stress; Concept of strain: Types, Stress strain diagram and its features. Stress strain diagram for ductile and brittle materials, Stress and strain in composite rods, Stress and strain in bolt and nut assembly, Stress due to self weight of members, Stress in nuts and bolts, Thermal stress.

Compound stress and strain:

Two-dimensional stresses, principal stress, principal planes, Mohr's circle for the stresses, strain analysis, principal strains.

Shear force and bending moment:

Types of support and beams, Shear force (SF), Bending Moment (BM), Relation between load, SF and BM. Shear force diagram and Bending Moment diagram of beams subject to concentrated and distributed load. Beams with overhangs, Beams subjected to couples.

Bending and shear stress:

Theory of simple bending of initially straight beams. Distribution of normal and shear stresses in different sections. Composite beams, carriage springs.

Strain Energy:

Strain Energy, Resilience and Strain Energy due to Axial load, Bending Moment and Twisting Moment.

Slope and deflection:

Slope and deflection of beams by double integration method, Macaulay's method and moment area method, Principle of Virtual Work, Unit load and Unit couple method for determining slope and deflection of beams, Castigliano's theorem, Maxwell's theorem of Reciprocal Relations.

Theories of Failure:

Maximum principal stress theory, Maximum Shearing stress Theory, Maximum Strain Theory, Total strain energy Theory, Maximum Distortion Energy Theory, Octahedral Shearing Stress Theory, Graphical representation of theories of failure.

Torsion:

Torsion in solid and hollow circular shafts, Torque and Horse Power transmitted by solid and hollow shafts, combined bending and Torsion, close coiled helical springs, strain energy in Torsion, Combined bending and torsion.

Stresses in cylindrical and spherical shells:

Stresses in thin cylinders and thin spherical shell under internal pressure, Thick cylinders subjected to internal and external pressures, compound cylinders, Membrane stress in shells, Application to cylindrical, spherical and conical shells.

Columns: Definition of a column, types of failure in a column, definition of the critical load of a column, Slenderness ratio of a column, Influence of end conditions and effective length, Design of eccentrically loaded columns.

Text Book

1. Strength of Materials, S.S. Rattan, TMH

Reference Book

1. Strength of Materials, Lehri & Lehri, Kataria,
2. Mechanics of Materials, R.C. Hibler
3. Mechanics of solids, S.H. Crandall & Dahl,TMH

ME 2020 SOLID MECHANICS AND MACHINE DESIGN Cr-4

Course Outcomes: At the end of the course, the students will be able to:

CO1. analytically evaluate various types of stresses in different structural element
CO2. estimate two dimensional stresses and strains analytically
CO3. draw shear force and Bending Moment diagram beams
CO4. calculate the stresses in thin shells and circular shafts subjected to combined bending and twisting
CO5. ability design the component subjected to static and variable loads.
CO6. determine the life of component subjected to complex loading
CO7. design, model and solve using modern engineering tools

Pre-requisite: Engineering Mechanics (ME 1001)

Simple stress and strain
Concept of stress: Definition, Reason of stress phenomenon, normal stress and shear stress; Concept of strain: Types, Stress strain diagram and its features. Stress strain diagram for ductile and brittle materials, Stress, Stress due to self weight of members, Stress in nuts and bolts, Thermal stress.

Compound stress and strain
Two-dimensional stresses, principal stress, principal planes, Mohr’s circle for the stresses, strain analysis, principal strains.

Shear force and bending moment
Types of support and beams, Shear force (SF), Bending Moment (BM), Relation between load, SF and BM. Shear force diagram and Bending Moment diagram of beams subject to concentrated and distributed load.

Theories of Failure
Maximum principal stress theory, Maximum Shearing stress Theory, Maximum Strain Theory, Total strain energy Theory, Maximum Distortion Energy Theory, Octahedral Shearing Stress Theory, Graphical representation of theories of failure.

Torsion
Torsion in solid and hollow circular shafts, Torque and Horse Power transmitted by solid and hollow shafts, combined bending and Torsion, close coiled helical springs, strain energy in Torsion, Combined bending and torsion.

Stresses in cylindrical and spherical shells
Stresses in thin cylinders and thin spherical shell under internal pressure, Thick cylinders subjected to internal and external pressures.

Columns
Definition of a column, types of failure in a column, definition of the critical load of a column, Slenderness ratio of a column, Influence of end conditions and effective length,

Design of fastening elements
Design of riveted joints (Methods of riveting, Application to Boiler Drum), Design of welded joints (strength of butt, transverse and parallel fillet weld, circular fillet weld subjected to torsion and bending, axially loaded unsymmetrical,), Design of bolted joints (types of screw fastening/locking devices, bolts of uniform strength, Design of cotter joints, Design of knuckle joints.

Design of transmission elements
Design of shafts (types of shaft, shafts subjected to torsion, bending and combined loading, design consideration/application as per ASME code), Design of keys (types of keys, design of sunk key), Design of couplings (protected type rigid and bushed-pin- type flexible coupling).

Design of springs
Closed coil helical springs of circular section, spiral spring.

Text Book
1. Strength of Materials, S.S. Rattan, TMH
2. Design of Machine Elements - VB Bhandari (TMH), 3rd Ed.
3. Design Data Hand Book, S. Md. Jallaludeen (Anuradha Pub.)

Reference Book
1. Strength of Materials, Lehri&Lehri, Kataria,
2. Mechanics of Materials, R.C. Hibler
3. Mechanics of solids, S.H. Crandall &Dahl,TMH

ME 3003 INTERNAL COMBUSTION ENGINES & GAS TURBINES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. analyze Otto, Diesel and Dual Combustion cycles.
CO2. identify the need for Carburetors, Fuel pumps and nozzles, fuel injectors.
CO3. analyze Fuel knocks and suggest controlling measures.
CO4. apply engine power measurement methods and obtain Performance characteristic curves.
CO5. categorize cooling, lubrication and ignition systems in IC engines.
CO6. identify methods of improving work output and efficiency of gas turbine.

Prerequisite : Engineering Thermodynamics (ME 2001)

Introductions:

Classification of I.C. Engines. Fundamental difference between SI and CI engines, Comparison of two stroke and four stroke engines. Otto, Diesel and Dual cycle. Valve timing diagram, Properties and rating of IC engine, fuels, Additives and non-petroleum fuels.

Carburetion and Fuel injection:

Function of carburetors, Description and principle of simple carburetor and its drawback, petrol injections. Requirements of diesel injections system. Types of injection systems, Fuel pumps and nozzles, types of fuel injections, Spray formation, penetration and direction.

Combustion of Fuels:

Stages of SI engine combustion, Effect of engine variables on ignition lag and flame propagation, fuel knock, control of knock. SI engine combustion chamber stage of diesel combustion, variables affecting delay period. Diesel knock and methods of control. CI engine combustion chambers.

Supercharging:

Thermodynamic cycle with supercharging and its effect. Efficiency of supercharging engines Methods of supercharging and scavenging of two stoke engines.

Test and Performance:

Fuel air and power measurement methods. Performance of SI and CI engines, Characteristic curves, Governing of speed.

Engine Emission and Control:

Engine Emissions and its harmful effects. Gasoline and Diesel emission. Methods of measuring pollutants controlling of engine emission.

Cooling Lubrication and ignition systems:

(a) Air cooling and water cooling systems effects of cooling on power output and efficiency.(b) Properties of lubricants additives lubricating systems.(c) Battery, Magnet ignition systems ignition timing.

Gas Turbines:

Gas turbine Shaft Power cycle: Introduction open cycle single shaft and twin shaft arrangements. Multi-spool arrangement ideal cycle. Methods of accounting component losses. Comparative performance, of practical cycles. GOGAS cycles and co-generations schemes. Closed cycle gas turbines.

Gas Turbine cycles for Aircraft Propulsion:

Criteria of performance, Intake and propelling nozzle efficiencies, simple turbojet cycle, turbofan and turboprop engine.

Introduction to Alternative Fuels: LPG, LNG, CNG, Alcohol, Hydrogen, Vegetable oils and Biogas.

Text Book

1. IC Engines, V Ganeshan, TMH, 4th edition
2. Gas Turbines, V Ganeshan, TMH, 3rd edition

Reference Book

1. IC Engines, Mathur and Sharma, Dhanpat Rai & Sons
2. IC Engines, S.P. Sen, Khanna Publishers
3. IC Engines, Gill and Smith, OXFORD & IBH
4. An introduction to energy Conversion (Vol. II), Kadambi & Prasad, Wiley Eastern.
5. Gas Turbine Theory, Cohen, Rogers and Saravanamutto,Pearson Education

ME 3009 FUNDAMENTALS OF MACHINE DESIGN Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify basic requirement for machine elements, machines and manufacturing considerations in design.
CO2. analyze and apply the domain knowledge in practical problems. Besides, the complex practical problems can be simulated and solved using engineering tools such as ANSYS.
CO3. design and determine geometrical dimensions of a component subjected to complex stress system.
CO4. implement and design the domain knowledge in practical systems.
CO5. ability design the component subjected to static and variable loads.
CO6. determine the life of component subjected to complex loading.
CO7. design, model and solve using modern engineering tools.

Prerequisite : Mechanics of Solids (ME 2012)

*Standard Design Data Books are allowed during examinations

Introduction:

Basic requirement for machine elements and machines, Design procedure, Design Synthesis, Use of standards in design, Selection of engineering materials, Selection of factor of safety, Manufacturing considerations in design, Various stresses in machine elements.

Design of fastening elements:

Design of riveted joints (Methods of riveting, Application to Boiler Drum), Design of welded joints (strength of butt, transverse and parallel fillet weld, circular fillet weld subjected to torsion and bending, axially loaded unsymmetrical, eccentrically loaded welded joint), Design of bolted joints (types of screw fastening/locking devices, bolts of uniform strength, eccentrically loaded (in-plane, out-plane) bolted joints. Design of cotter joints, Design of knuckle joints.

Design of transmission elements:

Design of shafts (types of shaft, shafts subjected to torsion, bending and combined loading, design consideration/application as per ASME code), Design of keys (types of keys, design of sunk key), Design of couplings (types of couplings, protected type rigid and bushed-pin- type flexible coupling), Design of belt (selection of flat/ V-belt from manufactures catalogue).

Design of springs:

Closed coil helical springs of circular section, spiral spring, Leaf springs.

Design of levers & brackets:

Hand lever, foot lever, bell crank lever, rocker arm, wall brackets.

Text Book

1. Design of Machine Elements - VB Bhandari (TMH), 3^{rd} Ed.
2. Design Data Hand Book, S. Md. Jallaludeen (Anuradha Pub.)

Reference Book

1. Machine Design - Sharma/Agarwal (katson publishing House)
2. Machines Design Data Book - P.S.G. College of Technology, Coimbatore.
3. Mechanical Engineering Design - Shigley J E, Mischiee C. R.; TMH
4. Mechanical Design - of Machines, Maleev/Hartman (CBS)

ME 3010 METAL CUTTING AND CUTTING TOOL DESIGN Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. identify the necessity of “manufacturing”, purpose & principle of machining and To demonstrate tool geometry and define tool angles in different systems

CO2. categorize between orthogonal and oblique cutting and chip flow deviation. illustrate the mechanism of chip formation in machining ductile and brittle materials and able to conduct complex mechanical engineering experiments to analyze and interpret the experimental data.

CO3. explain the benefits and the purposes of determining cutting forces and able to conduct complex mechanical engineering experiments to analyze and interpret the experimental data.

CO4. assess failure of cutting tools, mechanisms and pattern of tool wear, the essential properties of cutting tool materials, and assess tool life, Machinability & economics of machining.

CO5. design cutting tool, form tool, press tool, broach, twist drill, press tool etc.

Prerequisite : Basic Manufacturing Processes (ME 2010)

Introduction to machining :

Manufacturing: need and concept, purpose, classification and principles. Machining: purpose and principle, Aims & objective of machining & manufacturing industries, Generation of surfaces in machining. Constraints in fulfilling the machining objectives and control over the machining constraints.

Geometry of cutting tools :

General configuration of cutting edges of tools, concept of rake and clearance angles, Description of tool geometry: Tool-in-hand system, ASA, ORS, NRS Systems, Geometry of multiple-point cutting tools, Conversion of tool angles.

Mechanism of machining :

Mechanism of chip formation in machining ductile and brittle materials, classification and characteristics of chips, , chip reduction coefficient and cutting ratio, shear angle, cutting strain, velocity relationship and Kronenberg relationship, effect of cutting variables on chip reduction co-efficient, Built-up-edge (BUE) formation, orthogonal cutting and oblique cutting, causes of chip flow deviation and angle of deviation, effective rake angle, effects of oblique cutting in chip flow, chip-tool contact length.

Mechanics of metal cutting :

Needs & purposes of determining cutting forces; force system during turning & their significances; Merchant circle diagram: its use, advantages & limitations; development of mathematical expressions for cutting forces using MCD, stress in conventional shear plane, energy of cutting process, Ernst-Merchant angle relationship, Lee-shaffer's relationship, chip breaking effect and chip breakers; Tool dynamometry: turning tool dynamometer, drill dynamometer.

Failure, wear, tool life and cutting tool materials :

Causes and modes offailure of cutting tools; Mechanism & pattern of cutting tool wear; Form stability; Criteria of flank and crater wear; Tool life-definition in R&D & shop floor; evaluation of tool life, Taylor's tool life equation, role of different machining parameters on tool life and surface finish, economics of machining, Gilbert's model, concept, definition & criteria of judgment of machinability, Factors affecting machinability, tool Materials & chronological development, location and causes of heat generation in machining, cutting fluid & its effect; Surface integrity in machining: superficial layer and surface integrity, surface roughness evaluation, surface roughness measurements.

Advanced Machining Processes:

High speed machining; Dry and semi-dry machining; hard machining; High performance and high efficiency machining; multitasking and one-pass machining; ultrasonically and thermally assisted machining; Micro-machining.

Cutting Tool design :

Design of single point cutting tool; Design of broach tool; Form tools; Boring tools, Reamers, Twist drill and Milling cutters.

Text Book

1. Machining and Machine Tools: A. B. Chattopadhyay, Wiley-India Pub, 2012.
2. A Text. Book of Production Engineering: P.C. Sharma, S.Chand & Co., 2008.

Reference Book

1. Metal Cutting Theory and Practice: A. Bhattacharyya, Jamini Kanta Sen of Central Book Pub, 1984.
2. Fundamentals of Metal Cutting and Machine Tools: B.L. Juneja, G.S. Sekhon, & Nitin Seth, New Age International Pub, 2005.
3. Metal Cutting Principles: M. C. Shaw, Oxford Pub, 2002.
4. Fundamentals of Machining & Machine Tools: Boothroyd & Knight, CRC press, 1988.
5. Tool Design: Cyril Donaldson, V. C. Goold, Tata McGraw-Hill, 1976.

ME 3011 HEAT TRANSFER Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. analyze the mechanism of conduction and its application to thermal and energy systems.

CO2. solve the complex problems of convection heat transfer in fluids for implementation in various industrial and scientific systems.

CO3. access the phenomena of boiling and condensation applicable to design of industrial and thermal systems.

CO4. develop an efficient heat exchange process for design and fabrication of heat exchangers used in various industrial purposes.

CO5. formulate an analysis of radiation heat exchange process in various thermal and energy systems for the solution of heat transfer problems.

Prerequisite : Mathematics-I (MA 1001)

Introduction:
Scope of the subject, the three modes of heat transfer-conduction, convection and radiation. Fourier conduction equation, Newton's law of cooling and Stefan- Boltzmann equation for black body radiation. Simultaneous heat transfer mechanisms.

Conduction: Mechanism of conduction: Derivation of the generalized heat conduction equation in Cartesian coordinates, polar cylindrical and polar spherical coordinates. Different types of boundary conditions encountered in heat conduction problems.

Solution of the one dimensional steady state heat conduction equation with constant thermal conductivity and without internal heat generation in Cartesian coordinates. Extension of the solution to composite walls by electrical analogy. Thermal contact resistance, Effect of variable thermal conductivity on temperature distribution in plane wall.

Solution of the one dimensional steady state heat conduction equation with constant thermal conductivity and without internal heat generation in Cylindrical and Spherical coordinates. Extension of the solution to composite cylinders/spheres by electrical analogy. Critical thickness of insulation.

Heat transfer from fins (only longitudinal fins with constant cross sectional area), Fin efficiency and effectiveness.

Convection:

Mechanism of convection and basic concepts: Dimensional analysis for forced and free convection, Nusselt number.

Concept of thermal boundary layer, Prandtl number, Expressions for local and average values of heat transfer coefficients for a flat plate.

Experimental correlations for forced and free convection for various geometries.

Fundamentals of Thermal Radiation:

Blackbody radiation, Planck's law, Spectral and total emissive power, Wein's displacement law, Spectral and total intensity of radiation, Radiation properties: emissivity, absorptivity, reflectivity and transmissivity, Kirchoff's law.

Radiant heat transfer:

Radiation shape factor, Relation for shape factor and shape factor algebra. Heat exchange between black bodies through non-absorbing medium. Gray bodies and real bodies. Heat exchange between gray bodies. Radiosity and irradiation. Electrical analogy and radiation network for a 2-surface and 3-surface enclosures in non-absorbing medium, radiation shields.

Heat exchangers:

Types of heat exchangers and heat exchanger configurations. The overall heat transfer coefficient and fouling factor. LMTD and effectiveness-NTU analysis of heat exchangers.

Text Book

1. Heat and Mass Transfer, R. K. Rajput, S. Chand & Company, 5th Edition

Reference Book

1. Heat transfer, J P Holman and S. Bhattacharya, McGraw Hill Education, 10th Edition.
2. Introduction to Heat Transfer, S. K. Som, PHI Learning Private Ltd, 2013.
3. Engineering Heat Transfer, M. M. Rathore, Jones & Bartlett Learning, 2011.
4. Heat and Mass Transfer, Y. A. Cengel and A. J. Ghajar, McGraw Hill Education, 4th Edition

ME 3012 DESIGN OF MACHINE ELEMENTS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. analyze and apply the domain knowledge in practical problems. Besides, the complex practical problems can be simulated and solved using engineering tools such as ANSYS.
CO2. design and determine geometrical dimensions of a component subjected to complex stress system.
CO3. implement and design the domain knowledge in practical systems.
CO4. ability design the component subjected to static and variable loads.
CO5. determine the life of component subjected to complex loading.
CO6. design, model and solve using modern engineering tools.

Prerequisite : Fundamentals of Machine Design (ME 3009)

Design against fatigue load:

Stress concentration and factors, methods for reduction of stress conc., endurance strength and limit stress, notch sensitivity, LCF and HCF. Design for finite life of components and cumulative damage. Design for infinite life, Soderberg and Goodman lines, and modified Goodman's lines. Design of springs against fatigue load. Bolted joint under fluctuating load. Evaluation of fatigue life in machine components using *ANSYS/ MATLAB* (*optional*).

Design of IC Engine Components:

Cylinder liners & Piston, Connecting rod, Crankshaft, Valve mechanism, Demonstration of temperature and stress/strain distribution in IC Engine components using *ANSYS* (*optional*).

Design of Gear Drives:
Design of spur gear, Design of Helical gear (equivalent spur gear and virtual number of teeth, force analysis and design of helical gear by AGMA method), Design of bevel gear.

Sliding and Rolling contact bearings:

Basic modes of lubrication, viscosity index, Petroff's & McKee's Equation, Selection of Lubricants, Theory of film (Stribeck's Equation), Static and dynamic load carrying capacity, equivalent bearing load, selection of bearing life from manufacturer's catalogue. Demonstration of a typical bearing failure.

Strategies in design of machine elements:

Design optimization for functional life and cost using *ANSYS/ MATLAB/ NASTRAN/ DOE***.**

Text Book
1. Design of Machine Elements: VB Bhandari (TMH)
2. Machine Design-An Integrated Approach , Robert L. Norton (Pearson)

Reference Book

1. Mechanical Engineering Design, Shigley J E, Mischiee C R (TMH)
2. Machine Design data book - P.S.G.College of Technology, Coimbatore.
3. Design Data Hand Book - K. Mahadevan & K.B.Reddy(CBS)

ME 3014 REFRIGERATION AND AIR CONDITIONING Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. recognize the natural refrigeration processes and limitations thereof.
CO2. compute COP, power required and mass of refrigerants in theoretical and actual refrigeration systems.

CO3. compute moist air properties using fundamental science based formulae and psychrometric chart.
CO4. comprehend the components and their interaction in air conditioning systems.
CO5. prescribe primary data for air-conditioning for predefined requirements.
CO6. comprehend environmental concerns related to modern refrigeration and air-conditioning practices.

Prerequisites : Engineering Thermodynamics (ME 2001) and Heat Transfer (ME 3011)

Introduction to Refrigeration:

Reversed Carnot Cycle, Reversed Brayton Cycle, Vapour compression cycle, Units of refrigeration, Coefficient of performance.

Refrigerants:

Classification of refrigerants: Halocarbon compounds, Azeotrope, Hydrocarbons, Inorganic compounds, Properties of refrigerants, Comparison of common refrigerants, uses of important refrigerants.

Air Refrigeration system:

Open Air refrigeration cycle, Closed or dense Air refrigeration cycle, Air refrigerator working on Reversed Carnot cycle, Air refrigerator working on Bell-Coleman cycle, Methods of Air refrigeration systems, Simple Air cooling system, Simple Air Evaporative cooling system, Boot-strap Air cooling system, Boot-strap Air Evaporative cooling system, Regenerative Air cooling system.

Vapour Compression system:

Types of Vapour Compression Cycle, Actual vapour compression cycle, T-s and P-h diagram simple saturation cycle, super heated and sub-cooled cycle, Effect of suction pressure and discharge pressure on performance.

Multistage compression and multi-evaporator system:

Different arrangements of compressors and intercooling, multistage compression with intercooling, Multi-evaporation system, dual compression system.

Vapour Absorption system:

Simple Ammonia Absorption system, improved vapour absorption system, Electrolux system, Comparison of vapour absorption system with vapour compression system.

Psychometrics:

Properties of air-vapour mixtures, Psychometric chart, Law of air-water vapour mixture, Enthalpy of mixture, simple heating and cooling, Humidification, Dehumidification mixture of air streams.

Requirements of comfort Air conditioning:

Oxygen supply, Heat removal, Moisture removal, Air-motion purity of air, Thermodynamics of human body, Comfort and comfort chart, Effective temperature, factors governing optimum effective temperature.

Air conditioning system:

Processes in air conditioning, summer air conditioning, winter air conditioning and year round air conditioning, cooling load calculation.

Refrigerant Compressor:

Classification of Compressor, Reciprocating Compressor, Work done by a single stage reciprocating Compressor, Hermetic Sealed Compressor, Rotary compressor, CentrifugalCompressor.

Text Book

1. Refrigeration and Air Conditioning, C. P. Arora, McGraw Hill Education, 3rd Edition, 2013.
2. Refrigeration and Air Conditioning, R. S. Khurmi, and J. K. Gupta, S. Chand Ltd, 2013

Reference Book

1. Refrigeration and Air Conditioning, R. C. Arora, PHI Learning Pvt. Ltd., 2013.
2. A course in Refrigeration and Air Conditioning, S.C. Arora and S. Domkundwar, Dhanpat Rai & Co (P) Ltd, 2013.
3. Refrigeration and Air Conditioning, Manohar Prasad, New Age International, 2003.

ME 3015 MANUFACTURING PROCESSES & DESIGN Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the different basic machining processes and machine tools.
CO2. apply the different non- traditional machining processes for up growing high strength materials with complicated and miniaturized product manufacturing.
CO3. understand the industrial automation with computer controlled machines and industrial robots.
CO4. design the work holding and tool guiding devices for mass production.
CO5. design the forging dies.
CO6. define sequence of operations leading to optimized time and cost.

Prerequisite : Basic Manufacturing Process (ME 2010)

Conventional Machine Tools & Machining Processes:
Types, Specification, Operations, Tools, Accessories and attachments, Estimation of cutting time of conventional machining processes. Turning; Taper turning and thread cutting, Shaping; Quick return Mechanisms. Milling; Up milling, Down milling and indexing. Grinding; Surface grinding, Centreless grinding, grinding wheel specification, wheel truing and dressing. Finishing Processes: Reaming and boring, Lapping, Honing, Super finishing. Turret & Capstan lathe, multi spindle automatic lathe, Gear Machining & Transfer machines.

Non-conventional machining:
Classification and principles of non-conventional machining processes such as AJM, USM, EDM, ECM, PAM, LBM and EBM.

Manufacturing process Automation:
Introduction to industrial automation and control, NC & CNC, part programming, DNC, CNC and adaptive control, Industrial robot application, robot anatomy, coordinate system, work envelope, grippers, actuators, sensors, automated guided vehicles (AGV) system.

Jigs and Fixtures:
Principles of design and construction. Principles of Location and Clamping. Design of simple Jigs for drilling operations, simple fixtures for milling and broaching operation.

Press Tool Design:
Press working equipment and operations, Press selection, Shearing principle, Stock strip layout, Pressure calculation, Blanking and Piercing die design, design procedure for progressive and compound dies, Wire drawing and deep drawing.

Forging Die Design:
Forging equipments, Drop forging, Press forging and upset forging, Die design for machine forging and upset forging, Selection of sizes of forging equipments, Materials and manufacture of forging dies.

Process Planning:
Contents of process plan, process operations, steps in process planning, planning and tooling for low cost processing.

Text Book

1. Advanced Machining Processes, V. K. Jain, Allied Publishers Pvt. Ltd.; 1st edition (2007)
2. A Text Book of production Engineering, P C Sharma, S. Chand Publications, 2010
3. Automation, Productions systems, and computer Integrated manufacturing, Mikell P. Groover, PHI Learning pvt. Ltd-New Delhi (3rd edition)

Reference Book

1. Fundamental of Tool design, F. W. Wilson, ASTM
2. Tool Design, Donaldson, Mc Graw Hill, 4th Edition.
3. Modern Machining Process, P.C. Pandey, H.S. Shan , TMH,3rd Edition
4. Introduction to Micromachining, V.K. Jain, Narosa Publishing house , 2010

ME 3017 INDUSTRIAL ENGINEERING & OPERATIONS RESEARCH Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. apply mathematics, science, and engineering
CO.: design, develop, implement and improve integrated systems that include people, materials, information, and equipment
CO3. formulate and solve linear programming problems.
CO4. recognize types of transportation and assignment problems and apply solution techniques.

Prerequisite : Mathematics-I (MA 1001)

Production, Planning and Control:
Introduction, Types of Production processes (Project/Job, Batch, Mass/Line, Continuous), Production, Planning & Control (PPC) and its functions, Aggregate Production Planning (Chase, Level, and Mixed Strategy).

Forecasting and Its Techniques:
Introduction, Errors in forecasting, Qualitative and Quantitative forecasting; Simple Moving Average, Weighted Moving Average, Exponential Smoothening, Linear Regression Techniques.

Inventory Control:
Inventory Control: Different stock limits,Relevant Costs, P & Q Systems of Inventory, EOQ & EBQ Models with shortages and without shortages , ABC Analysis, Material Requirement Planning Calculations

Scheduling:
Operations scheduling, Job shop scheduling, Priority dispatching rules, Johnson's rule, n jobs with 2&3 machines. Queuing theory, JIT, TQM

Operations Research:
Introduction to Linear Programming (LP), Graphical Method, Simplex Method, Big M and Duality, Transportation Problems, Assignment Problems, Project Management-CPM and PERT, Critical path, Crashing,

Text Book
1. Production and Operation Management, R. Paneerselvam, Prentice Hall of India, 3rd edition,
2. Operation Research by Hira and Gupta, S. Chand

Reference Book
1. Operations Management: Processes and Supply Chains,Larry P. Ritzman, Manoj K. Malhotra, Lee J. Krajewski, PHI,10th, 2012.
2. Industrial Engineering and Management, S.Tripathy, PHI, 2014.
3. Modern Production/Operations Management, Sarin Buffa, Wiley India Pvt Ltd, 8th,2011.
4. Industrial Engineering and Production management, Telsang Mertand, S.Chand, 2002.
5. Operation Research by S D Sharma

ME 3020 ADVANCED MANUFACTURING PROCESSES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. apply the different non- traditional machining processes for up growing high strength materials with complicated and miniaturized products.
CO2. understand the challenging issues in production of micro dimensioned products.
CO3. apply the advanced forming processes for production of precession parts.
CO4. apply the different micro fabrication processes to produce micro components.
CO5. understand the concepts of smart materials and their use to mankind.

Prerequisite : Basic Manufacturing Process (ME 2010)

Non-conventional Machining:
Classification of non-conventional machining processes, Basic Principles, features of equipment, process variables and application of AJM, USM, ECM, EDM, PAM, LBM, and EBM**.**

Micro manufacturing:

Scopes of micro manufacturing, size effect and tooling issues in micro manufacturing. Micro turning, micro grinding, Ultrasonic assisted micromachining, Abrasive jet micromachining.

Metal Forming processes:

Hydro forming, Explosive forming, Electromagnetic forming and hydroelectric forming. Micro forming– micro bending, micro extrusion, micro molding.

Micro Fabrication processes:

Electron Beam Welding, Laser Beam Welding, Fabrication of MEMS-Chemical Vapor Deposition (CVD), Physical Vapor Deposition (PVD), Epitaxy, Sputtering, Lithography, Etching, Additive manufacturing, Green manufacturing, Concurrent engineering, Lean manufacturing, Various shape memory alloys. Manufacturing technology of SMAs. Electro rheological (ER) and magneto-rheological (MR) materials: Characteristics of ER and EM fluids. ER and EM materials.

Text Book

1. Advanced Machining Processes, V. K. Jain, Allied Publishers Pvt. Ltd.; 1st edition (2007)
2. Introduction to Micromachining, V.K. Jain, Narosa Publishing house , 2010

Reference Book

1. Manufacturing Technology, Part –II, P.N. Rao , TMH, 3rd Edition, 2014
2. High Velocity Forming of Metals, ASTM
3. An Introduction to Microelectromechanical Systems Engineering, Maluf, Nadim, Norwood, Massachusetts, U.S.A.: Artech House, 1999, ISBN 10: 0890065810 / ISBN 13: 9780890065815
4. Smart materials and Structures, Gandhi, M.V. and Thompson, B.S., , Chapman and Hall, 1992

ME 3022 PRINCIPLES OF TURBOMACHINES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. design and calculate different parameter for Turbomachines
CO2. understand thermodynamic and kinematic behind Turbomachines
CO3. provide prerequisite to fluid power courses.

Prerequisite : Fluid Dynamics & Hydraulic Machines (ME 2008)

Introduction:

Definition of Turbo-machines, classification, Euler's equation for Turbo-machine, Energy Equation, Adiabatic Flow through Nozzles and diffusers, work and efficiency of Turbine and compressor stage.

Centrifugal Compressors and Fans:

Basic constructional features, velocity diagrams, slip factor, energy transfer, power input factor, stage pressure rise and loading coefficient, pressure coefficient, degree of reaction, Centrifugal compressor characteristic, surging, rotating Stall and Choking.

Axial Flow Compressors and Fans:

Basic constructional features, turbine versus compressor blades Advantages of axial flow compressors, working principle, velocity triangle, elementary theory, stage work, work done factor, stage loading, degree of reaction; vortex theory, simple design calculations, introduction to blade design, cascade test, compressibility effects, operating characteristics.

Centrifugal Pumps:

Basic constructional features, work done and velocity triangles, pump losses and efficiencies, minimum starting speed, specific speed, model testing of pumps, pumps in series and parallel, net positive suction head, priming, cavitation, performance curve.

Axial Pump:

Description, velocity triangles, work done on the fluid, energy transfer, axial pump characteristics, cavitation.

Radial Flow Turbine:

Basic constructional features, stage velocity triangle, Enthalpy-Entropy Diagram, Stage losses, performance characteristics.

Axial Flow Turbine:
Basic constructional features, velocity triangle, single impulse stage, multi-stage velocity compounded, multi-stage pressure compounded, reaction stage, blade to gas speed ratio, losses and efficiency, work done factor, low hub-tip ratio stages, performance characteristic.

Text book

1. Hydraulic and Fluid Mechanics Including Hydraulics Machines, P. N. Modi & S. M. Seth, Standard Book House.
2. Turbines Compressors and Fans, S. M. Yahya, Tata McGraw-Hill Education

Reference Book

1. Principle of Turbo Machinery, Turton R.K., Springer Publication.
2. Fundamentals of Turbo Machinery, William W., John Wiley and Sons.
3. Gas Turbine Theory, Cohen and Roger, Pearson Education.
4. Turbo Machinery Basic Theory and Application, Logan E.J.
5. Principles of Turbo Machinery, Shepherd Dennis G., Mac Millan Publisher, New York.
6. TurboMachines, A Valan Arasu, Vikas Publishing House Pvt. Ltd.
7. Gas Turbines, V Ganesan, Tata MacGarw Hill Education.

ME 3024 MECHANICAL VIBRATION AND NOISE ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand damping, natural frequency and resonance.
CO2. model and write mathematical equation of a vibration system.
CO3. measure noise level and predict physiological effects on human.
CO4. select and implement the best noise control technique.

Prerequisite : Machine Dynamics (ME 2002)

Two Degree of Freedom Systems:

Generalized Derivation of Equation of motion, Static and dynamic coupling, Langrange's equations. Undamped dynamic vibration observers.

Multi-Degree of freedom system:

Derivation of Equations, Influence coefficients, Eigen values and Eigen vectors, Calculation of Natural Frequencies by Rayleigh, Stodala, Matrix iteration and Holzer-Methods.

Torsional Vibration:

Multi-rotor systems, geared system and branched system

Vibration of continuous system:

Vibration of strings, free longitudinal vibration of prismatic bars, Lateral vibrations of uniform beams.

Introduction to acoustics:

Propagation of acoustic disturbances, the decibel scale for the measurement of sound pressure, Acoustic energy density and intensity, the wave equations, acoustic impedance.

Human Response to sound:

Noise effects, auditory response, Ratings and Regulations.

Noise control:

Principles of passive noise control, Acoustic enclosures, Acoustic barriers, Sound-absorbing materials, Vibration isolations materials and Damping materials.

Text Book

1. Mechanical Vibrations and Noise Engineering, Ashok G. Ambekar, PHI.

Reference Book

1. Theory of Vibration and Application, William T. Thomson, CBS
2. Textbook of Mechanical Vibrations, Rao.V. Dukkipati, PHI
3. Noise and vibration control, L. Beranek, McGraw-Hill

ME 3026 MECHATRONICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. select and apply the knowledge, techniques, skills and modern tools in mechatronics engineering technology.

CO2. apply concepts of circuit analysis, analog and digital electronics, automation and controls, motors, electric drives, power systems, instrumentation, and computers to aid in the design, characterization, analysis, and troubleshooting of mechatronics systems.

CO3. apply the different drive systems for actuation of various parts and components of a system.

CO4. understand the different controllers used in industries, machines and industrial robots.

Prerequisites : Basic Electronics (EC 1001) and Fluid Mechanics (ME 2003)

Introduction:

Definition of mechatronics. Mechatronics in manufacturing, products and design. Review of fundamentals of electronics. Data conversion devices, sensors, microsensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs.

Drives:

Stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer systems.

Hydraulic systems:

Flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps. Design of hydraulic circuits.

Pneumatics:

Production, distribution and conditioning of compressed air, system components and graphic representations, design of systems.

Controllers:

Description of PD, PI and PID controllers. CNC machines and part programming. Industrial Robotics.

Textbook

1. Mechatronics: electronic control systems in mechanical and electrical engineering, Boltan, W., , Longman, Singapore, 1999.
2. Mechatronics, HMT ltd. Tata Mcgraw-Hill, New Delhi, 1988.

Reference Book

1. Robotics technology and flexible automation, S. R Deb and S. Deb., , Tata McGraw-Hill, New Delhi, 1994.
2. Computer automation in manufacturing - an Introduction, T. O. Boucher, Chapman and Hall, 1996.
3. Mechatronics: Principles, concepts and applications, N. P. Mahalik, TMH

ME 3028 SUPPLY CHAIN MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. to analyze the manufacturing operation of a firm
CO2. apply sales, operations planning, MRP and lean manufacturing concepts.
CO3. apply logistics and purchasing concepts to improve the supply chain operation.
CO4. apply quality management tools for process improvement.

Prerequisite : NIL

Introduction:
Understanding the supply chain, decision phases in supply chain, process view of supply chain, supply chain flows.

Drivers & Obstacles of Supply Chain Performance :
Supply chain performance: Strategic fit and scope; Supply chain drivers, Obstacles to Achieving Strategic fit.

Design the Distribution Network:
Designing the distribution network, role of distribution, factors influencing distribution, design option for distribution.

Network Design:
Network design in the SC, factors influencing network design, models for facility location.

Transportation in Supply Chain:
Transportation in the supply chain, factors affecting transportation decisions, modes of transportation and their performance.

Pricing in Supply Chain:
Pricing and revenue management in the SC, Sourcing decision in SC, supplier selection, supplier assessment.

Coordination in Supply Chain:
Coordination in the SC, Lack of coordination and the bullwhip effect, Supply chain information system, E-business and supply chain.

Text Book

1. Supply Chain Management: Strategy, Planning, and Operation, Chopra Sunil and Meindl Peter, PHI, 5thEdition, 2013.

Reference Book

1. Supply Chain Management: Text and Cases, Janat Saha, Pearson Education, First Edition, 2009.
2. Logistics and Supply Chain Management, Martin Christoper, Pearson Education, 1998.
3. Designing and Managing the Supply Chain, David Semchi-Levi, Philip Kaminsy, TMH, 3rd Edition, 2007.

ME 3030 PRODUCT LIFECYCLE MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. identify and analyse the product design and development processes in manufacturing industry and to define the components and their functions of product design and development processes and their relationships from concept to customer over whole product lifecycle.
CO2. analyse, evaluate and apply the methodologies for product design, development and management and to undertake a methodical approach to the management of product development to satisfy customer needs.
CO3. generate an innovative idea for product design in a systematic approach and apply the check the quality of the new design by using product design tools.
CO4. understand the stages of product lifecycle management and the components of Product life cycle environment to integrate the various stages of PLM into engineering product ranges and portfolios that will eventuate into commercial success.
CO5. integrate lifecycle management strategies and knowledge to develop new and/or formulate appropriate engineering design solutions in engineering environment

Prerequisite : Industrial Engineering & Operations Research (ME 3017)

Fundamentals of Product Development:

Trend analysis, competitive landscape, PESTLE Analysis, Overview of Products and services, Types of Product development, Overview of Product development methodologies, Product development Planning and Management,

Generic Product Development Process:

Identifying customer needs –voice of customer –customer populations- hierarchy of human needs-need gathering methods – affinity diagrams – needs importance- establishing engineering characteristics-competitive benchmarking- quality function deployment- house of quality- product design specification-case studies,concept development stages, systemlevel design, Detail design, Testing and refinement Production ramp up

Product design tools and technology:

Theory of inventive problem solving, General Theory of Innovation and **TRIZ**, Value engineering Applications in Product development and design, Model-based technology for generating innovative ideas, Quality aspects in product design, Failure mode effect analysis.

Product Life Cycle Management:

System architecture, Information models and product structure, functioning of the system. Significance of PLM, Customer Involvement.

Product life cycle environment:

Product Data and Product Workflow, The Link between Product data and Product Workflow, Key Management Issues around Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy.

Components of Product Life Cycle Management:

Different phases of product lifecycle and corresponding technologies, Foundation technologies and standards (e.g. visualization, collaboration and enterprise application integration), Core functions (e.g., data vaults, document and content management, workflow and program management), Functional applications (e.g., configuration management) Product organizational structure, Human resources in product lifecycle, Methods, techniques, Practices, Methodologies, Processes, System, components in lifecycle, slicing and dicing the systems , Interfaces, Information, Standards, Examples of PLM in use.

Text Book

1. Product design and development, Ulrich Karl T and Eppinger Steven D., McGraw Hill Pub. Company, 1995.
2. Product Design, Kevin Otto, Kristin Wood, Indian Reprint 2004, Pearson Education,ISBN 9788177588217
3. Product Life Cycle Management , Antti Saaksvuori, AnselmiImmonen, Springer,1st Edition (Nov.5,2003).

Reference book

1. Product Design and Manufacture, Chitale A. K. and Gupta R. C, Prentice-Hall of India, New Delhi
2. Engineering of creativity: introduction to TRIZ methodology of inventive Problem Solving, Semyon D. Savransky, CRC Press.
3. Systematic innovation: an introduction to TRIZ ; (theory of inventive ProblemSolving), John Terninko, Alla Zusman, CRC Press.
4. Emotional Design, Donald A. Norman, Perseus Books Group New York , 2004
5. Product Lifecycle Management - Driving the Next Generation of Lean Thinking, Grieves Michael, McGraw-Hill, 2006.
6. Stark, John. Product Lifecycle Management: Paradigm for 21st CenturyProduct Realization,Springer-Verlag, 2004. ISBN1852338105

ME 3032 INTRODUCTION TO FLUID MECHANICS AND HEAT TRANSFER Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. understand the concept of heat and fluid flow phenomena.
CO2. express the mathematical formulation of a physical problem.
CO3. think for a solution to cooling or heating in industrial equipment.
CO4. analyze and develop the different techniques for thermal energy storage.

Prerequisite : Mathematics-I (MA 1001)

Introduction:
Properties of fluids, Types of fluids, Types of fluid flow, modes of heat transfer, Laws of heat transfer.

Kinematics of fluid flow:

Streamlines, path line & streak lines, stream tube, Types of fluid flow, Continuity equation of motion in three-dimensions, Local and convective acceleration, Velocity potential function and stream function, Vorticity and circulation, Vortex flow, Equation of forced vortex flow and free vortex.

Dynamics of fluid flow:

Euler's equation of motion, Bernoulli's equation from Euler's equation, Practical applications of Bernoulli's equation—Venturimeter, Orficemeter, Pitot tube.

Conduction Heat Transfer:

Derivation of the general 3-dimensional heat conduction equation with variable thermal conductivity and internal heat generation in Cartesian coordinates. Transformation of the conduction equation into polar cylindrical and polar spherical coordinates, different types of boundary conditions encountered in heat conduction. Solution of the one dimensional steady state heat conduction equation with constant thermal conductivity and without heat generation in Cartesian, Cylindrical and Spherical coordinates. Extension of the solution to composite walls/cylinders/spheres by electrical analogy. Effect of variable thermal conductivity., Introduction to numerical solution of the heat conduction equation.

Convection Heat Transfer:

Conservation equations for mass, momentum and energy for two dimensional steady state flow in Cartesian, cylindrical and spherical coordinates. Non dimensionalization of the conservation equations.

Boundary Layer:

Hydrodynamic and thermal boundary layer concepts, Boundary layer growth over a flat plate, Boundary layer thickness, displacement thickness, Momentum thickness, and energy thickness, Laminar and Turbulent boundary layer, Boundary layer equations, momentum integral and energy integral equations for boundary layer flow over a flat plate. Solution of the integral equations to derive expressions for drag and heat transfer coefficients. Average values of drag and heat transfer coefficients. Experimental correlations for forced and free convection for various geometries.

Radiation Heat Transfer:

Radiation properties, emissive power and emissivity, Kirchoff's identity. Planck's relation for monochromatic emissive power of a black body, Stefan-Boltzman law and Wein's displacement law , Radiation shape factor, Relation for shape factor and shape factor algebra.

Text Book

1. Fluid Mechnics, Modi & Seth
2. Heat & Mass Transfer, R. K. Rajput, S. Chand & Company

Reference Book

1. Heat Transfer, J. P. Holman, Tata McGraw-Hill
2. Engineering Heat & Mass Transfer, Mahesh M. Rathore, University Science Press
3. Heat and Mass Transfer: Fundamentals and Applications, Yunus A. Cengel , Afshin J. Ghajar
4. Fluid Mechanics Fundamentals and Applications, John M. Cimbala , Yunus A. Cengel
5. Introduction to Fluid Mechanics and Fluid Machines, S K Som , Gautam Biswas , S Chakraborty.

ME 4031 POWER PLANT ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the location and layout of power plants.
CO2. understand the basic principles of physics and mathematical expression used in power generation by steam turbines.
CO3. understand the principles for improving the efficiency and speed of steam turbines with minimum consumption of water, coal and other resources.
CO4. get placement in organization to manage coal based power plants in the country.

Prerequisites : Engineering Thermodynamics (ME 2001) and Fluid Dynamics &Hydrauli Machines (ME 2008)

Sources of energy:

Fuel, water, wind and nuclear reactors, principal types of power plants and choice of power plants, power plant layouts.

Analysis of steam cycles:

Introduction, Classification of power plant cycles, Carnot cycle, Rankine cycle, Modified Rankine cycle, Reheat cycle, Regenerative cycle, Binary vapour cycle, Its engineering applications.

Generation of steam:

Boilers and its mountings and accessories, combustion equipment, Air supply systems for combustion, fuel and ash handling systems, dust collectors.

Flow of steam through nozzles:

Continuity, energy and momentum equations, nozzle shape for different applications, Outer velocity, throat and exit areas for flow without and with friction, choked flow and critical pressure ratio, effect of variations in nozzle back pressures, super saturated flow in nozzles. **T**ypes of steam turbines, axial variation of pressure and velocity through various types of turbines.

Performance characteristics:

Power, efficiency and other related calculations for simple impulse, pressure compounded impulse and velocity compounded impulse turbines using velocity triangles. Reaction turbines and degree of reaction. Parsons' turbines, Power, efficiency and other related calculations for reaction turbine. Internal losses in steam turbines and reheat factor. Governing of steam turbines.

Steam condensers and cooling tower for power plant application:

Surface condensers, condenser vacuum and vacuum efficiency, maintaining vacuum by air pumps, sources of air leakage into the condenser, Dalton's law of partial pressures applied to steam and air mixtures, Air pump capacity for wet and dry air pumps, Cooling water requirements, Cooling towers.

Introduction to Nuclear power plants:

Nuclear fuels, Chain reaction, Neutron balance, coolants, Reflectors, Moderators, control rods, types of reactors, Boiling water reactors, pressurized water reactors.

Text Book

1. Power Plant Engineering, P. K. Nag Tata McGraw-Hill Education, 2002

Reference Book

1. Power Plant Engineering, R. K. Rajput Laxmi Publications (P) Ltd., Fourth Edition.
2. Power Plant Engineering, M. K. Gupta, PHI Learning, 2012.
3. Power Plant Engineering, P.C. Sharma, S. K. Kataria & Sons, 2009.

ME 4032 FLEXIBLE AND SUSTAINABLE MANUFACTURING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. the philosophy of Group Technology and its importance in grouping components and machines.
CO2. the concept of flexibility, its advantages in manufacturing and different types of FMS and their layouts.
CO3. the importance of green, intelligent and web based manufacturing

Prerequisite : Basic Manufacturing Processes (ME 2010)

Introduction:
FMS definition and classification of manufacturing systems, Automated production cycle, Need of flexibility, Concept of flexibility, Types of flexibilities and its measurement.

FMS Equipment:
Why FMS, Factors responsible for the growth of FMS, FMS types and applications, Economic justification for FMS, Functional requirements for FMS equipments, FMS processing and QA equipment, e.g., turning and machining centers, Co-ordinate measuring machines, Cleaning and deburring machines, FMS system support equipment, Automated material handling and storage equipment, cutting tool and tool management, Work holding considerations, Fixture considerations in FMS environment.

Group Technology:
GT concepts, Advantages of GT, Part family formation-coding and classification systems; Part machine group analysis, Methods for cell formation, Use of different algorithms, mathematical programming and graph theoretic model approach for part grouping, Cellular vs FMS production.

Sustainable Manufacturing:
Introduction, importance and scope in the present scenario, green manufacturing, intelligent manufacturing, web based manufacturing, virtual manufacturing, lean and agile manufacturing.

Text Book
1. Automation, Production Systems, and Computer-Integrated Manufacturing, Mikell P. Groover, Pearson Education, ISBN 81-7808-511-9. 3rd Edition, 2007

Reference Book
1. Flexible Manufacturing Cells and systems, W.W. Luggen Prentice Hall India
2. Green Manufacturing: Fundamentals and Applications, David A. Dornfeld, Springer, 2013
3. Virtual Manufacturing, Prashant Banerjee, Dan Zetu, Wiley; 1 edition (March 9, 2001), ISBN-10: 0471354430, ISBN-13: 978-0471354437.
4. Performance Modeling of Automated Manufacturing Systems, Vishwanathan & Narahari, Prentice Hall India, ISBN: 978-81-203-0870-1.

ME 4033 FUNDAMENTALS OF FINITE ELEMENT METHOD Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. know interpolation models, convergence requirements, global and local coordinate system.
CO2. know higher order elements in term of natural co-ordinate system, isoparametric formulations and numerical integration.
CO3. variational approaches, Rayleigh-Ritz and Galerkin Method.
CO4. apply in solid mechanics and heat transfer problems.

Prerequisites : Mathematics-I (MA 1001) and Mechanics of Solids (ME 2012)

Introduction:
Overview of FEM, General description of FEM, Engineering Application of FEM.

Basic Procedure:

Discritization of domain, interpolation models, simplex, complex and multiplex elements, selection of the order of the interpolation, convergence requirements, linear interpolation polynomialsin Global and local co-ordinate system.

Higher Order and Isoparametric Elements:

Higher order elements in terms of Natural co-ordinate system, one dimensional elements using classical interpolation polynomials, two dimensional elements using classical interpolation polynomials, Isoparametric elements, numerical integration.

Derivation of Element Matrices and Vectors:

Direct Approach, Variatonal approach, derivation of Finite Element equations using Rayleigh-Ritz and Galerkin Method, Solution of eigenvalue problems using weighted Residual approach.

Assembly of Element Matrices and Derivation of System Equations:

Co-ordinate transformations, Assemblage of Element equations, Incorporation of boundary conditions.

Application to Solid Mechanics and Heat Transfer Problems:

Formulation of solid and structural mechanics, formulation of FE equations(Static Analysis), application to (Truss Elements, Beam Elements, Triangular Elements, Tetrahedral Elements).

Text Book

1. The Finite Element Method in Engineering, S S Rao, Elsevier Publications

Reference Book

1. Concept and Application of FEM, R D Cook, D S Malkus (Wiley edition)
2. Fundamentals of Finite Element Analysis, D.V. Hutton, McGraw Hill.

ME 4035 COMPUTER CONTROLLED MANUFACTURING SYSTEM Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the latest developments and the main elements in computer integrated manufacturing systems.
CO2. create awareness about the implementation techniques for GT and CAPP.
CO3. classify and distinguish NC, CNC and DNC systems.
CO4. develop manual and APT part programs for 2D complex profiles, automated tool paths and G-codes for machining components and test the programs through simulation.
CO5. apply modern computational, analytical, simulation tools and techniques to face the challenges in manufacturing.

Prerequisite : NIL

Fundamental of Manufacturing and automation:

Types of production, Objectives of a manufacturing system, production concepts and mathematical models, automation strategies.

Process planning:

Group Technology and Computer Aided Process Planning, Introduction-part families-parts classification and cooling - group technology machine cells benefits of group - technology. Process planning function CAPP - Computer generated time standards.

Numerical Control production System:

Numerical control, coordinate system and machine motion, Types of NC system, machine tool applications, problems of conventional NC, CNC, DNC.

Part Programming:

Basics of NC programming, mathematics of tool paths, machining forces, Tool offsets, programming steps, NC programming Languages, G-Code and M-Code, APT Programming, CAD/CAM NC programming. Rapid prototyping

Computer Networks for manufacturing:

Hierarchy of computers in manufacturing, local area networking, manufacturing automation protocol.

The Future automated Factory:

Trends in manufacturing, The future automated factory.

Text Book

1. Automation, Production Systems, and Computer-Integrated Manufacturing, Mikell P. Groover, Pearson Education, ISBN 81-7808-511-9. 3rd Edition, 2007
2. CAD/CAM, Ibrahim Zeid, TMH

Reference Book

1. Computer Integrated Manufacturing, Paul Ranky Prentice Hall of India
2. Computer Integrated Manufacturing System, Yorem Koren, McGraw-Hill, 1983

ME 4037 TOTAL QUALITY MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. provide knowledge to. understand the philosophy and core values of Total Quality Management(TQM)
CO2. understand total quality concept and techniques for managing, controlling, and improving quality
CO3. choose appropriate statistical techniques for improving processes;
CO4. write reports to management describing processes and recommending ways to improve them;
CO5. develop research skills that will allow them to keep abreast of changes in the field of Total Quality Management;
CO. emphasise the process of learning and discovery rather than the presentation of fact.

Prerequisite : Industrial Engieering & Operations Research (ME 3017)

Definition of Quality, Dimensions of Quality, Quality Planning, Quality Costs - Analysis Techniques for Quality Costs, Basic Concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership - Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation

TQM Principles - Customer satisfaction - Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement - Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement - Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership - Partnering, Sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures - Basic Concepts, Strategy, Performance Measure.

Statistical Quality Control, The Seven Tools of Quality, Measures of Central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and Attributes, Process Capability, Concept of Six Sigma, New Seven Management Tools.

TQM Tools, Benchmarking, Reasons to Benchmark, Benchmarking Process, Quality Function. Deployment (QFD), House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM), ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System, Implementation of Quality System, Documentation, Quality Auditing.

Text Book

1. Quality Management: Concepts and Tasks, V. Narayana and N.S. Sreenivasan, New Age International, 1996

Reference Book

1. Total Quality Management, Dale H. Besterfiled, Pearson Education, 2003 (Indian reprint - 2004)
2. The Management and Control of Quality, James R. Evans & William M. Lidsay, 5th Edition, South-Western (Thomson Learning), 2002
3. Total Quality Management for Engineers, M. Zeiri, Wood Head Publishers, 1991

ME 4039 FUNDAMENTALS OF COMPUTATIONAL FLUID DYNAMICS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. make the mathematical interpretation of the physical problems.
CO2. understand the basic algorithim and think to develop suitable algorithims.
CO3. choose suitable discretization techniques for a particular problem.
CO4. analyze the different numerical solution methods and choose the suitable method.
CO5. understand the advantages of numerical solution before attempting experimental solutions

Prerequisite : Introduction to Fluid Mechanics & Heat Transfer (ME 3032)

Introduction:
Definition of CFD, solution procedure of a CFD problem, Classification of partial differential equations: Elliptic equations, Parabolic equations, Hyperbolic equations, Accuracy, Consistency, Stability and Convergence.

Mathematical Formulation:
Governing Equations: Mass Conservation Equation, Energy Equation, Momentum Equation, The general scalar transport equation, Boundary conditions, Initial condition.

Discretization Methods:

Finite Difference Formulation:
Steady one dimensional conduction problem, Unsteady one dimensional conduction problem (simple explicit method, simple implicit method, Crank-Nicolson method), Two dimensional heat conduction problem, Convection diffusion problem.

Finite Volume Formulation:
Steady one dimensional conduction problem, Unsteady one dimensional conduction problem, Two dimensional conduction problem, Steady one dimensional convection diffusion problem (upwind scheme), Two dimensional convection diffusion problem.

Flow field calculation:
Discretization of the momentum equation, Staggered grid, SIMPLE algorithm, SIMPLER algorithm.

Solution Methods:
Direct vs Iterative methods, Gauss-Seidel Method, SOR method, Tri-Diagonal Matrix (TDMA) algorithm.

Text Book
1. Numerical Heat Transfer and Fluid Flow, S V Patankar, Hemisphere Publishing.

Reference Book
1. Computational Fluid Dynamics, John D Anderson, Jr, McGraw Hill Book Company.
2. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, H. Versteeg , W. Malalasekera, Prentice Hall.
3. Computer Simulation of flow and heat transfer, P.S., Ghoshdasdidar, Tata McGraw-Hill Publishing Company Ltd.
4. Finite Difference Method, M. N. Ozisik, CRC.
5. Computational Fluid Flow and Heat Transfer, Muralidhar and T. Sundararajan, Narosa

ME 4041 OPERATIONS RESEARCH Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the advanced analytical methods for better decision making.
CO2. Understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively;
CO3. Know the formulation of mathematical models for quantitative analysis of managerial problems in industry;
CO4. Use the Operations Research approaches and computer tools in solving real problems in industry;

Prerequisite : Mathematics-I (MA 1001)

Unit-1

Introduction to Linear Programming (LP), Graphical Method, Simplex Method, Artificial variable techniques, Duality and Dual simplex method, Transportation Problems, Assignment Problems, Project Management-CPM and PERT, Critical path, Crashing, Operations scheduling, Job shop scheduling, Priority dispatching rules, Johnson's rule, n jobs with 2&3 machines.

Unit-2

Non-Linear Programming: Unconstrained univariate optimization problems: Bisection method & Newton's method; Unconstrained multivariate optimization: Gradient search method; Constrained optimization: Kuhn Tucker conditions, Quadratic and Separable Programming methods.

Unit 3

Dynamic Programming: Principle of Optimality, Concepts of state and stage, Solution of Discrete Problems through Backward Dynamic Programming, Multi-stage Dynamic programming problems, Shortest path, minimum spanning tree, maximum flow and minimum cost flow problems;

Unit -4

Queuing Theory: Markov Process - Description of state, Transition probability matrix, Birth and Death process, Markovian and Semi-Markovian Single-channel and Multiple-channel queues, Queuing Networks, Replacement Theory, Game Theory. Two person Zero-sum game, Saddle point, Mixed strategies, Use of dominance, Sub .games method

Unit 5

Discrete-event Simulation: Time-flow mechanisms, Random number and Random variate generation, Simulation of queuing, inventory and industrial problems, Integer Programming: 0-1 and mixed integer programming problem formulation, Branch and Bound method, Cutting-plane method.

Text Book

1. Operation Research by Hira and Gupta, S.Chand

Reference Book

1. Operation Research: An Introduction, Taha H A, PHI
2. Operation Research, Phillips, Rabindran and Solberg, John Wiley & Sons
3. Introduction to Operation Research, Hiller F S and Lieberman G J
4. Operation Research by S.D.Sharma

ME 4043 TOTAL QUALITY MANAGEMENT & RELIABILITY ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. know about Total Quality Management (TQM), TQM tools and techniques applied to manufacturing.
CO2. know about reliability and maintainability of different systems.
CO3. understand the improvement of quality and the development and transformation due to human involvement.
CO4. know about failure models, component reliability & system reliability.
CO5. know about mean down time, maintainability of systems & condition monitoring.

Prerequisite : Mathematics-I (MA 1001)

BASIC CONCEPTS
Evolution of total quality Management - Definition of quality - Comparison between traditional approach and TQM, Deming - Crosby - Juran - Taguchi, Ishikawa theories - Quality costs - Product quality Vs Service quality Strategic planning -Goal setting - Steps involved in strategic planning - TQM implementation.

TQM PRINCIPLES & BASIC TOOL
Customer Satisfaction - Types of customers, customer supplier chain, Customer perception of quality customer feed back - Customer complaints - Customer retention - Service quality.Employee involvement - Employee motivation - Maslow's hierarchy of needs - Herzberg theory - Empowerment and team work.

Basic Tools: Introduction to seven basic tools - Check sheets, histograms -Control charts, Pareto diagram - Cause and effect diagram - Stratification - Scatter diagrams.

NEW SEVEN MANAGEMENT TOOLS & ADVANCED TOOLS
Affinity diagram - Relations diagram - Tree diagram - Matrix diagram - Matrix data analysis diagram - Process decision program chart - Arrow diagram.

Advanced QC tools: Advanced QC tools like QFD - Root cause analysis - Taguchi method - Mistake proofing (poka-yoke) - Failure mode and effects analysis (FMEAs), failure mode and effects criticality analysis (FMECAs) and Fault tree analysis (FTAs) etc. - Quality Management Systems.

RELIABILITY
Definition - Probabilistic nature of failures - Mean failure rate - Meantime between failures - Hazard rate - Hazard models, Weibull model - System reliability improvement - Redundancy - Series - Parallel and Mixed configurations.

MAINTAINABILITY
Introduction - Choice of maintenance strategy - Mean time- to repair (MTTR) -Factors contributing to Mean Down Time (MDT) - Fault diagnosis, and routine testing for unrevealed faults - Factors contributing to Mean Maintenance Time - (MMT) on condition maintenance - Periodic condition monitoring - Continuous condition monitoring - Economics of maintenance.

Text Book

1. Joel E. Rose,”Total Quality Management”, 2nd Edition, Kogan Page Ltd., USA,1993.
2. Srinath, L. S.,”Reliability Engineering”, Affiliated East West Press, New Delhi, 1995.

Reference Book

1. Balagurusamy, E.,”Reliability Engineering”, Tata McGraw Hill publishing Co., New Delhi, 1984.
2. Greg Bound, et.al,”Beyond Total Quality Management towards the emerging paradigm”, McGraw Hill Inc., 1994.
3. Zeiri,,”Total Quality Management for Engineers”, Wood Head Publishers, 1991.

ME 4045 BOUNDARY LAYER THEORY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1 . understand the basic concepts of Boundary Layer and its applications.
CO2 . learn how to use a variety of methods for solving viscous and boundary layer flow problems,
CO3 . understand the adverse effects of phenomena such as the separation of the flow around an airfoil.
CO4 . know the analytic techniques, Computational Fluid Dynamics (CFD) and wind tunnel experiments.

Prerequisites : Fluid Mechanics & Hydraulic Machines (ME 2013) and Aerodynamics-I (AS 2006)

BASIC LAWS:
Basic laws of fluid flow – Continuity, momentum and energy equations as applied to system and control volume – Concept of flow fields.

FUNDAMENTALS OF BOUNDARY LAYER THEORY
Viscous fluid flow – Boundary conditions – Development of boundary layer – Estimation of boundary layer thickness –Displacement thickness, momentum and energy thickness for two-dimensional flows. General stress system in a deformable body – General strain system.

NAVIER STOKES EQUATION
Relation between stress and strain system in a solid body (Hooke's Law) – Relation between stress and strain rate system in liquids and gases (Stroke's Law) – The Navier -Strokes Equation (N-S) – General properties of Navier - Stokes Equation.

EXACT SOLUTION OF NAVIER-STOKES EQUATION
Two dimensional flow through a straight channel, Hagen –Poiseulle flow – Suddenly accelerated plane wall – Flow near a rotating disk – Very slow motion: Parallel flow past a sphere.

LAMINAR BOUNDARY LAYER
Analysis of flow past a flat plate and a cylinder – Integral relation of Karman – Integral analysis of energy equation –Laminar boundary layer equations – Flow separation –Blasius solution for flat–plate flow – Boundary layer temperature profiles for constant plate temperature.

BOUNDARY LAYER METHODS
Falkner Skan Wedge flows – Integral equation of Boundary layer – Pohlhausen method –Thermal boundary calculations – One parameter and two parameter integral methods.

INCOMPRESSIBLE TURBULENT MEAN FLOW
Two-dimensional turbulent boundary layer equations – Integral relations – Eddy viscosity theories – Velocity profiles.

COMPRESSIBLE – BOUNDARY LAYER FLOW
The law of the wall – The law of the wake – Turbulent flow in pipes and channels –Turbulent boundary on flat plate– Boundary layers with pressure gradient.

Text Book
1. Turbulent Flows in Engineering, Reynolds AJ, John Wiley & Sons, 1980
2. Incompressible Flow, Panton RL, John Wiley & Sons, 1984

Reference Book
1. Boundary Layer Theory, Schlichting H, McGraw Hill, New York, 1979
2. Viscous fluid Flow, White FM, McGraw Hill Co. Inc., NY, 1991, 2nd Edition
3. Fundamentals of Aerodynamics, Anderson JD, McGraw Hill Book

ME 4049 ADVANCED MECHANICS OF SOLIDS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. know the application of fixed and continuous beams.
CO2. evaluate the shear centre for symmetrical and unsymmetrical beams.
CO3. know the application of curved beams and concepts in the theory of elasticity.
CO4. evaluate the stress analysis by photo elastic method, stress optic law and brittle coating method.

Prerequisite : Mechanics of Solids (ME 2012)

Fixed and continuous beams:

Fixed and continuous beams.

Curved Beams:

Bending of Beams with small initial curvature, strain energy of beam with small initial Curvature, Deflection of beam with small initial curvature, curved beam with large initial curvature.

Shear Centre:

Shear centre for sections symmetrical about both axes, shear centre for section symmetrical about one axis.

Unsymmetrical Bending:

Unsymmetrical Bending stress at any point in cross-section, sign convention, Direction of neutral axis, Determining stress and deflection in Beams with unsymmetrical bending.

Basic concepts in theory of Elasticity:

Basic concepts in theory of Elasticity (Theoretical approach in Cartesian co-ordinates only), stress at a point. Notation for stress, sign convention for stress. Differential equations of equilibrium, strain components, compatibility equations.

Engineering Stress Analysis:

Two-dimensional photo elastic method of Stress analysis, Stress optic law, Light and dark field in polariscope. Iso-chromatic fringe pattern: stress determination by Brittle Coating method.

Text Book

1. Advanced mechanics of materials, A. P Boresi.; R.J Schimdt.; Wiley

Reference Book

1. Strength of Materials: G.H. Ryder.
2. Strength of Materials: Dr Sadhu Singh
3. Strength of materials, Beer and Johnson TMGH.

ME 4050 ROBOTICS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. select different sensors and actuators for body parts of robot.
CO2. analyze the kinematics of robot.
CO3. control robot by programming.
CO4. select the best robotics applications and be able to justify the overall advantages to industry.

Prerequisite :NIL

Introduction:

Definition of a Robot, Basic Concepts, Robot configurations, Types of Robot drives, Basic robot motions, Point to point control and Continuous path control.

Components and Operation:

Basic control system concepts, Control system analysis, Robot actuation and feedback, Manipulators, direct and inverse kinematics, Coordinate transformation, Brief Robot dynamics, Types of Robot and Effectors, Robot/ End and Effectors interface.

Sensing and Machine Vision:

Range sensing, Proximity sensing, Touch sensing, Force and Torque sensing. Introduction to Machine vision, Sensing and Digitizing .Image processing and analysis.

Robot Programming Methods:

Languages, Capabilities and limitation, Artificial intelligence, Knowledge representation, Search techniques in A I and Robotics.

Industrial Applications:

Application of robots in machining, Welding, Assembly, Material handling, Loading and Unloading, CIM, Hostile and Remote environments.

Text Book

1. Robotic Engineering: An Integrated Approach- Richard D. Klafter, Thomas A. Chmielewski and Michael Negin , Prentice Hall of India

Reference Book

1. Industrial Robotics Technology – Programming and Applications- Mikell P. Groover, Mitchell Weiss, McGraw Hill International Edition.
2. Foundation of Robotics: Analysis and Control -Yoshikawa, Prentice Hall of India.
3. Robotics; control, sensing, vision and intelligence, K. S. Fu, R. s. Gonzalez and C. S. G. Lee, TMH

ME 4051 ROBOTICS AND FLEXIBLE MANUFACTURING SYSTEM Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. understand the use of robots and design the robotic path generation
CO2. use the different drive systems for different robot application and analyze the sensing and vision of a robot
CO3. understand the need of flexible manufacturing and the application of robot in it.
CO4. select appropriate tooling for manufacturing the part in integrated environment.

Prerequisite :NIL

Introduction:
Definition, robotic system, symbols, description of position and orientation, transformation of coordinate frames, joint variables, D-H algorithm.

Kinematics of manipulators:

Direct and inverse kinematics, velocity and static forces, dynamics of manipulator.

Robot drives, actuators and control:

Drive systems, pump classification, pneumatic system, electrical drives, piezoelectric actuators, drive mechanisms.

Robot end effectors:

Classification of end effectors, types of grippers, drive system for grippers, active and passive grippers.

Sensors and robot vision:

Need of sensing systems, sensory devices, types of sensors, robot vision system

Robot languages and programming:

Classifications, computer control and robot software, VAL system and language.

Group technology and FMS:

Benefits of group technology, flexible manufacturing system, FMS work station, planning and analysis, application of FMS.

Computer integrated manufacturing (CIM):

Computer aided process planning, computer integrated production planning system, material requirement planning, manufacturing resource planning.

Text Book

1. Robotics Technology and Flexible automation, S. R. Deb and S. Deb, TMH (2nd edition)
2.Automation, Productions systems, and computer Integrated manufacturing, Mikell P. Groover, PHI (3rd edition)

Reference Book

1. Robotics and Control, R. K. Mittal and I. J. Nagrath, TMH
2. Fundamentals of robotics Analysis & Control, Robert J. Schilling, PHI,
3. Robotics; control, sensing, vision and intelligence, K. S. Fu, R. s. Gonzalez and C. S. G. Lee, TMH

ME 4053 FLUID POWER ENGINEERING AND CONTROL Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. understand the basic principles of fluid power and symbols.
CO2. understand the working of various components of hydraulic systems.
CO3. understand the designing procedures for the hydraulic power circuits.
CO4. understand the fundamentals of pneumatic systems and their components.
CO5. understand the designing procedures for the pneumatic power circuits.
CO6. understand the concepts of fluidics, PLC’s, and their applications in designing fluidic control devices.

Prerequisite :Fluid Mechanics (ME 2003)

Fluid power systems and fundamentals:

Introduction to fluid power, Advantages of fluid power, Types and applications of fluid power systems, Properties of hydraulic fluids, General fluidtypes, Fluid power symbols.

Basics of Hydraulics: applications of Pascal's Law, laminar and turbulent flow, Reynolds's number, Darcy's equation, Losses in pipes, valves and fittings.

Hydraulic systems and components:

Sources of hydraulic power: Pumping theory, Pump classification, Gear pump, Vane pump, Piston pump and Variable displacement pumps, construction and working of pumps, Pump performance.

Fluid power actuators: Linear hydraulic actuators–Types of hydraulic cylinders, Single acting, Double acting special cylinders like tanden, rodless, telescopic, cushioning mechanism, Construction of double acting cylinder, Rotary actuators – Fluid motors, Gear, Vane and Piston motors.

Design of hydraulic circuits

Construction of Control Components: Director control valve, 3/2 way valve, 4/2 way valve, shuttle valve, check valve, pressure control valve, pressure reducing valve, sequence valve, flow control valve, fixed and adjustable, electrical control solenoid valves, Relays, ladder diagram.

Accumulators and Intensifiers: Types of accumulators, Accumulators circuits, sizing of accumulators, intensifier, Applications of Intensifier, Intensifier circuit.

Pneumatic systems and components

Pneumatic Components: Properties of air, Compressors, Filter, Regulator, Lubricator unit, Air control valves, Quick exhaust valves and pneumatic actuators.

Fluid power circuit design, Speed control circuits, synchronizing circuit, Penumo hydraulic circuit, Sequential circuit design for simple applications using cascade method.

Design of pneumatic circuits

Servo systems: Hydro mechanical servo systems, Electro hydraulic servo systems and proportional valves.

Fluidics: Introduction to fluidic devices, simple circuits, Introduction to electro hydraulic pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control, Fluid power circuits, failure and troubleshooting.

Text Book

1. John Watton, Fundamentals of Fluid Power Control, 1st Ed., Cambridge University Press, 2009.

Reference Book

1. Fluid Power with Applications, Anthony Esposito, 7th Ed., Prentice Hall, 2009.
2. Basic Fluid Power,Dudelyt, A. Pease and John T. Pippenger, Prentice Hall, 1987.
3. Pneumatic systems – Principles and maintenance, Majumdar S.R, Tata McGraw Hill, 1995.
4. Hydraulic control systems, Manring, N. D., 1st Ed., John Wiley & Sons, 2005.
5. Introduction To Fluid Power, Johnson, James L., Delmar Publishers, 2003

ME 4054 BIOMECHANICS Cr-3

Course Outcome : At the end of the course, the students will be able to :

CO1. apply principle of mechanics to model human body.
CO2. analyze motion of leg parts and hand parts to develop artificial limbs.
CO3. find out the stress produces in different body parts during physical activities in daily life.
CO4. design and develop set up for physiotherapy applications.

Prerequisite : Engineering Mechanics (ME 1001)

Introduction:
Mechanics, Biomechanics, Basic Concepts, Newton's Laws, Dimensional Analysis, Systems of Units, Conversion of Units, Mathematics, Scalars and Vectors, Modelling and Approximation, Generalized Procedure, Scope of the Text, Notation.

Statics Analyses of System in Equilibrium:

Overview, Newton's Laws of Mechanics, Conditions for Equilibrium, Free-Body Diagrams, Procedure to analyse Systems in Equilibrium, Notes Concerning the Equilibrium Equations, Constraints and Reactions, Simply Supported Structures, Cable-Pulley systems and Traction Devices, Built-in-Structures, Systems involving Friction, Center of Gravity Determination.

Applications of Statics to Biomechanics:

Skeletal Joints, Skeletal Muscles, Basic Considerations, Basic Assumptions and Limitations, Mechanics of the Elbow, Mechanics of the shoulder, Mechanics of the spinal column, Mechanics of the Hip, Mechanics of the knee, Mechanics of the ankle.

Stress and Strain:

Basic Loading Configurations, Uniaxial Tension Test, Load-Elongation Diagrams, Simple Stress, Simple Strain, Stress-Strain Diagrams, Elastic Deformations, Hooke's Law, Plastic Deformation, Necking, Work and Strain Energy, Strain Hardening, Hysteresis Loop, Properties Based on Stress-Strain Diagrams, Idealized Models of Material Behavior, Mechanical Properties of Materials.

Mechanical Properties of Biological Tissues:

Viscoelasticity, Analogies Based on Springs and Dashpots, Empirical Models of Viscoelasticity, Time-Dependant Material Response, Comparison of Elasticity and Viscoelasticity, Common Characteristics of Biological Tissues, Biomechanics of Bone, Biomechanics of Tendons and Ligaments, Biomechanics of Skeletal Muscles, Biomechanics of Articular Cartilage.

Introduction to Dynamics & Linear Kinematics:

Dynamics, Kinematics and kinetics, Linear, angular, and General Motions, Distance and Displacement, Speed and Velocity, Acceleration, Inertia and Momentum, Degree of Freedom, Particle Concept, Reference Frames and Coordinates Systems, Prerequisites for Dynamic Analyses. Uniaxial Motion, Position, Displacements, Velocity and Acceleration, Dimensions and Units, Measured and Derived Quantities, Uniaxial Motion with Constant Acceleration.

Text Book

1. Fundamentals of Biomechanics – Nihat Ozkaya and Margareta Nordin (Springer), 2nd Ed.

Reference Book

1. Fundamentals of Biomechanics-Duane Knudson . (Springer)
2. Text book of Biomechanics and exercise therapy- Dr. C.Nagavani

ME 4055 SOLAR ENERGY SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. learn the fundamentals of solar energy conversion systems, available solar energy, solar applications.
CO2. learn about PV technology principles and techniques of various solar cells /materials for energy conversion.
CO3. learn how to advance the current technology of the solar energy systems for making the process economical, environmentally safe and sustainable.

Prerequisite : NIL

Solar radiation:
Sun as the source of radiation, Sun-Earth relationships, solar constant, solar radiation at the earth's surface, depletion of solar radiation, measurement of solar radiation, solar radiation data, solar time, solar radiation geometry, solar radiation on tilted surfaces.

Solar collectors:
Classification, comparison of concentrating and non-concentrating types. Flat plate collectors: construction, liquid flat-plate collector efficiency, effect of various parameters on performance. Concentrating collectors: Working principle of flat plate collector with plane reflectors - Cylindrical parabolic concentrators - Compound parabolic concentrator (CPC) - linear Fresnel lens collector – Paraboloidal dish collector - Central tower receiver.

Applications of solar thermal technology:
Electric power generation: Low temperature systems - Low temperature power generation using liquid flat plate collectors - Solar pond electric power plant – Solar chimney power plant. Medium temperature system - Power generation using line focusing cylindrical parabolic concentrating collectors. High temperature systems - Power generation using paraboloid dish collectors - Central tower receiver power plant. Solar water heating system, passive solar space heating and cooling system, solar cooker, solar distillation, solar dryer, solar cooling- Absorption cooling – Solar desiccant cooling. Solar green house.

Solar photovoltaic systems:
Fundamentals of solar cells, P-N junction photodiode, photovoltaic conversion - description and principle of working of a solar cell, cell structure, solar module and panel, I-V characteristics of a PV module, maximum power point, cell efficiency, fill factor, SPV system classification, SPV system components, SPV applications.

Solar energy storage and economic analysis:
Storage of solar energy: thermal storage-sensible and latent heat storage, electrical storage and chemical Storage. Economic Analysis: Initial and annual costs, definition of economic terms for a solar system, present worth calculation, repayment of loan in equal annual installments, annual savings, cumulative savings and life cycle savings, payback period, clean development mechanism.

Text book

1. Solar Energy, Principles of Thermal Collection and Storage, Sukhatme. S. P, Nayak. J. K, Tata McGraw Hill,Third edition, 2010.

Reference book
1. Solar Energy: Fundamentals & Applications, Garg. H. P, Prakash. J, Tata McGraw Hill, 2000.
2. Solar Engineering of Thermal Processes, Duffie. J. A and Beckman. W. A, John Wiley, 1991.
3. Solar Energy Utilization, Rai. G. D, Khanna Publishers, Year 2011.

ME 4056 MECHATRONIC SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. select and apply the knowledge, techniques, skills and modern tools in mechatronics engineering technology.
CO2. apply concepts of circuit analysis, analog and digital electronics, automation and controls, motors, electric drives, power systems, instrumentation, and computers to aid in the design, characterization, analysis, and troubleshooting of mechatronics systems used in industries as well as home appliances.
CO3. apply the different drive systems for actuation of various parts and components of a system.
CO4. understand the different controllers used in industries, machines and industrial robots.

Prerequisite : Basic Electronics (EC 1001)

Introduction:
Definition of mechatronics, need of mechatronics system, Examples of mechatronics systems in manufacturing, products, design. Review of fundamentals of electronics. Data conversion devices, sensors and transducers, (pressure, velocity, level, light, accelerometers, gyros, compass, encoders, strain gauges, LVDT, potentio meter), smart sensors, micro sensors, transducers, signal processing devices, relays, contactors and timers. Signal conditioning basics, filtering, protection, pulse width modulation, opamps and their applications, Microprocessors (8085 and Arduino) micro controllers for sensing, actuation and control, and PLCs. Digital data, analog data, AD-DA conversion, demonstration on data acquisition systems using NI LabVIEW)

Logic circuits:
Digital logic, logic gates, application of logic gates, sequential logic Basic modelling of systems, first order systems, second order systems, performance measure of second order systems

Drives:
Switching, solenoids, stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams. (Programming a servomotor using NI Labview)

PneumaticsandHydraulic actuation systems:
Flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps, production, distribution and conditioning of compressed air, system components and graphic representations, design of systems.

Controllers:
Close loop and open loop systems, description of PD, PI and PID controllers. CNC machines and part programming. Introduction to Robotics, forward and invers kinematics (Demonstration on programing robot and CNC part programming).

Text Book
1. Mechatronics: electronic control systems in mechanical and electrical engineering, Boltan, W., Longman, Singapore, 1999.
2. Mechatronics, HMT ltd. Tata Mcgraw-Hill, New Delhi, 1988.
3. A Text book of Mechatronics , Rajput, S Chand, New Delhi, 2008

Reference Book

1. Robotics technology and flexible automation, S. R Deb and S. Deb., , Tata McGraw-Hill, New Delhi, 1994.
2. Computer automation in manufacturing - an Introduction, T. O. Boucher, Chapman and Hall, 1996.
3. Micromechatronics, modelling, analysis, and design with MATLAB, V. Giurgiutiu, S. E. lyshevski, CRC Press,2015
4. Mechatronics: Principles, concepts and applications, N. P. Mahalik, TMH

ME 4057 PRODUCTION AND OPERATIONS MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. describe (identify/write) the various components that make up the manufacturing planning and control system and the interaction among them.

CO2. develop the models that are applicable for supply chain inventory management, including those for quantity discounts, safety stocks, and order quantity and reorder point interactions.

CO3. develop the algorithms that are appropriate for solving single-machine, two-machine, parallel-machines and flow shop scheduling problems.

CO4. show how (i) the material requirement plans, manufacturing resource plans, and capacity requirement plans can be developed, and (ii) lot sizing decisions can be made for a manufacturing system.

Prerequisite : NIL

Module-I Overview of Operations Management

Introduction , Responsibilities of Production Manager, Strategic Decisions in Operations, Manufacturing Vs. Service Operation, Types of Production processes (Project/Job, Batch, Mass/Line, Continuous), Concept of FMS (Flexible Manufacturing System), Role of Production, Planning & Control (PPC), New Product Development & Process Design, **Importance of operations in services, service classifications, service package, Distinctive characteristics of service operations.**

Module-II Work Study, Aggregate Planning, Project Management, and Supply chain Mnagement

Introduction of Work Study, Method study Procedure, Principles of Motion Economy, Stop Watch Time Study Procedure, Importance of Rating & Allowances in Time Study, Aggregate Planning: Relevant cost; Evaluation of strategic alternatives (Level, Chase and Mixed), Project Management: Basic concept, Network principles-CPM, PERT, Crashing**.** Understanding the supply chain, decision phases in supply chain, process view of supply chain, supply chain flows

Module-III Facility Location and Layout, Scheduling

Importance & Factors affecting the Plant Location, Single and Multi facility location Techniques (Centroid and Minimax method), Plant Layout & its classification, Relationship Diagram & Block Diagramming, Assembly Line of Balancing, Sequencing,2 and 3 Machine cases: Johnson’s Rule, Job shop Scheduling: Priority dispatching Rules,

Module – IV Inventory Control, Quality Control

Inventory Control: Relevant Costs, P & Q Systems of Inventory, Basic EOQ Model, and Model with Quantity discount, Economic Batch Quantity. Safety Stock, Reorder Point, ABC Analysis, Material Requirement Planning,. Concept of Quality Management, Statistical Quality Control, X Bar, R and P Charts. Acceptance sampling,

Text Book

1. Production and Operation Management, R. Paneerselvam, Third Edition,2013

Reference Book

1. Production and Operation Management, K. Aswathappa K. Shridhara Bhat
2. S.N. Charry, Production and operations management, TMH

ME 4058 FINITE ELEMENT METHOD FOR ENGINEERS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. obtain an understanding of the fundamental theory of the FEA method.
CO2. generate the governing FE equations for systems governed by partialdifferential equations.
CO3. formulate with Rayleigh-Ritz and Galerkin Method.
CO4. understand the use of the basic finite elements for structural applications using truss, beam
CO5. understand the application and use of the FE method for heat transfer problems
CO6. understand the application and use of the FE method for other engineering problems.

Prerequisite : Mathematics - I (MA 1001)

Introduction to FEM:

Introduction, Basic concepts of FEM, Comparison of Finite Element and Exact solutions, Applications of FEM.

Direct Formulation:

Axial rod problem, Beam problem, Heat conduction problem, Electrical circuit problem.

Basic Procedure:

General procedure of FEM, Elements and shape functions, Co-ordinate transformations: Global coordinates and natural coordinates,

Types of Elements:

One dimensional linear element, One dimensional quadratic element, Two dimensional linear triangular element (CST: Constant Strain Triangle), Isoparametric elements, Three dimensional elements.

Finite Element Formulation:

Derivation of Finite Element equations using Rayleigh-Ritz and Galerkin Method. Rayleigh-Ritz method for one dimensional structural (bar) problem, Stiffness matrix and load vector for one dimensional structural problems, Galerkin method for one dimensional heat conduction problem. Conductivity matrix and heat rate vector for one dimensional heat conduction problems.

Assembly of Element Matrices and Treatment of Boundary Conditions:

Assemblage of element equations, Treatment of boundary conditions.

Application to Engineering Problems:

Application to structural bar problems, truss problems, heat conduction problems with various boundary conditions, electrical and magnetic field problems.

Text Book

1. Introduction to Finite Elements in Engineering, T. R. Chandrupatla, A. D. Belegundu, Pearson, 4^{th} Edition, 2015.

Reference Book

1. Fundamentals of the Finite Element Method for Heat and Fluid Flow, Roland W. Lewis, Perumal Nithiarasu and K.N. Seetharamu, Wiley; 1^{st} edition, 2004.
2. Fundamentals of Finite Element Analysis, D.V. Hutton, McGraw Hill.

ME 4059 MECHANICS OF COMPOSITE MATERIALS Cr-3

Course Outcome : At the end of the course, the student will be able to :

CO1. understand the characteristics & application of a composite material and different manufacturing methods of laminated fiber-reinforced composite materials.
CO2. know the strength of a unidirectional lamina and strength of an orthotropic lamina.
CO3. the macromechanical behavior of a lamina, stress-strain relation for anisotropic material.
CO4. know the micromechanical behavior of a lamina and to determine various elastic constants.
CO5. know about classical lamination theory and stress-strain variation in laminate.

Prerequisite :NIL

Introduction:
An overview of composites, Classification & characteristics of composite materials, Application and advantages of composites, advanced fibers, Fiber properties, Matrix materials, Fillers, Fabrication of polymer, metal, ceramic matrix composites.

Elastic behavior of unidirectional lamina:
Longitudinal behavior of unidirectional composites, Transverse stiffness and strength, Failure modes, expansion coefficients and transport properties.

Macro-mechanical behavior of a lamina:.
Stress-strain relation for anisotropic materials, stiffness, compliances, and engineering constants for orthotropic materials. Stress-strain relation for plane stress in an orthotropic material.

Micro-mechanical behavior of a lamina:
Determination of elastic constants (E1, E2, μ12, G12)

Analysis of Laminated Composites:
Classical lamination theory, lamina stress-strain behavior, stress and strain variation in laminate, resultant laminate forces and moments.

Test methods:
Measurement of physical properties, Measurement of Mechanical properties, Flexural properties, Fracture toughness and Impact properties.

Text Book
1. Mechanics of Composite Materials, R.M. Jones, 2nd Ed., Taylor and Francis.

Reference Book
1. Composite Materials, K.K. Chawala, Springer-Verlag.
2. Engineering Mechanics of Composite Materials, I.M. Daniel and Ori Ishai, Oxford University Press (Indian 2nd Ed.)

ME 4060 MECHANICAL MEASUREMENTS & CONTROL Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify significance of mechanical measurements and learn Basic transducer elements, signal conditioning elements and data presenting elements.
CO2. apply different methods to measure Strain, vibration and shock, pressure and temperature.
CO3. apply control system fundamentals to do mathematical modeling.
CO4. analyze systems and errors in time domain and frequency domain

Prerequisite : NIL

Introduction to Generalized Mechanical Measurement System:

The significance of mechanical measurements.

Basic detector transducer elements:

Electrical transducer, Sliding Contact devices, Variable- Inductance transducer elements. The differential transformer, Variable- reluctance transducers. Capacitive transducers. The piezoelectric effect, photo-electric transducers, Electronic Transducer element.

Signal Processing:

Electrical Intermediate modifying devices, input circuitry, the simple current sensing circuit, the ballast circuit, the voltage-dividing potentiometer circuit. The voltage balancing potentiometer circuit. Resistance bridges.

Measurement of Strain:

The Electrical resistance strain gauge. The metallic resistance strain gage, Selection and installation factors for metallic strain gages, Circuitry, Metallic strain gage, The strain gage ballast circuit, the strain gage bridge circuit, Temperature compensation.

Measurement of Pressure:

Pressure measurement systems, Pressure measuring transducers, Gravitations transducers, Elastic transducers, Elastic diaphragms, Secondary transducers used with diaphragms, strain gage pressure cells, Measurement of high pressure, Measurement of low pressures. Dynamic characteristic of pressure measuring systems. Calibration method.

Temperature Measurement:

Use of bimetals pressure thermometers. Thermocouples, Pyrometer, calibration of temperature measuring devices.

Vibration and Shock:

Measurement and test methods- Vibrometers and accelerometers, Elementary vibrometers and vibration defectors.

Measurement system modeling:

Description of open and closed loop control systems and their block diagrams. Use of block diagrams and signal flow graph to find the overall transfer function.

Basic characteristics of feedback control systems:
Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness. Basic modes of feedback control: proportional, integral and derivative. Feed-forward and multi-loop control configurations, stability concept, relative stability, Routh stability criterion. Time response of second-order systems, steady-state errors and error constants. Performance specifications in time-domain. Root locus method of design. Lead and lag compensation.

Frequency-response analysis:

Relationship between time & frequency response, Polar plots, Bode's plot, stability in frequency domain, Nyquist plots. Nyquist stability criterion. Performance specifications in frequency-domain. Frequency-domain methods of design, Compensation & their realization in time & frequency domain. Lead and Lag compensation. Tuning of process controllers. State variable formulation and solution.

Text Book

1. Mechanical Measurements: Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard V, Prentice Hall; 6 edition (August 17, 2006)
2. Control systems Engineering: I. J. Nagpal and M. Gopal, New Age International Publishers,

Reference Book

1. A course in mechanical measurement and instrumentation: A K Sawhney, P Sawhney, DR Co
2. Mechanical Measurements and Instrumentation, R K Rajput, S.K. Kataria & Sons
3. Mechanical and Industrial Measurements: Process Instrumentation and Control, R. K. Jain, Khanna Publishers

ME 4062 TRIBOLOGY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. know hydrostatic step bearings and application to pivoted thrust bearings.
CO2. know hydrodynamic lubrication, petroffs equation, Reynold's equations.
CO3. evaluate the friction loss in concentric bearings, bearing modulus and Sommerfeld number.
CO4. know the bearing pads and bearing materials.

Prerequisite : NIL

Study of various parameters:

Viscosity, flow of fluids, viscosity and its variation -absolute and kinematic viscosity, temperature variation, viscosity index determination of viscosity, different viscometers used.

Hydrostatic lubrication:

Hydrostatic step bearing, application to pivoted pad thrust bearing and other applications, hydrostatic lifts, hydrostatic squeeze films and its application to journal bearing.

Hydrodynamic theory of lubrication:

Various theories of lubrication, petroffs equation, Reynold's equation in two dimensions -Effects of side leakage - Reynolds equation in three dimensions, Friction in sliding bearing, hydro dynamic theory applied to journal bearing, minimum oil film thickness, oil whip and whirl anti -friction bearing.

Friction and power losses in journal bearings :

Calibration of friction loss friction in concentric bearings, bearing moduIus, Sommerfield number, heat balance, practical consideration of journal bearing design considerations.

Air lubricated bearing:

Advantages and disadvantages application to Hydrodynamic journal bearings, hydrodynamic thrust bearings. Hydrostatic thrust bearings. Hydrostatic bearing Analysis including compressibility effect.

Study of current concepts of boundary friction and dry friction.

Types of bearing oil pads:

Hydrostatic bearing wick oiled bearings, oil rings, pressure feed bearing, partial bearings -externally pressurized bearings.

Bearing materials:

General requirements of bearing materials, types of bearing materials.

Text Book

1. Fundamentals of Tribology, Basu, Sen Gupta and Ahuja, PHI

Reference Book

1. Tribology in Industry **:** Sushil Kumar Srivatsava, S. Chand &Co.
2. Tribilogy, Friction and Wear of Engineering Materials, I.M. Hutchings, Elsevier Limited.

ME 4063 METAL FORMING PROCESSES Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. explain the plastic deformation of metals is achieved on industrial scale and analyze the behaviour of materials during forming processes.

CO2. understand the concept of technological procedures in industrial manufacturing processes related to pressure shaping of metals and estimate the required forming loads and powers of different forming processes.

CO3. explain the essence of each technological operation employed in industrial pressure shaping of metals

CO4. integrate knowledge gained in this course to select and design a complete metal forming system.

Prerequisite : Basic Manufacturing Processes (ME 2010)

Introduction:
Fundamentals of plasticity, stress and strain, stress-strain relationship, yield criteria and flow rules, instability.

Fundamentals of Metal Forming:
Classification of forming processes, mechanisms of metal forming- lab method, limit analysis, upper bound and lower bound theorem, slip line solution, temperature of metal working, hot working, cold working; Friction and lubricants in metal forming

Rolling of Metals:
Rolling processes, forces and geometrical relationship in rolling, simplified analysis of cold and hot rolling, rolling load, rolling process variables, defects in rolling, torque and power calculations, friction hill.

Forging:
Classification of forging process, forging of plates and circular discs, forging load calculation, open-die and closed-die forging, stress and strain distribution in forging process, friction and lubrication in forging process.

Extrusion:
Classification of extrusion process, Analysis of Extrusion process, Extrusion load estimation, extrusion process parameters, extrusion of tubes and production of seamless pipes.

Drawing of tubes, rods and wires:
Wire drawing dies, tube drawing process, analysis of wire drawing, deep drawing and tube drawing, drawing force calculation.

Sheet Metal forming:
Forming methods, bending, stretch forming, spinning, hydraulic forming, forming limit criteria, defect in formed parts.

Text Book
1. Fundamentals of Metal Forming Processes, B. L. Juneja, New Age International Publishers, 2nd Edition, 2010

References Book
1. Principles of Metal Working Processes, G.W. Rowe, CBS Publishers, 2005, ISBN-10: 8123904282 ISBN-13: 978-8123904283.
2. Metal Forming Hand book, ASM

ME 4064 ALTERNATIVE FUELS AND RENEWABLE ENERGY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the potential, availability and the properties of the alternate and renewable fuels.

CO2. understand the basic principles of physics and the performance, combustion and emission characteristics of LPG, CNG and other alternate fuels in SI and CI engines.

CO3. understand the basic principles of different renewable energy sources like solar, biomass, wind, geothermal, tidal, ocean and wave energy and its merits and demerits.

CO4. keep our environment clean from different pollutions.

CO5. get placement in organizations to manage alternate fuels and renewable energy based power generation in the country.

Prerequisite : NIL

Introduction to Renewable Energy:

Forms of energy, Fossil fuels and climate change, Renewable energy sources (direct and indirect uses of solar energy and non-solar energy), Importance of energy storage and distribution, Biological storage, Chemical storage, Heat storage, Electrical storage, Mechanical storage, Distribution of energy.

Solar Power Generation:

The nature and availability of solar radiation, Low temperature solar energy applications, Active solar heating, Passive solar heating, Solar thermal engines and electricity generation, Economics, potential and environmental impact.

Bio Power Generation:

Bioenergy past and present, Biomass as a solar energy store, Biomass as a fuel, Primary biomass energy sources: plant materials, Secondary biomass sources: wastes, residues, and co-products, Physical processing of biomass, Thermochemical processing, Biochemical processing, Vegetable oils and biodiesel, Environmental benefits and impacts, Economics, Future prospects for bioenergy.

Tidal and Wave Power Generation:

Nature of tidal source, Physics of tidal energy, Power generation from barrages, Environmental considerations for tidal barrages, Integration of electrical power from tidal barrages, Economics of tidal barrages, Tidal lagoons, Tidal streams/currents, Tidal current projects, Tidal current assessment, Physical principles of wave energy, Wave energy sources, Wave energy technology, Integration (wave energy for isolated communities and large electricity grids).

Wind Power Generation:

Energy and power in the wind, Characteristics of wind, Wind turbines (types, horizontal and vertical axis wind turbines), Linear momentum and basic theory, Dynamic matching, Blade element theory, Aerodynamics of wind turbines, Power extraction by a turbine, Electricity generation, Power from wind turbines, Environmental impact, Economics of energy generation, Commercial development and wind energy potential, Offshore wind energy.

Geothermal Power Generation:

The mining of geothermal heat, Source of heat, Physics of deep geothermal resources, Technologies for exploiting high enthalpy steam fields, Technologies for direct use of geothermal energy, Harnessing geothermal resources, Environmental implications, Economics and world potential.

Text Book

1. Renewable Energy- Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, 3rd Edition, 2012.

Reference Book

1. Renewable Energy Resources, John Twidell and Tony Weir, Taylor & Francis Group, 3rd Indian Edition, Vikash Publications, 2010.

ME 4066 MACHINE MAINTENANCE AND CONDITION MONITORING Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. understand the philosophy behind different maintenance techniques and select the best maintenance practices.
CO2. use successfully different condition monitoring techniques to predict health of a machine.
CO3. analyze and find out the root cause of defect in machine and system.
CO4. apply different NDT methods to find out fault in machine and structure.

Prerequisite :Kinematics & Kinetics of Machines (ME 2009)

Maintenance strategies:
Breakdown, Preventive, Predictive and Proactive maintenance. Plant machinery classification, Condition based maintenance.

Transducers for condition monitoring:
Principles and application of accelerometers, velocity pickups, eddy current probes, stroboscopes, proximity probes, spike energy detector, laser vibrometer, condenser microphones, thermocouples, optical pyrometer, ultrasonic thickness detector, acoustic emission transducer.

Fundamentals of Signal processing:
Fast Fourier Transform (FFT) analysis, Sampling rate, Nyquist sampling theorem, aliasing, filters, A/D converter, Windowing.

Vibration Monitoring:
Measuring vibration: Signal forms, phase, overall and spectral vibration, Measurement point location, Transducer mountings.

Rotating machinery fault analysis:
Imbalance, Misalignments, Looseness, Oil whirl, Bent shafts, Coupling problem, Bearing defects, Gear defects.

Vibration level classification:
ISO standards, Peak and RMS levels, Time domain averaging, Trending fault data. Case studies based on vibration data and signature of machines.

Wear and Debris Analysis:
Principle of Tribology, Industrial and Automotive Lubricants, Lubricants Properties, Lubricants Contamination and Prevention, Lubricants Mechanism and Failures, Sampling of Lubricants, Wear particle size, Ferrography, Particle Counting, Magnetic Plugs, Spectrometric metals analysis and Types of Wear Particles. Case studies based on oil analysis data of machines.

Temperature Monitoring:
Infra-red Thermograghy, Principles, Instruments, Thermal imaging, Locating hot spots for maintenance intervention, Ascertaining condition of refractory lining, Identifying faults in cooling system and in electrical Equipments, Plant Heat audit .Case studies based on thermal images.

Non Destructive Testing:
Faults that can be detected by NDT, Ultrasonic, Radiography Methods, Eddy Current Method, Acoustic Emission Method, Dye penetrant Method. Case studies based on available NDT data.

Advance Maintenance Practices:
Total Productive Maintenance (TPM), Reliability Centered Maintenance (RCM), Computerized Maintenance Management Systems (CMMS), Five Zero Maintenance Concept. Maintenance Planning and Scheduling, Budgeting, Costing.

Text Book

1. Maintenance Engineering and Management, Sushil Kumar Srivastava, S.CHAND,

Reference Book

1. Maintenance Engineering and Management, K.Venkataraman, PHI, 1st Edition
2. Plant Maintenance and Reliability Engineering, N.V.S. Raju, CENGAGE, 1st Edition

ME 4068 INDUSTRIAL SAFETY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. achieveindustry professions
CO2. provide Safety, Health & Environmental Awareness
CO3. enhance knowledge, skills and .develop good working environment to teach skills to avoid acidents and loss.

Prerequisite : NIL

Introduction to Industrial Safety:
History and development of safety movement, Need for safety, Safety legislation: Acts and rules, Safety standards and codes, Safety policy: safety organization and responsibilities and authorities of different levels.

Types of industries:
Light, heavy, high tech – manufacturing (iron and steel), process (oil refinery), service (hospital); Overview of a typical modern industry: activity flow, machineries, operations, parameters which could lead to accidents; ranges of temperatures and pressures, working media like fluids and gases, safety concerns (over pressure, gas leaks, etc.)

Areas of industrial safety:
Process safety, personnel safety, instrument safety, facility safety, environmental safety.

Accidents:
Accident sequence theory, Causes of accidents, Accident prevention and control techniques, Plant safety inspections, Job safety Analysis and investigation of accidents, First aid.

Financial costs:
Direct and indirect social costs of accidents. Compilation procedure for financial costs. Cost data, quality and its limitations-Budgeting.

Hazard Identification:
Identification of hazard, Categorization methods for elimination of hazard, Mechanical hazards; machine guarding, safety with hand tools/ portable power tools, Pressure vessel hazards and their control, Safety in material handling: hazards and safe Practices, safety with storage of materials, Electrical hazards: classification, safe work practices, Chemical hazards: laboratory safety, bulk handling of chemicals, Fire and explosion hazards, Fire detection, Prevention ,control, and extinguishments, Industrial layout, Industrial waste management.

Hazard analysis:
Checklist procedure, Preliminary hazard analysis, What if analysis, Failure mode effect analysis,
Hazard and operability (HAZOP) studies, Hazard analysis techniques: Fault tree analysis, Event tree analysis, General outline of DOW index, Risk estimation and management, Major hazard control, On-site and Off-site emergency preparedness.

Text Book

1. Industrial Safety, Health and Environment Management Systems, R.K. Jain and Sunil S. Rao, Khanna publishers, 2006.

Reference Book

1. Check list for work place inspection for improving safety, " health and working condition ", Intl. Labour Organisation Geneva, 1987.
2. Safety and failure of components, "Proceedings of Mechanical Engineering ", London, Vol. 184, Part 38, 1974.
3. Industrial Safety Management,L M Deshmukh, TMH, 1st Edition, 2005.

ME 4069 COMPUTER INTEGRATED MANUFACTURING Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. understand the modern technologies and the engineering tools used for manufacturing engineering applications.
CO2. understand the application of computers in the documentation, creation of database and use of CAPP system in industries.
CO3. apply the knowledge in various fields of Computer Aided Manufacturing.
CO4. develop manual and APT part programs for 2D complex profiles, automated tool paths and G-codes for machining components and test the programs through simulation.
CO5. apply modern computational, analytical, simulation tools and techniques to face the challenges in manufacturing

Prerequisite : Basic Manufacturing Processes (ME 2010)

Automation and Computer Integrated Manufacturing:
Automation in production systems, Manufacturing support systems, Product cycle & Production development cycle, Types of production, Definition of CIM, Elements of CIM, Benefits of CIM .

Computer Aided Process planning:
Introduction, Variant, Generative, Forward and Backward Process planning, CAPP benefits , input format , Totally Integrated process planning systems , Expert process planning using Commercial systems: CAM-I, CAPP

Computer Aided Manufacturing:

Introduction to CAM, CAD/CAM Integration, Constructional Features of CNC Machines, Tooling and Work Holding Devices, DNC.

Part Programming for CNC Machines:
Structure of CNC program, Coordinate system, G & M codes, cutter radius compensation, tool nose radius compensation, tool wear compensation, canned cycles, sub routines, do loop, mirroring features, Manual part programming for CNC turning and machining centre for popular controllers like Fanuc, Siemens, Generation of CNC program using CAM software.

Fundamentals of Networking:
Principles, techniques, networking methods, network standards, Ethernet, Internet, system security, remote systems, document and work flow management.

Factories of future:

Trends in manufacturing, The future automated factory.

Text Book
1. Automation, Production Systems, and Computer-Integrated Manufacturing, Mikell P. Groover, Pearson Education, ISBN 81-7808-511-9. 3rd Edition, 2007
2. CAD/CAM, Ibrahim Zeid, TMH

Reference Book
1. Computer Integrated Manufacturing, Paul Ranky Prentice Hall of India
2. Computer Integrated Manufacturing System, Yorem Koren, McGraw-Hill, 1983

ME 4071 **AUTOMOBILE ENGINEERING** **Cr-3**

Course Outcome : At the end of the course, the students will be able to :

CO1. select and identify most appropriate chassis and engine for given mobility application.
CO2. understand and model steering, braking and suspension systems for new vehicle.
CO3. identify fault in vehicle subsystems and carryout troubleshooting.
CO4. understand and select a suitable transmission and electrical system for automobiles.

Prerequisite : Kinematics & Kinetics of Machines (ME 2009)

Introduction:
Main units of automobile chassis and body, different systems of the automobile, description of the main parts of the engine, motor vehicle act.

Suspension System:
Function, types, leaf spring suspension system, coil spring suspension system, torsion bar, telescopic type shock absorber.

Transmission System:
clutch : single plate, multi plate, centrifugal clutch, their functions; gear box: Sliding mesh, constant mesh and synchromesh gearbox, design of 3 speed and 4 speed gear box, over drive, torque converter, semi and fully automatic transmission.; Hooks Joint: Hooks Joint, propeller, shaft, transmission system for two wheel and four wheel drives, Hotchkiss and torque tube drives; Differential and rear axle: differential, rear axles, types of rear axles, semi floating, three quarter floating and full floating types.

Braking System:
Hydraulic braking system, braking of vehicles when applied to rear, front and ill four wheels, theory of internal shoe brake, design of brake lining and brake drum different arrangement of brake shoes, servo and power brakes.

Front wheel Geometry and Steering System:
Camber, castor, Kingpin inclination, toe-in, center point steering condition for true rolling components of steering mechanism. power steering system.

Electrical systems of an automobile:
Starting system, starting drive, generation system, ignition system other electrical system.

Power for propulsion:
Types of resistance, traction, tractive effort, power required for propulsion for vehicle.

Text Book

1. Automobile Engineering – R B Gupta, Satya Prakasan, New Delhi

Reference Book

1. Automobile Engineering - G.B.S.Narang.
2. Automobile Mechanics - J.Heitner.
3. Automobile Engineering - K.M.Gupta. Vol I & II (Umesh Publications)

ME 4073 COMPUTATIONAL FLUID DYNAMICS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. make the mathematical interpretation of the physical problems.
CO2. understand the basic algorithim and think to develop suitable algorithims.
CO3. choose suitable discretization techniques for a particular problem.
CO4. analyze the different numerical solution methods and choose the suitable method.
CO5. understand the advantages of numerical solution before attempting experimental solutions
CO6. apply the knowledge for the simulation of the industrial problems in commercial softwares

Prerequisites : Fluid Mechanics (ME 2003) and Heat Transfer (ME 3011)

Introduction:
Methods of prediction: Experimental, Theoretical, Numerical, Classification of partial differential equations: Elliptic, Parabolic, Hyperbolic PDEs, an overview of finite difference, finite element and finite volume methods

Mathematical Formulation of Physical Phenomena:
Governing Equations: Mass Conservation Equation, Energy Equation, Momentum Equation, The general scalar transport equation, Different kinds of Boundary conditions, Initial condition

Discretization Methods:

Finite Difference Formulation:
Steady one dimensional conduction problem, Unsteady one dimensional conduction problem (simple explicit method, simple implicit method, Crank-Nicolson method), Two dimensional heat conduction problem, Convection diffusion problem, consistency, stability and convergence

Finite Volume Formulation:
Steady one dimensional conduction problem: Interface conductivity, Source Term Linerization, implementation of different kind of boundary conditions, Unsteady one dimensional conduction problem, Two dimensional conduction problem, Steady one dimensional convection diffusion problem (upwind scheme, exponential scheme, hybrid scheme, power-law scheme), Two dimensional convection diffusion problem.

Flow field calculation: .
Solution of Navier-Stokes Equations for Incompressible Flows: Stream function vorticity and artificial compressibility methods, Staggered grid, SIMPLE SIMPLEC and SIMPLER algorithms

Solution Methods:
Direct vs Iterative methods, Gaussian Elimination, Gauss-Seidel Method, SOR method, Tri-Diagonal Matrix (TDMA) algorithm

Special Topics:
Numerical solution of phase change problems.

Text Book
1. Numerical Heat Transfer and Fluid Flow, S V Patankar, Hemisphere Publishing.

Reference Book
1. Computational Fluid Dynamics, John D Anderson, Jr, McGraw Hill Book Company.
2. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, H. Versteeg , W. Malalasekera, Prentice Hall.
3. Finite Difference Method, M. N. Ozisik, CRC.
4. Computer Simulation of flow and heat transfer, P.S., Ghoshdasdidar, Tata McGraw-Hill Publishing Company Ltd.
5. Computational Fluid Flow and Heat Transfer, Muralidhar and T. Sundararajan, Narosa

ME 4075 MACHINE TOOLS TECHNOLOGY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. design gear box
CO2. design different machine tools considering static and dynamic loads
CO3. understand effect of vibrations on life of machine tools
CO4. understand design considerations for Special features in Machine tools & NC machines.

Prerequisite : Manufacturing Processes and Design (ME 3015)

General classification of machine tools:

working and auxiliary motions, Hydraulic transmission and its elements Mechanical transmission and is elements, General requirement of machine tools.

Kinematics of Machine Tools :

Stepped and stepless drive, basic consideration on the design of drives, Variable speed range in machine tools, Graphical representation of speed and structure diagram, selection of optimum ray diagram, design of speed and feed gear boxes, Step less regulation of speed and feed rates

Machine Tool structure :

Design criteria, materials static and dynamic stiffness, basic design procedure, design of beds and columns, Model technique in design of machine tool structure

Guideways and powers Screws :

classification of guideways, materials and lubrication. Design criteria and calculations for slideways, Design of guides under hydrostatic lubrication. Aerostatics slideways, Antifriction guideways combination guideways, Classifications of power screws, Design principle of powers screws, re-circulating powers screw assemblies, elimination of backlash.

Machine tool spindles and its bearings :

Materials of spindles, effect of machine tools, compliance on machining accuracy, design principles of spindles, antifriction and sliding bearings

Controlling system in machine tools :

Classifications, control systems for changing speeds and feeds, ergonomics consideration applied to design of control members, principle of automatic and adaptive control

Vibration in machine tools :

Forced vibration, self excited vibration, stick -slip vibration and its minimization, vibration isolation.

Numerical control of machine tool :

Fundamental concepts and its classifications, Components of NC machines and their description, elements of part programming.

Text book

1. Machine Tool Design, N K Mehta, Tata McGraw-Hill, 2012

Reference Book

1. Design of Machine Tools, S K Basu & D K Pal, OIBH
2. Principles of Machine Tools, Amitabha Bhattacharyya,Gopal Chandra Sen, New Central book Agency

ME 4077 ADVANCED OPERATIONS RESEARCH Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. advance Operations Research is a discipline that deals with the application of advanced analytical methods to help make better decisions.
CO2. understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively;
CO3. knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry;
CO4. skills in the use of Operations Research approaches and computer tools in solving real problems in industry;

Prerequisite : Industiral Engineering & Operations Research (ME 3017)

Non-Linear Programming:

Unconstrained univariate optimization problems: Bisection method & Newton's method; Unconstrained multivariate optimization: Gradient search method; Constrained optimization: Kuhn Tucker conditions, Quadratic and Separable Programming methods

Dynamic Programming:

Principle of Optimality, Concepts of state and stage, Solution of Discrete Problems through Backward Dynamic Programming, Multi-stage Dynamic programming problems Shortest path, minimum spanning tree, maximum flow and minimum cost flow problems;

Queuing Theory:

Markov Process - Description of state, Transition probability matrix, Birth and Death process, Markovian and Semi-Markovian Single-channel and Multiple-channel queues, Queuing Networks ,Replacement Theory, Game Theory. Two person Zero-sum game, Saddle point, Mixed strategies, Use of dominance, Sub .games method

Discrete-event Simulation:

Time-flow mechanisms, Random number and Random variate generation, Simulation of queuing, inventory and industrial problems Integer Programming: 0-1 and mixed integer programming problem formulation, Branch and Bound method, Cutting-plane method.

Text Book

1. Operation Research, Hira and Gupta, S. Chand

References Book

1. Operation Research: An Introduction, Taha H A, PHI
2. Operation Research, Phillips, Rabindran and Solberg, John Wiley & Sons
3. Introduction to Operation Research, Hiller F S and Lieberman G J
4. Operation Research, S D Sharma

ME 4079 ADDITIVE MANUFACTURING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. uunderstand the concept of additive manufacturing, its benefits and applications
CO2. know the various liquid, powder and solid material based technologies in Rapid Prototyping and Rapid Tooling.

CO3. design solid models and converting it to STL file format required for part generation.
CO4. focus on the various errors in the RP parts
CO5. apply reverse engineering for generating RP parts.

Prerequisite : NIL

Introduction:
Need & Development of RP systems, RP process chain, Impact of Rapid prototyping and Tooling on Product Development, Benefits, Applications, Digital prototyping, Virtual prototyping.

Liquid and Solid Based Rapid PrototypingSystems:
Stereo lithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, 3D printing: Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

Powder Based Rapid Prototyping Systems:
Selective Laser Sintering, Direct Metal Laser Sintering, 3D Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations.

Data Processing for Rapid Prototyping:
Process planning for rapid prototyping, CAD model preparation, Data Requirements & geometric modeling techniques: Wire frame, surface and solid modeling data formats - Data interfacing, Tessellation of surfaces, STL file generation Defects in STL files and repairing algorithms, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation.

Issues of Prototype:
Accuracy issues in Rapid Prototyping, Strength of RP Parts, Surface roughness problem in Rapid Prototyping, Part deposition orientation and issues like accuracy, surface finish, build time, support structure, cost etc.

Rapid Tooling:
Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect, Fabrication processes, Applications, Rapid tooling techniques such as laminated metallic tooling, direct metal laser sintering, vacuum casting.

Reverse Engineering:
Introduction to reverse engineering, Integration of reverse engineering and rapid prototyping.

Text Book

1. Rapid Prototyping: Principle and Applications, Rafiq I Noorani, Wiley & Sons, 2006

References Book

1. Rapid prototyping: Principles and applications, Chua C.K., Leong K.F., and Lim C.S., Yes Dee Publishing Pvt.Ltd, Third edition,2010.
2. Rapid Prototyping And Engineering Applications, Frank W. Liou, CRC Press, Special Indian Edition, 2007.
3. Journey from Rapid Prototyping to Rapid Manufacturing , Somnath Chattopadhyaya, LAP Lambert Academic Publishing,,2011.
4. Rapid Prototyping Technology: Selection and Application, Kenneth G. Cooper, Cooper Cooper, Marcel Dekker Inc, 1st Edition, 2001.

MECHANICAL (AUTOMOBILE) ENGINEERING

Program Educational Objectives (PEOs):

The Program Educational Objectives (PEOs) of B.Tech Program in Mechanical (Automobile) Engineering are established and are listed as follows

PEO-1. To lead a successful career in industry or pursue higher studies or entrepreneurial endeavors.

PEO-2. To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.

PEO-3. To demonstrate effective communication skill, professional attitude and a desire to learn.

Program Outcomes (POs):

The Program Outcomes of UG in Mechanical (Automobile) Engineering are:

a. An ability to apply knowledge of mathematics, science, and engineering
b. An ability to design and conduct experiments, as well as to analyze and interpret data and report
c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. An ability to function on multidisciplinary teams
e. An ability to identify, formulate, and solve engineering problems
f. An understanding of professional and ethical responsibility
g. An ability to communicate effectively
h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. A recognition of the need for, and an ability to engage in life-long learning
j. A knowledge of contemporary issues
k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

AE 4031 TRACTOR AND FARM EQUIPMENTS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify different component and part of tractor and power tiller.
CO2. select Farm Equipments for land preparation.
CO3. do trouble shooting of tractor power tiller.

Prerequisite : Internal Cumbustion Engines & Gas Turbines (ME 3003)

General Design of Tractors:
Classification of Tractors-Main components of Tractor-Safety Rules.

Control of the Tractor and Fundamentals of Engine Operation:
Tractor controls and the starting of the tractor engines-Basic notions and definition-Engine cycles-Operation of multicylinder engines-General engine design - Basic engine performance characteristics.

Engine Frame Work and Valve Mechanism of Tractor:
Cylinder and pistons-Connecting rods and crankshafts Engine balancing – Construction and operation of the valve mechanism-Valve mechanism components – Valve mechanism troubles.

Cooling system, Lubrication System and Fuel System of a Tractor:
Cooling system – Classification –Liquid cooling system – Components, Lubricating system servicing and troubles – Air cleaner and turbocharger – Fuel tanks and filters –Fuel pumps.

Farm Equipments:
Working attachment of tractors-Farm equipment – Classification – Auxiliary equipment – Trailers and body tipping mechanism.

Text Book
1. Farm Tractor-Maintenance and Repair, Jain, McGraw-Hill Education.

Reference Book
1 Tractor and Automobiles, Rodichev and G. Rodicheva, MIR Publishers, 1987.
2 Design of Automotive engines for tractor, Kolchin. A., and V. Demidov, MIR Publishers, 1972.

AE 4032 NOISE, VIBRATION AND HARSHNESS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. model noise and vibration problems
CO2. Conduct measurement using instrumentation of automotive NVH
CO3. Identify the sources of noise and vibration
CO4. measure sound intensity and human sensitivity and carryout statistical and frequency analysis.

Prerequisite : Machine Dynamics (ME 2002)

NVH in the Automotive Industry:
Sources of noise and vibration. Design features. Common problems. Marque values. Noise quality. Pass-by noise requirements. Target vehicles and objective targets. Development stages in a new vehicle programme and the altering role of NVH engineers.
Sound and Vibration Theory:

Sound measurement. Human sensitivity and weighting factors. Combining sound sources. Acoustical resonances. Properties of acoustic materials. Transient and steady state response of one degree of freedom system applied to vehicle systems. Transmissibility. Modes of vibration.

Test Facilities and Instrumentation:
Laboratory simulation: rolling roads (dynamometers), road simulators, semi-anechoic rooms, wind tunnels, etc. Transducers, signal conditioning and recording systems. Binaural head recordings. Sound Intensity technique, Acoustic Holography, Statistical Energy Analysis.

Signal Processing:
Sampling, aliasing and resolution. Statistical analysis. Frequency analysis. Campbell's plots, cascade diagrams, coherence and correlation functions.

NVH Control Strategies & Comfort:
Source ranking. Noise path analysis. Modal analysis. Design of Experiments, Optimization of dynamic characteristics. Vibration absorbers and Helmholtz resonators. Active control techniques.

Text Book

1. Noise Control of Internal Combustion Engine,Baxa,, John Wiley, 1984.
2. Fundamental of Noise and Vibration, Norton M. P., Cambridge University Press, 1989.

Reference Book

1. Theory and Practice, Ewins D. J., Model Testing :, John Wiley,1995.
2. Dynamic Vibration Absorbers, Boris and Kornev, John Wiley, 1993.
3. Vibration Testing Theory and Practice, McConnell K, , John Wiley, 1995.
4. Vehicle Refinement Controlling Noise and Vibration in Road Vehicles, M. Harrison, Elsevier.

AE 4033 COMBUSTION ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. model mathematically the combustion processes.
CO2. make performance calculation of engine.
CO3. select Intake and Exhaust Systems for Engines.
CO4. model Supercharging, Turbocharging and Scavenging in Engines.

Prerequisites : Internal Cumbustion Engines & Gas Turbines (ME 3003) & Engineering Thermodynamics (ME 2001).

Thermodynamics of Combustion:
Premixed and diffusion combustion process in IC engines and gas turbines. First and Second Law of Thermodynamics applied to combustion- combustion Stoichiometry chemical equilibrium, spray formation and droplet combustion.

Chemical Kinetics of Combustion:
Fundamentals of combustion kinetics, rate of reaction, equation of Arrhenius activation energy. Chemical thermodynamic model for Normal Combustion.

Flames :
Laminar premixed – flame speed correlations- quenching, flammability, and ignition, flame stabilization, laminar diffusion flames, turbulent premixed flames-Damkohler number.

Burning of Fuels:
Spray formation & droplet behavior, gas turbine spray combustion, direct injection engine combustion, detonation of liquid – gaseous mixture, combustion of solid fuels,

Text Book

1. An Introduction to Combustion Concepts and Application, Stefan R. Turns, McGraw-Hill.

Reference Book

1. Combustion Engineering, Gary L. Borman, Kenneth W. Ragland, Mc Graw Hill
2. Some fundamental of Combustion, Spalding. D.B., Butterworth Science Publications, London, 1985.
3. Combustion Process High Speed Gas Dynamics and Jet Propulsion Series, Lewis. B., Pease. R.N. and Taylor. H.S., Princeton University Press, Princeton, New Jersey, 1976.

AE 4034 AUTOMOTIVE SAFETY AND LIGHTING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Design an automobile for the safety and comfort
CO2. select best safety attachments and ergonomics
CO3. conduct test as per safety standard
CO4. select most suitable automotive lighting systems

Prerequisites : Basic Electronics (EC 1001) and Basic Electrical Engineering (EE 1003)

Automotive Safety:
Active and passive safety, Driver assistance systems in automobiles, Definitions and terminology, Balance of stiffness and toughness characteristics and energy absorption characteristics of vehicle structures, Design of crash crumple zones, Modeling and simulation studies, Optimization of vehicle structures for crash worthiness, Types of impacts, and Impact with rebound, movable barrier tests, Analysis and simulation of vehicle in barrier impacts, Roll over crash tests, Behavior of specific body structures in crash testing, Photographic analysis of impact tests, Regulatory requirements for crash testing.

Ergonomics and Human response to Impact:
Importance of Ergonomics in Automotive safety, Locations of controls, Anthropomerty, Human impact tolerance, Determination of Injury thresholds, Severity Index, Study of comparative tolerance, Application of Trauma for analysis of crash injuries. Injury criteria's and relation with crash and modeling and simulation studies in dummy.

Vehicle safety systems:
Survival space requirements, Restraints systems used automobiles, Types of safety belts, Head restraints, Air bags used in automobiles, Use of energy absorbing systems in automobiles, Impact protection from steering controls, Design of seats for safety, types of seats used in automobiles. Importance of Bumpers in automobiles, Damageability criteria in bumper designs. Introduction to the types of safety glass and their requirements and rearward field of vision in automobiles, Types of rear view mirrors and their assessment. Warning devices, indicators, hinges, latches, wipers, horns, etc.

Fundamentals of light, vision and colour:
Electromagnetic radiation and light, Propagation of light, Spectral sensitivity of light,Measures of radiation and light, Standard elements for optical control. Illuminant calculations, Derivation of luminous flux from luminous intensity, flux transfer and inter reflection, luminance calculations, discomfort glare, eyes as an optical system, visual processing, lightingfor results, modes of appearance, Pointers for lighting devices. Nature of the colour, Tri-chromatic Colorimetry, Surface colour, colour spaces and colour solids,, colour rendering.

Light Measurements, Testing equipment, calibration and photometric practice:
Basics of standards and detectors, spectral measurements and Colorimetry, illuminant meters and luminance meters, colorimeters. Fundamentals of equipment used for light measurement in Automotive field; Gonio-Photometer, Reflecto-meter, Colorimeter, Integrating sphere, types, application, coordinates system, Types of sensors and working principle, construction, characteristics etc. used in different equipment. National and international Regulations, test requirements and testing procedure.

New Technology in Automotive lighting:
Technology progress in automotive lighting, Gas Discharges lamps, LED, adoptive front lighting system, Daylight running lamps.

Text Book

1. Low speed Automobile Accidents, Watts, A. J., et al Lawyers and Judges 1996.

Reference Book

1. An Introduction to Modern Vehicle Design, Jullian Happian-Smith SAE, 2002
2. Crashworthiness of Vehicles, Johnson, W., and Mamalis, A.G., MEP, London, 1995
3. Lamps and Lighting, Edward .A, Hodder & Stoughton, London, 1993.

AE 4035 TWO AND THREE WHEELERS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. select best components of two and three wheeled vehicles given application.
CO2. design and develop a two wheeler.
CO3. do trouble shooting of two wheeler and three wheeler.

Prerequisites : Internal Cumbustion Engines & Gas Turbines (ME 3003) and Machine Dynamics(ME 2002)

Power Unit:
Two stroke and four stroke SI engine, merits and demerits. Symmetrical and unsymmetrical port timing diagrams. Types of scavenging processes merits and demerits, scavenging efficiency. Scavenging pumps. Rotary valve engine.Fuel system. Lubrication system. Magneto coil and battery coil spark ignition system. electronic Ignition system. Starting system. Kick starter system.

Chassis and Sub-Systems:
Mainframe, its types. Chassis and shaft drive. Single, multiple plates and centrifugal clutches. Gear box and gear controls. Front and rear suspension- systems. Shock absorbers. Panel meters and controls on handle bar.

Brake and Wheels:
Drum brakes, Disc brakes, front and rear brake links layouts. Spoked wheel, Cast wheel. Disc wheel. Disc types. Tyres & tubes.

Two wheeler dynamics:
Stability of two wheelers on straight and curved path.

Two Wheelers:
Case study of major Indian models of motorcycles, SCOOTERS AND MOPEDS. Bajaj,Vespa, Lambretta scooters. Enfield, TVS-Suzuki, Hero-Honda, Yamaha RX-100, Kawasaki Bajaj Motor cycle. Kinetic Spark, Hero Majestic, TVS mopeds. Servicing and maintenance.

Three Wheelers:
Case study of Indian Models. Front engine and rear engine. Auto rickshaws. Pickup van. Delivery Van and Trailer, stability of three wheelers.

Text Book

1. Two Wheelers, K. K. Ramlingam, SCITECH

Reference Book

1. Automobile Engineering vol I & II, Gupta H M 1st edition Reprint 2006.
2. Automobile Engineering, Gupta R B, Satya Prakashan 2004.

AE 4036 AUTOMOTIVE CHASSIS, SUSPENSION AND TRANSMISSION SYSTEM Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. select most suitable Tyres, Drive train, Steering System, Brakes and Suspension System for given
CO2. design chassis, transmission system and Suspension System.
CO3. identify and solve problems related to Tyres, Steering System, Brakes, and Suspension and transmission system.

Prerequisite : Machine Dynamics(ME 2002)

Introduction:
Types of chassis layout with reference to power plant locations and drive. Vehicle frames. Various types of frames. Constructional details. Materials. Testing of vehicles frames. Unitised frame body construction, Loads acting on vehicle frame.

Transmission:
Layout of power transmission system, requirement of transmission system Clutch Need of clutch. Types of clutches, principle, construction, torque capacity, clutch operating system. Performance curve.

Gear Box:
Requirement of gearbox, different types of gear box viz sliding, constant mesh and synchromesh gear box. Construction details of gear boxes. Gear ratios of vehicle Gear box operation principle.

Hydro dynamic drive:
Fluid coupling, Principle and operation Torque capacity Performance characterictic. Torque converter Construction, principle of operation, Torque capacity multistage torque converter Performance behaviour.

Automatic transmission:
Construction and operating principle, 4 forward and reverse & 3 forward and reverse. Over drive unit and its operation.

Electrical drive:
Construction and operation Electric drive Ward Leonard control system, construction and operation, advantages and disadvantages.

Front axle and Steering System:
Types of front axle. Constructions details. Materials. Front wheel geometry viz. Castor, Camber, King pin inclination, Toe-in. Conditions for true rolling motion of wheels during steering. Steering geometry. Ackerman and Davis steering system. Constructional details of steering linkages. Different types of steering gear boxes. Steering linkages and layouts. Power and Power assisted Steering.

Drive Line:
Effect of driving thrust and torque reactions. Hotch Kiss drive, torque tube drive and radius rods. Propeller shaft. Universal joints. Constants velocity universal joints. Front wheel drive. Final Drive Differential: Different types of final drive. Worm and worm wheel, Straight bevel gear, Sprial bevel gear and hypoid gear final drives. Differential principles. Construction details of differential unit.Differential locks. Differential housings.

Rear Axles:
Construction of rear axles. Types of loads acting on rear axles. Full floating. Three quarter floating and semi floating rear axles. Rear axle housing. Construction of different types of axle housings.

Suspension System:
Need of suspension system, types of suspension, suspension springs, constructional details and characteristics of leaf, coil and torsion bar springs. Independent suspension, Rubber suspension, Pneumatic suspension, Shock absorbers.

Braking System:
Classification of brakes, drum brake & disc brakes. Constructional details-Theory of braking. Mechanical hydraulic and Pneumatic brakes. Servo brake. Power and power assisted brakes different types of retarders like eddy current and hydraulic retarder. Anti lock braking systems.

Text Book
1. Automobile Engineering Vol-I, Kripal Singh, Standard Publisher Distributor.

Reference Book
1. A Text book of Automobile Engineering, Volume-II. P.S.Gill, S.K. Kataria & Sons Publisher of Engineering & Computer Books.
2. Basic automobile Engineering, Nakra C P , , Dhanpat Rai Publication co. Ltd 7th edition, 2005
3. Automobile Engineering, De A, Galgotia Publication Pvt. Ltd. 2004.

AE 4037 VEHICLE MAINTENANCE Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. keep record of vehicle operation and maintenance, service schedules.
CO2. follow best vehicle maintenance procedures.
CO3. acquire skills in handling situations where the vehicle is likely to fail.
CO4. repairing and overhauling procedure.
CO5. enabling students to operate and manage maintenance workshops.
CO6. inspect and diagnose the problems occurring in the various components of the vehicle.

Prerequisites : Automotive Chassis, Suspension & Transmission System (AE 4036) and Automotive electrical Systems and electronics (AE 4045)

Maintenance records and Schedules:
Importance of maintenance. Scheduled and unscheduled maintenance. Preparation of check lists. Chassis lubrication. Cost effectiveness. Pre-trip. Inspection forms. Log books. Trip sheets. Other maintenance record forms.

Maintenance, Repair and Overhauling of engine:
Dismantling of engine components. Cleaning methods. Visual inspection and dimensional check of various engine components. Minor and Major tune up Reconditioning, repairing methods of engine components. Assembly procedure. Special tools used for maintenance, repair and overhauling.

Maintenance, Repair and Overhauling of Chassis, Drive Line components:
Clutch - Mechanical, Automatic types Gear box - Mechanical Automatic types. Final reduction. Propeller shaft. Front and rear suspension systems. Rigid and independent types. Brakes systems - Hydraulic, Servo, Air. Air bleading. Steering system. Wheel alighment - Tyres.

Maintenance, Repair and Servicing of Electrical System:
Battery - Testing methods. Starter motor. Charging system - DC Generator, AC Alternator, Regulator, Ignition systems - Coil ignition, Transistor assisted ignition, Capacitor discharge ignition. Eletric Horn, Wiper, Flasher, Electric fuel pump, Gauges. Lighting system Head lights focussing. Wiring system.

Maintenance, Repair and Servicing of Cooling System:
Cooling system - types, water pump, radiator, thermostat valve. anti corrosion and anti freezing solutions.

Lubrication system, Fuel system and Body:
Lubricating system - Oil analysis, oil topping up, oil change, oil filters, oil relief valve. Fuel system - Petrol, diesel fuel feed system components. Body repair tools, minor body panel beating, tinkering, and soldering, polishing, painting. Door locks mechanism. Window glass actuating mechanism.

Text Book

1. Fleet Management, JOHN Doke, McGraw Hill Co, 1984.

Reference Book

1. Motor vehicle engine servicing, Judge. A.N., 3rd, Edition, Pitman Paperpack, London, 69.
2. Maintenance of High speed diesel engines, Judge. A.W., Chapman Hall Ltd., London,'56.
3. Diesel Engine operation and Maintenance, Maleev V.L., Maintenance, McGrawHill Book Co., New York, 1954.

AE 4038 AUTOMOTIVE MATERIALS AND PROCESSES Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. apply of modern metallic and non metallic materials in automobile
CO2. predict Elastic, plastic and fracture behavior of materials new materials.
CO3. select recent material and manufacturing process for automobile components.

Prerequisites : Material Science and Engineering (ME 2007)

High strength steels:
Bake hardening (BH) grades, Isotropic steels, Interstitial free (IF) grade steels, Rephosphorized steels, High strength micro alloy steels, Dual phase steels, TRIP steels, Boron steels, Multiphase steels, AHSS grades – Austenitic SS, L-IP, TWIP; Hydroforming process.

Natural fiber composites:
Why natural fiber composites? Natural fiber classification – Bast fibers, Leaf fibers, Sead fibers, Fruit fibers, Wood fibers; Fiber properties; TS & TP composites with NFs and their properties; Automotive applications.

Smart Materials:
What are Smart Materials? Functional properties that lead to their consideration; Piezoelectric materials, Electoactive materials, Shape memory alloys (SMA), Optical fibers, Nano-composites. What are MEMS? Uses as sensors, actuators and signaling devices in vehicles.

Nano-composites:
Defination, Types, Mechanisms, Structure=property relationship, Basic classes – TP, TS, Elastomers and blends; Forms – Fibers, Foams, Film, Membranes and Paints; Geometric forms – Nanospheres (clay), Nanotubes (Single &multi wall) & Nano fibers, and Nanoplatelets; Importance of interface between matrix and nanophase; Functionalization; Production of Nano-composites – Melt processes, Solution processes, In-situ processes and other processes; Structural characterization of Nano-composites – X-ray Diffraction, Electron microscope (SEM, TEM), Scanning probe microscopy (SPM, AFM), Spectroscopic methods (EDS, FTIR); Mechanical behaviors, Thermal

response, Fire retardancy, Chemical resistance and Electrical-Magnetic-Optical properties of ploymer nano-composites; Applications and future trends – Automobiles, Coatings, Adhesives, Fire retardants, Micro-electronic packages, Optical integrated circuits, Sensors, Membranes, etc.

Text book

1. Materials for Engineers and Technicians, 4^{th} edition, Higgins, Elsevier.
2. Polymer Nanocomposites and their Applications, Ray & Bousmania, , ASP, 2006

Reference Book

1. Experimental Stress Analysis, L. S. Srinath, Tata McGraw Hill, 1998
2. Automotive Engineering Light Weight, Functional and Novel Materials, Cartor, Taylor & Francis Group.

AE 4041 ASSEMBLY LINE AUTOMATION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify the applications of PLC are to automobile assembly line.
CO2. design PLC programs to solve industrial control problems.
CO3. identify processes to be best done by robotics application to reduce cost and increase productivity.
CO4. design and apply pneumatics and hydraulic circuit using computer for automated factory.

Prerequisites : Kinematics & Kinetics of Machines (ME 2009) & Fluid Mechanics (ME 2003)

Fundamental of Manufacturing and automation:
Types of production, functions in manufacturing, production concepts and mathematical models, automation strategies.

PLC (Programmable Logic controller):
Over view and architecture, PLC programming, Application examples.

Pneumatics and Hydraulics:
Pneumatic components: Properties of air compressors-filter, regulators, Unit- Air control Valves, Quick Exhaust valves, Pneumatic actuators- Fluid Power, Circuit design, speed control circuits. Hydraulic system- sources of hydraulic power, Fluid power actuators, Pumping theory, Direction control valves, pressure control valves, Types of hydraulic cylinders.

Robotics and Robot applications:
Robot introduction- definition –classification and specification. Mechanism: Kinematic parameters and modeling-Direct and inverse kinematic differential motion and jacobians. Introduction to Dynamics path planning, trajectory planning and control –skew, joint interpolation and straight line motion. Offline programming and simulation.

Computer Networks for manufacturing:
Hierarchy of computers in manufacturing, local area networking, manufacturing automation protocol.

The Future automated Factory:
Trends in manufacturing, The future automated factory.

Text Book

1. Industrial Automation and Robotics, A. K. Gupta and S. K. Arora, Laxmi Publications, New Delhi
2. Computer-Based Industrial Control, Krishna Kant, Prentice Hall of India Ltd, 1997.
3. Chemical Process Control – Theory and Practice", Stephanopoulous, Prentice Hall of India Ltd, 1984.
4. Fundamentals of Industrial Instrumentation and Process Control", William C. Dunn, TataMcGrawHill, 2009.

Reference Book

1. Oil Hydraulics, Majumdar S.R., Tata McGraw- Hill, 2000.
2. Fluid power with application, Anthony Esposito. Pearson education, 2000.

AE 4042 AUTOMOTIVE INSTRUMENTATION SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. select appropriate microcomputer.
CO2. use different sensors and actuators for various automotive systems.
CO3. adopt the electronic engine management systems.
CO4. adopt the electronic vehicle management and special instrumentation systems.

Prerequisites : Basic Electronics (EC 1001) & Internal Combustion Engines & Gas Turbines (ME 3003)

Introduction to microcomputer:
Microcomputer: Buses, memory, timing, CPU registers; Microprocessor architecture: Initialization, operation codes, program counter, branch and jump instructions, subroutine. Analog to digital converters and Digital to analog converters, sampling, polling and interrupts, digital filters, lookup table.

Sensors and actuators:
Speed sensors, Pressure sensors: Manifold Absolute Pressure sensor, knock sensor, Temperature sensors: Coolant and Exhaust gas temperature, Exhaust Oxygen level sensor, Position sensors: Throttle position sensor, accelerator pedal position sensor and crankshaft position sensor, Air mass flow sensor. Solenoids, stepper motors and relays.

Electronic engine management system:
Electronic engine control: Input, output and control strategies, electronic fuel control system, fuel control modes: open loop and closed loop control at various modes, EGR control, Electronic ignition systems – Spark advance correction schemes, fuel injection timing control.

Electronic vehicle management system:
Cruise control system, Antilock braking system, electronic suspension system, electronic steering control, traction control system, Transmission control, Safety: Airbags, collision avoiding system, low tire pressure warning system.

Other instrumentation systems:
Input and output signal conversion, multiplexing, fuel quantity measurement, coolant temperature and oil pressure measurement, display devices- LED, LCD, VFD and CRT, Onboard diagnostics (OBD), OBD-II, off board diagnostics, telematics, GPS navigation, the GPS system structure.

Text Book

1. "Understanding Automotive Electronics", William B.Riddens, 5th edition- Butter worth Heinemann, Woburn- 1998.

Reference Book

1. Embedded System – Architecture, Programming, Design, Rajkamal, Tata McGraw Hill, 2003.
2. Experimental methods for engineers, Holman, J.P., McGraw-Hill, 1988.
3. Instrumentation Devices and Systems, Raman, C.S., Sharma, G.R., Mani, V.S.V., Tata McGraw Hill, New Delhi, 1983.
4. Understanding Automotive Electronics, Bechhold, SAE- 1998.
5. Embedded System Design – A Unified hardware & Software Introduction, Frank Vahid, John Wiley, 2002.

AE 4043 OPTIMIZATION TECHNIQUES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. apply principles of optimization to real life problems.
CO2. model and use design of experiments to save time and money during testing of vehicles.
CO3. solve multivariable problems using optimization technique.

Prerequisites : Numerical Methods(MA 2004) and Industrial Engineering & Operations Research (ME 3017)

Analysis of Variance and its meaning:
One-way classification- two-way classification. Basic principles of design of experiments (replication, randomization and local control)- CRD- RBD- LSD.

Factorial experiments and their need:
Factorial Experimental Designs with out confounding (Theory and Problem only, no derivation expected).

Taguchi Approach:
Parameter Design, Robust Design

Optimal problem formulation:
Boundary phase method – Fibonacci search method

Golden section search method:
Powell's conjugate direction method – Conjugate gradient method – Variable-metric method.

Kuhn-Trucker conditions:
Penalty function method – Frank-Wolfe method – Generalized reduced gradient method – Generalized projection method.

Genetic algorithms (GAs):
working principle – difference between GAs and the traditional methods – GAs for constrained optimization – Simulated annealing – Global optimization: using steepest descent method and GA.

Quantitative Techniques:
Assignment, Transportation problem, Network analysis (CPM/PERT), Job sequencing, LPP (graphical & simplex), Artificial variables, dual problems, Integer programming problems**.**

Text Book

1. Design of Experiments, D.C.Montogomary, McGraw-Hill, 7^{th} Edition.
2. Optimization in Engg. Design, K. Deb, McGraw-Hill. 1957.

Reference Book

1. Experimental Designs, Cochran, W.G. and Cox, G.M., 2nd Edition, John Wiley & Sons, Inc,
2. Quality Engineering using robust design, Phadke, M. S:, Prentice Hall, 1989.
3. Taguchi Techniques for quality engineering, Philip, R. J.:, McGraw Hill, 1989.
4. Optimization theory and applications, Rao, S.S., Wiley Eastern, 1984.
   Operations research, S.D. Sharma, Kedar nath Publications

AE 4044 VEHICLE DYNAMICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. apply concept of mechanical vibrating system.
CO2. predict and model suspension and tyre related vibrations.
CO3. simulate and analyze vibrations from vehicles.
CO4. analyze the stability and handling characteristics of vehicle at different operating conditions. CO5: Analyze and select suitable tires for a vehicle.

Prerequisite : Machine Dynamics (ME 2002)

Introduction:
Fundamental of vibration, Mechanical vibrating systems. Modelling and Simulation - Model of an automobile, Single, two, multi degrees of freedom systems, Free, forced and damped vibrations. Magnification factor - Transmissibility

Multi-degree of freedom systems:
Vibration absorber, Closed coupled system, Eigen value problems, Far coupled Systems, Orthogonality of mode shapes, Modal analysis, and Forced vibration by matrix inversion. Approximate methods for fundamental frequency, Dunkerley's lower bound, Rayleigh's upper bound, Hozler method for close coupled systems and branched systems.

Suspension and Tyers:
Requirements. Sprung mass frequency. Wheel hop, wheel wobble, wheel shimmy. Choice of suspension spring rate. Calculation of effective spring rate. Vehicle suspension in fore and apt directions. Ride characteristics of tyre, Effect of driving and braking torque, Gough's tyre characteristics.

Vehicle Handling:
Oversteer, under steer, steady state cornering. Effect of braking, driving torques on steering. Effect of camber, transient effects in cornering.

Stability of Vehicles:
Directional stability of vehicles. Load distribution. Calculation of Tractive effort and reactions for different drives - Stability of a vehicle on a slope, on a curve and a banked road.

Text Book
1. Vehicle handling Dynamics Theory and Application, Masato Abe, Elsevier.

Reference Book
1. Vehicle Dynamics Theory and Application, Theory and Application, Reza N. Jazar, Springer.
2. Automotive Chassis, Heldt.P.M., Chilton Co., New York, 1992.
3. Vehicle Dynamics, Ellis.J.R., Business Books Ltd., London, 1991.
4. Suspension and Tyres, Giles.J.G. Steering, llliffe Books Ltd, London, 1998.

AE 4045 AUTOMOTIVE ELECTRICAL SYSTEMS AND ELECTRONICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. use various sensors for engine management.
CO2. select appropriate microcomputer and actuators for various automotive systems.
CO3. perform tests on an automotive electrical system.

Prerequisites : Basic Electrical Engineering (EE 1003) & Basic Electronics (EC 1001)

Starting System:
Condition at starting, Behavior of starter during starting, and its characteristics, Principle & construction of starter motor, working of different starter drive units, care and maintenance of starter motor. Starter Switches. Three point starter-basic construction and working principle.

Lighting System & Accessories:
Insulated & earth return systems, Positive & negative earth systems, Details of head light & side light, Headlight dazzling & preventive methods, Electrical fuel-pump, Speedometer, Fuel, oil & temperature gauges, Horn, Wiper system, Trafficator.

Automotive Electronics:
Current trends in modern automobiles Open and close loop systems- Components for electronic engine management, Electronic management of chassis system, Vehicle motion control.

Transducer:
Introduction, Mechanical spring devices, Pressure sensing primary devices, Basic requirements of transducer, Classification of transducer, Resistive transducer, Capacitive Transducer, Strain gauges, Thermistors, Thermocouples, R.V.D.T, Magnetoresistors, Magnetostrictive Transducers, Photoelectric transducer, Digital displacement transducer.

Sensors and Actuators:
Hall Effect, hot wire, thermistor, piezo electric, piezoresistive, based sensors. Introduction, basic sensor arrangement, types of sensors, oxygen concentration sensor, lambda sensor, crankshaft angular position sensor, cam position sensor, Mass air flow (MAF) rate, Manifold absolute pressure (MAP), Throttle plate angular position, engine oil pressure sensor, vehicle speed sensor, stepper motors, relays, detonation sensor, emission sensors.

Electronic Fuel Injection and Ignition Systems:
Introduction, feed back carburetor systems. Throttle body injection and multi port or point fuel injection, fuel injection systems, Injection system controls. Advantages of electronic ignition systems: Types of solid-state ignition systems and their principle of operation, Contact less electronic ignition system, and electronic spark timing control.

Digital Engine Control System:
Open loop and closed loop control systems-Engine cranking and warm up control-Acceleration enrichment-Deceleration leaning and idle speed control. Distributor less ignition-Integrated engine control systems, Exhaust emission control engineering.

Electronic Dashboard Instruments:
Onboard diagnosis system, security and warning system.

Text Book

1. Automotive Electrical Equipment, P.L. Kohli, McGraw-Hill Education
2. Electronics Engine Controls, Steve V. Hatch, CENGAGE Learning

Reference Book

1. Modern Electrical Equipment of Automobiles, Judge. A.W., , Chapman & Hall, London, 1992.
2. Understanding Automotive Electronics, 6th edition, Ribbers, Elsevier.
3. Storage Batteries , Vinal. G.W., John Wiley & Sons Inc., New York, 1985.
4. Automobile Electrical Equipment, Crouse. W.H. , McGraw Hill Book **CO1**nc., New York, 1980

AE 4046 MARKETING MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. select best promotional and advertisement strategy for new product.
CO2. prepare questioner and conduct market survey and interpret the results.
CO3. do market forecasting.

Prerequisites : Nil

Marketing Concepts:
Approaches to Marketing –Core concepts of marketing - Marketing Process – Functions of Marketing.

Marketing Environment:
The changing marketing environment – Analyzing needs and trends in Macro Environment and Micro Environment.

Market Segmentation:
Bases for market segmentation of consumer goods, industrial goods and services – Market Targeting and positioning strategies.

New Product Decision Process:
Types of new products – Test Marketing of a new product, Packaging – Purpose, Types and New Trends in packaging.

Marketing Mix:
Four P's – Its significance in the competitive environment – Product and Product Line – Product Mix – Product Life Cycle – Managing the product in Product Life Cycle.

Physical Distribution:
Importance and role of distribution in marketing – Introduction to the various channels of distribution –Promotion Tools – Sales Promotion, Advertising, Personal Selling, Direct Marketing and Online Marketing as promotion tools.

Pricing:
Importance – methods – objectives –factors.

Market Evaluation and Controls:
Types, processes, obstacles to marketing control – Marketing Audit – Marketing Ethics.

Text Book
1. Principles of Marketing 9th Edition - Philip Kotler and Gary Armstrong.

Reference Book
1. Marketing - Stanton,,Michael Etzel,Walker(Tata)
2. Marketing Management - V.S.Ramaswamy and S.Namakumari
3. Marketing Special Indian Edition- Dhruv Grewal, Michael Levy

AE 4047 THEORY AND DESIGN OF JIGS AND FIXTURES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. select most suitable jigs and fixture for automotive application.
CO2. design and prepare Jigs and fixtures for given components.

Prerequisite : Manufacturing Processes and Design (ME 3015)

Introduction: Definitions of Jigs and Fixtures, Principles of Jigs and Fixtures design, preliminary analysis and planning of Jigs and fixture parts and their materials, Basic steps in the design of jigs and fixtures and Advantages of Jigs & Fixtures.

Location and Clamping:
Degrees of freedom-3-2-1 location principle, Radial location and diamond pin location, Principle of pin location, Location from pin surfaces, location from a profile, location from a cylinder, Circular location, Jamming and remedies. Location Adjustable locators, redundant locators, fool proofing; Adjustable supports and centralizes Strap clamps, cam clamps , screw clamping, latch clamps, wedge clamps, pivoted clamps, eccentric operator clamp, power clamps, quick acting clamps, equalizers.

Loading and unloading problems:
Loading, Entering, locating and clamping, symmetric consideration. Unloading, Bur clearance, ejectors, receivers, chip problems, relief and projection, shields and seals.

Cutter Guidance:
Various types of setting blocks, Press fit bushes, Renewable bushes, Slip bushes, Threaded bushes, Special bushes, Drills with attached bushing for small holes.

Design of Jigs and Fixtures:
Three construction principles, Built-up type, casting and weldment. Practicing the various types of jigs, practicing the various types of milling fixtures, broaching fixtures, function of broaching fixtures-internal and external broaching fixtures.

Text Book

1. Jigs and fixtures, Joshi. P.H. Tata McGraw-Hill, 1988

References Book

1. Jigs and Fixtures, Design Manual Industrial Henriksen, Erik.K., Press Inc., Madison Avenue, New York, 1983.
2. Tool design Donaldson G.H., Lecain, Gould. V.V., , TMH Edition, 1990
3. Fundamentals of Tool design ASTME, Prentice Hall, 1989.

AE 4048 TOTAL LIFE CYCLE MANAGEMENT Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. distinguish between the terms PDM and PLM
CO2. understand and implement basic components and functionality of a PDM system.
CO3. use a PDM system to support and control a product realization process.
CO4. given project, choose, configure, and adjust a PDM system to effectively support, follow up and control the project.

Prerequisite : Environmental Science (CH 1005)

Introduction:
Definition of total life cycle (TLC)-Concept of TLC-Life cycle impacts-Integrating life cycle technologies-Products and processes within TLC-TLC methodology-TLC assessment data to complex products-Results Improvement for product, Life Cycle Costing (LCC).

Vehicle End Life:
Design for end of old vehicle management –Problems of old vehicles in emerging markets-recovery and economic feasibility of materials such as Plastics, rubber aluminum, steel, etc.

Trade offs:
Applying life cycle thinking to define tradeoffs along the supply, manufacture-use and end of life chain-Effect on the customer- Expectation of the customer-Evaluate product cost on fuel consumption, emissions, durability, environment and health.

Sustainability:
What is sustainability-Use of renewable resources-View to design horizon. Harmonization of Environmental Goals: TLC for emerging vs. developed markets-Rules and regulations to guide designers-International common practices for end of life products.

Total quality environment (TQE):
Environmental management system (EMS), product evaluation standards, requirements of ISO 14001, environmental policy, elements of environmental planning: environmental aspects, legal and other requirements, objectives and targets, and environmental management programme.

Text Book

1. Total Quality Management, K. C. Arora,. S.K. Kataria & Sons, 2007-08.

AE 4061 FUELS AND EMISSIONS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. apply different types of Alternative fuels in Automobiles.
CO2. test Performance of Alternative Fuels used in Automobiles.
CO3. model of pollutant formation in engines.
CO4. select treatment and control Techniques.

Prerequisites : Environmental Science (CH 1005) and Internal Combustion Engines & Gas Turbines(ME 3003)

Introduction:
General Scenario on automotive Pollution, Pollutants-sources-formation-effects-transient operational effects on pollution.

Engine Combustion and Pollutant Formation:
HC, CO, NOx, Particulate Matters, Aldehyde emissions, Effect of operating variables on emission formation.

Emission Control Efforts:
Supply of fuel – establishment of national test centers, construction of road networks.

Alternate Fuels:
Estimation of petroleum reserve – need for alternate fuels – Merits & Demerits and uses of CNG, LPG, Alcohols, Hydrogen, Bio-fuels, Electric Energy, Solar Energy.

Emission Standards :
Evaluation of Emission Standards – Mandatory Tests for Emission measurement – Type Approval & Production Conformity Tests – Driving Cycles, Bharat Stages & Euro emission standards.

Control Techniques for SI and CI:
Design changes, optimization of operating factors, Control of Crankcase emission, Evaporative emission, Exhaust emission - exhaust gas recirculation, air injector PCV system, thermal reactors, catalytic converters.

Test Procedure & Instrumentation for Emission Measurement:
Test procedures- Measurements of invisible emissions -ORSAT apparatus, NDIR analyzer, Flame ionization detectors, Chemiluminescent analyzer, Gas analyzer, Measurements of visible emissions – Comparison methods & Obscure methods - Smoke meters, Emission standards.

Text book
1. Automotive Engineering Fuels and Emissions (Classroom & Shop Manual), Ollembeak, CENGAGE Learning

Reference Book
1. Engine Emissions, B.P. Pundir, Narosa Publishing House, 2007.
2. Internal Combustion Engines, V. Ganesan, Tata McGraw Hill Co., 2004.
3. Automobile Engineering, K.K. Ramalingam, Scitech Publications Pvt. Ltd., 2005

AE 4063 TOTAL QUALITY MANAGEMENT IN AUTOMOBILES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. implement TQM in different processes.
CO2. select best quality practices for given organization.
CO3. do quality audit and follow international standard.

Prerequisite : Engineering Metrology and Measurements (ME 2014)

Introduction to Quality:
Defining Quality, Quality as a Management Framework, Quality and Competitive Advantage, Quality cost, Quality losses, link between Quality and productivity.

Tools for Quality Control:
Basic tools of quality (the stem and leaf plot, histogram, box plot etc.), ISO 9000:2000, Six Sigma, Total quality management, introduction to total quality management, the evolution of total quality, Statistical methods for Quality control and improvement.

Statistical Process Control:
Statistical Process Control, Specification & Limits, Charts for variables & attributes, Process Control (X, R & P chart), Summary of Control Chart Construction, Designing Control Charts.

Sampling Plan:
Design of single sampling plan. Double, multiple and sequential sampling plans, O.C. curve, AOQ, AOQL.

Reliability:
Reliability analysis and predictions, Bath-Tub Curve, Exponential and Weibull distribution in modelling reliability, System reliability.

Experimental Design:
Experimental designs and factorial experiments: Concepts of randomization, Blocking and Confounding Single factor randomized design, ANOVA, 2^k factorial experiments Taguchi philosophy; Loss function; Signal to noise ratio, Orthogonal arrays for parameter and tolerance design.

Process Capability:
Process capability analysis using histogram, use and interpretation of Cp, normality and process capability ratio, process capability analysis using designed experiment.

Text Book
1. Fundamentals of Quality Control and Improvement, Amitava Mitra , Wiley , 3rd Edition, 2008.

Reference Book

1. Quality Planning and Analysis, Frank Gryna, TMH, 2001.
2. Total Quality Management, J.R. Evans – South-Western; 3rd Revised edition, 2002.
3. Total Quality Management, L. Suganthi, PHI, 1st Edition, 2004.

AE 4065 ENGINE TRIBOLOGY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. select triobological elements based on design considerations.
CO2. realize the importance of proper choice of tribological elements
CO3. apply the knowledge of wear and lubricants for different applications

Prerequisite : Machine Dynamics (ME 2002)

Surface, Friction and Wear:
Topography Of The Surfaces - Surface Features Of Metal And Composites – Surface Interaction –Definition of Friction- Laws of Friction - Friction Properties Of Metallic, Ceramic, Polymer and lamellar solid materials– Wear-Types of Wear – Archard Wear Equation - Wear of brass-unlubricated wear of metals-wear regime maps for metals-Mechanism of Adhesive – Abrasive wear equation- Mechanism of Abrasive wear – particles properties: hardness, shape and size- Wear Resistance Materials – Wear testing methods.

Lubrication Theory:
Lubricants and Their Physical Properties - Lubricants Standards - Lubrication Regimes Hydrodynamic Lubrication - Reynolds Equation, Thermal, Inertia And Turbulent Effects - Elasto Hydrodynamic and Plasto Hydrodynamic And Magneto Hydrodynamic Lubrication - Hydro Static Lubrication - Gas Lubrication. – Stirbeck Diagram.Design And Performance Analysis Of Thrust And Journal Bearings – Slide Bearing -Full, Partial, Fixed And Pivoted Journal Bearings Design - Lubricant Flow And Delivery- Power Loss, Heat And Temperature Rotating Loads And Dynamic Loads In Journal Bearings - Special Bearings - Hydrostatic Bearing Design.

Rolling Element Bearings:
Geometry And Kinematics - Materials And Manufacturing Processes - Contact Stresses -Hertzian Stress Equation - Load Divisions - Stresses And Deflection - Axial Loads And Rotational Effects, Bearing Life Capacity And Variable Loads - ISO Standards – Oil Films And Their Effects - Rolling Bearings Failures, Needle bearing.

Tribo Measurement and Instrumentation:
Surface Topography Measurements –Assessment Statically Methods –Stylus Profilometers - Optical Microscopy - Scanning Electron Microscope – Transmission Electron Microscopy – AFM – XPS – EDX – XRD – hardness measurement – micro hardness – nano indentation - Instrumentation – Wear Measurements – Wear Debris Analysis - Bearings Performance Measurements.

Engine Tribology:
Introduction – Modified Stribeck Curve for Engine Components – Fuel Energy Distribution of Engine Components – Tribological Engine Components: Friction and wear - Piston Assemblies: Surface topography, wear prediction – Valve Train: Surface Roughness, wear prediction, waviness – Engine Bearings: Asperity Interaction, journal waviness, bearing with microgrooves, wear prediction – Design modification of Engine components.

Text Book

1. Introduction to Tribology of Bearing, B.C. Majumdar, S. Chand, 2nd Edition, 2012.

Reference Book

1. Friction And Wear Of Materials, Ernest Rabinowie z, Inter science Publishers,1995
2. Tribology – Hand Book, Neale, M.J., , Butterworth, 1995.
3. Theory And Practice Of Lubrication Of Engineers, Fuller D.D., John Wiley Sons,198.
4. Friction And Lubrication Of Solids, Bowden, F.P. & Tabor, D., Oxford University Press 1986

AE 4067 OFF-ROAD VEHICLES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. select off road vehicles for different constructional and land preparation activities.
CO2. do trouble shooting of off road vehicles.

Prerequisites : Machine Dynamics (ME 2002) and Internal Combustion Engines & Gas Turbines (ME 3003)

Introduction:
Classification of off road vehicles and their application Excavator: Different types of Shovel and Dragline, their construction, operating principles, operating cycles. Production capacity and cost of production.

Transport Equipment:
Various types of Dumpers, Main system, components and Carrying capacity of Dumper.

Road making and maintenance Machines:
Different types of Dozer, Grader, and their onstruction. Operating principles, Production capacity and application mechanism.

Other equipment:
Scraper and front end loader, their construction and operation.

Maintenance:
Maintenance aspect of Off Road vehicles.

Text Book

1. Latest Development of Heavy Earth Moving Machinery, De, A., Annapurna Publishers, Dhanbad 1995

Reference Book

1. Road Making Machinery, Abrosimov, K. Bran berg, A and Katayer, K. M I R. Publishers Moscow.1971
2. Moving the Earth, Nichols, Herber L (Jr.), Galgotia Publishing House, New Delhi,1962.
3. Digging of soils by earthmover with Power Parts, Rudnev, V. K., Oxanian Press Pvt.Ltd., New Delhi, 1985

MECHATRONICS ENGINEERING

MH 2002 **PRINCIPLES OF MACHINE TOOLS** **Cr-3**

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the different basic machining processes and machine tools.
CO2. understand and Identify various parts of machine tools
CO3. apply various design aspects of spindles and bearings
CO4. reduce vibration and chatter developing on machine tools

Pre-Requisite: NIL

Machine Tools
Turning, Drilling, Milling Machine - Types, Types of cutters, operations, Indexing methods. Shaping, Planing and Slotting Machine – Operations and quick return mechanisms, Work and tool holding devices. Boring machine - Operations, Jig boring machine. Broaching machine – operations

Classification and General principles of Machine Tools
General classification of machine tools, working and auxiliary motions in machine tools, Parameters defining working motion of a Machine Tool, Machine Tool Drives, Hydraulics transmission and its elements, Mechanical transmission and its elements, General requirement of machine tools, Layout of Machine Tool

Machine tool drives
Design considerations for drives based on continuous and intermittent requirement of power, Types and selection of motor for the drive, Regulation and range of speed based on preferred number series, geometric progression. Design of speed gear box for spindle drive and feed gear box, stepped speed drives and step less speed drive

Design of Machine Tool Structures
Functions of Machine Tool Structures and their requirements, Design criteria, materials, static and dynamic stiffness, Basic design procedure, design of beds and columns, Housings, bases and tables. Design of Guideways and Power Screws. Functions and types of Guideways

Machine Tool spindles and its Bearings
Materials of spindles, Effect of machine tool compliance on machining accuracy, Design principles of spindles, Antifriction and sliding bearings.

Controlling systems in Machine Tools
Classification, Control systems for changing speeds and feeds, Ergonomic considerations applied to design of control members, principles of automatic and adaptive control.

Text Book
1. Machine Tools Design and Numerical Control, N. K. Mehta, TMH.
2. Design of Machine Tools, S. K. Basu, D. K. Pal, OIBH.

Reference Book
1. Principles of Machine Tools, G. C. Sen, Bhattacharya, New Central Book Agency.
2. Metal Cutting Theory and Practice, A. Bhattachary, New Central Book Agency (P) Ltd.
3. Machining and Machine Tools, A. B. Chattopadhyay, Wiley-India Publication.

MH 3002 **CIM AND ROBOTICS** **Cr-3**

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the modern technologies and the engineering tools used for manufacturing engineering applications.
CO2. understand the application of computers in the documentation, creation of database and use of CAPP system in industries.
CO3. apply the knowledge in various fields of Computer Aided Manufacturing.
CO4. understand the mechanics and application of robots
CO5. apply modern computational, analytical, simulation tools and techniques in manufacturing

Pre-Requisites: (MH 2002) and Sensors & Actuators (EI 3007)

Fundamental of Manufacturing and Automation
Types of production, functions in manufacturing, production concepts and mathematical models, automation strategies.

Process Planning
Introduction, process plan development, CAPP, CAPP benefits, CAPP approaches, Variant CAPP, Generative CAPP, Hybrid CAPP.

Numerical Control Production System
Numerical control, coordinate system and machine motion, Types of NC system, machine tool applications, problems of conventional NC, CNC, DNC.

Part Programming
Basics of NC programming, mathematics of tool paths, machining forces, Tool offsets, programming steps, NC programming Languages, G-Code and M-Code, APT Programming, CAD/CAM NC programming.

Introduction to Robotics
Introduction, definition, classification, specification, work envelops and other basic parameters of Robotics.

Robot Mechanics
Kinematic Parameters and Modeling- Direct and Inverse Kinematics - Differential motion and jacobians Introduction to Dynamics Path planning — Trajectory Planning and Control — Slew, Joint interpolated and straight line motion.

Computer Networks for Manufacturing
Hierarchy of computers in manufacturing, Local area networking, manufacturing automation protocol.

The Future Automated Factory
Trends in manufacturing, The future automated factory.

Text Book

1. Automation, Production Systems, and Computer-Integrated Manufacturing, Mikell P. Groover, Pearson Education, ISBN 81-7808-511-9. 3rd Edition, 2007
2. Robotics Technology & Flexible Automation, S.R. Deb & S. Deb, Tata McGraw Hill, 2010
3. CAD/CAM, Ibrahim Zeid, TMH

Reference Book

1. Computer Integrated Manufacturing, Paul Ranky Prentice Hall of India
2. Computer Integrated Manufacturing System, Yorem Koren, McGraw-Hill, 1983
3. Robot Dynamics & Control, M. W. Spong & M.Vidyasagar, Wiley, 1989
4. Robotic Systems: Advanced Techniques & Applications, S.G. Tzafestas, Kluwer, Academic publisher, 1992

MH 3006 INDUSTRIAL AUTOMATION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the industrial automation with computer controlled machines, measurement systems and industrial robots.
CO2. design and apply pneumatics and hydraulic circuit using computer for automated factory.
CO3. identify and Design PLC programs, implement PID using electronic, digital, pneumatic and hydraulic methods to solve industrial control problems.
CO4. select the best robotics applications and be able to justify the overall advantages to industry
CO5. uunderstand the principles of application of AGV, ASRS in automated industries.

Pre-Requisites: Kinematic & Dynamics Machinery (ME 2013) and Principle of Control Systems (EE 3009)

Introduction
Introduction to Industrial Automation and Control, Automations; basic laws and principles, level of automationIntroductions to sensors and measurement systems; pressure measurement, temperature measurement, velocity measurement, force and torque measurements, response of measuring systems.

Laws and principles of hydraulics and pneumatics
Components of basic Pneumatic and Hydraulic systems; Characteristics and properties pumps and compressors used in industry; Pneumatic and Hydraulic accessories like filters, lubricators, air dryers, pipelines, connectors; Pneumatic and Hydraulic actuators and their classifications; Proportional and Servo Valves, Construction and working of various Pneumatics and Hydraulics valves; Pneumatic and hydraulic circuits.

Industrial Control systems
Continuous and discrete control, Control requirements, Programmable Logic Controllers (PLCs), Sensors and Actuators. Introduction to Process Control, PID Control, Implementation of PID Controllers, Logic circuits: Pneumatic logic circuits, Electric and electronic controls used in automation.

Industrial Robotics
Industrial robot applications, Robotic Grippers, Sensors in robotics. Robot Programming, Robot application in machining, Welding and assembly, Hostile and remote environment.

Automation in material handling and storage system
Automated guided vehicle systems (AGV), Monorails and other rail guided vehicles, Conveyor systems, Automated storage systems, Engineering analysis of storage system.

Text Book
1. Industrial Automation and Robotics, A. K. Gupta and S. K. Arora, Lakshmi Publication, New Delhi, ISBN 8131805921, 2009
2. Mechatronics Principles, Concepts and Application, N. P. Mahalik, TMH, ISBN-0-07-048374-4, 2003

Reference Book
1. Automation, Production Systems, and Computer-Integrated Manufacturing, Mikell P. Groover, Pearson Education, ISBN 81-7808-511-9. 3rd Edition, 2007
2. Overview of Industrial Process Automation (1st Edition), K. L. S. Sharma, Elsevier, ISBN-978-012-415779-8
3. Industrial Robotics-Technology, Programming and Applications, M. P. Groover, McGraw Hill, 2001.

MH 3008 DESIGN OF MECHATRONIC SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the mechatronic systems design and their structure, ergonomic and safety.
CO2. analyze Theoretical and practical aspects of computer interfacing and real time data acquisition and control.
CO3. apply the knowledge to design mechatronics products.

Pre-Requisite: Digital Electronics (EC 2018), Principle of Control Systems (EE 3009), Sensors and Actuators (EI 3007) and DC AC and Special Electrical Machines (EE 2011)

Introduction to Mechatronics System
Key Elements – Mechatronics Design Process –Design Parameters – Traditional and Mechatronics Designs – Advanced Approaches in Mechatronics - Industrial Design and Ergonomics, Safety.

System Modelling
Introduction-Model Categories-Fields of Application-Model Development-Model Verification-Model Validation-Model Simulation-Design of Mixed Systems-Electro Mechanics Design-Model Transformation- Domain-Independent Description Forms-Simulator Coupling.

Real Time Interfacing
Introduction-Selection of Interfacing Standards Elements of Data Acquisition & Control Systems- Over View of I/O Process, General Purpose I/O Card and Its Installation, Data Conversion Process, Application Software- Lab View Environment and Its Applications, Vim-Sim Environment & Its Applications -Man Machine Interface.

Case Studies On Mechatronic System
Introduction –Fuzzy Based Washing Machine – Ph Control System – Autofocus Camera, Exposure Control– Motion Control Using D.C. Motor & Solenoids – Engine Management Systems. – Controlling Temperature of a Hot/Cold Reservoir Using PID- Control of Pick and Place Robot – Part Identification and Tracking Using RFID – Online Surface Measurement Using Image Processing.

Micro Mechatronic System
Introduction- System Principle - Component Design – System Design – Scaling Laws – Micro Actuation – Micro Robot – Micro Pump – Applications of Micro Mechatronic Components.

Text Book
1. Mechatronics System Design", Devdas Shetty, Richard A. Kolk 2nd Edition, Cengage Learning 2011.
2. Mechatronic Systems: Modeling and simulation" with HDL's, Georg Pelz, John Wiley and sons Ltd, 2003

Reference Book
1. Mechatronics Hand book, Bishop, Robert H CRC Press, 2002.
2. Mechatronics: Electronics in Products and Processes, Bradley, D.Dawson, N.C. Burd and A.J. Loader CRC Press 1991 , First Indian print 2010.
3. Mechatronics: A Foundation Course, De Silva Taylor & Francis, Indian Reprint, 2013

MH 3032 MODELING AND SIMULATION OF MECHATRONIC SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the basic concept and principles of modeling and simulation of systems
CO2. understand and apply various modeling techniques to physical systems
CO3. apply various simulation techniques to solve practical problems related to mechatronic systems

Pre-requisite: NIL

Introduction

Principles of modeling and simulation, modeling and simulation of mixed systems, transfer function, state space representation of SISO, MIMO, modeling of dynamic systems, construction, analysis, practical applications.

Physical Modelling

Mechanical and electrical systems, physical laws, continuity equations, compatibility equations, system engineering concept, system modelling with structured analysis, modelling paradigms for mechatronic system, block diagrams, mathematical models, systems of differential-algebraic equations, response analysis of electrical systems, thermal systems, fluid systems, mechanical rotational system, electrical-mechanical coupling**.**

Simulation Techniques

Solution of model equations and their interpretation, zeroth, first and second order system, solution of 2nd order electro-mechanical equation by finite element method, transfer function and frequency response, non-parametric methods, transient, correlation, frequency, Fourier and spectra analysis, design of identification experiments, choice of model structure, scaling, numeric methods, validation, methods of lumped element simulation, modelling of sensors and actuators, hardware in the loop simulation (HIL), rapid controller prototyping, coupling of simulation tools, simulation of systems in software (MATLAB, LabVIEW) environment.

Modelling and Simulation of Practical Problems

Pure mechanical models, Models for electromagnetic actuators including the electrical drivers, Models for DC-engines with different closed loop controllers using operational amplifiers, Models for transistor amplifiers, Models for vehicle system.

Text book

1. L. Ljung, T. Glad, "Modeling of Dynamical Systems", Prentice Hall Inc. (1994).
2. D.C. Karnopp, D.L. Margolis and R.C. Rosenberg, "System Dynamics: A Unified Approach", 2nd Edition, Wiley-Inderscience (1990).
3. G. Gordon, "System Simulation", 2nd Edition, PHI Learning (2009).

Reference Book

1. V. Giurgiutiu and S. E. Lyshevski, "Micromechatronics, Modeling, Analysis, and Design with MATLAB", 2nd Edition, CRC Press (2009).

MH 3034 PRODUCT DESIGN & DEVELOPMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify and analyse the product design and development processes in manufacturing industry.
CO2. analyse, evaluate and apply the methodologies for product design, development and management.
CO3. undertake a methodical approach to the management of product development to satisfy customer needs.
CO4. carry out cost and benefit analysis through various cost models.

Pre-requisite: Solid Mechanics & Machine Design(MH 2018)

Introduction
Need for IPPD, Strategic importance of Product development, integration of customer, designer, material supplier and process planner, Competitor and customer, Behavior analysis. Understanding customer, prompting customer understanding, involve customer in development and managing requirements, Organization process management and improvement, Plan and establish product specifications.

Concept Generation and Selection
Task, Structured, approaches clarification, search, externally and internally, explore systematically, reflect on the solutions and processes, concept selection, methodology, benefits.

Product Architecture
Implications, Product change, variety, component standardization, product performance, manufacturability, product development management, establishing the architecture, creation, clustering, geometric layout development, fundamental and incidental interactions, related system level design issues, secondary systems, architecture of the chunks, creating detailed interface specifications.

Industrial Design
Integrate process design, managing costs, Robust design, Integrating CAE, CAD, CAM tools, Simulating product performance and manufacturing processes electronically, need for industrial design, impact, design process, investigation of for industrial design, impact, design process, investigation of customer needs, conceptualization, refinement, management of the industrial design process, technology driven products, user, driven products, assessing the quality of industrial design.

Design for Manufacturing and Product Development
Definition, Estimation of Manufacturing cost, reducing the component costs and assembly costs, minimize system complexity, Prototype basics, principles of prototyping, planning for prototypes, Economic Analysis, Understanding and representing tasks, baseline project planning, accelerating the project, project execution.

Text book

1. Kari T.Ulrich and Steven D.Eppinger, ”Product Design and Development”, McGraw-Hill International Edns. 1999.

Reference book

1. Kemnneth Crow, "Concurrent Engg./Integrated Product Development”, DRM Associates,26/3, Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
2. Stephen Rosenthal,” Effective Product Design and Development”, Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3. Staurt Pugh,” Tool Design –Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing, New York, NY.

MH 4036 INTELLIGENT MANUFACTURING SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. ability to understand and demonstrate the concepts of machine learning techniques.
CO2. identify various components of knowledge based systems.
CO3. ability to apply various Intelligent techniques for manufacturing process optimization.
CO4. apply various methods to solve group technology problems and demonstrate the structure for knowledge based system for group technology.

Pre-requisite: Neural network & fuzzy logic control (EI 3023)

Introduction to Machine Learning

Goals of AI in manufacturing, tools for AI such as Search algorithm, Mathematical optimization, Evolutionary computation, fuzzy logic, Probabilistic methods for uncertain reasoning such as Bayesian network, Hidden Markov model, Kalman filter, Decision theory and Utility theory, statistical learning methods, support vector machines, neural networks, expert systems.

Industrial planning and decision making using intelligent systems

Production planning using fuzzy cognitive maps, computer aided process planning, Methods for inventory space allocation and storage processes analysis, Optimization of production costs and methods finding of the best process plan, Methods for production equipment selection and layout, Heuristic scheduling of multiple resources, Fuzzy multiple attribute decision making methods.

Intelligent techniques for manufacturing process optimization

Application of neural networks and fuzzy sets to machining and metal forming, Artificial neural network modeling of surface quality characteristics in machining processes, parametric optimization of machining processes using evolutionary optimization methods.

Knowledge Based Group Technology

Group Technology: Models and Algorithms, Visual method, Coding method, Cluster analysis method, Knowledge based group technology, Group technology in automated manufacturing system, Structure of knowledge based system for group technology (KBSGT), database, knowledge base, Clustering algorithms. Knowledge Based System for Equipment Selection (KBSES), Manufacturing system design, equipment selection problem, modelling the manufacturing equipment selection problem, problem solving approach in KBSES, structure of the KBSES

Text book

1. Yagna Narayana, “Artificial Neural Networks”, PHI, 2009.
2. Andrew Kussiak, “Intelligent Manufacturing Systems”, Prentice Hall, 1990.
3. A.B. Badiru , “Expert Systems Applications in Engineering and Manufacturing”, Prentice-Hall, New Jersey, 1992.

References book

1. R.V. Rao “Advanced Modeling and Optimization of Manufacturing Processes”, Springer-verlag, London. ISBN 978-0-85729-014-4.
2. Hamid R. Parsaei and Mohammad Jamshidi, “Design and Implementation of Intelligent Manufacturing Systems”, PHI, 2009`.

MH 4039 PROCESS PLANNING AND COST ESTIMATION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. to understand the basic concepts of manual and computer aided process planning in industries.
CO2. to understand and estimate the different elements of cost of production including depreciation.
CO3. ability to estimate the cost involved for foundry, forging, welding and sheet metal shops.
CO4. ability to estimate the cost involved in machining operations.

Pre-requisite: Principles of Machine Tools (MH 2002)

Process Planning
Introduction: methods of Process Planning, drawing interpretation, Material evaluation, selection and analysis: Manual, experienced based planning, Computer aided process planning, Variant, Generative Processes analysis, Types of Production. Production equipment and tooling selection.

Introduction to Costing Estimation
Aims of costing and Estimation, Functions and Procedure, Introduction to Costs, Computing Material cost, Direct Labor cost, Analysis of Overhead costs, Factory expenses, Administrative expenses, Selling and Distributing expenses, Cost Ladder, Cost of Product, Depreciation, Analysis of Depreciation.

Production Cost Estimation
Estimation in Foundry shop, Pattern Cost Casting cost, Illustrative examples. Estimation in Forging Shop, Losses in forging, Forging cost, Illustrative examples. Estimation in welding shop, Gas cutting, Electric Welding, Illustrative examples. Estimation in sheet metal shop, Shearing and Forming, Illustrative examples.

Calculation of Machining Times and Costs
Estimation of machining time for lathe operations, Estimation of machining time for drilling, boring, shaping, planning, milling and grinding operations, Illustrative examples.

Text book

1. M.S. Adithan and Pabla, “Estimating and Costing,” Konark Publishers Pvt. Ltd, 1989.
2. A.K. Chitale and R.C. Gupta, “Product Design and manufacturing”, Prentice Hall Pvt. Ltd., 1997.
3. Nanua Singh, “System Approach to Computer Integrated Design and Manufacturing”, John Wiley & sons, Inc., 1996.
4. Joseph G. Monks., “Operations Management, Theory and Problems”, McGraw Hill Book Company, 1982.

Reference book

1. G.B.S. Narang and V. Kumar, “Production and Planning”, Khanna Publishers, 1995.
2. T.R. Banga and S.C. Sharma, “Estimating and Costing”, Khanna publishers, 1986.

MH 4041 MICRO AND NANO MANUFACTURING SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. ability to understand different micro manufacturing processes and their applications.
CO2. understand the definition of Nanotechnology and increase in Nanotechnology awareness.
CO3. know the processing and applications of Nanoparticles and Nanomaterials.
CO4. understand the application of Computers in the area of Nano design.

Pre-requisite: Principles of Machine Tools (MH 2002)

Introduction
Working principles and process parameters, machine tools, applications of the micro manufacturing processes, challenges in meso, micro, and nano manufacturing, industrial applications and future scope of micro-manufacturing processes.

Microfabrication
Mechanical Micromachining, Physical Fabrication Methods, Lithography, Processing Setup, Nano Lithgraphy & Manipulation, Precision Micro and Nano grinding, Use of Spectrometers & Microscopes
Laser Based Micro and Nanofabrication Pulsed Water Drop Micromachining, Nano Materials, Synthesis of Nano materials, Bio Materials, Nano Composites, Development of Nano Particles.

Nano Technology
Nano technology Concepts and Applications Micro and Nanofabrication, Nano technology in India Scope for Microfabrication, Rise Nano technology Fields Commercialization Issues of Micro-Nano Technology.

Innovative Applications on Present Devices
Nanochips, Nanotubes and Nanowires, Integration of chips and microprocessors, Technology Support, Meeting Social Needs

Nano Design & CAD
Computer Aided Nano Design, VLSI product detailing Finite Element Analysis of Microstructures, 3-D Molecular Modelling

Acceptability of Nano Workmanship
Nano to millimeter Integration Atomic Scale Precision & Control, Promising Nano-centered Future.

Textbook

1. Tai Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata-McGraw Hill, New Delhi, 2002.
2. Sami Franssila," Introduction to Micro fabrication", John Wiley & sons Ltd, 2004. ISBN:470-85106-6
3. W.R. Fahrner "Nanotechnology and Nanoelectronics", Springer (India) Private Ltd., 2011.
4. Norio Taniguchi, "Nano Technology", Oxford University Press, New York, 2003

Reference book

1. Microfabrication & Nonmanufacturing by Mark J. Jackson 2. ASM handbook on machining
2. Mohamed Gad-el-Hak, MEMS Handbook, CRC press, 2006, ISBN : 8493-9138-5
3. Mark Madou , Fundamentals of Microfabrication, CRC Press, New York, 1997

MH 4043 MICRO ELECTRO MECHANICAL SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. ability to understand the basic concepts of micro electromechanical systems,various fabrication techniques and applications.
CO2. ability to critically analyze microsystems technology for technical feasibility as well as practicality.
CO 3. to understand the knowledge about Nano materials and various Nano measurements techniques.

Pre-requisites: Material Science and Engineering (ME 2007), Digital Electronics (EC 2011) and Sensors & Actuators (EI 3007).

Introduction to Microsystems
Overview of microelectronics manufacture and Microsystems technology. Definition- MEMS materials. Laws of scaling. The multi-disciplinary nature of MEMS. Survey of materials central to micro engineering. Applications of MEMS in various industries.

Micro Sensors & Actuators
Working principle of Microsystems, micro actuation techniques, micro sensors types, Micro actuators types: micro pump, micro motors, micro valves, micro grippers, micro accelerometers.

Fabrication Process
Substrates-single crystal silicon wafer Formation-Photolithography-Ion Implantation-Diffusion Oxidation, CVD-Physical Vapor Deposition-Deposition by epitaxy-etching process.

Micro System Manufacturing
Bulk Micro manufacturing- surface micro machining, LIGA, SLIGA, Micro system packaging materials, die level, device level, system level, packaging techniques, die preparation, surface bonding, wire bonding, sealing.

Microsystems Design and Packaging
Design considerations, Mechanical Design, Process design, Realization of MEMS components using intellisuite. Micro system packaging, Packing Technologies, Assembly of Microsystems, Reliability in MEMS. What's next-NEMS, micro factories and nanotechnology.

Text book

1. Mohamed Gad el Hak, "MEMS Handbook", CRC Press, 2002.
2. P. Rai Choudhury "MEMS and MOEMS Technology and Applications", PHI Learning Private Limited, 2009.
3. Sabrie Solomon, "Sensors Handbook," Mc Graw Hill, 1998.
4. Marc F Madou, "Fundamentals of Micro Fabricatio", CRC Press, 2nd Edition, 2002.

Reference book

1. E.H. Francis, Tay and W.O. Choong, "Micro fluidics and Bio mems application", IEEE Press New York, 1997.
2. S. Trimmer William, Ed., "Micromachanics and MEMS", IEEE Press New York, 1997.
3. Maluf, Nadim, "An introduction to Micro electro mechanical Systems Engineering", AR Tech house, Boston 2000.
4. Julian W.Gardner, K. Vijay, Varadan, O. Osama, Awadel Karim, "Micro sensors MEMS and Smart Devices", John Wiby & sons Ltd.,2001.

AEROSPACE ENGINEERING

AS 2001 AEROSPACE THERMODYNAMICS Cr-4

Course Outcome : At the end of the course, the students will be able to:

CO1. comprehend terminology related to thermal engineering and recognize the need of learning thermodynamics
CO2. appreciate the 1^{st} law in cyclic and acyclic processes.
CO3. interpret the 2^{nd} law in applications related to heat engine, heat pump and refrigerators.
CO4. read and comprehend steam table and Mollier chart in solving complex thermal problems.
CO5. understand the applicability of gas and steam power cycles in thermal engineering.
CO6. analyze the mechanism of conduction, convection and radiation and heat exchanger principle.

Prerequisite : Physics (PH 1003)

Basic concepts and definitions:
Scope of thermodynamics, Macroscopic and microscopic approaches, Definition of closed system and open system, Extensive and Intensive Properties, Point and Path function, Reversible and irreversible processes, Thermal, mechanical and chemical equilibrium, thermodynamic equilibrium, Zeroth law of thermodynamics, Forms of energy, energy transfer by heat, forms of work (electrical and mechanical), energy transfer by work.

First law of thermodynamics:
Moving boundary work (PdV work), PdV work for different processes, First law for closed systems (for cyclic and non-cyclic processes), introduction of internal energy as a thermodynamic property, flow work and energy of a flowing fluid, first law for control volumes (open systems) and introduction of enthalpy as a thermodynamic property.

Second law and Entropy:
Second law - thermal efficiency of heat engines – Kelvin-Planck statement and Clausius statement - perpetual motion machines - reversible and irreversible processes- Carnot cycle. Entropy: increase of entropy principle- isentropic process - T-ds relations and entropy change of ideal gases – isentropic efficiencies of steady flow devices - Exergy (only introductory information).

Pure substances:
Definition of pure substance, p-V and T-v diagrams for pure substances, specific volumes of saturated liquid, wet vapor and superheated vapour.

Gas Power Cycles :
The Carnot cycle and its value in engineering - Otto cycle- Diesel cycle- Dual Cycle, Brayton cycle, Gas Turbine cycle with intercooling, reheat and regeneration.

Heat Transfer:
Three modes of heat transfer-conduction, convection and radiation. Fourier conduction equation, Mechanism of convection and basic concepts: Dimensional analysis for forced and free convection, Nusselt number, Concept of thermal boundary layer, Prandtl number, Radiation properties, emissive power and emissivity, Kirchoff's identity. Planck's relation for monochromatic emissive power of a black body, Stefan-Boltzman law and Wein's displacement law, Radiation shape factor.

Heat Exchanger:
Types of heat exchangers and heat exchanger configurations. The overall heat transfer coefficient and fouling factor. LMTD and effectiveness-NTU analysis of heat exchangers.

Text Book

1. Engineering Thermodynamics, Second Edition, P. Chattopadhyay, Oxford University Press.

Reference Book

1. Fundamentals of Classical Thermodynamics, Gordon J. Van Wylen , Richard E. Sonntag, Claus Borgnakke, John Wiley, Fifth Edition
2. Engineering thermodynamics, P. K. Nag, McGraw Hill Education, Fifth Edition.
3. Thermodynamics, An Engineering Approach, Yunus A Cengel and Michael A. Boles, Mc Graw Hill Education, 7th Edition, 2011 (reprint 2013)

AS 2002 AUTOMATIC CONTROL THEORY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. describe the transfer functions for automatic control systems; open-loop and closed-loop systems.
CO2. describe the various time domain and frequency domain tools for analysis and design of linear control systems.
CO3. describe the methods to analyze the stability of systems from transfer function forms.
CO4. describe the methods to analyze the stability of systems from transfer function forms.
CO5:. describe the methods to analyze the sampled-data control systems.

Prerequisites : Mathematics-II (MA 1002)

INTRODUCTION TO AUTOMATIC CONTROL SYSTEMS
Historical review, Examples of control systems: simple pneumatic, hydraulic and thermal systems, series and parallel systems, analogies, mechanical and electrical components.

OPEN AND CLOSED LOOP SYSTEMS
Closed loop control versus open loop control, Feedback control systems, Block diagram representation of control systems, reduction of block diagrams, Signal Flow Graph (SFG), Mason's Gain Formula, Output to input ratios.

TRANSIENT AND STEADY-STATE RESPONSE ANALYSIS
Laplace transformation, Response of systems to different inputs viz. Step, impulse, pulse, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.

STABILITY ANALYSIS
Stability definitions, characteristic equation, location of roots in the s-plane for stability, Routh-Hurwitz criteria of stability, Root locus and Bode techniques, concept and construction, frequency response.

SAMPLED DATA CONTROL SYSTEMS
Sampled data control systems - functional elements-sampling process - ztransforms- properties - inverse z-transforms- response between samples modified z-transforms - ZOH and First order Hold process- mapping between s and z planes - pulse transfer functions - step response.

Text Book

1. Katsuhiko Ogata., “Modern Control Engineering”,4th edition, Prentice Hall of India Private Ltd, NewDelhi, 2004.
2. Nagrath, I J and Gopal, .M., “Control Systems Engineering”, 4th edition, New Age International Pvt. Ltd., New Delhi, 2006.

Reference Book

1. Benjamin, C Kuo., “Automatic Control System”, 7th edition, Prentice Hall of India Private Ltd, New Delhi, 1993.
2. Richard, C. Dorf and Robert H. Bishop., “Modern Control System Engineering”, Addison Wesley, 1999.

AS 2003 INTRODUCTORY AERODYNAMICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. explain fluid properties and determine hydrostatic pressure using manometric data
CO2. demonstrate stability of floating bodies and types of flow. visualize different motion.
CO3. apply Bernoullis equation in moving fluids to find flow rate.
CO4. solve hydraulic pipe flow problems and hence calculate hydraulic and energy grade lines.
CO5. apply Raleigh's method and Buckingham theorem for dimensional analysis and model study.
CO6. find out efficiency of Pelton, Francis, Kaplan turbines using velocity triangle.
CO7. describe the characteristics curves of centrifugal pump and reciprocating pump.

Prerequisites : Physics (PH 1003) and Mathematics-I(MA 1001)

Fundamental Concepts:
Scope of fluid mechanics and its development as a science Physical property of Fluid: Density, specific gravity, specific weight, specific volume, surface tension and capillarity, viscosity, compressibility and bulk modulus, Fluid classification.

Fluid Statics:
Fundamental equation and its solution (constant density and constant temperature solutions), Units and scales of pressure measurement, Manometers, Hydrostatic thrusts on submerged surfaces (plane and curved), Buoyancy, Stability of unconstrained bodies in fluids, Fluids under relative equilibrium.

Kinematics of Fluid Flow:
Introduction, description of fluid flow, classification of fluid flow. Reynold's number, Acceleration of fluid particles, flow rate and continuity equation, differential equation of continuity, Mathematical definitions of irrotational and rotational motion. Circulation, potential function and stream function. Flow net.

Fluid Dynamics :
Introduction, Euler's equation along a streamline, energy equation, Bernoulli's equation and its application to siphon, venturimeter, orificemeter, pitot tube. Flow in pipes and ducts: Loss due to friction, Minor energy losses in pipes Hydraulic Gradient Line (HGL), Total Energy Line (TEL), Power transmission in the fluid flow in pipes, fluid flow in pipes in series and parallel. Flow through nozzles.

Dimensional Analysis and Model study:
Dimensional homogeneity, dimensional analysis, Raleigh's method and Buckingham theorem. Superfluous and Omitted Variables, Similarity laws and model studies, Distorted models.

Text Book

1. A Text Book of Fluid Mechanics and Hydraulic Machines, R. K. Bansal . Laxmi Publications(p) Ltd. 2010, 9th Edition.

Reference Book

1. Introduction to Fluid Mechanics and Fluid Machines, S. K. Som, G. Biswas & S. Chakraborty, McGraw Hill Education (India) Pvt. Ltd, New Delhi, 3rd Edition, 2014.
2. A Text Book of Fluid Mechanics, R. K. Rajput, S. Chand Limited, 2008.
3. Hydraulics and Fluid Mechanics Including Hydraulics Machines, P.N. Modi, Standard Publishers Distributors, 19th Edition, 2013.
4. Fluid Mechanics, A. K. Mohanty, PHI Learning Pvt. Ltd., 2001.
5. Engineering Fluid Mechanics, K. L. Kumar, S. Chand Limited, 2008.
6. Fluid Mechanics, Y. Cengel and J. Cimbala, McGraw Hill Education (India) Pvt. Ltd, New Delhi, 2rd Edition, 2010.

AS 2004 AEROSPACE STRUCTURES - I Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. analyse structural elements in aircraft.
CO2 . solve three moment equation and moment distribution.
CO3 . make simplified analysis of a/c structures & apply energy methods.
CO4 . understand and solve the column problems.
CO5 . apply failure theories for various loading conditions

Prerequisites : Physics (PH 1003), Mathematics-I(MA 1001) and Mathematics-II(MA 1002)

STATICALLY DETERMINATE STRUCTURES
Equilibrium and Compatibility conditions for elastic solids. 2D elasticity equations for plane stress, plane strain and generalized plane strain cases, Stress Functions –Airy's Stress Function, Bending of end-loaded cantilever beams, Analysis of plane truss - Method of joints - 3 D Truss - Plane frames

STATICALLY INDETERMINATE STRUCTURES
Introduction, Methods for Indeterminate Beams- Superposition Method, Double Integration Method, Singularity Method and Clapeyron's Three Moment Equation Method. Matrix Methods for Indeterminate Trusses and Frames.

ENERGY METHODS
Strain Energy due to axial, bending and Torsional loads – Castigliano's theorems- Maxwell's Reciprocal theorem, Unit load method - application to beams, trusses, frames, rings, etc.

TORSION OF NON-CIRCULAR SHAFTS
Prandtl stress function solution, St. Venant warping function solution, Membrane Analogy and Torsion of a narrow rectangular strip. Beam torsion approximate solution – Open cross section beam torsion, closed section beam torsion, accuracy of the uniform torsion theory and Beams subjected to a variable torque.

BENDING AND BUCKLING OF THIN PLATES
Pure bending of thin plates, plates subjected to bending, twisting and distributed lateral load, Elastic buckling of Isotropic Flat plates in compression, Elastic buckling of plates due to shear and bending stresses, Elastic buckling of curved rectangular plates, Stiffened Panels, Columns subjected to local crippling failure – Needham method, Gerard method. Pure or complete tension field beams (Wagner's Theory), Incomplete diagonal tension field beam and tapered tension filed beam.

Text Book

1. Donaldson, B.K., "Analysis of Aircraft Structures - An Introduction", McGraw-Hill, 1993.

Reference Book

1. Timoshenko, S., "Strength of Materials", Vol. I and II, Princeton D. Von Nostrand Co, 1990.

AS 2006 AERODYNAMICS - I Cr-3

Course Outcome: At the end of the course, the students will be able to

CO1 . apply fluid mechanics concepts.
CO2 . calculate forces and moments acting on aero foils and wings under ideal flow conditions.
CO3. determine the aero foil and wing characteristics.
CO4 . design of a propeller and determine aerodynamic interaction effects between different components of aircraft.
CO5 . understand the real time viscous flow and Boundary Layer behaviour.

Prerequisites : Fluid Mechanics & Hydraulic Machines (ME 2013) and Mathematics (MA 1001)

INTRODUCTORY TOPICS FOR AERODYNAMICS
Vortex motions – vortex line, vortex tube- vortex sheet – circulation – Kelvin and Helmhotz theorem- Biot – Savarts' law – applications, Rankine's Vortex - Kutta – Joukowski theorem.

AEROFOIL THEORY
Aero foil nomenclature – aerodynamic characteristics – centre of pressure and aerodynamic centre- wing of finite aspect ratio – CL-α - diagram for a wing of finite aspect ratio. Generation of lift - starting and bound vortices - Kutta's trailing edge condition – thin aerofoil theory- method of singularities – elements of panel method.

THEORY OF PROPELLERS
Axial momentum theory – influence of wake rotation – blade-element theory – combined blade element and momentum theories- tip correction –performance of propellers.

WING THEORY
Flow past finite wings - vortex model of the wing - induced drag – Prandtl's lifting line theory - elliptic wing – influence of taper and twist applied to wings – effect of sweep back – delta wings- elements of lifting surface theory.

FLOW PAST NON-LIFTING BODIES AND INTERFERENCE EFFECTS
Flow past non lifting bodies- method of singularities – wing – body interference- effect of propeller on wings and bodies and tail unit –flow over airplane as a whole.

VISCOUS FLOW
Newton's law of viscosity, Boundary Layer, Navier-Stokes equation, displacement, Momentum thickness, Flow over a flat plate, Blasius solution.

Text Book
1. Fundamentals of Aerodynamics, John D. Anderson (Jr.) Fifth Edition, McGraw Hill Series.

Reference Book
1. Aerodynamics for Engineering Students, sixth Edition, Houghton, E.L., P. W. Carpenter, Steven H. Collicott, Daniel T. Valentine Elseveir Publishers Ltd.
2. Aerodynamics, Clancy, L.J., Indian Edition 2006, Sterling Book House Mumbai.
3. Aerodynamics for Engineers, fourth Edition, Bertin J J., Pearson Education 2002.
4. Milne Thomson, L.H., "Theoretical aerodynamics", Macmillan, 1985.

AS 2008 PROPULSION - I Cr-3

Course Outcome: At the end of the course, the students will be able to ;

CO1. understand the working principle, thermodynamic cycles and performance characteristics of gas turbine engines.
CO2. understand the internal flow and external characteristics near the inlets, starting problems and different modes of operation in supersonic inlets.
CO3. know the types and working principles of axial compressors, its velocity diagrams, blade design and performance characteristics of compressors.
CO4 . know the types of combustion chambers, the flame stabilization and combustion techniques.
CO5 . understand flow through nozzle, losses in nozzle, variable area nozzle and thrust vectoring.

Prerequisite : Thermodynamics (AS 2001)

FUNDAMENTALS OF GAS TURBINE ENGINES

Illustration of working of gas turbine engine – The thrust equation – Factors affecting thrust– Effect of pressure, velocity and temperature changes of air entering compressor –Methods of thrust augmentation – Characteristics of turboprop, turbofan and turbojet –Performance characteristics.

SUBSONIC AND SUPERSONIC INLETS FOR JET ENGINES

Internal flow and Stall in subsonic inlets – Boundary layer separation – Major features of external flow near a subsonic inlet – Relation between minimum area ratio and external deceleration ratio – Diffuser performance – Supersonic inlets – Starting problem on supersonic inlets – Shock swallowing by area variation – External declaration – Models of inlet operation.

COMPRESSORS

Principle of operation of centrifugal compressor – Work done and pressure rise – Velocity diagrams – Diffuser vane design considerations – Concept of prewhirl, rotation stall and surge – Elementary theory of axial flow compressor – Velocity triangles – degree of reaction – Three dimensional – Air angle distributions for free vortex and constant reaction designs – Compressor blade design – Centrifugal and Axial compressor performance characteristics.

COMBUSTION CHAMBERS

Classification of combustion chambers – Important factors affecting combustion chamber design – Combustion process – Combustion chamber performance – Effect of operating variables on performance – Flame tube cooling – Flame stabilization – Use of flame holders – Numerical problems.

TURBINES

Impulse and reaction blading of gas turbines – Velocity triangles and power output – Elementary theory – Vortex theory – Choice of blade profile, pitch and chord – Estimation of stage performance – Limiting factors in gas turbine design- Overall turbine performance – Methods of blade cooling – Matching of turbine and compressor.

NOZZLES

Theory of flow in isentropic nozzles – nozzles and choking – Nozzle throat conditions – Nozzle efficiency – Losses in nozzles – Over expanded and under – expanded nozzles – Ejector and variable area nozzles – Interaction of nozzle flow with adjacent surfaces – Thrust reversal.

Text Book

1. Hill, P.G. & Peterson, C.R. “Mechanics & Thermodynamics of Propulsion” Addison – Wesley Longman INC, 1999.

Reference Book

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. “Gas Turbine Theory”, Longman, 1989.
2. Oates, G.C., “Aero thermodynamics of Aircraft Engine Components”, AIAA Education Series, New York, 1985.
3. “Rolls Royce Jet Engine” – Third Edition – 1983.
4. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 1999.

AS 2010 AEROSPACE MATERIALS TECHNOLOGY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. recognize appropriate material for particular aerospace application.
CO2. develop and change the chemical, physical and mechanical properties of ferrous and non-ferrous alloys for aero structural applications.
CO3. select different non ferrous materials for different industrial and day to day life application.
CO4. change the mechanical properties of steel with or without change in chemical compositions.
CO5. use the technique to prevent corrosion of different ferrous and non ferrous alloys

Prerequisite : Chemistry (CH 1003)

Introduction:
Types of Materials, Crystallography: crystalline and non-crystalline solids, space lattices, crystal systems and unit cells. Defects in Materials: point defects, line defects (dislocations), surface defects and volume defects.

Structure of Materials:
Grains, grain boundaries, grain size, effect of grain size on properties of materials. Behaviour of Materials: Stress-strain diagrams, yielding, strain hardening, precipitation hardening, toughness, Resilience, Bauschinger's effect, Creep, Fatigue.

Phase Diagrams :
Basics of phase diagram, Gibb's phase rule, Lever rule, Isomorphous, Eutectic and Peritectic alloy system. Heat Treatment: Principles of heat treatment, Annealing, Normalizing, Hardening, Tempering, Mar tempering, Age hardening, Surface hardening, Case hardening.

Engineering Materials in Aerospace :
Ferrous Alloys in Aircrafts: Iron- C phase diagram, Alloy Steels, aircraft steel specifications, corrosion and heat resistant steels, structural applications, Maraging Steels, Super Alloys. Non-Ferrous (NF) Alloys in Aircrafts: Aluminium and its alloys, Magnesium and its alloys, Titanium and its alloys, Copper and its alloys, Corrosion resistance of NF alloys. Composites: Metal Matrix composites used in aircrafts.

Module 5: Materials Testing :
Destructive Testing - Tensile testing, compression testing, fatigue testing, torsion testing, impact testing. Non-Destructive Testing - Ultrasonic testing, Dye penetration testing, magnetic testing, acoustic testing, X-ray testing.

Materials Selection and Design Considerations:
Real life and hypothetical case studies to illustrate the procedure for selection of materials for designing various aircraft, missile and satellite components.

Text Book

1. Materials Science and Engineering, Willium D. Callister, Jr. John Wiley & Sons publications
2. Callister's Materials Science and Engineering Adapted By R. Balasubramaniam, Wiley India, Edition - 2010

Reference Book

1. Material Science and Engineering, V. Raghavan, Prentice Hall of India, 4th Edition.
2. Engineering Metallurgy: Applied Physical Metallurgy, R. A. Higgins, 6th Edition

AS 3009 AERODYNAMICS - II Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the energy, momentum and continuity equations.
CO2 know the various parameters affecting the normal and oblique shock waves.
CO3. know the various theories regarding the steady compressible flow.
CO4. know the various parameters of airfoil in high speed flow.
CO5. know the various methods for creating supersonic flow in wind tunnels.

Prerequisite : Aerodynamics-I (AS 2006)

ONE DIMENSIONAL COMPRESSIBLE FLOW
Energy, Momentum, continuity and state equations, velocity of sound, adiabatic steady state flow equations, Flow through converging, diverging passages, Performance under various back pressures.

NORMAL, OBLIQUE SHOCKS
Prandtl equation and Rankine – Hugonoit relation, Normal shock equations, Pitot static tube, corrections for subsonic and supersonic flows, Oblique shocks and corresponding equations, Hodograph and pressure turning angle, shock polar, flow past wedges and concave corners, strong, weak and detached shocks.

EXPANSION WAVES, RAYLEIGH AND FANNO FLOW
Flow past convex corners, Expansion hodograph, Reflection and interaction of shocks and expansion, waves. Method of Characteristics Two dimensional supersonic nozzle contours. Rayleigh and Fanno Flow.

DIFFERENTIAL EQUATIONS OF MOTION FOR STEADY COMPRESSIBLE FLOW
Small perturbation potential theory, solutions for supersonic flows, Mach waves and Mach angles, Prandtl-Glauert affine transformation relations for subsonic flows, Linearized two dimensional supersonic flow theory, Lift, drag pitching moment and center of pressure of supersonic profiles.

TRANSONIC FLOW OVER WING
Lower and upper critical Mach numbers, Lift and drag divergence, shock induced separation, Characteristics of swept wings, Effects of thickness, camber and aspect ratio of wings, Transonic area rule, Tip effects.

WIND TUNNELS
Blow down, indraft and induction tunnel layouts and their design features, Transonic, supersonic and hypersonic tunnels and their peculiarities, Helium and gun tunnels, Shock tubes, Optical methods of flow visualization.

Text Book

1. Rathakrishnan, E., "Gas Dynamics", Prentice Hall of India, 2003.

Reference Book

1. Shapiro, A.H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronold Press, 1982.
2. Zucrow, M.J. and Anderson, J.D., "Elements of gas dynamics", McGraw-Hill Book Co., New York, 1989.
3. Mc Cornick. W., "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, New York, 1979.
4. Anderson Jr., D., - "Modern compressible flows", McGraw-Hill Book Co., New York 1999.

AS 3010 AIRCRAFT STABILITY AND CONTROL Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1 . knowledge about degrees of stability, stability criteria, effect of fuselage and CG location, stick forces, aerodynamic balancing. (stick fixed).
CO2 . knowledge about degrees of stability, stability criteria, effect of fuselage and CG location, stick forces, aerodynamic balancing. (stick free condition).
CO3 . understanding about lateral control, rolling and yawing moments, static directional stability, rudder and aileron control requirements and rudder lock.
CO4 . understanding about dynamic longitudinal stability, stability derivatives, modes and stability criterion, lateral and directional dynamic stability.
CO5 . understanding the rotor function in vertical flight, rotor mechanism.

Prerequisites : Aerodynamics-I (AS 2006) and Aerodynamics-II (AS 3009)

STATIC LONGITUDINAL STABILITY AND CONTROL - Stick Fixed
Degree of freedom of rigid bodies in space - Static and dynamic stability - Purpose of controls in airplanes - Inherently stable and marginal stable airplanes - Static, Longitudinal stability - Stick fixed stability - Basic equilibrium equation - Stability criterion - Effects of fuselage and nacelle - Influence of CG location - Power effects - Stick fixed neutral point.

STATIC LONGITUDINAL STABILITY AND CONTROL - Stick Free
Stick free stability-Hinge moment coefficient - Stick free neutral points-Symmetric maneuvers - Stick force gradients - Stick _ force per 'g' - Aerodynamic balancing. Determination of neutral points and maneuver points from flight test.

LATERAL AND DIRECTIONAL STABILITY
Dihedral effect - Lateral control - Coupling between rolling and yawing moments - Adverse yaw effects - Aileron reversal - Static directional stability - Weather cocking effect - Rudder requirements - One engine inoperative condition - Rudder lock.

DYNAMIC STABILITY
Dynamic longitudinal stability: Equations of motion - Stability derivatives - Characteristic equation of stick fixed case - Modes and stability criterion - Effect of freeing-the stick - Brief description of lateral and directional. Dynamic stability - Spiral, divergence, Dutch roll, auto rotation and spin.

HELICOPTER FLIGHT DYNAMICS
Rotor function in vertical flight, Rotor Mechanism for forward flight, Trim, Stability and control.

Text Book

1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley & Son:, Inc, New York, 1988.
2. J.Seddon, "Basic Helicopter Aerodynamics", AIAA Series, 1990.

Reference Book

1. Etkin, B., "Dynamics of Flight Stability and Control", Edn. 2, John Wiley, New York, 1982.
2. Babister, A.W., "Aircraft Dynamic Stability and Response", Pergamon Press, Oxford, 1980.
3. Dommasch, D.O., Shelby, S.S., and Connolly, T.F., "Aeroplane Aero dynamics", Third Edition, Issac Pitman, London, 1981.
4. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 1998

AS 3011 AEROSPACE STRUCTURES - II Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. analyze for maximum bending stress in unsymmetrical sections.
CO2 . analyze for flexural shear stress.
CO3. analyze for Torsional shear stress.
CO4. analyze for Panel Buckling allowable load.
CO5 . analyze for flange and web load

Prerequisite : Aerospace Structures-I (AS 2004)

UNSYMMETRICAL BENDING
General, Principal axis and neutral axis methods- bending stresses in beams of symmetric sections with skew loads-bending stresses in beams of unsymmetrical sections.

SHEAR FLOW IN OPEN SECTIONS
Thin walled beams, Concept of shear flow, shear centre, Elastic axis. With one axis of symmetry, with wall effective and ineffective in bending, unsymmetrical beam sections.

SHEAR FLOW IN CLOSED SECTIONS
Bredt – Batho formula, Single and multi – cell structures.- Shear flow in single & multicell structures under torsion. Shear flow in single and multicell under bending with walls effective and ineffective.

BUCKLING OF PLATES
Rectangular sheets under compression, local buckling stress of thin walled section-Crippling stresses by Needham's and Gerard's methods, Thin walled column strength sheet stiffener panels-Effective width.

STRESS ANALYSIS IN WING AND FUSELAGE
Shear resistant web beams-Tension field web beams (Wagner's) – Shear and bending moment distribution for cantilever and semi-cantilever types of beams-loads on aircraft –lift distribution-V-n diagram-Gust loads.

Text Book
1. Bruhn. E.H. "Analysis and Design of Flight vehicles Structures", Tri - state off set company, USA, 1973.

Reference Book
1. Peery, D.J., and Azar, J.J., "Aircraft Structures", 2nd edition, McGraw-Hill, N.Y., 1993.
2. Megson, T.M.G., "Aircraft Structures for Engineering Students", Edward Arnold, 1995.
3. Rivello, R.M., "Theory and Analysis of Flight Structures", McGraw-Hill, 1993.

AS 3012 SPACE MECHANICS Cr-3

Course Outcome: At the end of the course, the students will be able to

CO1. understand solar time solar system and associated basic terms.
CO2. understand satellite orbits relation between position and time.
CO3. understand satellite orbit transfer, special perturbations.
CO4. understand about the various phases in missile launching.
CO5. understand about the spacecraft trajectories between planets.

Prerequisite : Engineering Mechanics (ME 1001)

BASIC CONCEPTS
The solar system, Reference frame and coordinate, the celestial sphere, the ecliptic , sidereal time, solar time, standard time, the earth atmosphere.

N-BODY PROBLEM
The many body problem, circular restricted three body problem, liberation points, two body problem, satellite orbits, relation between position and time, orbital elements.

SATELLITE INJECTION AND SATELLITE ORBIT PERTURBATIONS
Introduction to satellite injection , satellite orbit transfer, orbit deviation due to injection errors, special and general perturbations, methods of vibration of orbital elements.

BALLISTIC MISSILE TRAJECTORY
The boost phase, the ballistic phase, trajectory geometry, optimal flights, time of flight, re-entry phase, the position of the impact point , influence coefficients.

INTERPLANETARY TRAJECTORIES
Two dimensional interplanetary trajectories, Fast interplanetary trajectories, three dimensional interplanetary trajectories, Launch of Interplanetary spacecraft, Trajectory about the target planet.

Text Book
1. Cornelisse, J.W., " Rocket propulsion and space dynamics ", W.H. Freeman & co,1984.

Reference Book
1. Sutton, G. P., "Rocket Propulsion Elements", John Wiley, 1993
2. Van de Kamp, P., "Elements of Astromechanics", Pitman, 1979
3. Parker, E. R., "Materials for Missile and Spacecraft", McGraw-Hill Book Co. Inc., 1982.

AS 3013 PROPULSION - II Cr-3

Course Outcome: At the end of the course, the students will be able to ;

CO1. understand the types of rocket, missiles and its basic configuration.
CO2. know In detail about liquid propellant rockets and the various types of propellants used with their burning rates.
CO3. know the operating principle of ramjet, combustion and its performance.
CO4.. know the solid rocket operating principles and components of solid rocket motor
CO5. know about electric, ion and nuclear rockets. The basics of solar sails and its operating principle

Prerequisite : Propulsion-I (AS 2008)

RAMJET PROPULSION
Operating principle – Sub critical, critical and supercritical operation – Combustion in ramjet engine – Ramjet performance– Simple ramjet design calculations – Introduction to scramjet.

FUNDAMENTALS OF ROCKET PROPULSION
History of rocket propulsion, Operating principle – Specific impulse of a rocket – internal ballistics types of rocket, Basic configurations and application -Types of missiles and their structure, Heat transfer and cooling system in rocket , classification of Chemical rocket propulsion system, Rocket performance considerations.

CHEMICAL ROCKETS
Solid propellant rockets – Selection criteria of solid propellants – Important hardware components of solid rockets – Propellant grain design considerations – Liquid propellant rockets – Selection of liquid propellants. Cooling in liquid rockets – Hybrid rockets.

ADVANCED PROPULSION TECHNIQUES
Electric rocket propulsion – Ion propulsion techniques – Nuclear rocket – Types – Solar sail- Preliminary Concepts in nozzle less propulsion.

SCRAMJET PROPULSION
Fundamentals of hypersonic air birthing vehicles, Preliminary concepts in engine airframe integration, Various types of supersonic combustors, Requirements for supersonic combustors, Performance estimation of supersonic combustors.

PERFORMANCE OF AEROSPACE VEHICLES

Static performance, vehicle acceleration, performance characteristics, nozzle.

Text Book

1. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 5th Edn., 1993.
2. Hill, P.G. & Peterson, C.R. “Mechanics & Thermodynamics of Propulsion” Addison – Wesley Longman INC, 1999.

Reference Book

1. Cohen, H., Rogers, G.F.C. and Saravanamuttoo, H.I.H., “Gas Turbine Theory”, Longman Co., ELBS Ed., 1989.
2. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.
3. "Rolls Royce Jet Engine" - Third Edition - 1983.
4. Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors,Delhi,1999.

AS 3014 AVIONICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the avionics system in weapons design and technologies are studied.
CO2. understand the digital computers, microprocessors and memories are studied.
CO3. understand the avionics system architecture like data bus MIL STD 1553, B ARINC 429 are studied.
CO4. understand the control and display technologies like CRT, LED, LCD, EL and plasma panel are studied.
CO5. understand the communication system, flight control system and radar electronic warfare.

Prerequisites : Aircraft Systems & Instrumentation (AS 3017), Electrical Machines and Power Electronics (EE 2009)

INTRODUCTION TO AVIONICS
Importance and role of Avionics, Basic principles of Avionics – Typical avionics sub system in civil/ military aircraft and space vehicles, Need for avionics in civil and military aircraft and space systems - Integrated avionics and weapon systems-design, technologies.

PRINCIPLES OF DIGITAL SYSTEMS
Digital Computers - Microprocessors - Memories

DIGITAL AVIONICS ARCHITECTURE
Avionics system architecture-Data buses MIL-STD 1553 - B, ARINC 429, ARINC 629

FLIGHT DECK AND COCKPITS
Control and display technologies CRT, LED, LCD, EL and plasma panel - Touch screen - Direct voice input (DVI) - Civil cockpit and military cockpit : MFDS, HUD, MFK, HOTAS

INTRODUCTION TO AVIONICS SYSTEMS
Communication Systems - Navigation systems - Flight control systems - Radar electronic warfare - Utility systems Reliability and maintainability - Certification.

Text Book
1. Malcrno A.P. and Leach, D.P., "Digital Principles and Application", Tata McGraw-Hill, 1990.
2. Gaonkar, R.S., "Microprocessors Architecture - Programming and Application", Wiley and Sons Ltd., New Delhi, 1990.

Reference Book
1. Middleton, D.H., Ed., "Avionics Systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1919.
2. Spitzer, C.R., "Digital Avionic Systems", Prentice Hall, Englewood Cliffs, N.J., USA., 1917.
3. Brain Kendal, "Manual of Avionics", The English Book HOuse, 3rd Edition, New Delhi, 1993.

AS 3015 AIRCRAFT PERFORMANCE Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the airplane as a dynamic system, equilibrium conditions.
CO2. understand the different types of drag and drag polar.
CO3. understand the variation of thrust, power, SFC with velocity and altitude.
CO4. understand about performance in level flight, minimum drag and power required, climbing, gliding and turning flight, VN diagram and load factor.
CO5. understand the principles and mechanics behind the Helicopter flight.

Prerequisites : Aerodynamics-I (AS 2006), and Propulsion-I(AS 2008)

AIRCRAFT PROPERTIES
The airplane as a rigid body, the airplane as a dynamic system, Equilibrium conditions, Static stability conditions, Airplane dynamics, Airplane control .Aerodynamic properties of wing and its components.

DRAG ESTIMATION
Drag aerodynamics - Dimensional Analysis, Potential flow, induced drag, Flow of viscous fluid, parasite drag, and flow of a compressible fluid. Aerodynamic data - section characteristics, plan form characteristics, high lift and control devices, Determination of three dimensional wing data. Estimation of airplane drag, low speed drag estimation, high speed drag estimation.

PERFORMANCE
Performance computation ,generalized performance method, compressibility speed correction, Range and Endurance, Take - off and landing distances, acceleration in climb, turning performance, design performance.

CRUISING FLIGHT PERFORMANCE
International Standard Atmosphere - Forces and moments acting on a flight vehicle -Equation of motion of a rigid flight vehicle - Different types of drag –estimation of parasite drag co-efficient by proper area method- Drag polar of vehicles from low speed to high speeds - Variation of thrust, power with velocity and altitudes for air breathing engines . Performance of airplane in level flight - Power available and power required curves. Maximum speed in level flight - Conditions for minimum drag and power required.

MANOEUVERING FLIGHT PERFORMANCE
Range and endurance - Climbing and gliding flight (Maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide) -Turning performance (Turning rate turn radius). Bank angle and load factor – limitations on turn - V-n diagram and load factor.

HELICOPTER ROTOR AERODYNAMICS AND PERFORMANCE
Introduction, effect of gyroscopic precession, Torque reaction and directional control, dissymmetry of lift, Blade tip stall , Translating tendency and its correction, Coriolis effect and compensation, vortex ring state, power settling, over pitching, Auto-rotation, Ground effect.

Text Book

1. Perkins, C.D., and Hage, R.E., "Airplane Performance Stability and Control", John Wiley & soInc., New York, 1988.
2. Leishman, J.G., "Principle of Helicopter Aerodynamics", Cambridge Aerospace.

Reference Book

1. Etkin, B., "Dynamics of Flight Stability and Control", Edn. 2, John Wiley, New York, 1982.
2. Babister, A.W., "Aircraft Dynamic Stability and Response", Pergamon Press, Oxford, 1980.
3. Dommasch, D.O., Shelby, S.S., and Connolly, T.F., "Aeroplane Aero dynamics", Third Edition, Issac Pitman, London, 1981.
4. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 1998

AS 3017 AIRCRAFT SYSTEMS AND INSTRUMENTATION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. know about Location, visibility and probing of Instrument, Panels, Basic Instrument elements and Mechanism..

CO2. know about basic electrical system, communication and navigating system in aircraft.

CO3. state the ICAO instrumentation requirements and describe instrumentation elements, mechanisms, error sources and temperature compensation.

CO4. demonstrate an aircraft control systems, engine control systems (such as fuel control, ignition control, engine indications etc.) fuel systems and its components for both civil and military aircrafts.

CO5. demonstrate the electrical systems (both A.C & D.C) utilizing as an auxiliary power sources in aircrafts.

Prerequisites : Thermodynamics (AS 2001), Electrical Machines and Power Electronics (EE 2009)

AIRPLANE CONTROL SYSTEMS

Conventional Systems - fully powered flight controls - Power actuated systems – Modern control systems - Digital fly by wire systems - Auto pilot system active control Technology.

AIRCRAFT SYSTEMS

Hydraulic systems - Study of typical workable system - components - Pneumatic systems - Advantages - Working principles - Typical Air pressure system – Brake system - Typical Pneumatic power system - Components, Landing Gear systems - Classification.

AIR-CONDITIONING AND PRESSURIZING SYSTEM

Vapor Cycle systems, Bootstrap air cycle system - Evaporative vapour cycle systems - Evaporative air cycle systems - Oxygen systems - Fire protection systems, Deicing and anti icing systems- Humidity control. Air distribution systems. Cabin pressurization, tolerance, rain dispersal, antimisting and demisting.

ENGINE SYSTEMS

Fuels – Characteristics – Fuel Systems – Lubricant and Lubricant systems – Ignition and starting system – Electronic Engine controls – Full Authority Digital Control (FADEC) – engine Indicating, warning and control systems, Fire protection systems, Deicing and anti icing systems.

AIRCRAFT INSTRUMENTS

Flight Instruments and Navigation Instruments – Gyroscope - Accelerometers, Air speed Indicators – TAS, EAS- Mach Meters - Altimeters - Principles and operation - Study of various types of engine instruments - Tachometers - Temperature gauges - Pressure gauges - Operation and Principles.

FLIGHT INSTRUMENTS

Location, visibility and grouping of Instruments, Panels, Basic Instrument elements and Mechanism, Instruments Panels – Displays – Layouts – Grouping details of: i. Pitot instrument and systems. ii. Primary flight instruments. iii. Heading indicating instruments. iv. Remote indicating systems. v. Synchronous data transmission systems. vi. Flight director and Flight data recording systems. vii. ECAM/EICA/EFIS – Their concepts, detailed description maintenance and practices. ECAM – Electronic Central Aircraft Monitor. EICAS – Engine Indicator Crew Alert Systems. EFIS – Electronic flight Instruments Systems.

COMMUNCATION AND NAVIGATIONS SYSTEMS

Basic Principles Equipment – Power Sources – Airborne Navigational Equipment – VHF – ILS – DME – ADF – Radar and Doppler Navigation – Inertial Navigation, VOR MLS (Microwave Landing Systems) Cockpit Voice Recorder (CVR), ELT (Emergency Locator Transmitter).

Text Book

1. McKinley, J.L., and Bent, R.D., “Aircraft Maintenance & Repair”, McGraw-Hill, 1993.
2. “General Hand Books of Airframe and Powerplant Mechanics”, U.S. Dept. of Transportation, Federal Aviation Administration, The English Book Store, New Delhi1995.

Reference Book

1. Mekinley, J.L. and Bent, R.D., “Aircraft Power Plants”, McGraw-Hill, 1993.
2. Pallet, E.H.J., “Aircraft Instruments & Principles”, Pitman & Co., 1993.
3. Treager, S., “Gas Turbine Technology”, McGraw-Hill, 1997.

AS 3032 THEORY OF AEROELASTICITY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the phenomenon of aero elasticity.
CO2. solve problem related to single degrees of freedom
CO3. solve problems using the theorems of multiple degrees of freedom.
CO4. solve problems by analysing the systems which undergo static aero elasticity problems.
CO5. solve problems in aero elasticity using MATLAB.

Prerequisites : Mathematics-II (MA 1002) and Aerodynamics-I (AS 2006)

INTRODUCTION :
Aero elasticity phenomena, flutter, divergence, control reversal, flexibility effects on stability and control.

SINGLE DEGREE OF FREEDOM
Introduction to degrees of freedom , Response of single degree of freedom, system, Laplace transform, Harmonic excitation virtual work, Lagrange's equation.

MULTIPLE DEGREES OF FREEDOM

Classical theories of multi degree freedom system, Undamped mode and frequencies.

STATIC AEROELASTICIY
Static problem, divergence of wind tunnel models, wall - sting and strut - mounted models, control reversal, classical flutter analysis, one and two - degree of freedom flutter, flutter boundary characteristics.

MATLAB
Introduction to Mat Lab, application of mat lab for solving aero elastic problem. Design of spline matlab coding.

Text Book
1. Y.C. Fung, " An Introduction to the Theory of Aero elasticity (2002) ", John wiley &Sons,.

Reference Book
1. Bisplinghoff R.L., Ashley H and Hoffman R.L., “Aeroelasticity” – Addision Wesley Publication, New York, 1983.

AS 3034 WIND TUNNEL TECHNIQUE Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. solve the Buckingham theory to find the SI unit of a parameter
CO2. clearly understand the working of Blow down, Indraft tunnels and their specifications
CO3. understand Horizontal buoyancy, Flow angularities are checked while calibration
CO4. understand Component axis balance and internal balances are read and their measurements in wind tunnel.
CO5. get a clear idea about the smoke and tuft flow visualization procedures in Wind Tunnel testing.

Prerequisites : Aerodynamics-I (AS 2006) and Aircraft Systems & Instrumentation (AS 3017)

UNIT I : PRINCIPLES OF MODEL TESTING :
Buckingham Theorem - Non-Dimensional Numbers -Scale Effect Types of Similarities.

UNIT II : WIND TUNNELS

Classification - Special problems of Testing in Subsonic, Transonic, supersonic and hypersonic speed regions - Layouts - sizing and design parameters.

UNIT III : CALIBRATION OF WIND TUNNELS
Test section speed - Horizontal buoyancy - Flow angularities - Turbulence measurements - Associated instrumentation - Calibration of supersonic tunnels.

UNIT IV : WIND TUNNEL MEASUREMENTS
Pressure and velocity measurements - Force measurements - Three component and six component balances - Internal balances.

UNIT V : FLOW VISUALIZATION
Smoke and Tuft grid techniques - Dye injection special techniques - Optical methods of flow visualization.

Text Book

1. Rae, W.H. and Pope, A. "Low Speed Wind Tunnel Testing", John Wiley Publication, 1914.

Reference Boo

1. Pope, A., and Goin, L., "High Speed wind Tunnel Testing", John Wiley, 1915.
2. A Pope and J J Harper, Low Speed Wind Tunnel Testing, John Wiley & Sons.
3. Goethert B H, Transonic Wind Tunnel Testing, Pergaman Press

AS 3036 THEORY OF COMBUSTION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the concepts in combustion and make combustion calculations
CO2. know the flame temperature of commercial fuels burning in the combustion chambers of various engines.
CO3. know the rate of chemical reactions and emission characteristics of hydrocarbon fuels used in power plants and transportation sector.
CO4. know the thermodynamic and transport properties of fuels at elevated pressures and temperatures prevalent in the combustion chambers of actual engines
CO5. know the supersonic combustion.

Prerequisites : Aerothermodynamics (AS 2001), Propulsion-I (AS 2008) and Propulsion-II(AS 3013)

UNIT I-FUNDAMENTAL CONCEPTS IN COMBUSTION
Thermo - chemical equations - Heat of reaction first order, second order and third order reactions — premixed flames - Diffusion flames

UNIT II-CHEMICAL KINETICS AND FLAMES
Measurement of burning velocity - Various methods - Effect of various parameters on burning velocity - Flame stability - Detonation - Deflagration -Rankine – Hugoniot curve - Radiation by flames.

UNIT III-COMBUSTION IN GAS TURBINE ENGINES
Combustion in gas turbine combustion chambers - Re-circulation – Combustion efficiency - Factors affecting combustion efficiency - Fuels used for gas turbine combustion chambers - Combustion stability - Flame holder types – Numerical problems.

UNIT IV-COMBUSTION IN ROCKETS
Solid propellant combustion - Double base and composite propellant combustion - Various combustion models - Combustion in liquid rocket engines - Single fuel droplet combustion model - Combustion in hybrid rockets.

UNIT V-SUPERSONIC COMBUSTION
Introduction - Supersonic combustion controlled by mixing, diffusion and heat convection - Analysis of reaction and mixing processes - Supersonic burning with detonation shocks.

Text Book

1. Sharma, S.P., and Chandra Mohan, " Fuels and Combustion", Tata McGraw Hill Publishing Co., Ltd., New Delhi 1987.
2. Loh, W.H.T., Jet Rocket, " Nuclear, Ion and Electric Propulsion Theory and Design", Springer Verlag, New York 1982.

Reference Book

1. Beer, J.M. and Chigier, N.A., Combustion Aerodynamics, Applied Science Publishers Ltd., London, 1981.
2. Chowdhury, R., Applied Engineering Thermodynamics, Khanna Publishers, New Delhi, 1986.
3. Sutton, G.P., and Biblarz, 0., Rocket Propulsion Elements, 7th Edition John Wiley and Sons, Inc., New York, 2001.
4. Mathur, M., and Sharma, R.P., Gas Turbines and Jet and Rocket Propulsion, Standard Publishers,New Delhi, 1988.
5. Turns, S.R., An Introduction to Combustion Concepts and Applications,2nd Edition. McGraw Hill International Editions, New Delhi, 2000.

AS 4031 COMPUTATIONAL AERODYNAMICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. execute subsonic potential flow computations.
CO2. implement 2D panel methods on lifting and non-lifting bodies.
CO3. design components which require compressible flow computations.
CO4. design Converging nozzles, C&D nozzles and diffusers using Euler equations.
CO5. write numerical solvers from scratch for 2D compressible flow computations.

Prerequisites : Numerical Methods (MA 2004), Aerodynamics-I (AS 2006) and Aerodynamics-II (AS 3009)

BASIC ASPECTS OF COMPUTATIONAL AERODYNAMICS:
Why Computational Fluid Dynamics? What is CFD? - CFD as a research tool- as a design tool. Applications in various branches of engineering - Models of fluid flow- Finite Control Volume, Infinitesimal Fluid Element. Substantial derivative- physical meaning of Divergence of velocity.

GOVERNING EQUATIONS AND PHYSICAL BOUNDARY CONDITIONS:
Derivation of continuity, momentum and energy equations- physical boundary conditions significance of conservation and non-conservation forms and their implication on CFD applications- strong and weak conservation forms- shock capturing and shock fitting approaches.

MATHEMATICAL BEHAVIOR OF PARTIAL DIFFERENTIAL EQUATIONS AND THEIR IMPACT ON COMPUTATIONAL AERODYNAMICS:
Classification of quasilinear partial differential equations by Cramer's rule and eigen value method. General behavior of different classes of partial differential equations and their importance in understanding physical and CFD aspects of aerodynamic problems at different Mach numbers involving hyperbolic, parabolic and elliptic equations- domain of dependence and range of influence for hyperbolic equations. Well-posed problems.

BASIC ASPECTS OF DISCRETIZATION:
Introduction to finite differences- finite difference approximation for first order, second order and mixed derivatives. Pros and cons of higher order difference schemes. Difference equations- explicit and implicit approaches- truncation and round-off errors, consistency, stability, accuracy, convergence, efficiency of numerical solutions-Von Neumann stability analysis. Physical significance of CFL stability condition.

FINITE VOLUME METHODS:
Basis of finite volume method- conditions on the finite volume selections- cell-centered and cell-vertex approaches. Definition of finite volume discretization -general formulation of a numerical scheme- two dimensional finite volume methods with example.

GRID TYPES AND CHARACTERISTICS:
Need for grid generation. Structured grids-Cartesian grids, stretched (compressed) grids, body fitted structured grids, H-mesh, Cmesh, O-mesh, I-mesh, Multi-block grids, C-H mesh, H-O-H mesh, overset grids, adaptive grids. Unstructured grids- triangular/ tetrahedral cells, hybrid grids, quadrilateral/hexahedra cells.

CFD TECHNIQUES:
Lax-Wendroff technique, MacCormack's technique-Crank Nicholson technique-Relaxation technique - aspects of numerical dissipation and dispersion. Alternating-Direction-Implicit (ADI) Technique. Pressure correction technique- application to incompressible viscous flow- need for staggered grid. Philosophy of pressure correction method- pressure correction formula. Numerical procedures- SIMPLE, SIMPLER, SIMPLEC and PISO algorithms. Boundary conditions for pressure correction method.

Text Book
1. Computational Fluid Dynamics- The Basics with Applications, Anderson, J.D., Jr.,McGraw-Hill Inc., 1995.
2. Computational Fluid Mechanics and Heat Transfer, Second Edition, Anderson, D.A., Tannehill, J.C., Pletcher, R.H., Taylor and Francis, 1997.

Reference Book
1. Numerical Computation of Internal and External Flows-Fundamentals of Computational Fluid Dynamics, Second Edition, Hirsch, C., Elsevier, 2007.
2. An Introduction to Computational Fluid Dynamics-The Finite Volume Method, Second Edition, Versteeg, H.K. and Malalasekera, W., Pearson Education Ltd, 2010.
3. Computational Fluid Dynamics-A Practical Approach, Tu, J., Yeoh, G.H., Liu, C., Butterworth- Heinemann, 2008.

AS 4032 HELICOPTER AERODYNAMICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. know the major helicopter components, characteristics and configurations.
CO2. analyse the performance of a helicopter in forward flight, identifying conditions which limit the performance of the helicopter.
CO3. analyse the rotor and aircraft performance under conditions in which a helicopter is in hovering and axial flight.
CO4. use simplified aerodynamic theory as it applies to helicopter flight to perform preliminary aerodynamic design of a helicopter rotor
CO5. calculate the special power estimates.

Prerequisites : Aerodynamics-I (AS 2006) and Aerodynamics-II (AS 3009).

ELEMENTS OF HELICOPTER AERODYNAMICS
Configurations based on torque reaction-Jet rotors and compound helicopters-Methods of control -Collective and cyclic pitch changes - Lead - Lag and flapping hinges.

IDEAL ROTOR THEORY
Hovering performance - Momentum and simple blade element theories - Figure of merit - Profile and induced power estimation - Constant chord and ideal twist rotors.

POWER ESTIMATES
Induced, profile and parasite power requirements in forward flight-Performance curves with effects of altitude-Preliminary ideas on helicopter stability.

LIFT, PROPULSION AND CONTROL OF VISTOL AIRCRAFT
Various configuration - Propeller, rotor, ducted fan and jet lift - Tilt wing and vectored thrust - Performance of VTOL and STOL aircraft in hover, transition and forward motion.

GROUND EFFECT MACHINES
Types - Hover height, lift augmentation and power calculations for plenum chamber and peripheral jet machine - Drag of hovercraft on land and water, Applications of hovercraft.

Text Book
1. Gessow, A., and Myers, G,C., "Aerodynamics of Helicopter", Macmillan & Co., N.Y. 1987.
2. McCormick, B,W., "Aerodynamics of V/STOL Flight", Academic Press, 1987

Reference Book
1. Johnson, W., "Helicopter Theory," Princeton University Press, 1980.
2. McCormick, B,W., "Aerodynamics, Aeronautics and Flight Mechanics"John Wiley, 1995.
3. Gupta, L., "Helicopter Engineering", Himalayan Books, 1996.

AS 4034 AIRPORT AND AIRLINES MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to ;

CO1. understand the basic management aspect of airport and airlines system such as airports layout, air traffic control, landing procedure.
CO2. know the scheduling, flight planning and other economic and commercial activities.
CO3. know how government regulation and industry standards effect the cost of operating an airline.
CO4. know the relationship between various airlines, and operational issues affecting airlines and passengers.

Prerequisites : Nil.

AIRPORTS AND AIRPORT SYSTEMS:
Introduction, Organization and administration, Historical and legislative perspective.

AIRPORT OPERATIONS MANAGEMENT:
The airfield, Airspace and air traffic management, Airport operations management under FAR Part 139, Airport terminals and ground access, Airport security.

AIRPORT ADMINISTRATIVE MANAGEMENT:
Airport financial management, The economic, political, and social role of airports, Airport planning, Airport capacity and delay, The future of airport management.

INTRODUCTION TO AIRLINE PLANNING:
Structure of Airline Industry (Domestic & International)-Growth and Regulation-Deregulation-Major and National Carriers-Regional Carriers-Economic characteristics of the Airlines Airline Planning Process-Airline Terminology and Measures: airline demand, airline supply, average load factor, unit revenue, Airline Planning Decisions: Fleet Planning, Route Evaluation, Schedule Development, Pricing, Revenue Management.

FLEET PLANNING AND ROUTE EVALUATION:
Factors in Fleet Planning-Hub-and-Spoke System-Technical Aspects-Fleet Rationalization-Fleet Commonality-Long Range Aircraft-Noise Restrictions-Factors in Design and Development-Fleet Planning Process; Route Evaluation in Hub Networks-Route profitability estimation issues-Demand Driven Dispatch.

Text Book

1. Airport Planning and Management 6/E 0006 Edition by Young Seth, Mc GRAW Hills.
2. Airport Management by Ravindran P.C.K, Asian Law House.
3. Air Transportation:A Management Perspective (Fifth Edition) by Alexander T.Wells and John G.Wensveen, Brooks Cole,2003.
4. Airline Management by Charles Banfe, Prentice-Hall, 1991.

Reference Book

1. Airport Systems :Planning ,Design and Management by Rechard De Neufville Tata Mc Graw Hills.
2. Straight and Level:Practical Airline Economics by Stephen Holloway, Ashgate Publishing, 2003
3. Airline Marketing and Management by Stephen Shaw, Ashgate Publishing, 2004
4. An Introduction to Airline Economics (Sixth Edition), William O' Connor, Praeger Publishers,2000
5. Airline Management, by Peter P BelobabaMIT Open Courseware Lecture Notes, 2006.
6. Airline Operations and Scheduling by Massoud Bazargan, Ashgate Publishing, 2004.

AS 4035 SATELLITES AND SPACE SYSTEM DESIGN Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. know about the Payloads and missions, system view of spacecraft propulsion system, launch vehicles, and spacecraft mechanisms.
CO2. know about the about Preoperational spacecraft environment, operational spacecraft environments, environmental effects on design, the sun, the earth, and spacecraft effects, spacecraft structure and thermal control.
CO3. know about the various Attitude control, Electrical power systems, Telecommunications, telemetry command, data handling and process.
CO4 : know about the various Failures, Reliability, material and process, safety, configuration control, build and verification, system engineering, case studies.

CO5 : know about the Satellite design philosophy, satellite system design, COTS components in the space environment,. Micro satellites, mini satellites and nano satellites, in orbit operation, satellite application for meteorology, navigation, communication, geo observation, and space environment study.

Prerequisites : Propulsion-II (AS 3013) and Space Mechanics (AS 3012).

SPACE SYSTEM DESIGN

Payloads and missions, system view of spacecraft propulsion system, launch vehicles, spacecraft mechanisms.

SPCAECRAFT ENVIRONMENT AND ITS EFFECTS ON DESIGN

Preoperational spacecraft environment, operational spacecraft environments, Environmental effects on design, the sun, the earth, and spacecraft effects, spacecraft structure, thermal control.

SPACECRAFT SYSTEMS

Attitude control, Electrical power systems, Telecommunications, telemetry command, data handling and process.

PRODUCT ASSURANCE
Failures, Reliability, material and process, safety, configuration control, build and verification, system engineering, case studies

SATELLITE ENGINEERING AND APPLICATIONS

Satellite design philoshopy, satellite system design, COTS components in the space environment. Micro satellites, mini satellites and nano satellites, in orbit operation, satellite application for meteorology, navigation, communication, geo observation, and space environment study.

Text Book
1. P. Fortescue J. Stark, and G. Swinerd, "Spcaecraft systems engineering", John Wiley and sons, 2002.

AS 4037 CRYOGENICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1 . understand the background of cryogenic technology and its applications.
CO2 . understand the properties of cryogenic materials and their production.
CO3 . understand the different methods used for cryogenic insulation.
CO4 . understand the technique for storing cryogenics.
CO5 : understand the different cryogenic equipments and theri applications

Prerequisite : Aerothermodynamics (AS 2001)

INTRODUCTION
Historical Background - Introduction to cryogenic propellants - Liquid hydrogen, liquid helium, liquid nitrogen and liquid oxygen and their properties

PRODUCTION OF LOW TEMPERATURE
Theory behind the production of low temperature - Expansion engine heat exchangers - Cascade process Joule Thompson Effect - Magnetic effect -Ortho and H2 - Helium4 and Helium 3.

EFFICIENCY OF CRYOGENIC SYSTEMS
Types of losses and efficiency of cycles - specific amount of cooling - The fraction liquified - Cooling coefficient of performance - Thermodynamic efficiency – The energy balance Method.

CYCLES OF CRYOGENIC PLANTS
Classification of cryogenic cycles - The structure of cycles - Throttle expansion cycles - Expander cycles - Thermodynamic analysis - Numerical problems.

CRYOGENIC IN AEROSPACE APPLICATIONS
Cryogenic liquids in Rocket launching and space simulation Storage of cryogenic liquids - Effect of cryogenic liquids on properties of aerospace materials – Cryogenic loading problems - Zero gravity problems associated with cryogenic propellants - Phenomenon of tank collapse - Elimination of Geysering effect in missiles

Text Book
1. Haselden, G., “Cryogenic Fundamentals”, Academic Press, 1971
2. Barron, R. F., “Cryogenic Systems”, Oxford University, 1985

Reference Book
1. Parner, S. F., “Propellant Chemistry”, Reinhold Publishing Corpn., New York, 1985.
2. T.M. Flynn, Marcel Dekker., Cryogenic Engineering,
3. A.Bose and P. Sengupta, "Cryogenics: Applications and Progress", Tata McGraw Hill.
4. J.G. Weisend II, Taylor and Francis , "Handbook of Cryogenic Engineering".
5. *R.W. Vance and W.M. Duke , "Applied Cryogenic Engineering", John Wiley & sons.*

AS 4039 AIRFRAME REPAIR AND MAINTENANCE Cr-3

Course Outcome: At the end of the course, the students will be able to;

CO1 . familiarize in welding technology and sheet metal repair works.
CO2 . know the use of plastic and composite materials in Aircraft.
CO3 . know the Hydraulic and Pneumatic systems in Aircraft.
CO4 . know the Safety Practices.

Prerequisites : Manufacturing Technology (ME 2015) andAircraft Systems & Instrumentation (AS 3017)

WELDING IN AIRCRAFT STRUCTURAL COMPONENTS
Equipments used in welding shop and their maintenance - Ensuring quality welds - Welding jigs and fixtures - Soldering and brazing. Sheet metal Repair and Maintenance: Inspection of damage Classification - Repair or replacement - Sheet metal inspection - N.D.T. testing, riveted repair design, Damage investigation – Reverse technology.

PLASTICS AND COMPOSITES IN AIRCRAFT
Plastics in Aircraft : Review of types of plastics used in airplanes -Maintenance and repair of plastic components - Repair of cracks, holes etc., various repair schemes - Scopes. Advanced composites in Aircraft: Inspection - Repair of composite components — Special precautions - Autoclaves.

AIRCRAFT JACKING, ASSEMBLY AND RIGGING
Airplane jacking and weighing and C.G. Location. Balancing of control surfaces – Inspection and maintenance. Helicopter flight controls. Tracking and balancing of main rotor.

REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM
Trouble shooting and maintenance practices - Service and inspection -Inspection and maintenance of landing gear systems. - Inspection and maintenance of air - conditioning and pressurization system, water and waste system. Installation and maintenance of Instruments - handling - Testing -Inspection. Inspection and maintenance of auxiliary systems - Fire protection systems - Ice protection system - Rain removal system - Position and warning system - Auxiliary Power Units (APUs).

SAFETY PRACTICES
Hazardous materials storage and handling, aircraft furnishing practices -Equipments. Trouble shooting-theory and practices.

Text Book

1. Kroes, Watkins, Delp., "Aircraft Maintenance and Repair", McGraw Hill, New York, 1992.
2. Brimm, D. J., Bogges R. E., "Aircraft Maintenance", Pitman Publishing corp., New York, 1940.

Reference Book

1. Larry Reithmeir., "Aircraft Repair Manual", Palamar Books, Marquette, 1992.

AS 4041 ROCKETS AND MISSILES Cr-3

Course Outcome: At the end of the course, the students will be able to ;

CO1 . compute and analyze the various forces and moments acting on a rocket.
CO2 . formulate the equations of motions for flight and separation phases
CO3 . understand the combustion and propulsion systems in rocket
CO4 . select suitable materials for the rockets and missiles
CO5 . understand the design, performance and testing aspects.

Prerequisites : Propulsion-II (AS 3013) and Space Mechanics (AS 3012)

ROCKET DYNAMICS

Classification of launch vehicles and missiles – Rocket systems - Airframe components - Forces and moments acting on a rocket – Propulsion, aerodynamics, gravity – inertial and non-inertial frames - coordinate transformation – Equations of motion for three dimensional motion through atmosphere and vacuum, earth's atmosphere, numerical problems

SOLID PROPULSION AND PYROTECHNICS

Solid propellant rockets - classification, components and their design considerations, propellant grain design - grain mechanical properties, ballistics and burn rate design issues - igniter design - types of nozzles and thrust vector control, pyrotechnic devices and systems-classification, mechanisms and application of pyrotechnic devices in rockets and missiles. Design problems in rocket systems.

LIQUID PROPULSION AND CONTROL SYSTEMS

Liquid propellant rockets – classification and components - thrust chamber, feed systems, propellant tanks, turbo-pumps, types of valves and applications- their design considerations. Different bipropellant systems like cryogenics and their characteristics, pogo and slooh engine gimbal systems and thrusters for control. Spacecraft propulsion and control systems-Design problems.

MULTI-STAGING OF ROCKET AND SEPARATION DYNAMICS

Navigation and guidance systems in rockets and missiles - aerodynamic control systems of missiles- multi-staging of rockets - vehicle optimization techniques -stage separation system – dynamics, separation techniques - rocket flight dispersion, numerical problems.

DESIGN, MATERIALS AND TESTING OF ROCKETS

Design requirements and selection, performance evaluation and assessment, space environment on the selection of materials for rockets and spacecraft, material selection for specific requirements, advance materials-super alloys and composite materials. Qualification of rocket and missile systems, types of testing and evaluation of design and function.

Text Book

1. Ramamurthi.K.: Rocket Propulsion. Macmillan Publishers India first edition. 2010.
2. Sutton.G.P. and Biblarz.O.: Rocket Propulsion Elements.7th edition.Wiley India Pvt Ltd.2010.
3. Cornelisse, J.W, Schoyer H F R, and Wakker K F, "Rocket Propulsion and Space Dynamic", Pitman Publishing Co., 1979.

Reference Book

1. Ronald Humble, Henry and Larson.Space Propulsion Analysis and Design. McGraw-Hill. 1995
2. George M. Siouris, Missile Guidance and Control Systems, Springer-Verlag New York, 2000.

AS 4043 HYPERSONIC AERODYNAMICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1 . understand the basic concepts of Hypersonic Flow and its applications.
CO2 . solve problems involving inviscid hypersonic flows
CO3 . solve problems involving viscous hypersonic flows.
CO4 . understand the high temperature effects in hypersonic aerodynamics.
CO5 . understand the design issues for hypersonic wings.
CO6 . know the use of computational tools to evaluate hypersonic flows.

Prerequisites : Aerodynamics-I (AS 2006) and Aerodynamics-II (AS 3009).

INTRODUCTION:
History of hypersonic flight- a logical progression in the light of advancing technical findings. Hypersonic flow – definition, importance, physical aspects. Brief descriptive introductory preview of various phenomena such as Thin Shock layer, Entropy layer, Viscous Interaction, Effects of high Temperature and communication black out. Low density flow, free molecular flow.

HYPERSONIC SHOCK AND EXPANSION WAVE RELATIONS:
Oblique shock relations for high Mach numbers, Expansion wave relations for high Mach numbers. Theoretical basis of Mach number independence principle – corroboration by experimental results. Importance of experiments.

LOCAL SURFACE INCLINATION METHODS:
Newtonian flow and the hypersonic double limit of M&1, Modified Newtonian flow, Centrifugal force correction to Newtonian flow, wedge and tangent cone methods.

HYPERSONIC INVISCID FLOWS – I:
Hypersonic small disturbance theory, Equivalence principle and hypersonic similarity parameter; Hypersonic shock relations in terms of similarity parameter.

HYPERSONIC INVISCID FLOWS – II:
Application of small disturbance theory and equivalence of 1-dimensional piston motion with 2-dimensional hypersonic flow, Flat plate at an angle of attack by piston theory and comparison with exact shock expansion method, Bi-convex airfoil at zero angle of attack: comparison of piston theory and exact shock expansion method. Phenomenological aspects of hypersonic blunt body problem. Importance of blunt body problem and brief outline of Computational time-marching finite difference method and its advantage over other methods.

VISCOUS FLOWS:
Derivation of compressible boundary layer equations, Brief Introduction to the flatpalte case and Some Important results and conclusions for high Mach number flows, Special characteristics of hypersonic boundary layers, Introduction to hypersonic interaction parameters – weak & strong.

SHOCK TUBE BASED EXPERIMENTAL FACILITIES:
Shock Tunnel, Gun Tunnel, Free Piston Wind Tunnel, Ludweig tube, Measurement techniques, Samples of comparison of experimental and theoretical results.

HYPERSONIC FACILITIES:
Continuous hypersonic tunnel free flight experiments in tunnels and ballistic ranges – Measurement techniques. Role of experiments in computer code validation and Calibration.

Text Book

1. Hypersonic and High Temperature Gas Dynamics, Anderson J D, 2nd Edition, AIAA Education series, 2000.
2. Hypersonic Flow Theory, Hayes and Probstein,
3. Hypersonic Aerothermodynamics, Bertin J J, AIAA Education series, 1994.
4. Fluid Mechanics, Spurk J, Springer, Heidelberg 1997.

Reference Book

1. European Hypersonic Wind Tunnels, Wendt J F, AGARD Conference Proceedings No 428, Nov 1987, Paper 2.
2. Canning T N, Seiff A and James C S, Ballistic Range Technology AGARDOGRAPH report AD07 13915, Aug1970.
3. Introduction to Reactive Gas Dynamics, Brun, Raymond. Oxford University Press, 2009, Chapter 11: Facilties and Experimental Method
4. Shock Tube Techniques and Instrumentation, Harry J Davies and Churchack H D, 1969, US Army Material Command, Harry Diamond Lab, Washington DC
5. Burtschell Y, Brun R, and Zeitoun D, Shock Waves, Springer Verlag, Berlin, 1992.
6. Curtis P, Shock tubes, Pegasus Eliot Mackenzie Publishers, October 2004