ACADEMIC CURRICULA 2018 - 2022

BACHELOR'S DEGREE PROGRAMME

B. Tech in Electrical Engineering

Curricula & Syllabi

Kalinga Institute of Industrial Technology (KIIT)
Deemed to be University U/S 3 of UGC Act, 1956
Bhubaneswar, Odisha, India

ACADEMIC CURRICULA
2018 - 2022

B. TECH
ELECTRICAL ENGINEERING

Course Structure and Detailed Syllabi
for students admitted in
2018 - 22
Academic Session

Kalinga Institute of Industrial Technology (KIIT)
Deemed to be University U/S 3 of UGC Act, 1956
Bhubaneswar, Odisha, India

B.TECH IN ELECTRICAL ENGINEERING

Programme Educational Objectives (PEOs):

The B.Tech programme in Electrical Engineering aims to prepare the graduates with the following objectives:

1. Graduates shall be able to provide solutions to Electrical Engineering problems and allied areas involving energy systems, electrical drives and power system operation.
2. Graduates shall be able to perceive the feasibility and impact of engineering solutions in social, legal, environmental, economic, and multi- disciplinary contexts.
3. Graduates shall demonstrate professional responsibility and thrive to reinforce their knowledge being a part of formal or informal education programmes**.**

Programme Outcomes (POs):

The programme outcomes are:

a) Engineering knowledge: Ability to apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b) Problem analysis: Ability to identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c) Design/Development of solutions: Ability to design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d) Conduct investigations on complex problems: Ability to use research- based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e) Modern tool usage: Ability to create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
f) The engineer and society: Ability to apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g) Environment and sustainability: Ability to understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h) Ethics: Ability to apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i) Individual and team: Ability to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
j) Communication: Ability to 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.
k) Project management and finance: Ability to demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l) Life-long learning: Ability to recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes (PSOs):

The programme specific outcomes are:

m) Ability to design, control and implement electrical and electronic circuits, electrical drives, energy and power system for industrial applications.
n) Ability to carry out research in the fields of power converters, power system analysis, renewable energy, electric vehicle and smart grids.
o) Ability to utilize knowledge in solving practical problems for electrical systems.

Abbreviations used in describing the Category in all the courses are as follows:

BSC:	Basic Science Course
BSLC:	Basic Science Laboratory Course
ESC:	Engineering Science Course
ESLC:	Engineering Science Laboratory Course
HSMC:	Humanities, Social Science & Management Course
PCC:	Professional Core Courses
PCLC:	Professional Core Laboratory Course
PEC:	Professional Elective Courses
OEC:	Open Elective Courses
PROJ:	Project
IEC:	Industry Elective Course

COURSE STRUCTURE FOR B. TECH IN ELECTRICAL ENGINEERING

SCHEME-II

SEMESTER-I

Theory							
Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
1	MA1003	Mathematics-I	3	1	-	4	4
2	CH1007	Chemistry	3	-	-	3	3
3	HS1005	Professional Communication	2	-	-	2	2
4	LS1001	Biology	2	-	-	2	2
Total of Theory						11	11
Practical							
1	CH1097	Chemistry Lab	-	-	3	3	1.5
2	CS1093	Computer Programming	-	2	4	6	4
Sessional							
1	HS1085	Language Lab	-	-	2	2	1
2	CE1083	Engineering Graphics	-	1	2	3	2
Total Practical & Sessional						14	8.5
Semester Total						25	19.5

SCHEME-II

SEMESTER-II

Theory							
Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
1	MA1004	Mathematics-II	3	1	-	4	4
2	PH1007	Physics	3	1	-	4	4
3	EE1003	Basic Electrical Engineering	3	-	-	3	3
4	ME1003	Engineering Mechanics	3	-	-	3	3
Total of Theory						14	14
Practical							
1	PH1097	Physics Lab	-	-	3	3	1.5
2	EE1093	Basic Electrical Engineering Lab	-	-	2	2	1
Sessional							
1	ME1083	Basic Manufacturing Systems	-	1	2	3	2
2	CH1081	Environmental Science	-	-	2	2	1
Total Practical & Sessional						10	5.5
Semester Total						24	19.5

SEMESTER- III

Theory							
Sl. No	Course Code	Subject	L	T	P	Total	Credit
1	MA 2007	Mathematics-III(Electrical)	3	1	0	4	4
2	EE 2015	Electrical Circuits Analysis	3	0	0	3	3
3	EE 2017	Transformers and Induction Motors	3	0	0	3	3
4	EE 2013	Analog Electronic Circuits	3	0	0	3	3
5	EE 2019	Electrical and Electronics Measurements	3	0	0	3	3
6	CS 2001	Data Structure and Algorithm	3	1	0	4	4
Total Theory						20	20
Practical							
1	EE 2091	Network and Electronics Circuit laboratory	0	0	2	2	1
2	CS 2091	Data structure laboratory	0	0	2	2	1
3	EE 2092	Electrical Measurements Lab	0	0	2	2	1
Sessional							
1	HS 2081	Business Communication	0	0	2	2	1
Total Practical & Sessional						08	04
Semester Total						28	24

SEMESTER- IV

Theory							
Sl. No	Course Code	Subject	L	T	P	Total	Credit
1	EE 2020	DC Machines and Synchronous Machines	3	0	0	3	3
2	EE 2018	Digital Circuits	3	0	0	3	3
3	EE 2028	Linear Control System	3	0	0	3	3
4	EE 2022	Signals and System	3	0	0	3	3
5	EE 2024	Generation, Transmission and Distribution of Electric Power	3	1	0	4	4
6	EE 2026	Power Electronics	3	1	0	4	4
Total Theory						20	20
Practical							
1	EE 2096	Electrical Machines Laboratory	0	0	3	3	1.5
2	EE 2098	Power Electronics Laboratory	0	0	3	3	1.5
3	EE 2094	Digital Circuits Laboratory	0	0	2	2	1
Total Practical						08	4
Semester Total						28	24

SEMESTER- V

Theory							
Sl. No	Course Code	Subject	L	T	P	Total	Credit
1	EE 3017	Renewable Energy Sources	3	0	0	3	3
2	EE 3013	Microprocessors and Interfacing	3	0	0	3	3
3	EE 3002	Power System Operation and Control	3	1	0	4	4
4		HS Elective-1	3	0	0	3	3
5		Department Elective-I	3	0	0	3	3
6		Department Elective-II	3	0	0	3	3
Total Theory						19	19
Practical							
1	EE 3095	Control System Laboratory	0	0	3	3	1.5
2	EE 3093	Microprocessor Laboratory	0	0	3	3	1.5
3	EE 3099	PLC Laboratory				2	1
Sessional							
1	EE 3081	Electrical System Modeling using MATLAB	0	0	2	2	1
Total Practical & Sessional						10	05
Semester Total						29	24

SEMESTER- VI

Theory							
Sl. No	Course Code	Subject	L	T	P	Total	Credit
1	EE 3016	Power Carrier Communication System	3	0	0	3	3
2	EE 3008	Power System Protection	3	0	0	3	3
3		Department Elective-III	3	0	0	3	3
4		Department Elective-IV	3	0	0	3	3
5		Department Elective-V	3	0	0	3	3
6	OE/(MI)	Open Elective-I / (MI – 1)	3	0	0	3	3
Total Theory						18	18
Practical							
1	EE 3092	Power Systems Laboratory	0	0	3	3	1.5
2	EE 3094	Electric Drives Laboratory	0	0	3	3	1.5
Sessional							
1	EE 3082	Minor Project	0	0	4	4	2
Total Practical & Sessional						10	05
Semester Total						28	23

SEMESTER VII

Theory							
Sl. No	Course Code	Subject	L	T	P	Total	Credit
1	HS	Professional Practice Law and Ethics	2	0	0	2	2
2		Open Elective-II / (MI-2)	3	0	0	3	3
3		(MI - 3)	(3)	(0)	(0)	(3)	(3)
4		(MI – 4)	(3)	(0)	(0)	(3)	(3)
5		(HO-1)	(3)	(0)	(0)	(3)	(3)
Total Theory						5	5
Sessional							
	EE 4081	Project-/Intership					3
	EE 4083	Practical Training	-	-	-	-	2
	EE	(Project – Minor / Lab)	(0)	(0)	(4)	(4)	(2)
Total Practical & Sessional						0	5
Semester Total							10

SEMESTER VIII

Theory							
Sl. No	Course Code	Subject	L	T	P	Total	Credit
		HS Elective-II	3	0	0	3	3
		(MI – 5)	(3)	(0)	(0)	(3)	(3)
1		(MI – 6)	(3)	(0)	(0)	(3)	(3)
2		(HO-2)	(3)	(0)	(0)	(3)	(3)
3		(HO-3)	(3)	(0)	(0)	(3)	(3)
Total Theory						3	3
Sessional							
	EE 4082	Project -II/ Internship					10
Semester Total							13

LIST OF HS ELECTIVES

HS Elective – I

Sl. No	Course Code	Course Name	Credit
1.	HS 2002	Engineering Economics	3
2.	HS 2008	Economic Environment of India	3
3.	HS 2010	Financial Institutions, Markets and Regulations	3
4.	HS 2012	Development Economics	3

HS 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 3004	Electromagnetic Field	3
2.	ME 3062	Thermodynamics and Hydraulic Devices	3
3.	EE 3023	High Voltage Engineering	3
4.	EE 3029	IoT for Electrical Engineering	3
5.	EE 3038	Utilization of Electrical Power	3
6.	EE 3027	Electrical Engineering Materials	3

Dept. Elective - II

1.	EE 3006	Electric Drives and Control	3
2.	EE 3035	Energy Storage Technology	3
3.	EE 3037	Power Quality	3
4.	EE 3031	Neural Network and Fuzzy Logic	3
5.	EE 3015	Discrete Signal Processing	3
6.	EE 3033	Energy Conservation Techniques	3

Dept. Elective - III

1.	EE 3048	HVDC and FACTS	3
2.	EE 3050	Special Electrical Machines	3
3.	EE 3052	Power System Deregulation	3
4.	EE 3054	Bio-Inspired Algorithm	3
5.	EE 3056	Digital System Design using FPGA	3
6.	EE 3058	Energy Audit and Accounting	3

Dept. Elective - IV

1.	EE 3036	Discrete & Non linear Control Theory	3
2.	EE 3060	Industrial Automation	3
3.	EE 3024	Principle of Industrial Instrumentation	3
4.	EE 3062	Robotics and Control	3
5.	EE 3064	Bio-Medical Instruments	3
6.	EE 3066	Adaptive Control System	3

Dept. Elective – V

1.	EE 3068	Power Converter Analysis and Design	3
2.	EE 3070	Hybrid Electric Vehicle	3
3.	EE 3072	Computer Aided Power System	3
4.	EE 3074	Introduction to Machine Learning	3
5.	EE 3076	VLSI Circuit Design	3
6.	EE 3078	Energy Management and SCADA	3

HONORS COURSES OFFERED BY ELECTRICAL ENGINEERING

Area: Power System

Sl. No	Course Code	Course Title	Prerequisite/s
1	EE 4053	Digital Protection System	Microprocessor and interface (EE 3013), Power system Protection (EE 3008),
2	EE 4060	Distribution System Planning and Automation	Generation, Transmission and Distribution of Electrical Power (EE 2024)
3	EE 4068	State Estimation and Security	Power System Operation and Control (EE 3002)

Area: Smart Grid

Sl. No	Course Code	Course Title	Prerequisite/s
1	EE 4055	Wide Area Measurement System	Signals and System (EE 2022), Power System Protection (EE 3008)
2	EE 4062	Distributed Generation & Microgrid	Power Electronics (EE-2026), Generation, transmission and Distribution of Electrical power(EE 2024).
3	EE 4070	Smart Grid Technology	Power System Operation and Control (EE 3002), Renewable Energy Sources (EE 3017)

Area: Power Electronics

Sl. No	Course Code	Course Title	Prerequisite/s
1	EE 4057	Harmonics Elimination Techniques	Power Electronics (EE 2026)
2	EE 4064	Advanced Power Converters	Power Electronics (EE 2026)
3	EE 4072	Grid Integration and control	Power Electronics (EE 2026),Linear Control System (EE2028)

Area: Renewable

Sl. No	Course Code	Course Title	Prerequisite/s
1	EE 4059	Solar Photovoltaic and Fuel Cell	Power Electronics (EE 2026), Renewable Energy Sources (EE 3017)
2	EE 4066	Wind and Biomass	Transformers & Induction Motors (EE 2017)
3	EE 4074	Small Hydro power and Tidal Energy	Generation, Transmission and Distribution of Electrical Power (EE 2024)

LIST OF OPEN ELECTIVES OFFERED BY SCHOOL OF ELECTRICAL ENGINEERING

Sl. No	Course Code	Course Title	Prerequisite/s
1	EE 2015	Electrical Circuits Analysis	Basic Electrical Engineering (EE 1003)
2	EE 3017	Renewable Energy Sources	Basic Electrical Engineering (EE 1003), Physics (PH1003), Chemistry (CH 1003)
3	EE 3046	Solar Power Technology	Basic Electrical Engineering (EE 1003), Physics (PH1003)
4	EE 3042	Principles of Energy Conversion	Basic Electrical Engineering (EE 1003)
5	EE 3041	Electrical Hazards and Safety	Basic Electrical Engineering (EE 1003)
6	EE 2028	Linear Control System	Basic Electrical Engineering (EE 1003), Mathematics-II (MA 1004)
7	EE 4058	Smart Illumination Technology	Basic Electrical Engineering (EE 1003), Physics (PH1003)
8	EE 3033	Energy Conservation Techniques	Basic Electrical Engineering (EE 1003), Physics (PH1003)
9	EE 4047	Electrical Instrumentation	Basic Electrical Engineering (EE 1003
10	EE 4044	Energy Audit and Management	Basic Electrical Engineering (EE 1003), Physics (PH1003)

MINOR IN ELECTRICAL ENGINEERING

Sl. No	Course Code	Course Title	Prerequisite/s
1	EE 2015	Electrical Circuits Analysis	Basic Electrical Engineering (EE 1003)
2	EE 2028	Linear Control System	Basic Electrical Engineering (EE 1003), Mathematics-II (MA 1004)
3	EE 3042	Principles of Energy Conversion	Basic Electrical Engineering (EE 1003)
4	EE 2013	Analog Electronic Circuits	Physics (PH1007)
5	EE 2018	Digital Circuits	Nil
6	EE 2019	Electrical and Electronics Measurements	Basic Electrical Engineering (EE 1003)
7	EE 3013	Microprocessor and Interfacing	Digital Circuits (EE 2018)
8	EE 3017	Renewable Energy Sources	Basic Electrical Engineering (EE 1003), Physics (PH1007), Chemistry (CH 1003)
9	EE 3007	Power Transmission and Distribution	Electrical Circuits Analysis (EE 2015)
10	EE 3028	Power Electronics Circuits	Analog Electronic Circuits, Electrical Circuits Analysis
11	EE 3006	Electric Drives and Control	Power Electronics Circuits, Linear Control System
12	EE 3008	Power System Protection	Power Transmission and Distribution
13	EE 2099	Energy Conversion Laboratory	
14	EE 2097	Power Convertor Laboratory	
15	EE 3096	Power System Protection Laboratory	

MINOR IN ENERGY MANAGEMENT

Sl. No.	Course Code	Course Title	Prerequisite/s
1	EE 2015	Electrical Circuits Analysis	Basic Electrical Engineering (EE 1003)
2	EE 2028	Linear Control System	Basic Electrical Engineering (EE 1003), Mathematics-II (MA 1004)
3	EE 3042	Principles of Energy Conversion	Basic Electrical Engineering (EE 1003)
4	EE 2019	Electrical and Electronics Measurements	Basic Electrical Engineering (EE 1003)
5	EE 3017	Renewable Energy Sources	Basic Electrical Engineering (EE 1003), Physics (PH1007), Chemistry (CH 1003)
6	EE 3033	Energy Conservation Techniques	Basic Electrical Engineering (EE 1003)
7	EE 3058	Energy Audit and Accounting (Mandatory)	Renewable Energy Sources
8	EE 3078	Energy Management and SCADA (Mandatory)	Renewable Energy Sources, Linear Control System
9	EE 3007	Power Transmission and Distribution	Electrical Circuits Analysis
10	EE 4058	Smart Illumination Technology	Basic Electrical Engineering (EE 1003), Physics (PH1007)
11	EE 2099	Energy Conversion Laboratory	
12	EE 2092	Electrical Measurement Laboratory	
13	EE 4093	Energy System laboratory	

MINOR IN CIRCUITS AND AUTOMATION

Sl. No.	Course Code	Course Title	Prerequisite/s
1	EE 2015	Electrical Circuits Analysis	Basic Electrical Engineering (EE 1003)
2	EE 2028	Linear Control System	Basic Electrical Engineering (EE 1003), Mathematics-II (MA 1004)
3	EE 3042	Principles of Energy Conversion	Basic Electrical Engineering (EE 1003)
4	EE 2022	Signals and System	Nil
5	EE 2013	Analog Electronic Circuits	Physics (PH 1007)
6	EE 3039	Programmable Logic controllers	Basic Electrical Engineering (EE 1003)
7	EE 3043	Inverter and SMPS	Analog Electronic Circuits
8	EE 4061	Sensors for Engineering Applications	Electrical Circuits Analysis
9	EE 4063	Process Instrumentation and Control	Linear Control System
10	EE 4065	Components of Industrial Automation	Sensors for Engineering Applications, Signals and Systems
11	EE4092	Drives Laboratory	
12	EE 3099	PLC Laboratory	
13	EE 3098	Control laboratory	

MINOR IN POWER ELECTRONICS

Sl. No.	Course Code	Course Title	Prerequisite/s
1	EE 2015	Electrical Circuits Analysis	Basic Electrical Engineering (EE 1003)
2	EE 2028	Linear Control System	Basic Electrical Engineering (EE 1003), Mathematics-II (MA 1004)
3	EE 3042	Principles of Energy Conversion	Basic Electrical Engineering (EE 1003)
4	EE 2013	Analog Electronic Circuits	Physics (PH 1007)
5	EE 2018	Digital Circuits	Nil
6	EE 3028	Power Electronics Circuits	Analog Electronics Circuits, Electrical Circuits Analysis
7	EE 3006	Electric Drives and Control	Power Electronics Circuits, Linear Control System
8	EE 3013	Microprocessor and Interfacing	Digital Circuits
9	EE 3068	Power Converter Analysis and Design	Power Electronics Circuits, Linear Control System
10	EE 3070	Hybrid Electric Vehicle	Power Electronics Circuits
11	EE 4057	Harmonics Elimination Techniques	Power Electronics Circuits
12	EE 4064	Advance Power Converters	Power Electronics Circuits, Linear Control System
13	EE 2099	Energy Conversion Laboratory	
14	EE 2097	Power Convertor Laboratory	
15	EE 4092	Drives Laboratory	

MINOR IN INDUSTRIAL IOT

Sl. No	Course Code	Course Title	Prerequisite/s
1.	EE 2015	Electrical Circuits Analysis	Basic Electrical Engineering
2.	EE 2028	Linear Control System	Basic Electrical Engineering, Engg. Mathematics
3.	EE 4061	Sensors for Engineering Applications	Electrical Circuits Analysis , Analog Electronic Circuit
4.	EE 3056	Digital System Design using FPGA	Digital Circuit, Mathematics
5.	EE 3051	OOPS with Python	Computer Programming
6.	EE 4073	IoT in Industry	Electrical Circuits Analysis, Analog Electronic Circuit and Computer Programming
7.	EE 3053	Database Security	Computer Programming
8.	EE 3055	Wireless network systems	Analog Electronic Circuit and Computer Programming
9.	EE 3064	Bio-Medical Instruments	Linear Control System, Biology
10.	EE 4075	IoT Sensors and Protocols	Sensors for Engineering Applications and Computer Programming
11.	EE 4095	IoT Laboratory	
12.	EE 4097	Sensor and Control Laboratory	
13.	EE 3099	PLC Laboratory	

MINOR IN SMART ELECTRIC VEHICLES

Sl. No	Course Code	Course Title	Prerequisite/s
1.	EE 2015	Electrical Circuits Analysis	Basic Electrical Engineering
2.	EE 2028	Linear Control System	Basic Electrical Engineering, Mathematics
3.	EE 4061	Sensors for Engineering Applications	Electrical Circuits Analysis , Analog Electronic Circuit
4.	EE 3056	Digital System Design Using FPGA	Digital circuits, Mathematics
5.	EE 4067	Special Machines, Drives and Smart Inverter	Basic Electrical Engineering, Analog Electronic Circuit,
6.	EE 3070	Hybrid Electric Vehicle	Basic Electrical Engineering, Analog Electronic Circuit, Mathematics
7.	EE 3035	Energy Storage Technology	Physics, Chemistry
8.	EE 4071	IoT in Electric Vehicles	Special Machines, Drives and Smart Inverter and Computer Programming
9.	EE 4069	Vehicle Charging Technology	Basic Electrical Engineering, Chemistry
10.	EE 3017	Renewable Energy Sources	Physics, Chemistry
11.	EE 4095	IoT Laboratory	
12.	EE 4097	Sensor and Control Laboratory	
13.	EE 4099	Electric Vehicles and Smart Inverter Laboratory	

COURSES OF FIRST YEAR

MA 1003 Mathematics-I

Credit: 4
Category: BSC
Prerequisite(s): Nil

Course Description:

The laws of nature are expressed as differential equations. The construction of mathematical models to address real-world problems has been one of the most important aspects of each of the branches of science. This course is designed to familiarize the prospective engineers with techniques in ordinary differential equations, multivariate calculus and solution for ODEs numerically. This course also focuses on Linear algebra that covers system of linear equations and properties of matrices. The objective of the course is to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced levels of mathematics and applications that they would find useful in their disciplines.

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

CO1: model and formulate differential equation of Physical problems
CO2: apply different methods to solve 1st and 2nd order ODEs
CO3: apply numerical methods to solve ODEs
CO4: study differential calculus in engineering problems
CO5: use the essential tool of matrices and linear algebra
CO6: analyze Eigen-value problems

Topics:

- Ordinary Differential Equations.
- Linear differential equations of 2^{nd} order.
- Differential calculus and Numerical methods to solve ODEs
- Vector space and system linear of equations
- Matrix-eigenvalue Problems

Textbook(s):

1. Advanced Engineering Mathematics by Erwin Kreyszig, Wiley, INC, (online) 10^{th} Edition.
2. Differential Calculus, Shanti Narayan and P. K. Mittal, S. Chand, reprint 2009.

Reference Book(s):

1. Higher Engineering Mathematics, Grewal B.S., Khanna Publishers, 36th edition.
2. Introduction to engineering Mathematics, Dass H.K., S.Chand & Co Ltd, 11^{th} edition.
3. Higher Engineering Mathematics, Ramana B.V., TMH, 2007.
4. A course on ordinary & Partial Differential Equation, Sinha Roy and S Padhy, Kalyani Publication, 3rd edition.

CH1007 Chemistry

Credit: 3
Category: BSC
Prerequisite(s): Nil

Course Description:

The course depicts the basic concepts in Chemistry to strengthen fundamentals for pursuing education and research in engineering. It will help to develop the idea on feasibility and mechanism of different chemical processes, kinetics of complex reactions, idea on alternate sources of energy, modern batteries, exposure to use spectroscopic techniques for exploring structure of organic molecules and idea of different methods for synthesis of nano materials.

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

CO1: rationalize bulk properties and processes using thermodynamic consideration and apply the knowledge to decide the feasibility of a given process
CO2: analyze the kinetics of simple and multistep reactions as well as theories of reaction rates
CO3: evaluate some properties such as pH, solubility product etc. by using electrochemical cell and understand the working of modern batteries
CO4: understand the mechanism of corrosion and its different controlling measures
CO5: distinguish the different electromagnetic radiations used for exciting different molecular energy levels in various spectroscopic techniques to evaluate the structure of molecules
CO6: get an exposure to different methods used for synthesis of nanostructured materials

Topics:

- Chemical equilibrium and thermodynamics
- Chemical kinetics
- Electrochemistry
- Spectroscopy
- Chemistry of nano materials

Textbook(s):

1. Engineering Chemistry: Fundamentals and Applications- Shikha Agarwal, Cambridge University Press, 2016

Reference Book(s):

1. Textbook of Engineering Chemistry: Sashi Chawala, Dhanpat Rai and Co, 2016
2. Principles of Physical Chemistry- B.R. Puri, L.R Sharma, M.S. Pathania; 42nd Edition, Vishal Publishing Co.
3. Spectrometric Identification of Organic compaunds,7th Edition -Robert M. Silverstein, Fransis , Webster, Dravid j. Kiemle; Jhon Wiley& Sons, INC.
4. Nanostructures &Nanomaterials: Synthesis, Properties and Applications- G. Cao and Y. Wang, World Scientific Pvt. Ltd.; 2nd Edition

HS 1005 Professional Communication

Credit: 2
Category: HSMC
Prerequisite(s): Nil

Course Description:

Professional Communication is more emphasized on enhancing the four LSRW skills like Listening, Speaking, Reading and Writing in order to improve students' professional communication. It is basically designed to enhance speaking skills through pronunciation, stress and tone. This course is prepared to improve reading skills through reading, comprehending and retaining information.This course is basically expected to provide the learner an approach to communicate using all the four skills

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

CO1: understand the communication process and practical implementations in the workplace
CO2: apply verbal and non-verbal modes of communication effectively in practical situations
CO3: apply effective conflict management strategies
CO4: use English grammar correctly and unambiguously in technical writing
CO5: bridge the gap between native language and target language i.e. English
CO6: retain a logical flow while drafting reports and other technical pieces of writing

Topics:

- Communication: Process and Methods of Communication
- Basics of Grammar: Time & Tense, Subject-Verb Agreement, Analogy, Active & Passive Voice, Error Detection in Sentences
- Writing Skills: Paragraph Writing-Techniques & Skills, Use of Punctuation, Business Letter-Enquiry, Claim/ Complaint, Order
- Basic Sounds of English: Hearing & Listening, Introduction to Basic Sounds of IPA, Problem Sounds & MTI

Textbook(s):

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

Reference Book(s):

1. A Communicative English Grammar. Geoffrey Leech and Jan Svartvik. Third Edition. Routledge Publication.New York.2013.
2. Effective Technical Communication. MAshraf Rizvi TMH 2005
3. The Oxford Grammar (English) Sidney Greenbaum, Oxford University Press India. 1st Edition. 2005
4. Verbal Ability and Reading Comprehension for the CAT. Arun Sharma and Meenakshi Upadhyay, TMH,New Delhi,2007
5. Better English Pronunciation, Cambridge University Press, J D O'Connor, 2nd Edition (Paper Back) 2013

LS 1001 Biology

Credit: 2
Category: BSC
Prerequisite(s): Nil

Course Description:

Biology is important to everyday life because it allows humans to better understand their bodies, their resources and the potential threats existing in the environment. The engineering undergraduates need to be suitably exposed to the biological mechanisms of living organisms from the perspective of engineers. In addition, the course is expected to encourage engineering students to think about solving biological problems with engineering tools.

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

CO1: comprehend the typical characteristics which distinguish life forms and analyze life process at cellular level
CO2: apply concepts on structure and function of simple biomolecules in life processes
CO3: comprehend different biological process involved in life and to analyze their effect
CO4: understand different biological phenomenon and then relate it with engineering application domains
CO5: comprehend different physiological functions and then relate it to computer based techniques
CO6: understand biology and its relevance to engineering and technology

Topics:

- The Cellular organization of a living Organism
- The molecular and biochemical basis of an organism
- Enzymes, photosynthesis, metabolism and bioenergetics
- Molecular machines, biosensor and bioremediation
- Nervous system, immune system and cell signaling

Textbook(s):

1. Biology for Engineers. S. Thyagarajan, N. Selvamurugan, M.P Rajesh, R.A Nazeer, Richard W. Thilagarajan, S. Bharathi, M.K. Jaganathan. McGraw Hill Education (India) Ed., 2012

Reference Book(s):

1. Biology (Indian Edition), P.H. Raven and G.B. Johnson. McGraw Hill Education (India) Private Limited.
2. Concepts of Biology, Eldon D. Enger, Feederick C, Ross and David B. Bailey. TMH Publications.
3. Biology. Neil A. Campbell and Jane B. Recee, Pearson Education.
   Biology Concepts and Application, Cecie Starr, Thomson Books.

CS 1093 Computer Programming Laboratory

Credit: 3
Categories: ESLC
Prerequisite(s): Nil

Course Description:

The course aims to provide exposure to problem-solving (scientific and mathematical) through programming. It aims to train the students to the basic concepts of the C-programming language. This course involves lab component which is designed to give the student hands-on experience with the concepts. The course aims to enable the students to design, write and implement programs in C using different programming features. This course serves as the basic knowledge required for future important subjects like Object Oriented Programming and Data Structure.

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

CO1: understand computer fundamentals, the importance of programming, and it's basic usability.
CO2: analyze different control structures/statements in C programming.
CO3: understand various operators and it's precedence to solve various computing problems.
CO4: understand the importance of good programming practices.

Topics :

- Basic linux commands
- Operators and Expressions
- Branching statements (if-else, switch).
- Control statements (looping - for, while, do-while).
- Arrays
- Character Arrays (strings).
- Functions.
- Pointers and Dynamic Memory Allocation.
- Structures and Unions
- File Handling

CH 1097 Chemistry Laboratory

Credit: 1.5
Category: BSLC
Prerequisite(s): Nil

Course Description:

The Chemistry laboratory course is designed to develop basic concepts of quantitative analysis by using volumetric as well as instrumental methods. It includes classical titrations to estimate hardness, alkalinity, dissolved oxygen, ferrous ion content, chloride content in water/solution samples. It also gives hands on training to use advanced titration techniques such as potentiometric, pH metric and conductometric titrations which can be used with turbid and colored solutions in incredibly low concentrations. The course also gives an exposure to extensive use of UV-Vis spectroscopy for estimation of different ions in solution phase.

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

CO1: understand the significance of quantitative chemical analysis
CO2: prepare solutions of different concentrations and do their standardization
CO3: get an exposure to different instrumental techniques such as Conductometry, pH-metry, Potentiometry and Colorimetry
CO4: evaluate the rate constant of pseudo first order reactions
CO5: analyse basic water quality parameters like hardness, dissolved oxygen, alkalinity, ferrous iron contents
CO6: rationalize chemical handling and chemical safety in an advanced modern laboratory

Topics:

- Hardness of water sample
- Alkalinity of water
- Estimation of Fe^{2+} iron
- Dissolved Oxygen
- Potentiometric Titration
- Kinetics of Ester Hydrolysis
- Chloride Estimation
- pH metric Titration
- Conductometric Titration
- Concentration of $KMnO_4$ by Visible spectroscopy

HS 1085 Language Laboratory

Credit: 1
Category: HSMC
Prerequisite(s): Nil

Course Description:

Language Lab is more practical oriented which is designed with an objective to make the learner practice the skills which he/she has learnt in the theory I.e Listening, Speaking, Reading and Writing in order to improve their communication skills. It is basically designed to engage the students to learn to perform group activity or an individual activity. This course is prepared to improve the listening reading, speaking and writing skills . It is expected to orient the students with vocabulary, analogy, sentence completion and sentence correction.

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

CO1: use English grammar correctly and unambiguously in technical writing
CO2: apply verbal and non-verbal modes of communication effectively in practical situations
CO3: have a basic understanding of the communication process and to know the practical implementations in the workplace
CO4: retain a logical flow while drafting reports and other technical pieces of writing
CO5: develop competence in reading and comprehension
CO6: be familiar with English pronunciation and use neutral accent successfully

Topics:

- Reading & Comprehension
- Skit/ Role-Play Practice
- Listening Comprehension
- Time & Tense
- Business Letter
- Business Report
- Subject-Verb Agreement
- Visual Elements in Writing:
- Gadget-Supported Textual Formatting
- Attendance + Lab Record Checking
- Viva Voce

CE 1083 Engineering Graphics

Credit: 2
Category: ESLC
Prerequisite(s): Nil

Course Description:

The course of Engineering Graphics comprises of basics of drafting, projection of points & lines, line inclined to both the planes, projection of planes, Computer Aided Drafting, projection of solids and development of surfaces.

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

CO1: use common drafting tools properly
CO2: select, construct and interpret appropriate drawing scale as per the situation
CO3: draw orthographic projections of points, lines and planes
CO4: draw orthographic projection of solids like cylinders, cones, prisms and pyramids including sections
CO5: develop the sections of solids for practical situations
CO6: communicate ideas effectively using Computer Aided Drafting

Topics:

- Introduction to Engineering graphics
- Lettering
- Projection of points & lines
- Line inclined to both the planes
- Projection of planes
- Introduction to Computer Aided Drafting
- Projection of solids
- Section of solids
- Development of surface

Textbook(s):

1. Engineering Drawing + AutoCAD by K. Venugopal, New Age Publishers, 1st edition, 2011

Reference Book(s):

1. Engineering Drawing with an Introduction to AutoCAD by S. N. Lal, Cengage India Private Limited, 1st edition, 2017

MA 1004 Mathematics-II

Credit: 4
Category: BSC
Prerequisite(s): Nil

Course Description:

The course is to familiarize the students with series solutions of ODEs, Laplace Transforms, Fourier series, vector calculus, and numerical integration. For the ODEs with variable coefficients, the situation is more complicated to get their solutions in elementary functions. Legendre and Bessel's equations are important ODEs of this kind and their solutions, the Legendre polynomials and Bessel functions play an important role in engineering applications. Laplace transforms can be used as a mathematical toolbox for engineers to solve linear ODEs and related initial value problems. The Fourier series and vector calculus play a very important role in many engineering areas such as solid mechanics, aerodynamics, fluid flow, heat flow, quantum physics. The applied mathematician, engineer, physicist, or scientist must become familiar with the essentials of numerics and its ideas, such as interpolation and numerical integration.

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

CO1: understand application of Power series and solution of ODEs
CO2: use Power series solutions to Legendre and Bessel's equations
CO3: comprehend Laplace transform and IVPs
CO4: study periodic and non-periodic functions and their Fourier series expansion
CO5: develop vector differential and integral calculus and the applications of Green's theorem, Gauss Divergence Theorem & Stokes Theorem
CO6: apply numerical techniques in interpolation and evaluation of the definite integral

Topics:

- Series Solution of Differential Equations
- Laplace Transforms
- Fourier Series
- Vector Differential and Integral Calculus
- Interpolation and Numerical Integration

Textbook(s):

1. Advanced Engineering Mathematics by Erwin Kreyszig, Wiley, INC, 10^{th} Edition.

Reference Book(s):

1. Higher Engineering Mathematics, Grewal B.S., Khanna Publishers, 36th edition.
2. Introduction to engineering Mathematics, Dass H.K., S.Chand& Co Ltd, 11^{th}edition.
3. Higher Engineering Mathematics, Ramana B.V., TMH, 2007.
4. A course on ordinary & partial differential Equation, Sinha Roy and S Padhy, Kalyani Publication, 3rd edition.

PH 1007 Physics

Credit: 4
Category: BSC
Prerequisite(s): Nil

Course Description:

This course includes the fundamentals of different types of oscillations and its applications; mathematical expression of waves and its physical interpretation; the concept of interference, diffraction and their applications; the principle, construction and working of different Lasers. The course also gives a flavour of Quantum mechanics, which is the founding stone to the state of the art in modern techniques and paves the way towards the world of nano devices. It covers the formulation of Maxwell's electromagnetic equations, and verification of different properties of electromagnetic waves. Mechanical and magnetic properties of different materials and their applications are also covered in this course.
Course Outcomes: At the end of the course, the students will be able to:

CO1: utilize the concept of waves and intensity modulation in day to day life through various applications
CO2: apply the mechanism of LASER technology in different fields
CO3: formulate and solve engineering problems of electricity and magnetism using Maxwell's electromagnetic equations
CO4: apply the principles of quantum mechanics to related problems
CO5: apply the knowledge of magnetic materials in related applications
CO6: analyze the macroscopic behavior of solids and utilize them in future applications

Topics:

- Oscillation and wave
- Interference and diffraction
- LASER
- Quantum mechanics
- Electromagnetism
- Properties of matter (mechanical)
- Magnetism

Textbook (s):

1. Engineering Physics, B. K. Pandey and S. Chaturvedi, Cengage Publication, New Delhi

Reference Book(s):

1. Introduction to Electrodynamics, D J Griffiths, Pearson Education
2. Quantum Mechanics, L. I. Schiff, Tata McGraw-Hill Publications
3. Optics, A K Ghatak, Tata McGraw-Hill Publications
4. Concepts of Modern Physics, A. Beiser, Tata McGraw-Hill Publications
5. Engineering Physics, R K Gaur and S. L. Gupta, Dhanpat Rai Publications, New Delhi.

EE 1003 Basic Electrical Engineering

Credit: 3
Category: ESC
Prerequisite(s): Nil

Course description:

This course depicts on generating stations (Thermal, Hydro, Nuclear and Solar Photovoltaic Stations), transmission of powers (overhead transmission lines and underground cable); distribution system (AC and DC), types of wiring, types of batteries, safety measures, necessity of earthing and fuse. The basic concepts of DC and AC (Single Phase and Three Phase Circuits) network analysis, DC transients, AC networks (1-Phse and 3-Phase), AC series circuit resonance and magnetic circuits. This course will also cover single phase transformers, three Phase Induction machines, measuring Instruments and illumination.

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

CO1: explore the electric supply systems, safety measures and illumination
CO2: solve the different parameters in the DC circuits
CO3: solve the different quantities of 1-Phase and 3-Phase AC circuits
CO4: interpret the behavior of magnetic circuits
CO5: illustrate the application of transformer and induction motors
CO6: demonstrate electrical instruments for measurement

Topics:

- Introduction to electrical energy
- Safety measures in electrical system
- Types of wiring, batteries
- DC circuits
- Network theorems
- AC circuits
- Magnetic circuits
- Transformer and induction motors
- Measuring instruments
- Illumination

Textbook(s):

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, 3rd Edition 2017.

Reference Book(s):

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).

ME 1003 Engineering Mechanics

Credit: 2
Category: ESC
Prerequisite(s): Nil

Course Description:

The course on Engineering Mechanics is a specialized need-based extension of applied physics which is aimed at developing an understanding of the principle of statics and dynamics. The course focuses on learning methodical and logical idealization and subsequent implementation of corresponding procedures for analysis of rigid body, frame and machine under the action of force system which is highly essential for effective design. The course intends to develop the ability of drawing and analyzing the free body diagram of a system when at rest or motion using scalar/vector techniques. Further, the course serves as a prerequisite to fundamental machine design courses such as mechanics of solids and design of machine elements.

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

CO1: draw complete and correct free-body diagrams and write the appropriate equilibrium equations from the free-body diagram
CO2: use scalar analytical techniques for analyzing forces and moments in mechanical systems
CO3: analyzing forces in statically determinate structures such as trusses, frames and problems related to friction
CO4: determine the centroid and second moment of area
CO5: apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple and practical problems
CO6: solve real-life problems by using mathematics, physical laws and theorems

Topics:

- Concurrent Forces in a Plane
- Friction
- Parallel Forces in a Plane
- Moment of Inertia
- Force analysis of Plane Trusses
- Principle of Virtual Work
- Kinematics of Rectilinear Motion
- Kinematics of Curvilinear Motion
- Rotation of a rigid body

Textbook(s):

1. Engineering Mechanics (Revised 5th edition), TMH by S. Timoshenko, D.H. Young, J.V Rao and S. Pati.

Reference Book (s):

1. Engineering Mechanics (Statics and Dynamics) - Bear and Johnson, TMH
2. Engineering Mechanics (Statics and Dynamics) by I.H. Shames, Prentice Hall
3. Engineering Mechanics –S.S. Bhavikatti, New Age International
4. Engineering Mechanics (Statics and Dynamics)-S. Rajasekaran & G Sankarasubramanian, Vikas Publishing House.

PH 1097 Physics Laboratory

Credit: 1.5
Category: BSLC
Prerequisite(s): Nil

Course Description:

This lab course covers different measurement techniques of various parameters using the instruments i.e. interferometer, spectrometer, spherometer, Screw gauge, vernier calliper, microspope, and telescope. It includes the application of photoelectric effect and photovoltaic effect in photo cell and solar cell respectively. Evaluation of the mechanical strength of materials by calculating elastic constants such as Young's modulus, rigidity modulus and Poisson's ratio are also included. This course provides hands on training for the usage of electrical, optical and mechanical systems for various measurements with precision and analysis of the experimental data by graphical interpretation and error calculation.

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

CO1: calculate appropriate structural members using the fundamental concepts of the elastic behavior of materials
CO2: use the principles of interference and diffraction to find out the wavelength of an unknown monochromatic source of light
CO3: apply the concept of photoelectric emission to calculate the Planck's constant and analyze some aspects of electron-photon interaction through characteristic curves
CO4: explore the efficiency in terms of power output of a green energy source i.e. solar cell
CO5: calculate the acceleration due to gravity 'g' by using the concept of a compound pendulum

Topics:

- Estimation of elastic constants such as Young's modulus, rigidity modulus and Poisson's ratio
- Determination of wavelength of unknown source using Newton's rings and Michelson's interferometer
- Precision length measurement up to the order of 6 A° (distance between sodium D-lines) using Michelson interferometer
- Determination of grating element using a diffraction grating
- Study of photo cell and solar cell by analyzing their characteristic curves
- Determination of acceleration due to gravity using a bar pendulum

EE 1093 Basic Electrical Engineering Laboratory

Credit: 1
Category: ESLC
Prerequisite(s): Nil

Course Description:

The course of Basic Electrical Engineering lab comprises of various equipments and loads i.e voltmeters, ammeters, wattmeters, single phase and three phase transformer, induction motors etc. It is a specialized practical oriented course which intends to develop and understand various principles like Ohm's law and Kirchoff's law. The course focused on learning methodical and logical idealization of various theorems which is highly essential for solving a network. The course intends to make the students familiar with various parts of DC machines and AC machines. The course intends to develop the ability of problem solving by analyzing RL and RLC series circuits. This lab helps the students to understand the principle of operation of a single phase transformer with its no load calculation.

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

CO1: recall the safety practices in the laboratory and the associated work areas
CO2: comprehend the skills for working in a team with common objective
CO3: apply different theorems to find the parameters in DC and AC circuit
CO4: analyse the different parts of DC and AC machines to describe operational features thereof
CO5: apprise the experimental results in systematic manner
CO6: discuss about determination of resistance in incandescent lamp and power factor in fluorescent lamp

Topics:

- measurement of resistance of tungsten filament lamp
- measurement of inductance of a choke coil
- study and use of megger.
- study of different parts of dc machine and three phase induction motor
- layout of power system analysis
- determination of voltage ratio of a single phase transformer
- measurement of no load current and core loss of a single phase transformer
- verification of KCL and KVL.
- verification of voltage and current ratio of star and delta connection
- study & determine the power factor of the RLC series circuit
- study, connection & determine the power factor of fluorescent tube
- verification of the superposition theorem
- transient analysis of series RL and RC circuit using matlab-simulink with dc excitation

Textbook(s):

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(s):

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

ME 1083 Basic Manufacturing Systems

Credit: 2
Category: ESLC
Prerequisite(s): Nil

Course Description:

This laboratory practice is designed to impart students the basic knowledge on manufacturing or developing a given object irrespective of their branch of engineering. While furnishing the given object, students will familiar with various mechanical operations and the respective tools or machines. This course involves four different sections namely Fitting, Welding, Turning and Sheet metal which covers both conventional and advanced tools to provide students the updated manufacturing experience. Students are also advised with various safety precautions to be followed during a specific manufacturing practice. At the end, students will also gain knowledge on different advanced machines such as CNC and 3D printing.

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

CO1: practice different operations related to fitting shop
CO2: use different welding tools to prepare a given type of joint
CO3: demonstrate various turning operations including taper turning and knurling using a conventional lathe machine
CO4: design a tray and prepare it using sheet metal equipment involving soldering
CO5: appraise different operations using a CNC machine
CO6: interpret different advanced machines such as 3D printing/additive manufacturing

Topics:

- Turning operations
- Sheet metal operations
- Fitting
- Welding

CH 1081 Environmental Science

Credit: 1
Category: BSLC
Prerequisite(s): Nil

Course Description:

The course is designed to make the students aware of different environmental components and their composition. It will make the students understand different pollutants, their sources and management. It will also help students to apply the principles of Green Chemistry and implement them in synthesis of advanced materials required for engineering applications. It also outlines the basic steps for developing the EIA statements

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

CO1: understand the different components and composition of the environment
CO2: rationalize the different pollutants, their sources, effects and controlling measures
CO3: quantify water quality parameters
CO4: apply the systematic environmental impact assessment (EIA) requirements before setup of any project
CO5: understand and implement the principles of solid waste management
CO6: conceptualize the principles of green chemistry and implement them in synthesis of advanced material, so as to reduce the pollution

Topics:

- Overview on environment
- Environmental pollution: air pollution, water pollution
- Pollution management

Textbook(s):

1. Environmental Chemistry, A. K. De, New Age International Publishers.

Reference Book(s):

1. Environmental Chemistry- S. Chakroborty, D. Dave, S.S. Katewa, Cengage Publishers
2. Environment Science and Engineering, Aloka Debi. Second Edition ;Universities Press
3. Text Book of Environment studies for under graduate courses, Erach Bharucha : 2nd Edition, Universities Press
4. Fundamentals of Environment and Ecology, D. De, D. De; 2013, S. Chand Group
5. Engineering Chemistry, Jain and Jain, Dhanpat Rai Publishing Company

COURSES OF THE PROGRAMME

EE 2013 Analog Electronics Circuit

Credit: 3
Category: PCC
Prerequisite(s): Physics (PH 1007), Basic Electrical Engineering (EE 1003)

Course Description:

Characteristics of signal diode and Zener diode, clippers, clampers, Transistors characteristics, Biasing of BJT, Analysis of transistor, FET characteristics, MOS and CMOS, types and Analysis of amplifiers, Characteristics of ideal & non ideal OP-AMP, Op-AMP as differentiator, integrator, comparator, Schmitt trigger, 555 timer.

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

CO1: recall the characteristics and applications of P-N Junction diode
CO2: explain the various biasing circuits for BJT
CO3: utilize the characteristics of Field Effect Transistors
CO4: compare different Amplifier circuits
CO5: analyse various Feedback circuits
CO6: construct circuits using operational amplifiers

Topics:

- Bipolar Junction Transistor
- Field Effect Transistors
- Power Amplifier and Feedback Circuit
- Operational Amplifier:

Textbook(s):

1. Integrated Electronics- Analog and Digital Circuits and Systems, J. Millman&Halkias, C.D. Parikh, Mc-Graw Hill India, 2nd Edition, 2013 (10th Reprint).
2. Op-Amps and Linear Integrated Circuits - Ramakant A. Gayakward , Pearson, 4th Edition, May 2015.

Reference Book(s):

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- 5th Edition- New Age International Publishers, 2018.
3. Foundations Of Analog and Digital Electronic Circuits:-Anant Agarwal, Elsevier India,1st Edition (2013)

EE 2015 Electric Circuit Analysis

Credit: 3
Category: PCC
Prerequisite(s): Basic Electrical Engineering (EE 1003)

Course Description:

Type of sources, Theorems, Analysis of circuit with one nonlinear network, Self and Mutual Inductance, Dot convention, Coupled circuits, Transient response for R-L, R-C and R-L-C circuits, Two port network configuration, Interconnection of two port networks, Concepts of graph theory and different incidence matrices, Design of low pass, high pass, band pass, and band elimination filter.

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

CO1: analyze different electrical circuits using network theorems
CO2: understand the magnetically coupled circuits.
CO3: apply time domain and Laplace Transforms for finding transient responses.
CO4: analyze various parameters of two port networks.
CO5: analyze the electrical circuits using network topology
CO6: design the filters for elimination of undesired signals.

Topics:

- Network Theorems
- Magnetic Coupled Circuits
- Transient Response
- Two-Port Networks
- Network Topology
- Filter

Textbook(s):

1. Network Analysisby by M. E. Van Valkenburg, Pearson Education, 3rd Edition, 2006.
2. Networks and systems by D.Roy Choudhury, New Age Publication, 2nd Edition, June 2013.

Reference Book(s):

1. Circuits and Networks Analysis and Synthesis (2nd Edition) A Sudhakar Shyammohan and S Palli,McGraw-Hill, 5th Edition,2011.
2. Basic Circuit Analysis (2nd Edition), John O'Malley, Schaum's Outlines, McGraw-Hill, 2010(Reprint).
3. Fundamentals of Electric Circuits, Charles K. Alexander, Matthew N.O. Sadiku, McGraw Hill Education; 5 edition (1 July 2013).

EE 2017 Transformers and Induction Motors

Credit: 3
Category: PCC
Prerequisite(s): Basic Electrical Engineering (EE 1003)

Course Description:

Construction, Principle of Operation of single phase and three phase transformer, different tests, Regulation, Losses and Efficiency, equivalent circuit and Parallel operation of Transformer. Three Phase Transformer Connections and vector group, parallel operation of three phase transformer, construction and operation of Three-phase induction motor, Equivalent Circuit, different tests and Phasor Diagram, Torque-Slip characteristics, Circle Diagram, Methods of starting and speed control methods.

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

CO1: remember the construction, principle, losses, efficiency and Phasor diagram of transformers and induction motors
CO2: explain the different tests to develop the equivalent circuit of transformer and induction motor
CO3: plan for the parallel operation of single phase and three phase transformers
CO4: compare different connections and conversions of three phase transformers
CO5: evaluate the performance characteristics, different methods of starting and speed control of three phase induction motors
CO6: discuss the construction and principle of operation of different single phase induction motors

Topics:

- Single Phase Transformer
- Three Phase Transformer
- Three Phase Induction Motor
- Single Phase Induction Motor

Textbook(s):

1. Electrical Machinery by P. S Bimbhra, 7th Edition, Khanna Publishers, 2008.
2. Electric Machines, by Kothari. D P and I J Nagrath, 3rd Edition, Tata McGraw-Hill, New Delhi. 2004.
3. Electric Machinery, by E. Fitzagerald, C. M. Kingsley (Jr) and S. D. Umans, Tata McGraw Hill, 6th Edition 2003.

Reference Book(s):

1. Electrical Machines by Ashfaq Hussain, Dhanpat Rai, Delhi, 2nd Edition, 2008.
2. Electrical Machines, by P. K. Mukharjee and S. Chakravorti, Danpat rai Publication,2nd Edition, 18th reprint 2013.
3. Electrical Machines, by P. Purkait and I. Bandyopadhyay, Oxford University Press. 1st Edition, 2017.

EE 2018 Digital Circuits

Credit: 3
Category: PCC
Prerequisite(s): Basic Electrical Engineering (EE 1003)

Course Description:

Number Systems, Binary Codes, Logic Gates, Boolean Algebra, Minimization of Switching Functions, K-Map, Adders, Subtractors, Encoders, Decoders, Multiplexer, Demultiplexer, Latches and Flip Flops, Shift Registers, Counter, Digital to Analog and Analog to Digital converter, Standard logic, Analysis of TTL and CMOS chips.

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

CO1: recall the different types of number systems and logic gates
CO2: comprehend Digital Circuits using Boolean algebra and K-Maps
CO3: apply the concepts of Boolean algebra to the design Combinational Circuits
CO4: analyze the Flip-Flops, Counters and Shift registers
CO5: implement the different types of ADC and DAC
CO6: elaborate the various Logic Families of digital circuits and their characteristics

Topics:
- Introduction to Digital Circuits
- Number Systems:
- Logic Gates
- Boolean Algebra
- Minimization of Switching Functions
- Combinational Logic Design
- Sequential Logic Design .
- Flip Flops
- Shift Registers
- Counter
- ADC and DAC
- Logic Families

Textbook(s):
1. Digital Logic and Computer Design by M. Morris Mano – Pearson Education, 1st Edition,2011
2. Fundamentals of Digital Logic by Anand Kumar - PHI, 4th Edition, 2017

Reference Book(s):
1. Digital Principles and Applications by Malvino and Leach –TMH, 7th edition, 2011
2. Digital Fundamentals by T. L. Floyd and Jain – Pearson Education, 10th edition, 2011

EE 2019 Electrical and Electronics Measurements

Credit: 3
Category: PCC
Prerequisite(s): Basic Electrical Engineering (EE 1003)

Course Description:

Moving Iron type instrument, Induction type wattmeter, Energy meter, Power factor meter, different bridges,
Different types of Transducers, Tachometer. Thermistors, LVDT, different Electronic instruments such as Digital Energy Meter, Biometrics, Megger, Biomedical Instruments.

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

CO1: choose appropriate instrument for measurement of different electrical quantities
CO2: demonstrate the measurement of unknown electrical circuit elements using different AC/DC bridges
CO3: apply the techniques of the transducers to ascertain the values of measurands
CO4: analyze the functions of CROs and other electronic instruments
CO5: understand the operation of Biomedical instruments
CO6: predict the efficacy of the recent trends of measurement system

Topics:
- Measurement of Different Electrical Quantities
- DC/AC Bridge
- Transducers
- Electronic Instruments
- Recent trends of measurement system.

Textbook(s):
1. Electronic Instrumentation and Measurement Techniques, by William David Cooper, Pearson, 1st Edition,2010.
2. Electrical Measurements and Measuring Instruments, by Edward William Golding, F. C. Widdis, 3rd Edition, Reem Publications, reprint 2012.

Reference Book(s):
1. Electronics Instruments and Measurements by David A. Bell – Oxford University Press, 3rd Edition,2012.
2. A Course in Electrical and Electronics Measurement and Instrumentation by A. K. Sawhney, 10th edition, Dhanpat Rai, 1994.
3. Electrical Measurement and Measuring Instruments by Arthur Harris, Intelliz press, ISBN: 978-1-6825/-382-8/2018.

EE 2020 D.C. Machines and Synchronous Machines

Credit: 3
Category: PCC
Prerequisite(s): Transformers and Induction Motors (EE 2017)

Course Description:

Principle of operation, Types of DC Machines, Losses and Efficiency, Characteristics of different DC Machines,Speed control of DC Motor, Necessity of starters, Different testing methods, Principle of operation of synchronous generator, Phasor Diagram, Voltage Regulation, Method of Starting, Equivalent Circuit and Phasor diagram of synchronous motor, Construction of V curve and inverted V curves.

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

CO1: remember the Construction, principle and efficiency of synchronous machines and different DC machines
CO2: understand the armature reaction and characteristics of DC machines and Synchronous machines
CO3: apply phasor diagram to find the voltage regulation of a Synchronous generators
CO4: analyze the concepts of equivalent circuit and power flow diagram of synchronous motors
CO5: evaluate the V and the inverted V curves of synchronous motors
CO6: elaborate the power angle equations for the salient and cylindrical rotor synchronous motors

Topics:
- DC Generator
- DC Motor
- Synchronous Generator
- Three Phase Synchronous Motor

Textbook(s):
1. Electrical Machinery by P. S Bimbhra, 7th Edition, Khanna Publishers, 2008.
2. Electrical Machines by P. Purkait and I. Bandyopadhyay, Oxford University Press, 1st Edition 2017.
3. Electric Machinery by E. Fitzagerald, C. M. Kingsley (Jr) and S. D. Umans, McGraw Hill,6th Edition 2003.

Reference Book(s):
1. Electrical Machines by Ashfaq Hussain, Dhanpat Rai, Delhi, 2nd Edition, 2008.
2. Electric Machines by C. I. Hubert, , Pearson Education, 2nd Edition, 2003.
3. A Text Book of Electrical Technology, Vol. –II, AC and DC Machines, by B. L Theraja, A. K Theraja, S. Chand and Sons,23rd Edition , 2006.

EE 2022 Signals and System

Credit: 3
Category: PCC
Prerequisite(s): Mathematics II (MA 1004)

Course Description:

Classification of Signals, Types of Signals, Linear and Nonlinear, Time variant and invariant, Causal and non- causal, Static and dynamic, Stable and unstable system, LTI System, Cross Correlation and Auto Correlation of signals, Fourier series, Fourier transform of arbitrary signal and of standard signals, Z–Transforms, Properties of Z-transforms, Region of Convergence , Distinction between Laplace, Fourier and Z Transforms.

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

CO1: define various signals
CO2: understand continuous and discrete linear time invariant system
CO3: apply the signals through convolution and correlation techniques
CO4: analyze the time domain responses of LTI systems
CO5: assess the convergence of Z-transforms
CO6: discuss the applications of Sampling theorems

Topics:
- Introduction
- Continuous and Discrete Linear Time Invariant System
- Fourier Series and Fourier Transform
- Sampling

Textbook(s):
1. Signals and Systems by A.V. Oppenheim, A.S. Willsky and S.H. Nawab, 2nd Edition, Pearson, 2015.
2. Signals and Systems by Simon Haykin and Van Veen, Wiley, 2nd Edition,2002

Reference Book(s):
1. An Introduction to Signals and Systems, by John Alan Stuller, Cengage Learning, 1st Edition,2007.
2. Signals & Systems Analysis using Transform Methods & MATLAB, by M.J.Roberts, McGraw Hill,3rd Edition, 2007.
3. Principles of Linear Systems and Signals, by B. P. Lathi, Oxford. 2nd Edition, 2009,
4. Signals and Systems by J B Gurung, PHI,1st Edition, 2009.
5. Signals and Systems by T K Rawat, Oxford University Press,1st Edition, 2010.
6. Signals & Systems – Continuous and Discrete, by R.E.Zeimer, W.H.Tranter and R.D.Fannin, Pearson, 2007.

EE 2024 Generation, Transmission and Distribution of Electric Power

Credit: 4
Category: PCC
Prerequisite(s): Electrical Circuit Analysis (EE 2015)

Course Description:

Generation of Electric Power from Thermal, Hydro and Nuclear Power plant, Calculation of Line constants, Analysis of short, medium and long Transmission Line, Ferranti effect, Surge Impedance Loading, Sag and Stress calculation, different Insulators, String Efficiency, corona, Types, construction and Grading of Cables, Classification of distribution system, Load curve, Load duration curve, different factors, Classification and types of Substation, Equipment used, Bus-bar arrangement.

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

CO1: remember the operation of conventional generating stations
CO2: outline the utility of the circuit parameters of transmission lines
CO3: analyse the transmission line performance
CO4: examine mechanical design of transmission line
CO5: evaluate the performance analysis of different distribution system
CO6: elaborate the economic aspects of power plants and components of substation

Topics:

- Generation of Electric Power
- Transmission of Electric power
- Line constants
- Performance of Transmission line
- Mechanical Design of over head transmission lines
- Corona
- Distribution Systems
- Economics Aspects and Substation

Textbook(s):

1. Electrical Power System, by C.L. Wadhwa, New Age International (P) Limited, Publishers, 7th Edition, 2009.
2. A Text Book on Power System Engineering, by A. Chakrabarti, M.L. Soni, P.V. Gupta and U.S. Bhatnagar, Dhanpat Rai and Co., 2nd Edition,Reprint 2012.

Reference Book(s):

1. A Course in Power System, by J. B. Gupta, S K Kataria and Sons Publishers and Distributors,2013th Edition, 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, 3rd Revised Edition 2012.
4. Elements of Power System Analysis, by W.D. Stevenson Jr, MGH, 4th Edition, 1982.
5. Overhead Power lines planning, design and construction, by F Kiessling, P Nefzger, J F Nolasco and U Kaintzyk, Springer- Verlag,1st Edition.

EE 2026 Power Electronics

Credit: 4
Category: PCC
Prerequisite(s): Analog Electronic Circuits (EE 2013)

Course Description:

Elements of Power Electronics, Thyristor characteristics, Power BJT, Power MOSFET and IGBT, Controlled rectifiers, with R, R-L, R-L-E load and effect of freewheeling diode, Dual converters, Effect of source Inductance, 3-phase half wave and full wave controlled rectifiers, Chopper operation, Buck, Boost and Buck-Boost converters,
fly back converter, voltage commutation, Current commutation, Load commutation, Single phase Half Bridge and Full bridge inverters, Sinusoidal pulse width Modulation, Voltage regulator with R and RL load, Cyclo-converter with R-L Load, concept of 3-phase Cyclo-converter.

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

CO1: remember the working principles of various power electronic semiconducting devices
CO2: interpret the concepts of single phase and three phase controlled rectifiers
CO3: apply the semiconducting devices for the control of single phase and three phase Inverters
CO4: compare different topologies of DC to DC converters
CO5: evaluate the performance analysis different types of converters
CO6: choose a proper converter configuration for industrial suitability

Topics:
- Power Electronics Devices
- AC to DC Converters
- DC to DC Converters
- DC to AC Converters
- AC to AC Converters

Textbook(s):
1. Power Electronics by M. H. Rashid, Pearson Education, 3rd Edition, 2009.
2. Elements of Power Electronics, by Philip T. Krein, Oxford University Press, 2nd Edition,25 Sept 1997.
3. Power Electronics, by P S Bhimbra, Khanna Publishers, 5th Edition, 2011.

Reference Book(s):
1. Power Electronics, Converters, Applications and Design, by N. Mohan, Undeland and Robbins, John Wiley and Sons , 3rd Edition ,2009.
2. Modern Power Electronics by P. C Sen, S Chand Publisher,1stEdition- 2013.
3. Power Electronics, by K.R.Varmah and Chikku Abraham, Cengage Learning Publications,1st Edition, 2014.
4. Power Electronics, by M. D. Singh and K.B. Khanchandani, Tata McGraw - Hill publishers, 2nd edition, 2008.

EE 2028 Linear Control System

Credit: 3
Category: PCC
Prerequisite(s): Analog Electronic Circuits (EE 2013), Signals and System (EE 2022)

Course Description:

Open loop and closed loop control system, Mathematical modeling of mechanical system and electrical system,
Transfer function from signal flow graph using Mason's gain formula, Time response of first and second order system, Minimization of Errors through P, PI and PID controllers, Routh- Hurwitz stability criterion, Construction of Root Locus and rules, Polar plots, Bode plots, Nyquist stability criterion, Concept of state, State variable, State model for LTI system, Lag, Lead and lag lead compensators.

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

CO1: recall the terminology of control systems
CO2: understand the mathematical model of physical systems
CO3: apply the concepts of time domain analysis of different systems
CO4: analyze the stability of a system by classical methods
CO5: analyze frequency domain response and different compensators
CO6: discuss about the state space modeling of different systems

Topics:
- Introduction to Control System
- Modeling of Physical System
- Time Domain Analysis
- Concept of Stability
- Root Locus Technique
- Frequency Domain Analysis
- Compensators
- State Space Analysis

Textbook(s):
1. Control System Engineering, by Noran S Nise, John Wiley Publication, 6th Edition, 2012.
2. Modern Control Engineering, by K. Ogata PHI publication, 5th Edition, 2010.

Reference Book(s):
1. Control Systems Engineering ,by R. Anandnatarajan and P. Ramesh Babu, SCITECH,4th edition, 2016.
2. Control Systems: Theory and applications, by Smarajit Ghosh, Pearson. Publication ,2nd Edition,2012
3. Automatic control system, by Hasan Saeed, S.K. Kataria and Sons, 6th revised edition 2008
4. Modern Control Engineering, by D. Roy Choudhury PHI publication, 5th Edition,2009.
5. Automatic Control Systems, by Benjamin C. Kuo, Prentice-Hall,7th Edition,2009.
6. Control System Engineering, by I. J. Nagrath and M Gopal ,New age international publication, 4th Edition,2011.
7. Control System, by D N Manik, Cengage Learning India Pvt, 1st Edition,2012.
8. Automatic control systems, by Prof. B.S. Manke and S. N. Verma , Khanna publication,5th Edition, 2012.

EE 2091 Network and Electronics Circuit Laboratory

Credit: 1
Category: PCLC
Prerequisite(s): Basic Electrical Engineering Laboratory (EE 1093)

Course Description:

The main objective of the Network & Electronics Circuit laboratory is to design & verify different electrical & electronics circuits. It helps in measurement of current flowing through and voltage across different elements. It allows the students to verify different characteristics of electrical and electronic circuits. It enhances the ability of students to verify Thevenin's theorem, Maximum power transfer theorem, Two port network, series and parallel resonance and to design Schmitt trigger circuit, Active high pass & low pass filter with the help of variac, oscilloscope, function generator, DSO, multimeter etc.

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

CO1: remember the ways to measure single phase power using phase angle
CO2: understand the utility of Maximum power transfer and Thevenin's theorem
CO3: apply circuit concepts to find parameters for a two-port network and to check resonance condition in series and parallel circuiT
CO4: analyse line regulation and load regulation in a voltage regulator circuit using zener diode
CO5: assess the conditions of oscillations in a RC phase shift oscillator and to design Schmitt trigger circuit
CO6: design Active Low pass and High pass Filter and find cutoff frequencies

Topics:

- Verification of Maximum power transfer & Thevenin's theorem
- Verification of Two-port network & RLC resonance circuit
- Determination of line & load regulation using Zener diode
- Study of an RC phase shift oscillator and find its frequency of oscillation
- Design of Schmitt trigger circuit, Active Low Pass & High Pass Filter using op-amp

Textbook(s):

1. Fundamentals of Electric Circuits 4th Edition, by Charles K. Alexander, Matthew N.O. Sadiku, Mcgraw-Hill, 2009.
2. Circuit Theory, Analysis and Synthesis, by A. Chakrabarti, Dhanpat Rai Publishing Company (P)
   Limited, 5th Edition, 2008.

Reference Book(s):

1. Network Analysis 3rd Edition, by M.E. Van Valkenburg, Pearson Education, 2006.
2. Basic Circuit Analysis (Second Edition) John O'Malley, Schaum's Outlines, Tata McGraw-Hill, 2010 (Reprint)

EE 2092 Electrical Measurements Laboratory

Credit: 1
Category: PCLC
Prerequisite(s): Basic Electrical Engineering Laboratory (EE 1093)

Course Description:

The main objective of the Electrical Measurements laboratory is to provide the practical exposure to the student regarding operation of various electrical measuring instruments like ammeters, voltmeters, wattmeter, energy meters, transducers, bridge circuits, CROs, etc. Students are allowed to conduct various experiments for the understanding and knowing about measuring different electrical parameters. From this laboratory courses student will gain the skill to select correct measuring instrument for a specific application.

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

CO1: remember the utilities of various Electrical Measuring instruments
CO2: comprehend working principle, applications and characteristics of different electrical and electronic instruments for measurement
CO3: apply the measuring techniques in displacement, temperature transducers
CO4: analyse errors of electrical Measurements System
CO5: evaluate the choice of appropriate instruments for various electrical measurands
CO6: elaborate about the safety precautions while using electrical equipment

Topics:

- Measurement of Resistance by Wheatstone Bridge
- Measurement of Capacitance by Schering Bridge
- Measurement of Self-Inductance by Anderson's Bridge
- Active and reactive power measurement using two and single wattmeter method respectively
- To study and measure displacement using LVDT
- To be familiarized with phantom loading used for calibration of a wattmeter
- Measurement of phase angle and power factor for different category of loads using CRO

Textbook(s):

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(s):

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 Measurement and Measuring Instruments by Arthur Harris, Intelliz press, ISBN: 978-1-6825/-382-8/2018.

EE 2094 Digital Circuits Laboratory

Credit: 1
Category: PCLC
Prerequisite(s): Network and Electronics Circuit Laboratory (EE 2091)

Course Description:

The main objective of the Digital Circuits laboratory is to learn and understand the basic concepts of digital electronics. Students will be able to design basic logic circuits using different gates (AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR); combinational circuits like adder, subtractor, decoder, multiplexer, demultiplexer; sequential circuits like synchronous counters, asynchronous counters, shift registers. From this laboratory course students will be able to analyze & design digital circuits for a specific application.

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

CO1: recall the need and importance of Digital Circuit design
CO2: explain the digital circuits using Boolean algebra and K-maps
CO3: execute different combinational circuits
CO4: differentiating multiplexer and demultiplexer using logic gates
CO5: checking the operation of synchronous & asynchronous counters using different flip-flops
CO6: design different types of shift registers

Topics:

- Verification & implementation of different gates using universal gates
- Realization of adder & subtractor circuits
- Implementation of MUX & DEMUX using logic gates
- Design of synchronous & asynchronous counters using flip-flops
- Design of shift registers

Textbook(s):

1. Fundamentals of Digital Circuits by A.Anand Kumar - PHI, 4th Edition, 2017.
2. Digital Logic and Computer Design by M. Morris Mano - PHI, 2011.

Reference Book(s):

1. Digital Fundamentals by T.L. Floyd & Jain -Pearson Education, 10th Edition, 2011.
2. Digital Principles and Applications by Malvino & Leach -TMH, 7th Edition, 2011.

EE 2096 Electrical Machines Laboratory

Credit: 1.5
Category: PCLC
Prerequisite(s): Basic Electrical Engineering Laboratory (EE 1093)

Course Description:

The main objective of the Electrical machines laboratory is to provide the practical exposure to the student regarding operation of various electrical machines like DC generators, DC Motors, Alternators, Synchronous motors, Induction Motors, Special Motors and Transformers. Students are allowed to conduct various experiments for the validation of performance characteristics of all the machines. From this laboratory courses student will gain the skill to select correct machine for a specific application.

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

CO1: memorize the working principle and applications of different electrical machines
CO2: understand the challenges in industrial applications of electric motors
CO3: utilize different electrical machines
CO4: analyse different electrical machine according to the requirement in the industrial applications.
CO5: assess the safety precautions to be taken while using electrical equipment
CO6: design the equivalent circuit of the transformer and construct the circle diagram of an induction motor

Topics:

- No Load and Load Characteristics of a (i) D.C Shunt Generator and (ii) Separately Excited Generator
- Design of the equivalent circuit by using the open circuit and short circuit test on a single phase Transformer
- Determination of the voltage regulation of a three phase alternator using the Open circuit and short circuit test
- Design of the circle diagram using the No load and Block rotor test on three phase induction motor

Textbook(s):

1. Electrical Machinery, P. S Bimbhra, 7th Edition, Khanna Publishers, 2008.
2. Electrical Machines, by P. K. Mukherjee and S. Chakravorti, Dhanpat rai Publication, 18th reprint 2013

Reference Book(s):

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 2097 Power Convertor Laboratory

Credit: 1
Category: PCLC
Prerequisite(s): Basic Electrical Engineering Laboratory (EE 1093)

Course Description:

This laboratory deals with different power convertor which utilities the Power Electronic Converters are introduced. The AC-DC converters are examined in details with R and RL loads. Analysis of DC-DC converters are done so that experimental verification can be facilitated. The principle of chopper is applied in the Fly-Back Converters for SMPS. The waveforms and the output voltage equation of SMPS are experimentally verified.

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

CO1: choose an appropriate converter for variety of needs
CO2: comprehend the principles of operation of various converters
CO3: apply AC-DC converters for rectification
CO4: analyze the parameters and the waveforms of the output of the converters
CO5: assess the efficacy of a converter
CO6: discuss about the merits and demerits of the converters

Topics:

- Study of output voltage waveforms and parameters of three phase uncontrolled rectifier
- Study of single phase fully controlled AC-DC converter with R and RL laod
- Verify the performance of DC-DC Buck-Boost converters
- Verify the performance of Fly-Back Converters for SMPS

Textbook(s):

1. Power Electronics by M. H. Rashid, Pearson Education, 3rd Edition, 2009.
2. Elements of Power Electronics, by Philip T. Krein, Oxford University Press, 25 Sept 1997.
3. Power Electronics, by P S Bhimbra, Khanna Publishers, 5th Edition, 2011.

Reference Book(s):

1. Power Electronics, Converters, Applications and Design, by N. Mohan, Undeland and Robbins, John Wiley and Sons , 3rd Edition ,2009.
2. Modern Power Electronics by P. C Sen, S Chand Publisher- 2013.
3. Power Electronics, by K.R.Varmah and Chikku Abraham, Cengage Publications- 2014.
4. Power Electronics, by M. D. Singh and K.B. Khanchandani, Tata McGraw - Hill publishers, 2nd edition, 2008.

EE 2098 Power Electronics Laboratory

Credit: 1.5
Category: PCLC
Prerequisite(s): Basic Electrical Engineering Laboratory (EE 1093)

Course Description:

Utilities of Power Electronic Converters are introduced. The AC-DC converters are examined in details with R and RL loads. Analysis of DC-DC converters are done so that experimental verification can be facilitated. The principle of chopper is applied in the Fly-Back Converters for SMPS. The waveforms and the output voltage equation of SMPS are experimentally verified.

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

CO1: choose an appropriate converter for variety of needs
CO2: comprehend the principles of operation of various converters
CO3: apply AC-DC converters for rectification
CO4: analyze the parameters and the waveforms of the output of the converters
CO5: assess the efficacy of a converter
CO6: discuss about the merits and demerits of the converters

Topics:

- Study of output voltage waveforms and parameters of three phase uncontrolled rectifier
- Study of single phase fully controlled AC-DC converter with R and RL laod
- Verify the performance of DC-DC Buck-Boost converters
- Verify the performance of Fly-Back Converters for SMPS

Textbook(s):

1. Power Electronics by M. H. Rashid, Pearson Education, 3rd Edition, 2009.
2. Elements of Power Electronics, by Philip T. Krein, Oxford University Press, 25 Sept 1997.
3. Power Electronics, by P S Bhimbra, Khanna Publishers, 5th Edition, 2011.

Reference Book(s):

1. Power Electronics, Converters, Applications and Design, by N. Mohan, Undeland and Robbins, John Wiley and Sons , 3rd Edition ,2009.
2. Modern Power Electronics by P. C Sen, S Chand Publisher- 2013.
3. Power Electronics, by K.R.Varmah and Chikku Abraham, Cengage Publications- 2014.
4. Power Electronics, by M. D. Singh and K.B. Khanchandani, Tata McGraw - Hill publishers, 2nd edition, 2008.

EE 2099 Energy Conversion Laboratory

Credit: 1
Category: PCLC
Prerequisite(s): Basic Electrical Engineering Laboratory (EE 1093)

Course Description:

The main objective of the Electrical Energy Conversion laboratory is to provide the practical exposure to the student regarding operation of various electrical machines like DC generators, DC Motors, Alternators, Synchronous motors, Induction Motors, Special Motors and Transformers. Students are allowed to conduct various experiments for the validation of performance characteristics of all the machines. From this laboratory courses student will gain the skill to select correct machine for a specific application.

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

CO1: memorize the working principle and applications of different electrical machines
CO2: understand the challenges in industrial applications of electric motors
CO3: utilize different electrical machines
CO4: analyse different electrical machine according to the requirement in the industrial applications
CO5: assess the safety precautions to be taken while using electrical equipment
CO6: design the equivalent circuit of the transformer and construct the circle diagram of an induction motor

Topics:

- No Load and Load Characteristics of a (i) D.C Shunt Generator and (ii) Separately Excited Generator
- Design of the equivalent circuit by using the open circuit and short circuit test on a single phase Transformer
- Determination of the voltage regulation of a three phase alternator using the Open circuit and short circuit test
- Design of the circle diagram using the No load and Block rotor test on three phase induction motor

Textbook(s):

1. Electrical Machinery, P. S Bimbhra, 7th Edition, Khanna Publishers, 2008.
2. Electrical Machines, by P. K. Mukherjee and S. Chakravorti, Dhanpat rai Publication, 18th reprint 2013

Reference Book(s):

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 3002 Power System Operation and Control

Credit: 4
Category: PCC
Prerequisite(s): Generation, Transmission and Distribution of Electric Power (EE 2024), Linear Control System (EE 2028)

Course Description:

Bus classification, Nodal Admittance matrix, Formulation of load flow problem, Optimal operation of generators, Distribution of load on various generating units, Symmetrical components, Symmetrical and Unsymmetrical Fault analysis, Modeling of speed governing system, Steady state analysis, Dynamic response, Excitation system, Dynamics of synchronous machines, Swing equation, Equal area criterion, Effect of clearing time on stability.

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

CO1: understand the automatic generation control
CO2: classify different Power system faults
CO3: solve load flow problems
CO4: analyze economic operation of power system generation
CO5: apply various types of power system stability concept
CO6: elaborate the concepts of generation control and voltage control

Topics:
- Load Flow Analysis
- Economic Operation of Power Generation
- Symmetrical and Unsymmetrical Fault Analysis
- Automatic Generation and Voltage Control
- Stability Analysis

Textbook(s):
1. Modern Power System Analysis, I. J. Nagrath, D. P. Kothari, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 3rd Edition, 2003.
2. Power System Analysis- By John. J. Grainger & W. D. Stevenson, Jr., MGH, 2003 ,4th Edition, (15th Reprint).

Reference Book(s):
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, 2010, PHI Learning Private Limited

EE 3004 Electromagnetic Field

Credit: 3
Category: PEC
Prerequisite(s): Mathematics – II (MA 1004), Physics (PH 1007)

Course Description:

Rectangular, Cylindrical and Spherical Coordinate Systems, Coulomb's Law, Gauss's law, Maxwell's Equation, Uniqueness Theorem, Poisson's and Laplace Equation, Energy stored in magnetic field, Magnetic forces, Biot-Savart's law, Moving conductor in a static magnetic field, Faraday's law, Wave propagation in lossless dielectric, Reflection and Refraction in plane wave, Transmission-line equations.

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

CO1: choose appropriate coordinate system for the study of vector calculus
CO2: comprehend the different laws in static electric field
CO3: apply the knowledge of electromagnetics in the study of electric fields in different materials
CO4: analyze the concepts of Steady Magnetic Fields
CO5: apply Maxwell's equation for both static and time varying fields
CO6: elaborate the electromagnetic waves and transmission lines

Topics:
- Coordinate Systems and Vector analysis
- Static Electrical Field
- Dynamic Electric Field
- Static Magnetic Field
- Time Varying Magnetic Field
- Electromagnetic Waves and Transmission Line

Textbook(s):
1. Engineering Electromagnetic by W.H. Hayt & John A. Buck, 7th Edition TMH, 2006
2. Elements of Electromagnetic by M. N. O Sadiku, 4th Edition, Oxford, 2010.

Reference Book(s):
1. Electromagnetic waves and radiating Systems E.C Jordan & Balmin, 2nd Edition, PHI,2009
2. C. R. Paul, K.W. Whites, S. A. Nasor, Introduction to Electromagnetic Fields, 3rd Edition, TMH, 2011
3. Electromagnetic Field Theory by S. Salivahanan & S Karthie, Vikas Publishing House (S.Chand), 1stEdition, 2016.
4. Electromagnetic Field Theory by Rohit Khurana, Vikas Publishing House (S.Chand),1st Edition 2015

EE 3006 Electric Drives and Control

Credit: 3
Category: PEC
Prerequisite(s): DC Machines and Synchronous Machines (EE 2020), Power Electronics (EE 2026)

Course Description:

Four quadrant operation of an electric drive, Modification of characteristics of DC shunt and series motors, Concept of Electric Braking, Open loop, Closed loop speed control, Hysteresis controller, Chopper and rectifier based DC Separately excited motor and series motor drive control, characteristics of three phase Induction motors, Electric Braking of Induction Motors, Regenerative Braking, DC Dynamic braking, Plugging, Slip Power recovery scheme, PWM Voltage Source Inverter fed induction motor drives, Current source inverter fed induction motor drives, Comparison of VSI and CSI fed drives, Permanent magnet AC motor drives, Sinusoidal PMAC motor drives, Brushless DC motor Drives.

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

CO1: spell the need of Electric Drives in the industry
CO2: understand the characteristics and braking techniques of DC Motor Drives
CO3: apply the knowledge of drives for the Control of DC Motor Drives
CO4: analyze the characteristics of Induction Motor Drives
CO5: analyse the different speed control techniques for various industrial drives
CO6: discuss about the performance of Synchronous Motors and Brushless DC motor drives

Topics:

- Introduction to Electric Drive System
- D Motor Drives .
- Control of DC Motor Drives
- Solid State Control of DC Drive
- Induction Motor Drives
- Speed Control of Induction Motors
- Synchronous and Brushless DC Motor Drives

Textbook(s):

1. G.K. Dubey, Fundamentals of Electric Drives, Second Edition, Narosa Publishers, 2007.
2. S. K. Pillai: A First Course on Electrical Drives, New Age International Publishers, 2nd Edition, 2007.

Reference Book(s):

1. Bimal K. Bose, Power Electronics and Motor Drives: Advances and Trends, Academic Press, Har/Cdr edition (13 September 2006).
2. N. K. De, P. K. Sen: Electric Drives, PHI Learning Pvt. Ltd., 7th Edition, 2004.
3. Modern Power Electronics and AC Drives by Bimal. K. Bose, PHI Publisher, 1st Edition, 2013.
4. S.A. Nasar, Boldea , Electrical Drives, CRC Press, Second Edition, 2006
5. M. A. El-Sharkawi , Fundamentals of Electrical Drives , Thomson Learning, 1st Edition, 2000.
6. R. Krishnan, Electrical Motor Drives, PHI, Second Edition ,

EE 3007 Power Transmission and Distribution

Credit: 3
Category: PEC
Prerequisite(s): Electrical Circuit Analysis (EE 2015)

Course Description:

Comparison of AC and DC transmission, Resistance, Inductance of Single phase and three phase line with symmetrical and unsymmetrical spacing, Analysis of short, medium and long Transmission Line, Ferranti effect, Surge Impedance Loading, Corona and Corona Power losses, Types of conductor and insulator, String Efficiency, Sag and Stress calculation, Type, Construction and Grading of cables, Classification of distribution system, Economic choice of conductor, Kelvin's law.

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

CO1: remember the concepts of Complex Power, Per Unit System and Power System layout
CO2: understand the AC and DC Transmissions of Power Supple Systems
CO3: apply the knowledge of power transmission to find the Line Constants
CO4: analyze the Performance of Transmission Lines and examine the effects of Corona
CO5: analyse the performance of Underground Cables and Distribution Systems
CO6: elaborate the Mechanical Design of Overhead Transmission Lines

Topics:
- Introduction to Supply System
- Line Constants
- Performance of Transmission Line
- Corona
- Mechanical Design of Over Head Transmission Lines
- Underground Cable
- Distribution System

Textbook(s):
1. Electrical Power System, C.L. Wadhwa, New Age International (P) Limited, Publishers, second Edition, 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., 2nd Edition,Reprint 2012.

Reference Book(s):
1. A Course in Power System, J. B. Gupta, S K Kataria and Sons Publishers and Distributors, 2013th Edition,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, 3rd Edition, 2012.
4. Elements of Power System Analysis, W.D. Stevenson Jr, MGH, 4th Edition,1982.
5. Overhead Power lines planning, design and construction, by F Kiessling, P Nefzger, J F Nolasco and U Kaintzyk, Springer- Verlag, 1st Edition,2003

EE 3008 Power System Protection

Credit: 3
Category: PCC
Prerequisite(s): Generation, Transmission and Distribution of Electric Power (EE 2024)

Course Description:

Philosophy of protection, Basic elements in protective scheme, Principle of AC and DC arc interruption, Recovery voltage, Re-striking voltage, Current chopping, Types of circuit breakers, Arc extinction methods, Principle, Characteristics of H.R.C fuse, Method of grounding, Differential protection scheme of alternator, Differential protection scheme of transformer, Differential scheme for Bus Bar Protection, Time graded feeder protection, Circulating current and Merz-Price protection, Surge diverters.

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

CO1: remember the need of protective devices in power system
CO2: explain the classification of different AC and DC Circuit Breakers
CO3: apply the knowledge of Circuit Breakers, protective Elements and Earthing for the Alternator Protection
CO4: analyze the practices of Transformer Protection and Bus Bar Protection
CO5: analyse the protection technique used for Feeder
CO6: discuss about the Surge Protection

Topics:
- Circuit Breakers
- Protective Elements
- Earthing
- Alternator Protection
- Transformer Protection
- Bus Bar Protection
- Feeder protection
- Pilot Wire Protection
- Protection against Surges

Textbook(s):
1. Fundamentals of Power System Protection", Y. G. Paithankar, S. R. Bhide, 2nd edition, Prentice Hall of India Private Limited, New Delhi, 2011.
2. Power System Protection and Switchgear by B Rabindranath and M Chander , Wiley Eastern 2017, 2nd Edition.

Reference Book(s):
1. A Course in Power Systems, J. B. Gupta, S. K. Kataria and Sons Publishers and Distributors, 2013th Edition,2009.
2. Principles of Relaying", Van Warrington, Y. G. Paithankar. PHI,1st Edition, 2009.
3. Power system Switchgear and Protection N.Veerappan and S R Krishnamurthy, S Chand Publication, 1st Revised edition 2013.
4. Power system Protection and Switchgear, Badri Ram and D N Vishwakarma McGraw Hill, 2nd reprint 2012
5. Electrical Power System, C.L. Wadhwa, New Age International (P) Limited,, second Edition , 2009.

EE 3013 Microprocessor and Interfacing

Credit: 3
Category: PCC
Prerequisite(s): Digital Circuits (EE 2018)

Course Description:

8085 microprocessor architecture, Instruction sets, 8086 microprocessor architecture, Addressing modes, 8086 instructions, Assembly language programming, Architecture of 8051 microcontroller, Instruction-sets, 8051 assembly language programming, AVR Microcontroller architecture, Addressing modes of AVR, Assembly language programs, ADC, DAC interfacing, Digital PID controller implementation using microcontroller.

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

CO1: remember the history and architecture of 8085 and 8086 Microprocessors
CO2: explain assembly language programs in 8085 and 8086 Microprocessors
CO3: apply the assembly language for programming of 8051 Microcontroller
CO4: analyze the building of AVR Mirocontrollers
CO5: analyze the different programs of AVR microcontrollers
CO6: discuss about the Industrial Applications of Microprocessor and Microcontrollers

Topics:
- 8085 & 8086 Microprocessors
- 8051 Microcontrollers
- AVR Microcontrollers
- Industrial Application of Microprocessors and Microcontrollers

Textbook(s):
1. B. Ram, “Fundamentals of Microprocessors and Microcontrollers ", 7th Edition, Dhanpat Rai publications, 2010.
2. Muhammad Ali Mazidi, Sepehr Naimi,"Sarmad Naimithe AVR Microcontroller And Embedded Systems Using Assembly and C" PHI,1st Edition, Inc, 2017.

Reference Book(s):
1. R. Theagarajan "Microprocessors and Microcontrollers"-1st Edition, SCITECH publications (India) Private limited, 2004.
2. Desmukh , "Microcontrollers –Theory and Application"- 1st Edition, TMH Publication, 2005.
3. A. P. Mathur, "Introduction to microprocessors" e-TMH Publication – 3rd edition, 2011
4. Md. Rafiquzzaman, "Microprocessors & Microcomputer based System Design",2nd edition,1995.
5. Prof. S. K. Venkat Rama, "Advanced Microprocessor & Microcontrollers" Laxmi Publications- 1st edition,2004.
6. Udayashankara & M Mallikarjunaswamy, "8051 Microcontroller - Hardware, Software & Applications "TMH – 1st edition,2009.
7. M. A. Mazidi, "The 8051 Microcontroller & Embedded Systems" Pearson – 2nd edition, 2011.

EE 3015 Discrete Signal Processing

Credit: 3
Category: PEC
Prerequisite(s): Signals and System (EE 2022)

Course Description:

Terminology related to signals and systems, Discrete Time Signals and classification, LTI systems Linear convolution sum and de-convolution, Properties of convolution, 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, Introduction to Digital Filter, Design of IIR filters.

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

CO1: remember the terminology of Signals and Systems
CO2: understand the properties and applications of Convolution
CO3: apply the correlation techniques to the signals in discrete time domain
CO4: analyze the frequency response and the Z-transform of discrete-time signals and Systems
CO5: analyse the Discrete Fourier transform of Discrete-Time signals
CO6: design FIR and IIR Filters employing various windows

Topics:
- Terminology
- Discrete time Signals & Systems
- Discrete Fourier Transform
- Digital Filters

Textbook(s):
1. Digital Signal Processing by T. K. Rawat, Oxford Publication 1st Edition
2. Signals & Systems: Alan V. Oppenheim & Schafer-2nd Edition 2011 Pearson, 1997.

Reference Book(s):
1. Digital Signal Processing – J.G.Proakis and D.G.Manolakis , 4th Edition-PHI,2014.
2. Principle of Signal Processing and Linear System: B. P. Lathi, First Edition, Oxford University Press.
3. Digital Signal Processing: P. Ramesh Babu: Scitech, 4th Edition, 2009.

EE 3016 Power Carrier Communication System

Credit: 3
Category: PCC
Prerequisite(s): Signals and System (EE 2022)

Course Description:

Brief idea of noise and signal to noise ratio, Properties of Fourier transform and Fourier series, Principle of AM, Side Bands, Power Relationship, Assignable Frequency spectrum, Sideband Transmission, DSB, SSB, VSB, Balanced Modulation, Principle of FM, Frequency Deviation, Spectrum of FM wave, Sampling Process, Pulse Amplitude Modulation, Time Division Multiplexing, Frequency Division Multiplexing the Quantization Process, Data Form, Principles involved in ASK, PSK, BPSK, QPSK, WAN, WPAN, LAN and their Standardization, Satellite communication.

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

CO1: remember the Communication-Signal-Properties
CO2: distinguish between analog and digital modulation techniques
CO3: evaluate pulse modulation and demodulation technique
CO4: analyze different digital modulation techniques
CO5: assess the architecture of communication (Wide Area Network) Network in electric grid
CO6: examine the basic techniques in wireless and wire line communication in electric grid

Topics:

- Communication Signal Properties
- Amplitude and Angle Modulation
- Pulse Modulation
- Digital Modulation
- Modern Communication in Electrical Grid

Textbook(s):

1. Modern Digital And Analog Communication Systems by B P Lathi and Zhi Ding, Oxford publication, 4th edition, 2017
2. Smart Grid Applications, Communications, and Security, by Lars T. Berger, Krzysztof Iniewski, John Willey publication, 1st Edition, 2012.

Reference Book(s):

1. Synchronized Phasor Measurements and Their Applications, by Arun G. Phadke and James S. Thorp, Springer international,2nd Edition, 2018.
2. The Smart Grid; Enabling Energy Efficiency and Demand Response, by Clark W. Gellings, CRC Press; 1st edition (August 21, 2009).
3. Communication System, Simon Haykin, Wiley Publication; 4thedition (2006).

EE 3017 Renewable Energy Sources

Credit: 3
Category: PCC
Prerequisite(s): Basic Electrical Engineering (EE 1003)

Course Description:

Classification and Importance of Non-Conventional Energy Sources, Solar Radiations Measurement, Solar Cell Characteristics, Solar Cell Classification, Maximum Power Point Tracker (MPPT), Wind Turbine Sitting, Major Application of Wind Power, Wind Turbine Construction, Biomass Resources, Biomass Conversion Technologies, Urban Waste to Energy Conversion, Biomass Gasification, Liquefaction, Ethanol Production, Geothermal Energy, Types of Geothermal Resources, Exploration and Development of Geothermal Resources, Ocean Thermal Electric Conversion (OTEC) systems, Energy from tides, Limitation and scope of tidal energy, Wave energy conversion Devices, Principle of working of various types of fuel cells and their working, Performance and limitations, MHD generation principles.

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

CO1: define the fundamentals of Energy
CO2: explain the concept of Solar Thermal and Photovoltaic Systems
CO3: utilize Wind Energy Systems for the benefit of mankind
CO4: analyze Biomass Energy Resources
CO5: understand the operation of Geothermal Energy and Ocean Energy Systems
CO6: know the principles of Fuel Cells

Topics:
- Fundamentals of Energy
- Basics of Solar Energy, Solar Thermal and Photovoltaic Systems
- Basics of Solar Energy
- Wind and Biomass Energy
- Geothermal and Ocean Energy
- Fuel Cells

Textbook(s):
1. B. H. Khan, “Non – Conventional Energy Resources” Tata Mc Graw Hill, 2nd edition 2009.
2. N. K. Bansal, Manfred Kleemann, Michael Meliss, “Renewable energy sources and conversion technology", Tata Mc Graw Hill,1st Edition, 1990.

Reference Book(s):
1. Kothari D.P., “Renewable energy resources and emerging technologies”, Prentice Hall of India Pvt. Ltd, 2nd Edition,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, 1st Edition Reprint 2003.

EE 3023 High Voltage Engineering

Credit: 3
Category: PEC
Prerequisite(s): Electromagnetic Field (EE 3004)

Course Description:

Electrical Insulation and Dielectrics, Generation of High Voltage AC –by Tesla coil, Resonant Circuits and Cascade Transformers, Generation of DC High Voltage, Van-de-Graff Generators, Generation and analysis of impulse Generator Circuit, Measurement using Electrostatic voltmeters, Indian Standard Specification for DC, AC, Bushings, Isolators and Circuit Breakers, Ionization process, General Characteristics of Gaseous Insulation, Experimental determination of ionization coefficients, Pashen's law, Conduction and Breakdown in Commercial liquids, Intrinsic, Electromechanical, Thermal, Treeing and Tracking, Breakdown in composite dielectric, Test facilities provided in High Voltage laboratories, Classification of High Voltage laboratories, Selection and Rating of HV test equipment.

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

CO1: define High Voltage Electric Field Strength
CO2: understand the measurement of High Voltage and Current & testing of High Voltage Apparatus
CO3: apply the knowledge of electric fields in Conduction and Breakdown of Gases
CO4: analyze the phenomena of Conduction and Breakdown in Liquid and Solid Dielectrics
CO5: assess the Operation of High Voltage laboratories
CO6: discuss the problems of Electromagnetic Interference

Topics:

- Electric Field Strength
- Generation of High Voltage and Currents
- Measurement of High Voltage
- High Voltage Testing of Electrical Apparatus
- Conduction and Breakdown in Gases
- Conduction and Breakdown in Liquid Dielectrics
- Breakdown in Solid Dielectrics
- Operation of High Voltage Laboratories

Textbook(s):

1. M. S. Naidu and V. Kamaraju, High voltage Engineering, McGraw Hill, 5th Edition ,1995.
2. J. Kuffel and W. S. Zaengl, High Voltage Engineering: Fundamentals, Newnes Publisher,2nd Edition, 2000.

Reference Book(s):

1. C.L. Wadhwa : High Voltage Engineering, 2nd Edition, New Age International, 2007.
2. Ravindra Arora and Wolfgang Mosch: High Voltage Insulation Engineering, Wiley,1st Edition, 2012.

EE 3024 Principle of Industrial Instrumentation

Credit: 3
Category: PEC
Prerequisite(s): Electrical and Electronics Measurements (EE 2019)

Course Description:

Functional units, Classification and Performance Characteristics, Dynamic calibration, Pressure, vacuum, sound pressure level, Temperature measurement, Electrical type temperature sensor, Flow Measurement, Level measurement, Different methods of gas analysis Liquid Analysers, X-ray method, Chromatography, Mass spectrography, Pneumatic means, Frequency Telemetering Modulation, Modulation of Digital data, Transmission channels, Vibration and expansion, flue gas analysis, Turbine monitoring and control, safety and process, Lubrication system for Turbo alternator, Turbo alternator cooling system, Display methods, Alarm annunciation, Data logging system.

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

CO1: describe the construction and working principle of different mechanical measurement systems
CO2: explain transducers based measuring system using suitable calibration
CO3: analyze instruments for gas analysis and liquid analysis
CO4: know the application of telemetry system
CO5: compare the operation of data logging systems, display methods and alarm annunciation
CO6: examine the dynamic behavior (characteristics) of power plant instruments

Topics:

- Characteristics of Measurement system
- Pressure, Temperature and Flow Measurement
- instruments for Analysis
- Telemetry
- Power Plant Instrumentation
- Display, Recording and Alarm Systems

Textbook(s):

1. Principle of Industrial Instrumentation, D Patranabis, Third Edition, McGraw Hill Education Private Limited, New Delhi, 2018.
2. Power Plant Instruments- K. Krishnaswamy, M. Ponnibala, PHI publication,1st Edition 2009.

Reference Book(s):

1. Power plant engineering-P. K. Nag, McGraw-Hill,4th Edition 2010.
2. Electrical and Electronic Measurements and Instrumentation by R K Rajput, S Chand- 4th edition, 2015
3. Introduction to Instrumentation and Measurement, by Robert B. Northrop, 3rd Edition, CRC Press, 2014.

EE 3027 Electrical Engineering Materials

Credit: 3
Category: PEC
Prerequisite(s): Basic Electrical Engineering (EE 1003), Physics (PH 1007)

Course Description:

Crystallization of materials, Dielectric properties of insulators in static fields, Spontaneous polarization, Piezoelectricity, Frequency dependence of the electric polarization, Ionic polarization as function of frequency, Magnetic properties of Materials, Lenz's Law and induced dipole moments, Magnetic dipole moment of a current loop, Some properties of ferromagnetic materials, Spontaneous magnetization and the Curie-Weiss Law, Classifying materials as semiconductors, General properties and specifications of pure copper and aluminum, Wiedemanm-Franz law, Different types of solders, Metals and alloys for different types of fuses, fusing, characteristics of different carbon and graphite brushes, arc-lamps and electric furnaces, Introduction to superconductivity.

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

CO1: recall the Aggregate of Atoms and atomic structures in molecules of various materials
CO2: explain the Behavior of Dielectrics in Alternating Fields
CO3: apply the knowledge of atomic structures in Classification of Magnetic Materials
CO4: analyze the Ferromagnetic, Antiferromagnetic and Semiconducting materials
CO5: assess the properties and characteristics of the Conducting Materials
CO6: discuss about the Nanomaterials and nanostructures

Topics:
- Atoms and Aggregate of Atoms
- Behavior of Dielectrics in Alternating Fields
- Classification of Magnetic Materials
- Conducting Materials

Textbook(s):
1. Electrical engineering Materials by R. K. Shukla & A. Singh, Tata Mc Grow-Hill Publishing Company Ltd, 1st Edition,New Delhi, 2010.
2. A course in Electrical engineering Materials by R K Rajput, Lakshmi Publication,1st Edition, 2016.

Reference Book(s):
1. Electronic Properties of Materials, by Rolf E Hummel, Springer (India) Pvt Ltd, New Delhi,4th Edition,2010.
2. Electrical Engineering Materials, by A.J. Dekker, Prentice-Hall of India Pvt Ltd, New Delhi, 1st Edition,2009.
3. Material Science, by M.S. Vijay & G. Rangarajan, McGrow-Hill Publishing Company Ltd New Delhi,1st Edition, 2011.

EE 3028 Power Electronic Circuits

Credit: 3
Category: PEC
Prerequisite(s): Analog Electronic Circuits (EE 2013)

Course Description:

Elements of Power Electronics, Thyristor characteristics, Power BJT, Power MOSFET and IGBT, TRIAC and DIAC Characteristics and applications, controlled rectifiers with R, R-L, R-L-E load and effect of freewheeling diode, Dual converters, Effect of source Inductance, 3-phase half wave and full wave controlled rectifiers Step up and Step Down choppers, 2^{nd} and 4^{th} quadrant choppers for control of DC motor, Switch Mode Power Supply, Fly back converter, Single phase Half Bridge and Full bridge inverters, Concept of multi level inverters, Cyclo-converter with R-L Load, Concept of 3-phase cyclo-converter.

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

CO1: remember the working principles of various power electronic semiconducting devices
CO2: interpret the concepts of single phase and three phase controlled rectifiers
CO3: apply the semiconducting devices for the control of single phase and three phase Inverters
CO4: compare different topologies of DC to DC converters
CO5: evaluate the performance analysis different types of converters
CO6: choose a proper converter configuration for industrial suitability

Topics:

- Introduction to Power Electronics
- Power Electronic Devices
- AC to DC Converters
- DC to DC Converters
- Switch Mode Power Supply SMPS
- Inverters
- AC to AC Converters

Textbook(s):

1. Power Electronics By M. H. Rashid, Pearson Education, 3^{rd} Edition, 2014.
2. Power Electronics by P S Bhimbhra, Khanna Publishers, 4^{th} Edition, 2012.

Reference Book(s):

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, 1^{st} edition-2005.

EE 3029 IoT for Electrical Engineering

Credit: 3
Category: PEC
Prerequisite(s): Digital Circuit (EE 2018), Signals and System (EE 2022)

Course Description:

Components in internet of things, Sensing and Actuation, Internet Communications, IP Addresses, MAC Addresses, TCP and UDP Ports, Asset Performance Management, Operational Optimization, Comprehensive Customer Services and Experiences, System on Chip (SoC), ARM®, Raspberry Pi, Evolution of Pi and technical specification comparative study, GPIO Interfacing Cloud, Analytics & UI, Client Server Model, HTTP, Thingspeak, AWS, Cloud MQTT, Sensor based automated technologies, PIR Sensor, GSM module, Node MCU Module, Bluetooth module, Humidity sensor.

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

CO1: identify the components of IoT
CO2: analyze various protocols of IoT
CO3: apply internet of things in power sector
CO4: examine schemes for the applications of IoT in home automation
CO5: demonstrate embedded development platform
CO6: create building blocks of Internet of Things and characteristics

Topics:

- Introduction to IoT
- Internet of Things in the Power Sector
- Advanced Embedded Development Platforms
- Home Automation

Textbook(s):

1. "Designing the Internet of Things", Adrian McEwen, Hakim Cassimally, Wiley publication, 1st Edition, November 2013.
2. The Internet of Things in the Power Sector Opportunities in Asia and the Pacific, Ramamurthy, A. and Jain, P, 1st Edition, 2017.

Reference Book(s):

1. "The Internet of Things: A Survey", Journal on Networks, Luigi Atzori, Antonio Lera, Giacomo Morabito, Elsevier Publications, 1st Edition, October, 2010.
2. "The Internet of Things in the Cloud:A Middleware Perspective", Honbo Zhou, 1st Edition,CRC Press-2012.
3. "Architecting the Internet of Things", Dieter Uckelmann, Mark Harrison, 1st Edition, Springer, 2011.

EE 3031 Neural Network and Fuzzy Logic

Credit: 3
Category: PEC
Prerequisite(s): Mathematics- II (MA 1004), Biology (LS 1001)

Course Description:

Biological Neuron model, Basic neuron model, Classification, Feed forward and Recurrent topologies, Activation functions, Types of Learning algorithms, Perceptron representation, Linear inseparable problem, Multilayer network model, Back propagation learning methods, Back Propagation Algorithm, Competitive Learning, Vector Quantization, Clustering and classification, SOM learning algorithm, Grossberg layer and its training, Adaptive Resonance Theory, Architecture of Hopfield Network, Energy function, General Concepts of Associative Memory, Bidirectional Associative Memory, Basic concept of fuzzy logic, Crisp set, Fuzzy set, Crisp and fuzzy relation, Fuzzification, Membership function, Linguistic variable, Universe of discourse, Interference in fuzzy logic, If-Then rule, de-fuzzification methods.

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

CO1: recall the Fundamentals of Artificial Neural Network
CO2: explain the concepts of Feed Forward Neural Network
CO3: apply the fundamental concepts of ANN to Unsupervised Neural Network
CO4: analyze the Recurrent Neural Network
CO5: evaluate the efficacy of Fuzzification and De-fuzzification of real life problems
CO6: design a fuzzy logic based controller for real world

Topics:

- Fundamentals of Artificial Neural Network
- Feed forward Neural Network
- Unsupervised Neural Network
- Recurrent Neural Network
- Fuzzy Logic

Textbook(s):

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Pai- PHI Publication. 1st Edition, 2011
2. Introduction to Artificial Neural Systems- Jacek M.Zurada, Jaico Publishing House, 1st Edition,1997.

Reference Book(s):

1. Neural and Fuzzy Systems: Foundation, Architectures and Applications, – N. Yadaiah and S. Bapi Raju, Pearson Education, 1st Edition, 2011
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications," McGraw Hill, 2nd Edition,1995.
3. B.Yegnanarayana, "Artificial Neural Networks," PHI, India, 2nd Edition,2006.

EE 3033 Energy Conservation Techniques

Credit: 3
Category: PEC/OEC
Prerequisite(s): Basic Electrical Engineering (EE 1003)

Course Description:

Energy security, Energy intensity, Need for energy sector reforms in India, Role of energy manager under energy conservation acts, Important of energy conservation, Principles, Planning, Conservation of electrical energy, Thermal energy, Human and animal mussel energy, Energy policy, Policy for conventional and non-conventional energy, Availability, Cogeneration, Gas turbine, Steam turbine and diesel engine cogeneration, Electrical Energy control, Demand side management, Power factor correction and equipments, Load scheduling, Load shifting load shedding, Motor drives, Motor efficiency and testing, Energy efficient motors, Electricity acts 2003, Building energy management, Cooling load temperature difference, Cooling load factor, Energy analysis of existing building.

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

CO1: understand various data analysis methodologies
CO2: demonstrate the concept of energy conservation and audit
CO3: apply the energy policies and understand its impact
CO4: analyze combined heating and power system
CO5: describe various applications and types of energy audit
CO6: prepare energy audit report of a system

Topics:

- Energy Scenario
- Energy Conservation
- Energy Policy
- Electrical Energy and Energy Management

Textbook(s):

1. Energy conservation and management, S.S Thipse, alpha science publication, 1st Edition, 2014
2. Industrial Energy management; principle and applications, Glovanin and Petrecca, The Kluwer international series, 1st Edition, 2007.

Reference Book(s):

1. Guide to electric load management by Anthony J. Pansini, Kenneth D. Smalling, pennwell publication, 3rd Edition,2012.
2. Energy efficient electric motors and their applications, Howard E Jordan, Plenum Publication 3rd Edition,2014
3. Energy management Hand book, Turner Wayne C Lillbun, The Fairmont press 3rd Edition, 2001

EE 3035 Energy Storage Technology

Credit: 3
Category: PEC
Prerequisite(s): Chemistry (CH 1007)

Course Description:

Energy availability, Demand and storage, Need for energy storage, Different types of energy storage, Comparison of energy storage technologies, Flywheel storage, Hydro storage, Thermal energy storage, Energy analysis of thermal energy storage, Solar energy and thermal energy storage, Battery fundamentals and technologies, Comparison of Lead-acid, Nickel-Metal hydride, Lithium Ion; Equivalent Circuit of an Electrochemical Cell, Charging and discharging operation of batteries, State-of-charge (SOC) of batteries, battery management systems, Hydrogen as energy carrier and storage, Fuel cells, Application of Energy Storage: Food preservation, Waste heat recovery, Solar energy storage: Greenhouse heating; Drying and heating for process industries.

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

CO1: remember different energy storage systems
CO2: understand the performance of different types of energy storage device
CO3: apply energy storage principles to different electrochemical system
CO4: analyze the principle of different types of fuel cell
CO5: solve the state of charge of batteries using different techniques
CO6: apply the energy storing devices to different types of industries

Topics:

- Energy Availability
- Mechanical, Thermal Energy Storage
- Electrochemical Energy Storage
- Fuel Cells

Textbook(s):

1. Huggins R. A., Energy Storage: Fundamentals, Materials and Applications, second edition, Springer International Publishing, 3rd Edition, 2015.
2. Dincer I., and Rosen M. A., Thermal Energy Storage: Systems and Applications, second edition, Wiley, 2011.

Reference Book(s):

1. Fuel Cell Fundamentals, O'Hayre R., Cha S., Colella W., and Prinz F. B., Wiley, Second Edition, 2009.
2. Chemical and Electrochemical Energy System, Narayan R. and Viswanathan B., Universities Press, (1998).
3. Battery Systems Engineering, Rahn C. D. and Wang C., First Edition, Wiley, 2013.
4. Electrochemical Energy Storage for Renewable Sources and Grid Balancing, Moseley P. T., and Garche J., Elsevier Science, 2014.
5. Compressed Air Energy Storage, Miller F. P., Vandome A. F., and John M. B., VDM Publishing, 2010.

EE 3036 Discrete and Non Linear Control Theory

Credit: 3
Category: PEC
Prerequisite(s: Linear Control System (EE 2028)

Course Description:

Transfer Function Decomposition, Controllable and Observable Canonical form, Non Uniqueness of State Model, Diagonalization, Concept of Controllability, Kalman and Gilbert Test, Stability, Pole assignment by state feedback using Ackermann's formula, Duality between controllability and observability, Full order Observer design, Design of full order observer using Ackermann's formula, Stability of a system, Bilinear Transformation, Pulse transfer function, Relationship between s-plane and z-plane. Stability : Routh Hurwitz in Discrete Domain and Jury's Test, Common physical nonlinearities, Phase plane method, Singular points, Limit cycle and Jump resonance, Derivation of describing function, Stability of nonlinear system using Lyapunov technique.

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

CO1: understand state space modeling
CO2: check controllability and observability of the system and design state feedback observer
CO3: know about discretization process
CO4: analyze the stability of discrete time control system
CO5: study the nonlinear behaviour of system by phase plane and describing function method
CO6: carry out stability analysis of nonlinear control system

Topics:

- State Space and State Solution
- Observability, Controllability and Stability
- Discrete Time Control Systems
- Nonlinear Control System

Textbook(s):

1. Advanced Control System, by B. N. Sarkar, PHI Learning, 3rd Edition, 2013
2. Control System Engg, by I.J. Nagrath and M Gopal, New age international publication, 2nd Edition,2007.

Reference Book(s):

1. Digital Control and State Variable Methods, M. Gopal, TMH Publishers, 3rd Edition, 2015.
2. Discrete time control systems by K. Ogata (PHI), 3rd Edition, 2015.
3. Automatic Control Systems by Benjamin C Kuo, Prentice-Hall, 3rd Edition,2015
4. Modern Control Engg. by K. Ogata PHI publication, 3rd Edition, 2016
5. Control systems Engineering by R. Ananda Natarajan and P. Ramesh Babu (SCITECH), 3rd Edition, 2015

EE 3037 Power Quality

Credit: 3
Category: PEC
Prerequisite(s): Generation Transmission and Distribution of Electrical Power (EE 2024), Power Electronics (EE 2026)

Course Description:

Terminology of PQ as per IEEE standard, Short and long duration voltage variations, Interruptions, Short and long voltage fluctuation, Imbalance, Flicker and transients, Principles of voltage regulation, Various causes of voltage flicker and their effects, Voltage sags versus interruptions, Economic impact of voltage sag, Areas of vulnerability, Definitions of harmonics, Causes and effect of harmonics, Triple harmonics, Consequences of harmonic resonance, Principles for controlling harmonics, PQ monitoring objectives and requirement, Theories of load compensation, Introduction to custom power devices and their applications in power system. Power quality instrumentation, Selection of power quality monitors.

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

CO1: define Introductory terminology of Power Quality in accordance with IEEE Standard 1159
CO2: explain the need of earthing and the symptoms of poor Power Quality
CO3: solve the difficulties of Flicker and Transient Over Voltages
CO4: analyze the effects of Voltage Sags, Swells and Interruptions
CO5: evaluate the effects, characteristics and consequences of Harmonics
CO6: formulate Power Quality Monitoring Systems and design custom power devices

Topics:

- Introduction to Power Quality
- Flicker and Transient
- Voltage Sag and Swells
- Harmonics
- Power Quality Monitoring

Textbook(s):

1. Electric Power Quality by Heydt, G T, Stars in circle Publications, Indiana 2nd edition-1994.
2. Electrical Power system Quality, by RC dugan, MF Mcgranaghan, S Santoso and H W Beaty, 2nd Edition TMH publication-2008.

Reference Book(s):

1. Arrillaga J and Watsone RN, Chen S, Power Quality Assessment, Wiley New York 2000
2. Bollen MHJ, Understanding Power Quality Problems; Voltage sag and instrumentations, IEEE press NY 2000 Power Quality C Sankaran CRC press

EE 3038 Utilization of Electrical Power

Credit: 3
Category: PEC
Prerequisite(s): Basic Electrical Engineering (EE 1003)

Course Description:

Selection of motor capacity, Equivalent current, Torque and power methods, Various kinds of Tariff, Economics of Generation, Load duration curve, Effect of Load Factor, diversity Factor and power factor on tariff, Heating methods, Resistance Heating, Induction Heating, Dielectric Heating, Resistance furnace, Arc furnace, Welding methods, Resistance, Electric arc, Atomic hydrogen, Ultrasonic and Laser welding, Terminology in illumination, lamp efficiency, Polar curve, Laws of illumination, Co-efficient of utilization, Maintenance factor, Depreciation factor, Solid Angle, Types of Lamps, Arc Lamp, Incandescent lamp, Sodium vapor lamp, Mercury Vapor Lamp, Fluorescent Lamp, Neon Lamp, Types of Lighting Scheme, Faradays law of electrolysis.

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

CO1: remember the considerations for Selecting Motor Power Rating and Capacity
CO2: understand the formulation of Electric Tariff
CO3: apply the knowledge of electric power in the field of Electric Heating and Welding
CO4: analyze various techniques of Illumination
CO5: analyse various types of lamps
CO6: analyse the Electrolytic Processes

Topics:
- Motor power rating and selection
- Electric Tariff
- Electric Heating and Welding
- Illumination
- Electrolytic Processes

Textbook(s):
1. Generation, Distribution and Utilization of Electrical Power by C.L. Wadhwa, Wiley Eastern Ltd, New Delhi, 2nd Edition, 2012.
2. Utilization of Electrical Power and Electric Traction by J B Gupta, S K Kataria and Sons, Delhi, 2nd Edition, 2011.

Reference Book(s):
1. Art & Science of Utilization of Electrical Energy by H. Pratab, Dhanpat Rai & Co.(P) Ltd. 2nd Edition,2013.
2. Utilization of Electric power by Er. R K Rajput, Lakshmi publications Pvt. Ltd, 1st Edition 2006.
3. Electrical Technology volume – III, by B L Thereja, A.K Thereja, S Chand Publisher, 2nd Edition, 2013.

EE 3039 Programmable Logic Controllers

Credit: 3
Category: PEC
Prerequisite(s): Digital Circuits (EE 2018), Signals and System (EE 2022)

Course Description:

Various input output devices and its interfacing with PLC, Switches, Architecture of PLC, The I/O section, The CPU, Memory design, Types, Programming Devices, Selection criteria for PLC, PLC Communication with PC and software , PLC Wiring – Installation of PLC, Ladder logic with different control elements, Timers and counters: ON delay timer instruction, Off-Delay timer instruction, Retentive Timer, Counter Instructions, Incremental encoder, counter applications, Combining counter and timer functions, PLC arithmetic functions, PWM generation, Analog Scaling – Encoder Interfacing – Servo drive control, Stepper Motor Control, Types and Configuration of HMI, Interfacing with PLC, PLC Networking – Networking standards & IEEE Standard.

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

CO1: compare conventional sequential control with programmable logic control system
CO2: develop programs using different PLC programming languages for sequential and continuous process
CO3: interface analog and digital input/ output devices with PLC using different communication protocol
CO4: demonstrate on the PLC based system and troubleshoot the errors associated with it
CO5: interface the HMI for industrial automation
CO6: develop the ladder diagram of process control for industrial automation

Topics:

- Introduction to Factory & Process Automation
- Switches
- Programmable Logic
- Programming of PLC
- HMI Systems and Networking

Textbook(s):

1. Programmable logic controller by Frank D. Petrusella, Tata McGraw-Hill publication, 2011
2. Programmable Logic Controllers by W. Bolton, Elsevier Newnes publication2nd Edition,2013

Reference Book(s):

1. John R Hackworth and Fredrick D Hackworth Jr., “Programmable logic controllers: Programming Methods and Applications”, Pearson Education, 2006.
2. SIMATIC Programming with STEP 7, SIEMENS Manual, 2014.
3. Introduction to programmable logic controller by Gary dunning, Thomson Asia Pte Ltd.
4. Programmable Controllers An engineer’s guide by E.A.Parr, Elsevier Newnes publication.

EE 3041 Electrical Hazards and Safety

Credit: 3
Category: OEC
Prerequisite(s): Basic Electrical Engineering (EE 1003)

Course Description:

Classification of hazards, Hazards management program Electrical hazards: Primary and secondary hazards, Arc, blast, Hot sticks, Insulated tools, Barriers and signs, Safety tags, Grounding of electrical equipment bonding of electrically conducting materials and other equipment, The six step safety methods, Pre job briefings, Decision tree-safe switching of power system, Lockout, Tagout, Flash hazard calculation and approach distances- calculating the required level of arc protection, Safety equipment, Procedures for low, medium and high voltage systems. Electrical safety program, Safety policy program implementation, Safety related case for electrical maintenance, Reliability centered maintenance (RCM), Regulatory bodies, National electrical safety code, Standard for electrical safety in work place.

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

CO1: understand the effects and control of electrical hazards
CO2: describe in the effects of industrial hazards
CO3: apply different techniques to protect from electrical hazards
CO4: select appropriate safety method for low, medium and high voltage equipment
CO5: know the safety program structure and rescue techniques from electrical hazards
CO6: apply the maintenance policy to electrical equipment based on standard procedure to avoid hazards

Topics:

- Electrical Hazards
- Industrial Hazards
- Grounding
- Safety Methods
- Safety Program and Policy implementation
- Safety related maintenance

Textbook(s):

1. 'Electrical Safety Handbook', John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel, Al Winfield, McGraw-Hill Education, 4thEdition, 2012.
2. 'Electrical Safety- a guide to the causes and prevention of electric hazards', Maxwell Adams. J, The Institution of Electric Engineers, IET 1994.

Reference Book(s):

1. Electrical Safety in the Workplace', Ray A. Jones, Jane G. Jones, Jones & Bartlett Learning, 2000.
2. Industrial safety and environment by Amit Gupta, Lakshmi publication private limited, 2006.
3. Handbooks of electrical Hazards and accidents by Leslie A Geddes, CRC press, 1995.
4. Risk reduction methods for occupational safety and health, by Roger C. Jensen, John wiley and sons, 2012.

EE 3042 Principles of Energy Conversion

Credit: 3
Category: PEC / OEC
Prerequisite(s): Basic Electrical Engineering (EE 1003)

Course Description:

Singly and Doubly Excited Magnetic system, EMF equation of DC generator, Methods of excitation, Armature reaction, Losses, Condition for maximum efficiency. DC Motor: Working principle, Torque developed, Speed control methods, Single Phase Transformer, Working principle, EMF equation, Transformer on no load and full load, Vector diagram, Losses and efficiency, condition for maximum efficiency, Auto transformer, 3 Phase transformers, rotating magnetic field, Principle of operation of induction motor, Slip, Vector diagram and equivalent circuit, Torque slip characteristics, Starting torque, Relation between full load and maximum torque, Power stages in induction motor, Starting methods for 3 phase induction, Alternator: Basic principle, Pitch factor, Distribution factor, emf equation, Alternator on load, Voltage regulation: Synchronous impedance method. Synchronous motor: Basic principle.

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

CO1: know the principle of operation of different electrical machines
CO2: understand the applications of different electrical machines
CO3: analyze the performance characteristics of DC machines
CO4: control the speed of a three phase induction motor for different applications
CO5: develop the equivalent circuit of 3 phase induction motor
CO6: describe on the starting methods of DC motors and induction motors

Topics:

- Electromechanical Energy Conversion
- DC Machines
- Transformers
- 3 Phase Induction Motor
- Synchronous Machine

Textbook(s):

1. Electrical Machines, Ashfaq Hussain, Dhanpat Rai, Delhi, 2nd Edition, 2008.
2. Electrical Machinery, P. S Bimbhra, 7th Edition, Khanna Publishers, 2008.

Reference Book(s):

1. Text of Electrical Technology; Vol -II; B. L. Theraja, and A. K. Theraja; S. Chand Publication
2. Text book of Electrical Machine by K R Sidhapura and D B Raval, Vikash, 1st edition, 2013.

EE 3043 Inverter and SMPS

Credit: 3
Category: PEC
Prerequisite(s): Power Electronics (EE 2026)

Course Description:

DC-DC converter topology, Buck, Boost, Buck-Boost, Cuk converter, Control topology, Fly-back converter, Forward converter, Bridge converter, Average modeling of converters, Small signal analysis to determine control to output transfer function for the converters. Single phase inverter and its control strategies to regulate the output voltage and frequency, Three phase inverter, 180 degree and 120 degree conduction, Sinusoidal unipolar and bipolar control technique, Cascaded type, Diode-clamped and Capacitor clamped multilevel inverter. Control of cascaded multi level inverter: Phase - shifting, Level-shifting, On-line and Off-line UPS system. Charging Station for battery used for Electric Vehicle (EV).

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

CO1: know various topologies of non-isolated DC-DC converters
CO2: design the components of DC-DC Converters
CO3: understand the operation of isolated DC-DC converter topologies
CO4: model the isolated type DC-DC converters
CO5: realize the operation and control of inverter and multilevel inverter topologies
CO6: demonstrate on inverters in UPS system and dc-dc converter in battery charging system

Topics:
- DC-DC converter
- Isolated DC-DC converter
- Inverter (DC-AC Converter)
- Introduction to multilevel inverter

Textbook(s):
1. Power Electronics: Circuits, Devices and Applications by M H Rashid, 3rd Edition, 2015, Pearson Education
2. Elements of Power Electronics by Philip T. Krein, 2nd Edition, 2016, OXFORD University Press.

Reference Book(s):
1. Power Electronics: Converters, Application and Design by Mohan, Undeland, Riobbins, John Wiley and Sons, 3rd Edition, 2012.
2. Power Electronics by MD Singh, K.B. Khanchandani, TMH Education Private Limited, 2nd Edition, 2011.

EE 3046 Solar Power Technology

Credit: 3
Category: OEC
Prerequisite(s): Basic Electrical Engineering (EE 1003)

Course Description:

Brief History of solar energy utilization, Blackbody radiation, Planck's formula in energy unit, Wien displacement law, Stefan Boltzmann law, Photoelectric effect, Einstein's theory of photons, Formation of a p-n junction, Space charge and internal field, Quasi - Fermi levels, The Shockley diode equation - Structure of a solar cell, Solar PV modules from solar cells, Balance of solar PV system, Power conditioning, Maximum power point operation Balance of System (BOS) for PV module installation, Concentrated solar power (CSP) systems, Solar Collectors, Solar Water Heater, Solar Passive Space –Solar Cookers, Solar Furnaces, Solar Green House, Solar Dryer, Solar Distillation

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

CO1: know the need of solar energy technology
CO2: describe operations of alternate energy sources
CO3: apply the principle of solar thermal system for domestic applications
CO4: analyze the various approaches of utilizing solar energy
CO5: analyze power conditioning and MPPT operation
CO6: understand standalone and grid connected PV system

Topics:

- Introduction to Solar Energy Generation
- Solar Cells
- Solar Photovoltaic System
- Solar Thermal systems

Textbook(s):

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(s):

1. Micheal Boxwell , "Solar Electricity Handbook", Green Stream publishing (2010).
2. Rai G.D, "Non-Conventional Energy Sources", Khanna Publishers, 4th Edition 2000.
3. Kothari D.P., "Renewable energy resources and emerging technologies", Prentice Hall of India Pvt. Ltd,2006.

EE 3048 HVDC and FACTS

Credit: 3
Category: PEC
Prerequisite(s): Generation, Transmission and Distribution of Electric Power (EE 2024), Power Electronics (EE 2026)

Course Description:

Application of HVDC transmission, Choice of converter configuration, Analysis of a twelve pulse converter. Principles of DC Link control, System control hierarchy, Firing angle control, Current and extinction angle control, Power Control, Reactive power requirements in steady state, Conventional control strategies, Alternate control strategies, Sources of Reactive Power, harmonics and filters, Generation of harmonics, types of ac filters, Definition of FACTS, types of FACTS compensators. Principle of SVC scheme, FACTS based shunt compensators: TCR, TSC, STATCOM, FACTS based series compensators, Combined Series –shunt Compensator: Unified Power Flow Controller (UPFC).

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

CO1: remember the introductory concepts of HVDC Transmission
CO2: describe the control of HVDC transmission systems
CO3: analyze the converter faults in HVDC transmission systems
CO4: analyze the harmonic generation and elimination
CO5: describe the application of FACTS devices in power system
CO6: understand shunt and series compensation in a transmission system

Topics:
- HVDC Transmission
- HVDC System Control
- Reactive Power Control in HVDC
- FACTS Controllers and Shunt Compensation
- Principle of Series Compensation

Textbook(s):
1. “HVDC Power Transmission Systems – Technology and System Interactions”, K. R. Padiyar, Third Edition, New Age International Publishers, 2015.
2. “Understanding FACTS – Concepts and Technology of Flexible AC Transmission Systems” - Narain G. Hingorani, Laszlo Gyugyi-Wiley India publications 2011.

Reference Book(s):
1. Sang, Y.H. and John, A.T., Flexible AC Transmission Systems, IEEE Press (2006).
2. Ghosh, A. and Ledwich,G., Power Quality Enhancement Using Custom Power Devices, Kluwer Academic Publishers (2005).
3. FACTS Controllers in Power Transmission and Distribution", K. R. Padiyar, New Age International Publishers, 2007.

EE 3050 Special Electrical Machines

Credit: 3
Category: PEC
Prerequisite(s): DC machines and Synchronous Machines (EE 2020)

Course Description:

Types of servomotor, DC Servo motor, Working principle, Field controlled and Armature controlled DC servomotor, AC Servomotor, Operating principle, Types of AC servo motors, Stepper Motor, Constructional features, Principle of operation, Step Angle, Types, Linear Induction Motor: Construction, Working Principle, Reluctance motor: Construction, Principle of operation, Torque-Speed characteristics, Switched reluctance motor, SRM Drive System, Hysteresis Motors: Construction, Principle of operation, Torque-speed characteristics, Universal motor: Construction, Principle of operation, Circuit model and Phasor Diagram, Torque developed and performance characteristics, Permanent Magnets, Permittance coefficient, Principle of operation, Modeling of a permanent magnet brushless DC Motor, EMF and torque equations.

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

CO1: recall the various Servo Motors
CO2: understand the Principle and Constructional Features of Stepper Motors
CO3: apply the principle of electromechanical energy conversion to Linear Induction Motors
CO4: analyse the performance of Reluctance Motors and Hysteresis Motors
CO5: analyze the torque and emf expression of different special electrical machines
CO6: discuss about different control techniques for Permanent Magnet Brushless DC Motors

Topics:
- Servo Motor
- Stepper and Linear Induction Motor
- Linear Induction Motor
- Reluctance, Hysteresis and Universal Motors
- Permanent Magnet Brushless DC Motors

Textbook(s):
1. "Krishnan R., "Permanent Magnet Synchronous and Brushless DC Motor Drives", CRC Press, New York, 2010.
2. S K Sahadev, Electrical Machines, Cambridge University Press, 1st Edition, 2018.

Reference Book(s):
1. Krishnan R., "Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application", CRC Press, New York, 2009.
2. Jacek F. Gieras, Jacek F. Gieras, Mitchell Wing, "Permanent Magnet Motor Technology: Design and Applications", CRC Press, Second Edition, 2002.
3. Hendershot J. R. and Miller T. J. E., "Design of Brushless Permanent Magnet Machines", Motor Design Books LLC, 2nd Edition, 2010.
4. Janardanan E.G., "Special Electrical Machines", PHI Learning Private Limited, 2015.
5. Veinott, Fractional Horse Power Electric Motors, McGraw-Hill.
6. V.U Bakshi, U.A Bakshi, Electrical Circuits and Machines, Technical Publication, Pune.
7. Fitzgerald, Charles Kingsley, Stephen D Umans. Electric Machinery, TMH

EE 3051 OOPS with Python

Credit: 3
Category: PEC
Prerequisite(s): Computer Programming (CS 1093)

Course Description:

Objects, Classes, Encapsulation and abstraction, Inheritance, Polymorphism, Python Programming basics, Inline function, Function overloading, Default arguments, Array of objects, Objects as function argument, Static Data members and member functions, function overloading; Constructor and Destructors, Concept of inheritance, Types of Inheritance, Virtual base class, Member classes: Classes within classes, Operator overloading, Rules for overloading operators; Polymorphism, Review of Function Overloading and Operator overloading; Run time polymorphism: virtual functions, Pure virtual functions, Abstract class, virtual constructors and destructors, Exception Handling: Basics of Exception Handling, Exception Handling Mechanism Templates, Files and Streams, Steps to process a File in a program. Different functions used in file, File modes, File pointers and their Manipulations, Error handling during file operation.

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

CO1: understand the difference between structure-oriented programming and object-oriented programming
CO2: use object-oriented programming language like Python and associated libraries to develop object oriented programs
CO3: apply various object-oriented features like class, object, inheritance, data abstraction, encapsulation polymorphism to solve various computing problems using Python language
CO4: understand and apply concepts of operator-overloading, contracture and destructtor
CO5: understand the and apply exception handling and use built-in classes from STL
CO6: implement, test and debug solutions in Python

Topics:

- Introduction to Object Oriented Programming
- Class and Object
- Inheritance
- Polymorphism
- Templates, Files and Streams

Textbook(s):

1. Python-3 Object Oriented Programming 3rd Edition,PactPub, ISBN 9781789615852
2. Mastering Object-Oriented Python: Build powerful applications with reusable code using OOP design patterns and Python 3.7, 2nd Edition Kindle Edition

Reference Book(s):

1. Core Python Programming Paperback – 1 January 2018, by R. Nageswara Rao
2. Python Programming: Using Problem Solving Approach Paperback – 10 June 2017 by Reema Thareja

EE 3052 Power System Deregulation

Credit: 3
Category: PEC
Prerequisite(s): Power System Operation and Control (EE 3002)

Course Description:

Power sector of India such as CEA, Planning Commissions, Salient features of Electricity act 2003 PGCIL, PFC, Ministry of Power, State and central governments, REC, utilities and their roles, Role of load dispatch center (SLDC/ RLDC), Different industry structures, Ownership and management models for generation, transmission and distribution, Competition in the electricity sector, Different market and trading models, Electricity price basics, Market Clearing price (MCP), Dynamic, spot pricing and real time pricing, Non price issues in electricity restructuring, Transmission planning, Different methods of transmission pricing, Congestion issues and management, Transmission pricing Model in India, Availability based tariff, Ancillary services for restructuring, , Power purchase agreements.

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

CO1: analyze the challenges regarding deregulation of power system
CO2: aware of the salient features of Electricity act
CO3: explain protocols for Power Sector Restructuring and Market Reform
CO4: analyze practices of Electricity Market Pricing and examine Non-Price Issues
CO5: demonstrate on different aspects of energy market in recent times
CO6: evaluate methods of Transmission Planning and Pricing

Topics:
- Different Power Sectors
- Power Sector Restructuring and Market Reform
- Electricity Markets Pricing and Non-Price Issues
- Transmission Planning and Pricing

Textbook(s):
1. Kankar Bhattacharya, Math H.J. Boller, Jaap E. Daalder, 'Operation of Restructured Power System' Klumer Academic Publisher, 2nd Edition, 2010.
2. S. K. Gupta, "Power System Operation Control and Restructuring" I. K. International Publishing House Pvt. Ltd, New Delhi, 2nd Edition, 2015.

Reference Book(s):
1. Loi Lei Lai; "Power system Restructuring and Deregulation", Jhon 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.
4. Mohammad Shahidehpour, and Muwaffaq alomoush, - "Restructured electrical Power systems" Marcel Dekker, Inc.,2009.
5. Cyber Laws and IT Protection, Harish Chander, Pub: PHI.
6. Cryptography and Network Security: Principles and Practice, Global Edition, 7/E, William Stallings, Pearson,

EE 3053 Database Security

Credit: 3
Category: PEC
Prerequisite(s): Computer Programming (CS 1093)

Course Description:

Introduction of Cyber Crime, Challenges of cyber crime, Classifications of Cybercrimes, Web jacking, Online Frauds, Software Piracy, Computer Network Intrusions, Password Sniffing, Identity Theft, cyber terrorism, Virtual Crime, Perception of cyber criminals, Cyber Crime and Criminal justice: The Indian Evidence Act of 1872 v. Information Technology Act, 2000: Status of Electronic Records as Evidence, Proof and Management of Electronic Records; Relevancy, Admissibility and Probative Value of E-Evidence, Proving Digital Signatures, Proof of Electronic Agreements, Tools and Methods in Cybercrime, Password Cracking, Key loggers and Spyware, virus and worms, Trojan Horses, Backdoors, DoS and DDoS Attacks , Buffer and Overflow, Attack on Wireless Networks, Phishing : Method of Phishing, Phishing Techniques, Cloud and IoT are the latest emerging technologies.

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

CO1: analyze and evaluate the cyber security needs of an organization
CO2: determine and analyze software vulnerabilities and security solutions to reduce the risk of exploitation
CO3: measure the performance and troubleshoot cyber security systems
CO4: implement cyber security solutions and use of cyber security, information assurance, using different tools
CO5: comprehend and execute risk management processes, risk treatment methods, and key risk and performance indicators
CO6: design operational and strategic cyber security strategies and policies

Topics:

- Cyber Crime
- Web jacking
- Cyber Crime and Criminal justice
- The Indian Evidence Act
- Tools and Methods in Cybercrime
- Cloud and IoT

Textbook(s):

1. Principles of Cyber crime, Jonathan Clough Cambridge University Press
2. John R.Vacca, Computer Forensics:Computer Crime Scene Investigation, 2nd Edition, Charles River Media, 2005
3. Cyber Law Simplified, VivekSood, Pub: TMH.
4. Cyber Security by Nina Godbole, SunitBelapure Pub: Wiley-India

Reference Book(s):

1. Information Warfare: Corporate attack and defense in digital world, William Hutchinson, Mathew Warren, Elsevier.
2. Cyber Laws and IT Protection, Harish Chander, Pub:PHI.
3. Cryptography and Network Security: Principles and Practice, Global Edition, 7/E, William Stallings, Pearson,

EE 3054 Bio-Inspired Algorithm

Credit: 3
Category: PEC
Prerequisite(s): Mathematics - II (MA 1004), Biology (LS 1001)

Course Description:

Different historical branches of Evolutionary computation, Genetic Programming: Trees as individuals, Major steps of genetic programming, Search operators on trees, Automatically defined functions, Fitness proportional selection and fitness scaling, Search Operators, Mutation for real-valued representations, Generational cycle-convergence of Genetic Algorithm, Classification of meta-heuristic techniques, Exploitation and exploration in population based algorithms; Properties of Swarm intelligent Systems, Particle Swarm Optimization Model, Constriction coefficients, synchronous and asynchronous updates, Binary PSO, Introduction to Ant Systems, Ant Colony Optimization Technique, Pheromones and its Density as Deciding Factor. Artificial, binary ABC and continuous ABC algorithms; Bacterial foraging techniques, Biological immune systems and artificial immune systems affinity measures- representations; Basic immune models and algorithms.

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

CO1: understand the basic concept of evolutionary computation
CO2: demonstrate swarm intelligence for existing systems
CO3: interpret the implementation issues of evolutionary algorithms
CO4: analyze different parameter settings of evolutionary algorithms
CO5: evaluate new evolutionary operators, representations and fitness functions
CO6: elaborate different evolutionary algorithms for engineering applications

Topics:

- Evolutionary computation
- Introduction to swarm Optimization
- Different Evolutionary Algorithms

Textbook(s):

1. Genetic Algorithms in Search, Optimization & Machine Learning, D E Goldberg, Addison-Wesley, 1989
2. James Kennedy and Russel E Eberheart, ‘Swarm Intelligence’, The Morgan Kaufmann Series in Evolutionary Computation, 2001

Reference Book(s):

1. Eric Bonabeau, Marco Dorigo, and Guy Theraulaz, “Swarm Intelligence: From Natural to Artificial Systems”, Oxford University Press, 1999
2. Engelbrecht, A.P. Computational Intelligence: An Introduction, Second Edition, John Wiley and Sons, 2007.
3. Dorigo, M., Stutzle, T., Ant Colony Optimization, MIT Press, 2004
4. Parsopoulos, K.E., Vrahatis, M.N., Particle Swarm Optimization and Intelligence: Advances and Applications, Information Science Reference, IGI Global, 2010
5. Clerc, M., Particle Swarm Optimization, ISTE, 2006 7. Nature Inspired Metaheuristic Algorithms, Xin-She Yang, Luniver Press, 2010.
6. Handbook on Evolutionary Computation, T. Baeck, D. B. Fogel, and Z. Michalewicz (eds.), IOP Press, 1997.
7. Andries P. Engelbrecht, “Computational Swarm Intelligence“, Wiley, John & Sons, 2006

EE 3055 Wireless Network Systems

Credit: 3
Category: PEC
Prerequisite(s): Computer Programming (CS 1093)

Course Description:

Overview of wireless communications and systems Review of digital communications, Cellular systems from 1G to 3G Wireless 4G systems, Radio propagation and propagation path-loss model, Free-space attenuation, Multipath channel characteristics, Signal fading statistics, Path-loss models, Fundamentals of cellular communications, Hexagonal cell geometry, Co-channel interference, Cellular system design, Sectoring using directional antennas, Multiple access techniques, Frequency division, Time division, Code division, Space division multiple access etc, Random access methods, Wide-area wireless networks, GSM, IS-136, IS-95, UMTS, Cdma2000, Long Term Evolution Technologies (LTE) OFDM, MIMO channels, Space Time Codes, LTE Advanced, Other Wireless systems IEEE 802.11 WLAN (WiFi), WiMAX.

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

CO1: remember the fundamentals of wireless communications and the evolution of wireless networks
CO2: comprehend the domains of application of Radio Propagation
CO3: apply the concepts of Cellular Communication
CO4: analyze the CDMA and FDMS systems
CO5: evaluate the utility of WANs
CO6: create new wireless systems for the mankind

Topics:

- Overview of wireless communications
- Radio propagation and propagation path-loss model
- Fundamentals of cellular communications
- Multiple access techniques
- Wide-area wireless networks
- Long Term Evolution Technologies
- Other Wireless systems

Textbook(s):

1. Wireless Communications: Principles and Practice, 2nd Edition. Theodore S. Rappaport, Pearson publications

Reference Book(s):

1. Mobile Wireless Communications. Mischa Schwartz. Paperback (2013) ISBN:9781107412712. Cambridge University Press.
2. The evolution to 4G cellular systems: LTE-Advanced. Ian F. Akyildiz, David M. GutierrezEstevez, Elias Chavarria Reyes. Broadband Wireless Networking Laboratory, School of Electricaland Computer Engineering, Georgia Institute of Technology.
3. Vijay K. Garg, Wireless Communications and Networking, Morgan Kaufmann Publishers,2007, ISBN 978-0-12-373580-5

EE 3056 Digital System Design Using FPGA

Credit: 3
Category: PEC
Prerequisite(s): Digital Circuits (EE 2018), Microprocessor and Interfacing (EE 3013)

Course Description:

System- level architecture design for FPGAs. TMS322F series architecture, Review of VHDL programming basics, Synthesizable VHDL, Synchronous and asynchronous processes, Finite state machines and memory, Practical test bench design, Performance testing, Design optimizations and performance comparison, FIFOs and streaming architectures, Design, optimize, Simulate and analyze the performance for a digital application, FPGA synthesis and iterative performance optimizations.

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

CO1: learn advanced design methodologies for high-performance FPGA applications
CO2: analyze the implementation of a complete sophisticated digital system using FPGA
CO3: apply translating software models of digital signal processing applications
CO4: comprehend sophisticated optimization techniques for streaming applications
CO5: understand design procedure and compare performance of FPGA based system
CO6: synthesize VHDL based digital system

Topics:

- System Level Design
- VHDL
- Programming Spartan-3E using VHDL
- Design Optimization using FPGA interface in NI-CRIO-9082
- Synthesis of Design Using VHDL

Textbook(s):

1. The Designer's Guide to VHDL, Peter J. Ashenden; HDL Chip Design, Douglas J. Smith;
2. Advanced FPGA Design Architecture, Implementation, and Optimization, Steve Kilts

Reference Book(s):

1. "Digital System Design with FPGA", Implementation using Verilog and VHDL, Cem Unsalan, Bora Tar.1st Edition TMH publication.

EE 3058 Energy Audit and Accounting

Credit: 3
Category: PEC
Prerequisite(s): Basic Electrical Engineering (EE 1003)

Course Description:

Indian Energy scenario, Energy audit-need, Types of energy audit, Energy audit instruments, Energy Conservation schemes, Classification of furnace, Controlled atmosphere in furnace, furnace fuels, efficiency of energy in furnace, thermal efficiency, heat losses, Characteristic of prime movers, Resistance heating, Induction heating, arc Heating, dielectric and microwave atmosphere generators, Radiant heating, Lighting: Lamp lifetime, Efficient lighting, Cost of electrical Energy, Power factor improvement, Capacitor rating, sitting the capacitor, Effect of power factor improvement, Interest Rate, Inflation Rate, Tax Rate, Cash Flows, Break even charts, Compounding Factors, Payments, Present Worth, Rate of Return Benefit–Cost Ratio, Payback Period, Life-Cycle Cost Analysis Method, Economic Evaluation.

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

CO1: recall the need of energy audit
CO2: understand the concept of energy conservation and audit
CO3: apply the concept of accounting in energy audit
CO4: analyse the capacitor rating for power factor improvement
CO5: evaluate the energy efficiency of furnace & CHP System
CO6: create a report for an Economic Evaluation

Topics:
- General Aspects of Energy Audit
- Energy Utilization and Conversion System
- Economic Analysis

Textbook(s):
1. W.R. Murphy and G. McKay, “Energy management”, Butterworth & Co Publishers, Oxford, UK, 2001.
2. Energy Audit of Building systems: An Engineering approach, by: Moncefkrarti, CRC PRESS, Second Edition, 2009.

Reference Book(s):
1. A Workbook for Energy Management in building by: Tarik Al-Shemmeri, Wiley-Blackwell.
2. Energy audit: Thermal power, combined cycle, and co-generation plants, by: Y. Pabbi, TERI, 2011.
3. Energy Management Handbook, Seventh Edition, (Fairmont Press Inc., 2007) by WC Turner.
4. Bureau of Energy Efficiency (BEE) (2016); Study material for Energy managers and Auditors Examination: Paper I.

EE 3060 Industrial Automation

Credit: 3
Category: PEC
Prerequisite(s): Linear Control System (EE 2028)

Course Description:

Architecture of Industrial Automation Systems, Measurement Systems Characteristics, Data Acquisition Systems, PI controller, PD controller, PID controller tuning methods: Ziegler-Nichols tuning method, Cohen coon tuning method, PLC Overview, Operation and architecture, PLC programming, Distributed control systems Overview, Functional requirements Communication for distributed control, SCADA system components, Architecture and communication, SCADA applications, Flow Control Valves, Hydraulic Control Systems - I, Hydraulic Control Systems - II, Industrial Hydraulic Circuit, Pneumatic Control Systems - I, Energy Savings with Variable Speed Drives.

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

CO1: recall fundamentals of Industrial Measurement Systems
CO2: understand the effect of parameters of controller on system performance
CO3: applications of controllers using different tuning methods
CO4: analyse the ladder logic of PLC according to the problem statement
CO5: analyse DCS and SCADA and their merits/demerits in an industrial automation
CO6: discuss about the application of controller in hydraulic and pneumatic systems

Topics:
- Introduction to Architecture of Industrial Automation
- Controller Tuning
- Automation
- Controllers in Industrial Instruments

Textbook(s):
1. Modern Control Engineering, 4th edition, Ogata, Prentice Hall of India, 2002.
2. Fundamentals of Industrial Instrumentation and Process Control, William C. Dunn, Tata McGraw Hill, 2009.

Reference Book(s):
1. Chemical Process Control – Theory and Practice, Stephanopoulous, Prentice Hall of India Ltd, 1984.

EE 3062 Robotics and Control

Credit: 3
Category: PEC
Prerequisite(s): Linear Control System (EE 2028)

Course Description:

Basic Concepts, Robot configurations, Types of Robot drives, Basic robot motions, Point to point control. Robot actuation and feedback, Manipulators, direct and inverse kinematics, Coordinate transformation, Brief Robot dynamics, Types of Robot and Effectors, Control Loops of Robotic Systems, Trajectory, Velocity and force control, Computed Torque control, Sensors and Sensor Based System in Robotics, Machine Vision System, Image Processing and Application of Machine Vision System, Robotic Assembly Sensors and Intelligent Sensors, Visual servo-control, Languages, Capabilities and limitation, Artificial intelligence, Knowledge representation, Search techniques in AI and Robotics, Application of robots in autonomous vehicles and other industrial areas.

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

CO1: recall the configurations of Robots
CO2: comprehend the kinematics and dynamics of robot
CO3: understand the trajectory planning of robot
CO4: familiarize the interfacing of robot with various sensors, actuators and camera
CO5: control the robot through AI Techniques
CO6: design of robot for various industrial applications

Topics:
- Introduction to Robotics
- Components and Operation
- Control design for Robotic System
- Robot Sensing and Vision
- Robot Programming Methods
- Industrial Applications

Textbook(s):
1. Robotic Engineering: An Integrated Approach- Richard D. Klafter, Thomas A. Chmielewski and Michael Negin , Prentice Hall of India,1989
2. Robotics, control vision and intelligence-Fu, Lee and Gonzalez. McGraw Hill International, 2nd edition, 2007.

Reference Book(s):
1. Introduction to Robotics- John J. Craig, Addison Wesley Publishing, 3rd edition, 2010.
2. Foundation of Robotics: Analysis and Control -Yoshikawa, Prentice Hall of India, 2003.

EE 3064 Bio-Medical Instruments

Credit: 3
Category: PEC
Prerequisite(s): Electrical and Electronics Measurements (EE 2019)

Course Description:

Components of the man-instrument system, Physiological system of the body, Problems encountered in measuring a living system. Resting and action potentials, Cardiovascular system, ECG, blood pressure and its measurement, The physiology of the respiratory system, Test and instrument for the mechanics of breathing, Somatic nervous system, Principle of ultrasonic measurement, Ultrasonic, Thermography, Elements of intensive care monitoring-ray, Use Spiro meter on the subject, Auditory system check-up using Audiometer, Measurement of Heart Rate using Stethoscope, Blood pressure using Sphygmomanometer, Pulse Rate and SpO2 using Pulse Oximeter, Skin Conductance and Skin Potential using Galvanic Skin Response Module.

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

CO1: recall various biomedical signal sources
CO2: understand cardiovascular system and related measurements
CO3: discuss the working principle of measurement instrument for respiratory and nervous system
CO4: analyze non-invasive diagnostic parameters
CO5: compare the procedures and types in laboratory work
CO6: design report on measuring and recording instruments for medical applications

Topics:

- Introduction of Bio-medical Instrumentation
- Sources of Bioelectric Potentials and Electrodes
- Cardiovascular System and Measurements
- Respiratory and Neuro-muscular System
- Measurement and Recording of Noninvasive Diagnostic Instrumentation
- Patient Care and Electrical Safety

Textbook(s):

1. Cromwell, L. and Weibell, F.J. and Pfeiffer, E.A., Biomedical Instrumentation and Measurement, Dorling Kingsley (2006) 2nd edition.
2. Carr, J.J. and Brown, J.M., Introduction to Biomedical Equipment Technology, Prentice Hall India (PHI) (2000) 4th edition.

Reference Book(s):

1. Geddes, L.A., and Baker, L.E., Principles of Applied Biomedical Instrumentation, Wiley InternationalScience (1989) 3rd edition.
2. Khandpur, R.S., Handbook of Biomedical Instrumentation, McGraw Hill (2003) 2nd edition.
3. Webster, J.G., Medical Instrumentation Application and Design, John Wiley (2007) 3rd edition.

EE 3066 Adaptive Control System

Credit: 3
Category: PEC
Prerequisite(s): Linear Control System (EE 2028)

Course Description:

Linear feedback, Effect of process variations, Adaptive schemes, The adaptive control problem, Least square and regression models, Estimating parameters in dynamic systems, Pole placement design, Indirect self tuning regulators (STR), Continuous time self-tuners, Direct STRs, Design of Minimum Variance and Moving average Controllers, Stochastic STRs, Linear Quadratic STR, Adaptive Predictive Control, The MIT Rule, Determination of Adaptation Gain, Lyapunov Theory, Design of MRAS using Lyapunov Theory, PID control, Auto tuning techniques, Transient Response methods, Principle of gain scheduling, Design of gain scheduling controllers, Nonlinear transformations.

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

CO1: remember the parameters of different controllers
CO2: understand the concept of parameter estimation of dynamic systems
CO3: apply adaptive controllers for different nonlinear systems
CO4: analyze the performance of indirect adaptive control techniques
CO5: evaluate model reference adaptive systems using Lyapunov Theory
CO6: design gain scheduling for controllers

Topics:
- Introduction to Adaptive Control
- Real- time Parameter Estimation
- Deterministic Self-tuning Regulators (STRs)
- Stochastic and Predictive Self-tuning Regulators (STRs)
- Model Reference Adaptive Systems
- Auto Tuning and Gain Scheduling

Textbook(s):
1. K.J. Astrom and B. Wittenmark, *Adaptive Control*, Addison, Pearson,2008.
2. S Sastry and M Bodson “Adaptive Control: Stability, Convergence and Robustness” Prentice-Hall, 2011.

Reference Book(s):
1. K.S. Narendra and A.M. Annaswamy, *Stable Adaptive Systems*, Prentice-Hall, 2005.
2. Adaptive Control Algorithms, Analysis and Applications by Ioan Doré Landau Rogelio Lozano Mohammed M’Saad Alireza Karimi, Springer Publication, Second Edition, 2011.

EE 3068 Power Converter Analysis and Design

Credit: 3
Category: PEC
Prerequisite(s): Power Electronics (EE 2026)

Course Description:

Single phase Rectifier Circuit: L-C filter design, Non-isolated dc-dc converters: Design and operation of buck-boost, Cuk, SEPIC, Zeta in DCM and CCM, Operation of Flyback Converter, Forward Converter and push-pull Converters in CCM, Design of Magnetic Materials suitable for high frequency transformers, Difference between hard and soft switching, Resonant circuit concept; ZCS and ZVS resonant converters; Electronic Ballasts, Modulation Strategies: Bipolar and Unipolar switching scheme; Performance parameters of 3 phase Sinusoidal PWM Inverters; Harmonic reduction techniques, Multi-level inverters, Gate drive circuits for Thyristor, MOSFET, IGBT, BJT, GTO.

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

CO1: chose appropriate power electronics converters for different applications
CO2: understand the need of high frequency transformers and Inductors
CO3: apply the knowledge of convertors to the operation and application of inverters
CO4: describe resonant converter and SMPS in various industrial applications
CO5: know the power quality improvement strategies using power electronic converters
CO6: design the gate driver circuit for different semiconductor devices

Topics:
- AC to DC Converters
- DC to DC Converters
- Switch Mode Power Supply
- Resonant Converters
- Inverters
- Gate drive Circuits

Textbook(s):
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(s):
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 3070 Hybrid Electric Vehicle

Credit: 3
Category: PEC
Prerequisite(s): DC machines and Synchronous Machines (EE 2020), Power Electronics (EE 2026)

Course Description:

Social and environmental importance of hybrid and electric vehicles, Introduction to various electric drive-train topologies, Power flow control in electric drive-train topologies, Various hybrid drive-train topologies, Fuel efficiency analysis, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, and Switch Reluctance Motor drives, Drive system efficiency, Storage Requirements in Hybrid and Electric Vehicles, Battery based , Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices, Sizing the drive system, sizing the propulsion motor, Sizing the power electronics, Selecting the energy storage technology, Communications, supporting subsystems classification, Comparison of different energy management strategies, Concept of tariff management in charging stations.

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

CO1: remember the models of Electric Vehicles and Hybrid Electric Vehicles
CO2: comprehend the mechanism of propulsion drive system
CO3: apply the traction Invertors to Control the output voltage and current
CO4: analyze the control of the speed and torque of various traction motors
CO5: explain the different energy storage systems
CO6: know the design novel Hybrid Electric Vehicle

Topics:
- History of Hybrid and Electric vehicles
- Electric Drive-Trains
- Electric Propulsion unit
- Energy Storage
- Energy Management Strategies

Textbook(s):
1. Electric and Hybrid Vehicles: Design Fundamentals, by Iqbal Husain, CBC Press, Second Edition, 2010.
2. Vehicular Electric Power Systems by Ali Emadi, Willis Press, 2003

Reference Book(s):
1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. Electric Vehicle Technology by James and John, John Wiley & Sons, Ltd First Edition, 2004.

EE 3072 Computer Aided Power System

Credit: 3
Category: PEC
Prerequisite(s): Power System Operation and Control (EE 3002)

Course Description:

Formation of Y_{bus} when regulating transformer present, Network matrices, Network graph, Basic Incidence matrices, Augmented matrices, Primitive networks, Network matrices by Singular and Non-singular transformation , 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, and link, Short circuit study of balanced network by Z_{bus}, LG fault, L-L fault, 3-ph fault with and without fault impedance, Problems. Load representation, Network performance equation, Swing equation, Machine equation, Solution techniques in transient stability study.

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

CO1: formulate Bus admittance matrix during load flow study
CO2: model power system components using graph theory
CO3: understand the incidence and network matrix of 3-phase networks
CO4: calculate the Bus impedance (Zbus) using algorithm
CO5: analyze the different fault study of 3-phase network using Zbus
CO6: know the solution methods for transient stability analysis

Topics:

- Load Flow Study using Computer Techniques
- Three Phase Networks
- Representation of Three Phase Elements in Short Circuit Study
- Transient stability Analysis

Textbook(s):

1. Computer Methods in Power System Analysis by Glenn W. Stagg, Ahmed H. El-Abiad, McGraw-Hill Book Company, International Editions, 2009.
2. Advanced Power System Analysis and Dynamics by L. P. Singh, New Age International (P) Limited, Publishers, Revised 4th Edition, 2011.

Reference Book(s):

1. Power System Analysis by N.V.Ramana, Pearson Publication,2011
2. Computer application techniques in Power System by M.A.Pai, TMH, 2006.
3. Electric Vehicle Technology by James and John, John Wiley & Sons, Ltd First Edition, 2004

EE 3074 Introduction to Machine Learning

Credit: 3
Category: PEC
Prerequisite(s): Mathematics - II (MA 1004), Data Structure and Algorithm (CS 2001)

Course Description:

Basic concepts of Machine learning, Techniques of Machine Learning Supervised learning, Unsupervised learning, learning theory, Introduction to Big Data Platform, Elements of Big Data, Big Data Analytics, Data Analytics Lifecycle, Fundamental concepts of cloud computing, Grid computing and mobile computing, H-computing, Simulated Annealing , Regression and its types Linear regression: Equations and algorithms, Clustering algorithms, K-means clustering, Hierarchical clustering, Performance evaluation for clustering, Applications, Density Estimation Parametric and non-parametric density estimation approaches, Dimension Reduction Principal component analysis (PCA), Linear discriminant analysis (LDA).

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

CO1: remember the basic building blocks of machine learning algorithms
CO2: comprehend Big data and cloud computing
CO3: utilize the supervised and unsupervised learning techniques
CO4: analyze specific machine learning algorithms to solve real-world problems
CO5: assess different Regression models
CO6: design Machine Learning Algorithm using its general principle

Topics:
- Machine Learning
- Big Data and Cloud computing
- Simulated Annealing and Regression
- Clustering

Textbook(s):
1. Shai Shalev-Shwartz, Shai Ben-David, Understanding Machine Learning From Theory to Algorithms, Cambridge University Press, 2014.
2. Machine Learning, Tom M. Mitchel , 1st edition Mc Graw hill 2018.

Reference Book(s):
1. Bishop. C M, Pattern Recognition and Machine Learning. Springer, 2006.
2. Duda, R O, Hart P E and Stork D G. Pattern Classification. Wiley-Interscience, 2nd Edition, 2000.

EE 3076 VLSI Circuit Design

Credit: 3
Category: PEC
Prerequisite(s): Digital Circuits (EE 2018), Analog Electronic Circuits (EE 2013)

Course Description:

PMOS, NMOS Transistors, Process parameters of PMOS and NMOS, Electrical Properties of CMOS circuits and device modeling, Scaling principle and fundamental limits, Propagation delays, Stick diagram and layout diagram. Elmore's Constant, Pass transistor logic, Transmission gates, Static and dynamic CMOS design, Static and dynamic latches and registers, Timing issues, Pipelines, Clock strategies, Memory architecture and memory control circuits, Low power memory circuit, Synchronous and asynchronous design, Data path circuits, architectures of ripple carry adder, Carry look ahead adders, High speed adders, Accumulators, Multipliers, Dividers, Barrel shifters, Full custom and semi-custom design, Standard cell design and cell libraries, FPGA building block architectures.

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

CO1: learn different steps involved in the fabrication of ICs using MOS transistor
CO2: explain electrical properties of MOS and BiCMOS devices
CO3: understand the design rules to be followed to draw the layout of any logic circuit
CO4: analyze different types of logic gates using CMOS inverter
CO5: design concepts to design building blocks of data path of any system using gates
CO6: demonstrate basic programmable logic devices and testing of CMOS circuits

Topics:
- MOS Transistor Principle
- Combinational Logic Circuits
- Sequential Logic Circuit
- Designing Arithmetic Building
- Implementation Strategies

Textbook(s):
1. Essentials of VLSI circuits and systems – Kamran Eshraghian, Eshraghian Dougles and A. Pucknell, PHI, 2005 Edition.
2. "Digital Integrated circuit –A design perspective", Jan Rabaey, Anantha Chandrakasan, B.Nikolic, Second Edition, PHI, 2003.

Reference Book(s):
1. CMOS logic circuit Design – John .P. Uyemura, Springer, 2007.
2. Modern VLSI Design – Wayne Wolf, Pearson Education, 3rd Edition, 1997.

EE 3078 Energy Management and SCADA

Credit: 3
Category: PEC
Prerequisite(s): Power System Operation and Control (EE 3002)

Course Description:

Energy Management Centers and Their Functions, Architectures, Characteristics of Power Generating Units and Economic Dispatch, Unit Commitment (Spinning Reserve, Thermal, Hydro and Fuel Constraints), Solution techniques of Unit Commitment, Generation Scheduling with Limited Energy, Energy management system, Energy Production Cost – Cost Models, Budgeting and Planning, Practical Considerations, Interchange Evaluation for Regional Operations, Types of Interchanges, Introduction to Supervisory Control and Data Acquisition, SCADA Functional requirements and Components, General features, Functions and Applications, Benefits, Configurations of SCADA, RTU (Remote Terminal Units) Connections, Power Systems SCADA and SCADA in Power System Automation.

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

CO1: know recent developments in Energy management System
CO2: understand economic load dispatch and unit commitment
CO3: analyze the economic aspect of energy production
CO4: demonstrate the knowledge of energy management to existing system
CO5: understand optimization and control of power systems
CO6: describe SCADA system

Topics:
- Introduction to Energy Management
- Economic Aspect
- SCADA System

Textbook(s):
1. Wood, A. J and Wollenberg, B. F, & sheble B.G."Power Generation Operation and Control", 2nd Edition John Wiley and Sons, 2003.
2. Handschin, Edmund, Petroianu& Alexandar. "Energy Management Systems", Springer Verlag, 1990.

Reference Book(s):
1. Green, J. N, Wilson, R, "Control and Automation of Electric Power Distribution Systems", Taylor and Francis, 2007.

EE 3081 Electrical System Modeling Using MATLAB

Credit: 1
Category: PCLC
Prerequisite(s): Basic Electrical Engineering (EE 1003), Power Electronics (EE 2026)

Course Description:

This course is proposed as a Sessional to UG students with the aim of imparting basic understanding of Modeling and Simulation so that the students will find it easy to use this knowledge in profession for applying to various engineering systems and design.

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

CO1: know the characteristic of half wave and full wave uncontrolled rectifier
CO2: understand the characteristic of half wave and full wave controlled rectifier
CO3: apply modeling techniques to Simulate the R-L and R-C circuit
CO4: analyse the methods of plotting of single phase and 3 phase sine wave
CO5: evaluate the simulated design of the PID controller
CO6: design a circuit to Plot I-V & P-V Characteristic of a PV cell

Topics:

- Simulation of single phase half wave uncontrolled rectifier with R & R-L load
- Simulation of single phase full wave uncontrolled rectifier with R & R-L load
- Simulation of Single Phase Half Wave Controlled Rectifier with R &R-L Load
- Simulation of Single Phase Full Wave Controlled Rectifier with R &R-L Load
- DC transient analysis of R-L and R-C series circuit in Matlab-Simulink
- Simulation of PID Controller
- Matlab Programming plot a 1-ph and 3-ph sine wave in MATLAB
- Modelling and simulation of DC shunt motor
- I-V Characteristic of PV system
- P-V Characteristic of PV system

Textbook(s):

1. Getting started with MATLAB by Rudra Pratap.

Reference Book(s):

1. Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers by Rudra Pratap.
2. MATLAB: An Introduction with Applications by Amos Gilat.

EE 3082 Minor Project

Credit: 2
Category: PROJ

Course Description:

Students are required to undertake a minor project either as an individual or in a group in consultation with the project guide which may be completed in one semester. The project work is aligned with the discipline of the student and its allied areas. It is preferably related to certain research objective or advanced technical domain. Students will demonstrate higher level learning outcomes and cognitive skills in the implementation of the project.

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

CO1: perform a background study on certain technical aspect and formulate a project objective
CO2: outline a pathway for the implementation of the project within the time line
CO3: apply fundamental engineering concepts, advanced technical know-how, use modern engineering tools, perform experiments and critically analyze the data
CO4: provide engineering solutions, design system components or processes with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
CO5: function effectively as an individual, and as a member or leader in a team under multidisciplinary settings following ethical practices
CO6: communicate effectively with a range of audiences and prepare technical reports

EE 3092 Power Systems Laboratory

Credit: 1.5
Category: PCLC
Prerequisite(s): Network and Electronics circuit Laboratory (EE 2091)

Course Description:

The main objective of the Power Systems laboratory is primarily used for teaching power system basic and advance modelling of transformers, transmission lines, fault analysis, protective relays characteristics and its schematics. The Power Systems Laboratory is equipped with different Protection Scheme of Alternator, over Current Relay, over voltage relay, Percentage biased Differential Relay, Microcontroller based negative sequence relay, Transmission line simulator kit. From this laboratory courses student will gain the skill to analyse the performance of power system networks, study different power system protective relays & develop computer software programs for analysis of power systems.

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

CO1: spell the characteristics of a transmission line
CO2: comprehend the uses of different relays in power systems
CO3: apply suitable techniques to locate the fault of an underground cable
CO4: analyze the results of short circuit analysis for symmetrical and unsymmetrical faults
CO5: assess the characteristics of a solar PV module
CO6: discuss the procedural steps needed to implement for interpreting the results of the power system software

Topics:

- Determine the ABCD parameters of a transmission lines.
- Study of electromechanical type over current relay & over voltage relay
- Fault location of Under Ground Cable by Varley Loop Test
- Develop software programs for analysis of power systems

Textbook(s):

1. Modern Power System Analysis, I. J. Nagrath, D. P. Kothari, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 4th Edition 2013.
2. Electrical Power System, C.L. Wadhwa, New Age International (P) Limited, Publishers, 2010.

Reference Book(s):

1. Power system analysis by Hadi Sadat Tata McGraw Hill.
2. Power System Protection and Switchgear by B Rabindranath and M Chander, Wiley Eastern (1977)
3. Fundamentals of Power System Protection", Y. G. Paithankar, S. R. Bhide, 2nd edition, Prentice Hall of India Private Limited, New Delhi, 2011
4. 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

EE 3093 Microprocessor Laboratory

Credit: 1.5
Category: PCLC
Prerequisite(s): Digital Circuit Laboratory (EE 2094)

Course Description:

This laboratory focuses on the assembly language programming on 8085, 8086 and 8051 processors. It covers the basic programming such as addition, subtraction, multiplication and division programs on microprocessor and microcontroller kits. The course also covers the complex programming based on arrays. Along with hands-on practice, the course also provides the different simulating platforms for program verification to the students. Further, interfacing programs on 8085 and 8051 processors are provided. Finally, the laboratory offers the basic learning on NodeMCU and Arduino embedded systems to the students.

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

CO1: remember the concept of microprocessors, microcontrollers and interfacing
CO2: understand the mnemonics in microprocessor 8085, 8086 and microcontroller 8051
CO3: apply the concept of the program logic to different applications
CO4: analyse electrical projects through programming in microprocessor and microcontroller
CO5: evaluate the different microprocessor and microcontroller programing
CO6: create own programs for different problems

Topics:

- Basic Programming of 8085 microprocessor
- Array Programming of 8085 microprocessor
- Basic Programming of 8086 microprocessor
- Array Programming of 8086 microprocessor
- Basic Programming of 8051 microcontroller
- Array Programming of 8051 microcontroller
- Interfacing programming using 8085 microprocessor and 8051 microcontroller
- Basic Programming on NodeMCU and Arduino Board
- PWM signals generation using Arduino Board

Textbook(s):

1. “Microprocessor architecture, programming and application with the 8085” by R. S. Goankar, Penram International Publications, 6th edition
2. “ Microprocessors and Interfacing, Programming and Hardware” by D. V. Hall, TMH, 3rd edition, 2012.
3. “ Microcontroller theory and applications” by Deshmukh, TMH, 2005
4. Arduinouno (Atmega328) on line manual.\

Reference Book(s):

1. 1.“ Introduction to Microprocessors” by A. P. Mathur, eTMH, 3 rd edition, 2011.
2. “Microprocessor and microcomputer based system design” by Md. Rafiquzzaman, 2nd edition
3. “Advanced microprocessors and microcontrollers” by Prof. S. K. V. Rama, Lashmi Publication, 1st edition
4. “8051 Microcontroller-Hardware, software and applications” by V. Udayashankara and Mallikarjunaswamy, TMH, 1st edition
5. “The 8051 microcontroller and embedded systems” by M. A. Mazidi, Pearson Pub., 2nd edition, 2011.

EE 3094 Electric Drives Laboratory

Credit: 1.5
Category: PCLC
Prerequisite(s): Power Electronics Laboratory (EE 2098)

Course Description:

This course will impart knowledge on performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using power electronics. Students will perform experiments related to topics studied in electric drives like various DC and AC motor drives and their control. Students will be encouraged to focus on industry oriented learning. They will be engaged to evaluate the performance of electrical drives with the use of computer-based analysis tools.

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

CO1: learn the importance of safety practices to be adopted in the laboratory
CO2: understand about the triggering circuit, control circuit and power circuit of a power electronic device
CO3: implement the industrial and domestic applications of various DC and AC motor drives
CO4 analyse the schemes of speed control of various DC and AC drives
CO5: evaluate the electrical and mechanical parameters of a given motor and to find its transfer function
CO6: design different electric drive circuits in Simulink environment and compare the result with experimentations

Topics:

- Determination of parameters of separately excited DC motor and to draw the block diagram to find the transfer function
- Speed control of separately excited DC motor by armature voltage control method using single phase fully controlled AC to DC converter with and without load
- Speed control of 3 phase squirrel cage induction motor using V/F control method
- Speed control of single phase induction motor by stator voltage control using single phase AC to AC converter
- Speed control of PMDC Motor using four quadrants DC chopper

Textbook(s):

1. G.K. Dubey, Fundamentals of Electric Drives, Second Edition, Narosa Publishers, 2007.
2. S. K. Pillai: A First Course On Electrical Drives, New Age International Publishers, 2nd Edition, 2007.

Reference Book(s):

1. Bimal K. Bose, Power Electronics and Motor Drives: Advances and Trends, Academic Press, Har/Cdr edition (13 September 2006).
2. N. K. De, P. K. Sen: Electric Drives, PHI Learning Pvt. Ltd., 7th Edition, 2004.
3. Modern Power Electronics and AC Drives by Bimal. K. Bose, PHI Publisher, 1st Edition, 2013.
4. S.A. Nasar, Boldea , Electrical Drives, CRC Press, Second Edition, 2006
5. M. A. El-Sharkawi , Fundamentals of Electrical Drives , Thomson Learning, 1st Edition, 2000.
6. R. Krishnan, Electrical Motor Drives, PHI, 2003

EE 3095 Control System Laboratory

Credit: 1.5
Category: PCLC
Prerequisite(s): Basic Electrical Engineering Laboratory (EE 1093)

Course Description:

The main objective of the Control Systems laboratory is primarily used for teaching Control system basics and Design of controllers for different systems. The Control Systems Laboratory is equipped with different modules for DC position control, AC position Control, DC Motor Speed Control, Frequency Response Analysis, Time Response Analysis, Tunning of PID controller, Temperature Controller, Pressure Controller, Flow Rate Controller etc. From this laboratory courses student will gain the skill to evaluate the performance of PID controller with respect to changes in control parameters, study the effect of controllers on different electrical and mechnical systems, analyse the stability of designed controller & develop computer software programs for analysis of controllers.

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

CO1: remembers the modern software tools for feedback controllers
CO2: understand the iterative nature of a successful controller design
CO3: apply the theoretical concepts and computational tools while designing controllers
CO4: analyse the characteristics obtained by by varying the input parameters in a SIMULINK environment
CO5: evaluate the electrical and mechanical parameters of a given system and to find the transfer function
CO6: create new programs in MATLAB environment

Topics:

- Time response analysis of linear system
- Tuning of PID controller or a First Order Process with Time Delay (FOPTD) Simulated System by Process Reaction Curve Method.
- Lead Compensator design
- Stability analysis using bode plot
- Stability analysis using root locus plot
- Design of Speed Controller for Armature controlled DC motor

Textbook(s):

1. Modern Control Engineering- By D. Roy Choudhury, PHI Publication, 5th Edition, 2009.
2. Control Systems- By Smarajit Ghosh, Pearson, Second Impression, 2013.

Reference Book(s):

1. Automatic Control System- By Hasan Saeed, Sixth Revised Edition, 2008
2. Modern Control Engineering- By K. Ogata, PHI publication, 5th edition 2010
3. Automatic Control Engineering- By B. C. Kuo , Prentice Hall, 7th edition 2009
4. Control System Engineering- By I. J. Nagrath and M. Gopal, New Age International Publication
5. Automatic control systems- By Prof. B.S. Manke & S.N.Verma ,Khanna publication, 2012.

EE 3096 Power Systems Protection Laboratory

Credit: 1
Category: PCLC
Prerequisite(s): Network and Electronics Circuit Laboratory (EE 2091)

Course Description:

The main objective of the Power Systems protection laboratory is primarily used for teaching power system protection basic and advance modelling of transformers, transmission lines, fault analysis, protective relays characteristics and its schematics. The Power Systems protection Laboratory is equipped with different Protection Scheme of Alternator, over Current Relay, over voltage relay, Percentage biased Differential Relay, Microcontroller based negative sequence relay, Transmission line simulator kit etc.. From this laboratory courses student will gain the skill to analyse the performance of power system networks, study different power system protective relays & develop computer software programs for analysis of power systems.

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

CO1: spell the characteristics of a transmission line
CO2: comprehend the uses of different relays in power systems
CO3: apply suitable techniques to locate the fault of an underground cable
CO4: analyze the results of short circuit analysis for symmetrical and unsymmetrical faults
CO5: assess the characteristics of a solar PV module
CO6: discuss the procedural steps needed to implement for interpreting the results of the power system software

Topics:

- Determine the ABCD parameters of a transmission lines
- Study of electromechanical type over current relay & over voltage relay
- Fault location of Under Ground Cable by Varley Loop Test
- Develop software programs for analysis of power systems

Textbook(s):

1. Modern Power System Analysis, I. J. Nagrath, D. P. Kothari, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 4th Edition 2013.
2. Electrical Power System, C.L. Wadhwa, New Age International (P) Limited, Publishers, 2010.

Reference Book(s):

1. Power system analysis by Hadi Sadat Tata McGraw Hill.
2. Power System Protection and Switchgear by B Rabindranath and M Chander, Wiley Eastern (1977)
3. Fundamentals of Power System Protection", Y. G. Paithankar, S. R. Bhide, 2nd edition, Prentice Hall of India Private Limited, New Delhi, 2011
4. 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

EE 3098 Control Laboratory

Credit: 1
Category: PCLC
Prerequisite(s): Basic Electrical Engineering Laboratory (EE 1093)

Course Description:

The main objective of the Control laboratory is design of controllers for different systems. The Control Laboratory is equipped with different modules for DC position control, AC position Control, DC Motor Speed Control, Frequency Response Analysis, Time Response Analysis, Tunning of PID controller, Temperature Controller, Pressure Controller, Flow Rate Controller etc. From this laboratory courses student will gain the skill to evaluate the performance of PID controller with respect to changes in control parameters, study the effect of controllers on different electrical and mechnical systems, analyse the stability of designed controller and develop computer software programs for analysis of controllers.

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

CO1: remembers the modern software tools for feedback controllers
CO2: understand the iterative nature of a successful controller design
CO3: apply the theoretical concepts and computational tools while designing controllers
CO4: analyse the characteristics obtained by by varying the input parameters in a SIMULINK environment
CO5: evaluate the electrical and mechanical parameters of a given system and to find the transfer function
CO6: create new programs in MATLAB environment

Topics:

- Time response analysis of linear system
- Tuning of PID controller or a First Order Process with Time Delay (FOPTD) Simulated System by Process Reaction Curve Method
- Lead Compensator design
- Stability analysis using bode plot
- Stability analysis using root locus plot
- Design of Speed Controller for Armature controlled DC motor

Textbook(s):

1. Modern Control Engineering- By D. Roy Choudhury, PHI Publication, 5th Edition, 2009.
2. Control Systems- By Smarajit Ghosh, Pearson, Second Impression, 2013.

Reference Book(s):

1. Automatic Control System- By Hasan Saeed, Sixth Revised Edition, 2008
2. Modern Control Engineering- By K. Ogata, PHI publication, 5th edition 2010
3. Automatic Control Engineering- By B. C. Kuo , Prentice Hall, 7th edition 2009
4. Control System Engineering- By I. J. Nagrath and M. Gopal, New Age International Publication
5. Automatic control systems- By Prof. B.S. Manke & S.N.Verma ,Khanna publication, 2012.

EE 3099 PLC Laboratory

Credit: 1
Category: PCLC
Prerequisite(s): Digital Circuit Laboratory (EE 2094)

Course Description:

PLC Laboratory is to aware the students about the Industrial Automation Techniques. The students will be familiar with different switches, sensors, actuators and measuring instruments which are most frequently used in process control industries. The students will be enabling with the upgraded relevant advanced software based controller utilized in modern industry. PLC laboratory gives the effort for making them efficient to design and construct the hardware part related to desired process control. Students can be able to know the technique and logical programme behind the Industrial process Control.

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

CO1: spell typical components of a Programmable Logic Controller
CO2: explain the concept of electrical ladder logic and its relationship to programmed PLC instruction
CO3: apply the concept of basic digital electronics and data manipulation
CO4: analyse the timers and counters using intermediate programming functions
CO5: evaluate the PLC circuits for entry-level PLC applications
CO6: design and program automated industrial production line

Topics:

- Introduction to PLC programmable logic controller
- Details of programming language as LAD
- LADDER Programming using NO,NC
- Programming on SPST and SPDT Logic
- Introduction to TIMER and COMPARATOR BLOCK
- Introduction to COUNTER BLOCK

Textbook(s):

1. Programmable logic Controller by Vijay R. Jadhav KHANNA PUBLISHERS Second Edition 2012
2. Industrial Automation Using PLC,SCADA and DCS by R.G Jamkar Laxmi Publications Private Limited; First edition 2017

Reference Book(s):

1. PLC and SCADA by Prof Rajesh Mehra and Er. Vikrant Vij Published by University Science Press, 1st edition
2. Programmable logic Controller: Programming methods and Applications By John R Hackworth and Frederick D. Hackworth Jr. PEARSON Edition: 1st Edition, 2006

EE 4044 Energy Audit and Management

Credit: 3
Category: OEC
Prerequisite(s): Basic Electrical Engineering (EE 1003)

Course Description:

Definitions of Energy Efficiencies, Estimation of Energy efficiencies in supply side and demand side, definition of energy conservation, management and audit, data collection and data analysis methodologies, demand and supply matching methodologies, optimization methodologies in input and output, Classification of furnace, arc furnace, controlled atmosphere in furnace, furnace fuels, efficiency of energy in furnace, thermal efficiency, Heat losses, reducing heat losses in hydraulic power systems compressed air, Heat recovery, drying and leak, Need for energy audit, energy audit and reporting format, financial audit, Energy index, Cost index, Budgeting and standard costing, representation of energy consumption, Energy economics.

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

CO1: understand the general aspects of energy audit and management
CO2: realize different data collection and analysis methodology
CO3: apply the concepts of energy utilization and conversion in furnace system
CO4: analyze combined heating and power system
CO5: examine different ways of representation of energy consumption
CO6: develop a system for profitability and financial appraisal

Topics:

- General Aspects of Energy Audit
- Energy Utilization and Conversion System
- Applications of Energy Audit

Textbook(s):

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, CRC PRESS, Second Edition, 2009.

Reference Book(s):

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 4047 Electrical Instrumentation

Credit: 3
Category: OEC
Prerequisite(s): Basic Electrical Engineering (EE 1003)

Course Description:

Errors in measurements, Moving Iron type instrument, Electrodynamometer type watt meters, Induction type energy meter, Electrical resonance type frequency meter, CT and PT, General equation of bridge balance, Maxwell's inductance, Anderson's bridge, Schering bridge, Errors, Definition and classification of transducers, Capacitance Transducers, Variable Inductance Transducers, Encoders. Thermocouples, Synchros, Piezoelectric Transducers, Hall effect Transducers, Tachometer. Thermistors, LVDT, Digital Energy Meter, Biometrics, Megger, Biomedical Instruments: ECG, Blood Pressure, Sonography.

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

CO1: choose appropriate instrument for Measurement of Different Electrical Quantities
CO2: comprehend the Electrodynamometrer type instruments
CO3: utilize concepts of AC bridges in determining circuit parameters
CO4: understand the characteristics and application of transducers
CO5: familiarize with the digital measuring instruments
CO6: understand the recent trends of measurement system

Topics:
- Measurement of Different Electrical Quantities
- AC Bridge
- Transducers
- Introduction to recent trends of measurement system

Textbook(s):
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(s):
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 Measurement and Measuring Instruments by Arthur Harris, Intelliz press, ISBN: 978-1-6825/-382-8/2018.

EE 4053 Digital Protection System

Credit: 3
Category: PEC
Prerequisite(s): Power system Protection (EE 3008), Microprocessor and interface (EE 3013)

Course Description:

Introduction, block diagram of numerical relay, sampling theorem, correlation with a reference wave, least error squared (LES) technique, digital filtering, and numerical over current protection. Procession Unit, Man-Machine Interface (MMI), Communication in Protection Relays, Information Handling with Sub-station Monitoring System (SMS), Protection and Coordinated Control, Place of Personal Computer, Self-Monitoring and Post Fault Analysis, Workstations and Remote Communication, Architecture, Interface to SCADA, Local Control Point: Man-Machine Interface, Reliability, Software Considerations, Redundancy, Privatization and Deregulation of Electrical Industry, Protective Relaying Capabilities, Digital protection: Digital protection of Transmission line, Synchronous Generator and power transformer.

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

CO1: know the digital system for relaying and signal processing
CO2: demonstrate the principle and communication protocol of numerical relay
CO3: examine in different monitoring protocols and architecture of relay
CO4: understand integrated digital substation control system
CO5: describe in digital protection scheme of transmission line
CO6: familiar with different digital protection of power apparatus

Topics:

- Principles of Numerical Relays
- Protection and Coordinated Control
- Reliability, Testing, and Maintenance for Numerical Relays
- Digital protection

Textbook(s):

1. Fundamentals of Power System Protection", Y. G. Paithankar, S. R. Bhide, 2nd edition, Prentice Hall of India Private Limited, New Delhi, 2011.
2. Digital Protection, L.P Singh, New age International Publisher, 2nd Edition, 1997.

Reference Book(s):

1. Protective Relaying: Principles and Applications, Fourth Edition, By J. Lewis Blackburn, Thomas J. Domin, CRC Press, Taylor and Francies.
2. Power System Protection Static Relays by T S M Rao, 2nd edition, Tata McGraw-Hill Education, 2005.

EE 4055 Wide Area Measurement System

Credit: 3
Category: PEC
Prerequisite(s): Power system Protection (EE 3008), Signals and System (EE 2022)

Course Description:

Computer relay architecture, Anti-aliasing filter, Substation computer hierarchy, Walsh functions, Discrete Fourier Transform, Kalman filtering, Wavelets, Elements of artificial intelligence, DFT and Phasor representation, Frequency Estimation, A generic PMU, Functional requirements of PMUs and PDCs, Nature of transient, TR of Instrument transformers and filters, Static state estimation , State estimation with Phasors measurements, Linear state estimation, Protection system with phasor inputs: Differential and distance protection of transmission lines, adaptive relaying, WAMS architecture, WAMS based protection concept.

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

CO1: remember Computer Relay Architecture
CO2: understand the concepts of Filters in Computer Relaying
CO3: apply phasor measurement in wide area measurement systems
CO4: comprehend Transient Response of Phasor Measurement Unit
CO5: identify phasor measurement applications and WAMS
CO6: Conceptualize with WAMS based protection and architecture

Topics:
- Computer Relaying
- Filters in computer relaying
- Phasor measurement systems
- Phasor measurement applications and WAMS
- Wide area measurement systems

Textbook(s):
1. A.G. Phadke, J.S. Thorp, “Computer Relaying for Power Systems”, John Wiley and Sons Ltd., Research Studies Press Limited, 2nd Edition, 2009.
2. A.G. Phadke, J.S. Thorp, “Synchronized Phasor Measurements and Their Applications”, Springer, 2008.

Reference Book(s):
1. Antonello Monti , Carlo Muscas , Ferdinanda Ponci ,`` Phasor Measurement Units and Wide Area Monitoring Systems”, Elsevier, 1st edition, 2016.
2. J. Lewis Blackburn , Thomas J. Domin, ``Protective Relaying: Principles and Applications”, 4th Edition, 2014

EE 4057 Harmonics Elimination Techniques

Credit: 3
Category: PEC
Prerequisite(s): Power Electronics (EE 2026)

Course Description:

True power factor, K-factor, Phase Shift, Phase Sequence, Standards- factors influencing the development of standards, Concept of THD, Existing harmonic standards (IEC, IEEE), General harmonics indices, Transformer magnetization, Power electronics loads, line- commutated converters current waveforms and THD, Switched mode power supplies, current waveforms and THD, Resonance, nuisance tripping, blown capacitor fuses and capacitor cells, degradation of internal capacitance, motor and torque pulsations, overheating, overloading neutrals, telephone interference, concept of harmonic phase angle displacement, harmonic symmetrical components, harmonic instrumentation, Passive filter design methods, tuned filters, FFT and DFT, concept of multi pulse converter, PWM for harmonic elimination.

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

CO1: know various terms related to harmonics and their standards
CO2: analyze the causes of harmonic generation from electrical loads
CO3: apply the signal processing techniques for assessment of harmonics
CO4: analyze the effects of harmonics on different electrical components and systems
CO5: understand the nature of harmonics with different techniques
CO6: design filters for Harmonic Elimination

Topics:
- Introduction to Harmonics
- Causes of Harmonics
- Effect of Harmonics
- Harmonic Measurement Methods
- Harmonics Elimination

Textbook(s):
1. Arrillaga J. and Waston N.R., “Power System harmonics”, Wiley Second Edition, U.S.A., 2003.
2. Prof. Mack Grady, “ Understanding Power System harmonics”;Dept of Electrical & Computer Engineering University of Texas at Austin , U.S.A., 2012.

Reference Book(s):
1. “Power Systems Harmonics” by George J. Wakileh, Springer, 2001.
2. F. Z. Peng, “Harmonic sources and filtering approaches,” IEEE Ind. Appl. Mag., vol. 7, pp. 18–25, 2001.
3. Power Electronics Converter Harmonics: Multipulse Methods for Clean Power, Derek A. Paice, Wiley-IEEE Press, 1999.

EE 4058 Smart Illumination Technology

Credit: 3
Category: OEC
Prerequisite(s): Basic Electrical Engineering (EE 1003)

Course Description:

Types of Illumination, Quality of good lighting, Factors affecting the lighting-shadow, Lighting schemes, Terminologies, Laws of Illumination, Concept of image by eyes and glare. Uniformity ratio, Direct ratio, Illumination required for various work planes, Selection of lamp and luminance, Determination of lamp lumen output taking into account voltage and temperature variations, Types of street and their level of illumination required, Terminologies, Various arrangements in street lighting, calculation of illumination level available on road. Optical design of luminaire, construction, software design of luminaire optics, Advanced interior lighting design calculations, Study of various types of sensors, software design on interior lighting, road lighting and flood lighting.

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

CO1: know the different lighting system
CO2: understand the design of interior lighting system
CO3: apply lighting system for outdoor applications
CO4: analyze the various criteria for the selection of lighting systems
CO5: perform calculations on photo metric performance of light sources and luminaries for lighting design
CO6: design various types of lighting systems

Topics:

- Introduction of Light
- Design of Interior Lighting
- Design of outdoor lighting
- Computer Aided Lighting System Design

Textbook(s):

1. Jack L. Lindsey, Applied Illumination Engineering , PHI, 1991
2. John Matthews, Introduction to the Design and Analysis of Building Electrical Systems, Springer, 1993

Reference Book(s):

1. V. V, Meshkov, Fundamentals of Illumination Engineering, Mir Publication, Russia, 2008
2. Ronald N. Helms & M Clay Belcher, Lighting for energy efficient luminous environments, Pentice Hall, 2012
3. "Lamps and Lighting", M.A. Cayless, Routledge, 1996

EE 4059 Solar Photovoltaic and Fuel Cell

Credit: 3
Category: PEC
Prerequisite(s): Power Electronics (EE 2026), Renewable Energy Sources (EE 3017)

Course Description:

Extra-terrestrial solar radiation, Solar spectrum at the earth surface, Estimation of solar radiation, The Photo voltaic effect, PN junction, PV cell characteristics, equivalent circuits, limits of cell parameter, losses in a solar cell, solar cell design, Design and structure of PV Modules, Maximum power point tracking (P&O), Stand-alone PV system configurations, Sizing of PV system, Grid-connected PV systems, Simple payback period, Life cycle costing(LCC), Comparison between fuel cells, Solar cells and batteries, components of fuel cells, principle of working of fuel cell, Types of Fuel Cells:Solid-oxide fuel cell (SOFC).

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

CO1: recall basics of insolation of Solar Resources
CO2: understand the potential of Solar Photovoltaic (PV) System
CO3: apply Maximum Power Point Tracking on solar PV system
CO4: develop engineering approach for designing a Solar energy system
CO5: determine the characteristic and principles of different fuel cells
CO6: design of standalone solar PV system

Topics:
- Solar Resources
- Solar Photovoltaic (PV) System
- PV System Design
- Fuel Cells

Textbook(s):
1. Solar Photovoltaics Fundamentals, Technologies and Applications by Chetan Singh Solanki, PHI Publication,2013.
2. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, NY (2006).

Reference Book(s):
1. Micheal Boxwell , "Solar Electricity Handbook", Green Stream publishing, 2010.
2. Rai G.D, "Non-Conventional Energy Sources", Khanna Publishers, 4th Edition, 2000.
3. Hand Book of Fuel Cells - Fundamentals and Technology and Application, Wiley & Sons Publishers, 2009.

EE 4060 Distribution System Planning and Automation

Credit: 3
Category: PEC
Prerequisite(s): Generation, Transmission and Distribution of Electric Power (EE 2024)

Course Description:

Factors affecting system planning, Planning Models, Load forecasting, methods of forecast, Load management, tariffs and metering of energy, Sub transmission, Substation location and rating. Types of feeders , Voltage levels , radial feeder, Design considerations of Secondary Systems, Voltage Drop And Power Loss Calculations:, Capacitors In Distribution Systems, Reforms in power sector, Methods of improvement, Reconfiguration, Reinforcement, Basic architecture of Distribution automation system, software and open architecture, RTU and Data communication , SCADA requirement and application functions, GIS/GPS based mapping of Distribution networks, Communication protocols for Distribution systems , issues in multi–year tariff and availability based tariff.

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

CO1: know the concepts of Distribution System Planning
CO2: understand the load forecasting techniques
CO3: ideate appropriate bus schemes for distribution substation
CO4: analyze the power loss calculation and its improvement in secondary distribution system
CO5: comprehend the concept of metering system and tariff
CO6: understand the concept of distribution system automation

Topics:

- Distribution System Planning
- Load Characteristics
- Sub transmission Lines and Distribution Substations
- Design considerations of Primary & Secondary Systems
- Voltage Drop And Power Loss Calculations
- Capacitors in Distribution Systems
- Distribution System Automation

Textbook(s):

1. Turan Gonen : Electric Power Distribution Engg., Mc-Graw Hill,1986.
2. A. S. Pabla : Electric Power Distribution, TMH, 2000.

Reference Book(s):

1. Shahnia, Farhad, Arefi, Ali, Ledwich, ``Electric Distribution Network Planning",2018,Springer Nature Singapore Pte Ltd.
2. James Northcote-Green , Robert G. Wilson, ``Control and Automation of Electrical Power Distribution Systems", 1st Edition, September 22,2006 , Taylor and Francis Publisher

EE 4061 Sensors for Engineering Applications

Credit: 3
Category: PEC
Prerequisite(s): Electrical and Electronics Measurement (EE 2019)

Course Description:

Resistance strain gauge, piezoelectric pressure gauge, characteristics. Pressure gauge, Capacitor plate sensor, inductive sensor, LDVT Accelerometer systems, Rotation sensors, Drag cup devices, Piezoelectric devices, Rotary encoders, Photo sensors, Photomultiplier, photo resistor and photoconductors, photodiodes, phototransistors, photovoltaic devices, fiber-optic applications, light transducer, solid –state transducers, liquid crystal devices, Bimetallic strip, Bourdon temperature gauge, thermocouples, Resistance thermometers, thermostats, PTC thermistors, bolometer, Pyroelectric detector, Proximity detectors- inductive and capacitive, Ultrasonic photo beam detectors, Reed switch, magnet and Hall–effect units, Doppler detectors, liquid level detectors, flow sensors, smoke sensors.

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

CO1: remember the practices of Strain and Pressure Measurement
CO2: describe the measurement techniques of sensors and transducers
CO3: comprehend the ways of applications of various Motion Sensors
CO4: apply the concept of light radiation in sensor technology
CO5: understand the concept of heat and temperature sensors and their applications
CO6: use of sensors in electrical and non-electrical parameter measurement

Topics:
- Strain And Pressure Measurement
- Motion Sensors
- Light Radiation
- Heat And Temperature
- Electronic Sensors

Textbook(s):
1. Doebelin E O," Measurement Systems, Application and Design", McGraw Hill, Fifth Edition, 2004.
2. Ian R Sinclair, "Sensors and transducers", Third Edition, Newness Publishers , 2001.

Reference Book(s):
1. Jack P Holman, "Experimental Methods for Engineers", Seventh Edition, McGraw Hill, USA, 2001.
2. Robert G Seippel, "Transducers, Sensors and detectors", Reston Publishing Company, USA, 1983.

EE 4062 Distributed Generation and Micro-Grid

Credit: 3
Category: PEC
Prerequisite(s): Power Electronics EE 2026), Generation, Transmission and Distribution of Electrical power (EE 2024)

Course Description:

Conventional power generation, Energy crises, Non-conventional energy (NCE) resources, Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations, Requirements for grid interconnection, limits on operational parameters, voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues, Concept and definition of micro grid, typical structure and configuration of a micro grid, AC and DC micro-grids, modes of operation and control of micro grid, Modeling and Stability analysis of Micro grid, regulatory standards, Micro grid economics.

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

CO1: know about the different renewable energy sources
CO2: explain the concepts of Distributed Generation (DG)
CO3: recall the regulatory standards of Distributed Generation
CO4: analyze the impact of grid integration through Distributed Generation
CO5: understand the concepts of Micro Grids
CO6: evaluate Power Quality Issues in Micro-Grids

Topics:

- Introduction to Micro-grid
- Distributed Generations (DG)
- Impact of Grid Integration
- Micro grids
- Power Quality Issues In Micro grids

Textbook(s):

1. Gevork B. Gharehpetian S. Mohammad Mousavi Agah ‘Distributed Generation Systems’ ,1st Edition, 2017.
2. Pat Wheeler ,Frede Blaabjerg,"DC Distribution Systems and Microgrids",Publisher Institution of Engineering and Technology, 2018

Reference Book(s):

1. M.S Mahmoud“ Microgrid advanced control method and Renewable energy system integration”,BH Publication, 2016.
2. Gevork B.Gharehpetian,S.Mohammad Mousavi Agah “Distributed Generation Systems”,1st Edition,Elsevier Publication,2017.

EE 4063 Process Instrumentation and Control

Credit: 3
Category: PEC
Prerequisite(s): Basic Electrical Engineering (EE 1003), Linear Control System (EE 2028)

Course Description:

Various process schemes, unit operations, batch and continuous process. Description and characteristics heat exchangers, furnaces, boilers and condensers, distillation columns, absorbers, reactors, Radio isotope and ultrasonic methods of Instrumentation and its applications in process industries, Measurement and transmission of process, Different control techniques and interaction of process parameters –On – off control, feed forward, Cascade, Ratio, Override controls, Multivariable control, Optimal control, Adaptive control, Digital P-I-D controller –scheme and simulation, Tuning of controllers, Zeigler Nichols, Cohen Coon and other methods, Control valves, valve positioners, Supervisory control, Direct digital control (DDC)

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

CO1: know the characteristics of batch and continuous process
CO2: understand significance of process parameters in industrial processes
CO3: measure process parameters using various techniques
CO4: analyze different methods for process control and control action generation
CO5: estimate the parameters for Controller Tuning
CO6: develop intelligent methods in different Industrial Process Control applications

Topics:

- Process characteristics
- Measurement of process parameters
- Process control methods and control action generation
- Controller tuning
- Final control elements
- Computer control of processes

Textbook(s):

1. Harriot, Process Control, TMH, New Delhi
2. Patranabis, D. Principles of Process control, TMH, New Delhi
3. Coughnower and Koppel Process system Analysis and Control .Mc Graw hill

Reference Book(s):

1. Smith , L. Digital Computer process control, intext Education Publishers, 1972
2. Franklin Digital control of dynamic systems 3rd Edition Pearson, 2003
3. Johnson, C. Process control instrumentation technology, PHI, New Delhi

EE 4064 Advanced Power Converters

Credit: 3
Category: PEC
Prerequisite(s): Power Electronics (EE 2026)

Course Description:

Diode-Clamped, Capacitor-Clamped Multilevel Inverters; Multilevel Inverters Using H-Bridges (HBs) Converters- Cascaded Equal Voltage Multilevel Inverters (CEMI), Binary, Trinary Hybrid Multilevel Inverter (THMI); Different PWM techniques, POD, APOD and PD PWM techniques, Equivalent Circuits of ZSI, Operating Principle; Control of ZSI, Inverter Based AC/DC/AC Converter Topology, Direct Matrix Converter Topology, Commutation Difficulties of the Direct Matrix Converter, Current and Voltage Commutation Methods, Modulation Technique for Direct Matrix Converter, Application of ZSI in solar PV system, Application of matrix converter in wind energy conversion system.

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

CO1: know different configurations of Multilevel Inverters
CO2: comprehend the various PWM techniques of multilevel inverters
CO3: analyze the equivalent circuits, operating principle and control of Z-Source Inverters
CO4: analyze the circuits, operating principles and control of Matrix Converters
CO5: evaluate various Modulation Techniques for direct Matrix Converters
CO6: determine the various industrial applications of converters

Topics:
- Multilevel Inverters
- Z-source Inverters
- Matrix converters
- Application of converters

Textbook(s):
1. F. L. Luo and H. Ye, Advanced DC/AC inverters application in renewable energy, Boca Raton, FL: CRC press: Taylor and Francis, 2013
2. Elements of Power Electronics, by Philip T. Krein, Oxford University Press, 25 Sept 1997.
3. Power Electronics, Converters, Applications and Design, by N. Mohan, Underland and Robbins, John Wiely and Sons, 3rd Edition,2011.

Reference Book(s):
1. Bin Wu, High Power Converters and AC Drives, Publisher : John Willey & sons, second edition, 2017.
2. Power Electronics Converter Harmonics: Multipulse Methods for Clean Power, Derek A. Paice, Wiley-IEEE Press, 1999.

EE 4065 Components of Industrial Automation

Credit: 3
Category: PEC
Prerequisite(s): Signals and System (EE 2022)

Course Description:

Digital and Analog Signals, Signal Sampling Process, Analog to Digital Conversion, Relays Contractors and Switches, Thermistor, RTD, LVDT, Synchro, Load Cells, Indicators, Electronic controllers, Sensors and transducers, Interfacing signal conditioning, Signal analysis techniques, DAQ hardware, Instrumentation buses, IEEE 488.I and IEEE 488.2, Serial interfacing-RS 232C, RS 422, RS 423, RS 485, CAMAC, VXI, SCXI, PXI, Characteristic features of industrial networks, Low level networks and their features, Field bus architecture, Architectural levels of Industrial controls, Servomotors, Stepper motors, Process I/O systems. Local & remote I/O systems, Different types of controllers, Direct controllers and their tuning, Direct Digital Controllers, Software implementation of Multi-loop Controllers, Distributed Control Systems.

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

CO1: understand various applications of digital and analogue signals
CO2: learn working principle of various types of Sensors, Actuators and Controllers
CO3: analyze data acquisition system, serial Interfacing and signal conditioning process
CO4: demonstrate architecture of industrial network orientation
CO5: analyze the significance of different motors and input-output modules in industrial automation system
CO6: design and Tune controller for Industrial Application

Topics:
- Signals and Conversion
- Industrial Electronics Controller
- Data Acquisition Methods and Communication System
- Industrial Automation and Control

Textbook(s):
1. Computer-Based Industrial Control, Krishna Kant, 2nd Edition, PHI
2. Fundamentals of Industrial Instrumentation and Process Control, W. C. Dunn, TMH, 2009.

Reference Book(s):
1. Modern Automation System, M. Abdelati, University Science Press, 2009.

EE 4066 Wind and Biomass

Credit: 3
Category: PEC
Prerequisite(s): Transformers and Induction Motors (EE 2017)

Course Description:

Wind power in India, Power extracted from the wind, rotor-swept area, Air density, Global wind patterns and wind speed distribution, Components of Wind Energy Conversion System, Wind turbine blades aerodynamic design, System design trade-offs, system control requirement, Electrical Generators for Wind Energy Conversion System, Self-Excited Induction Generator and Doubly Fed Induction Generator operation, Speed control regions, Generator drives: Fixed and variable speed drives, Bio fuels, classification, Biomass conversion technologies: Physical Method, Thermal conversion: pyrolysis, gasification and liquefaction, Types of Gasifiers, Classification of biogas plants, biogas digester and types.

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

CO1: learn wind power and biomass potential at a particular location
CO2: understand Government policies for Wind energy
CO3: apply the Wind Energy Conversion System (WECS)
CO4: use of generators and variable speed drive for WECS
CO5: demonstrate the benefits of Biomass energy
CO6: create a report on the environmental and social impacts of Wind and Biomass power

Topics:

- Introduction of Wind Energy
- Wind power Systems
- Electrical Generators and Drives
- Bio Energy

Textbook(s):

1. Wind and Solar Power system by Mukund R Patel, CRC Publication, 2005.
2. Donald L. K., "Biomass for Renewable Energy, Fuels and Chemicals", Academic press, Elsevier, 2003.

Reference Book(s):

1. B. H. Khan, "Non – Conventional Energy Resources" Tata Mc Graw Hill, 2nd edition, 2009.
2. Wind Electrical Systems by S.N. Bhadra, D. Kastha, S. Banerjee, Oxford Higher Education, 2005

EE 4067 Special Machines, Drives and Smart Inverter

Credit: 3
Category: PEC
Prerequisite(s): Basic Electrical Engineering (EE 1003), Analog Electronic Circuit (EE 2013)

Course Description:

Hybrid stepping motor, construction, principles of operation, Essential conditions for the satisfactory operation of a 2-phase hybrid step motor, Control circuits for stepping motors, Development of a double-sided LIM schematic of LIM drive for electric traction development, field analysis of a DSLIM, PMSM Principle of operation – EMF and torque equations – Starting – Rotor configurations – Dynamic model, axial and radial flux motors – operating principle – characteristics, Types of solar inverter, Selection of off grid inverter, Selection of power conditioning unit (PCU), Sizing of solar inverter, protection, Mounting arrangement of string inverter, IEC/IEEE /Grid Compliance of inverters, Grid-Connected Inverters vs. Stand-Alone Inverters,

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

CO1: remember the need of different special machines
CO2: comprehend different special machines as part of control system components
CO3: develop a double-sided linear induction motor
CO4: understand the principle of Permanent Magnet Synchronous Motors
CO5: know the operation and characteristics of synchronous reluctance motors
CO6: estimate and select suitable Inverters for different applications

Topics:

- Stepper Motors
- Linear Induction Motor
- Permanent Magnet Synchronous Motors
- Synchronous Reluctance Motors
- Smart Inverters Selection

Textbook(s):

1. Miller, T. J. E., Brushless Permanent Magnet and Reluctance Motor Drives, Oxford Science Publications, 1989.
2. Kenjo, T., and Sugawara, A., Stepping Motors and their Microprocessor Controls, Oxford Science Publications, 1984.

Reference Book(s):

1. Krishnan, R., Electric Motor Drives: Modeling, Analysis, and Control. Prentice Hall, (2001).
2. Krishnan, R., “Permanent Magnet and BLDC Motor Drives”, CRC Press, 2009.
3. Chang-liang, X., "Permanent Magnet Brushless DC Motor Drives and Controls", Jun 2012.

EE 4068 State Estimation and Security

Credit: 3
Category: PEC
Prerequisite(s): Power System Operation and Control (EE 3002)

Course Description:

Energy control center, security analysis and monitoring, Introduction to State Estimation (SE) in power systems: Weighted Least Square (WLS) Estimation, Network Observability and Pseudo–measurements, Topological observability and its algorithm. Bad data detection in WLS method, chi square test, identification of bad data: method of normalized residual and test, application of PMU in state estimation, linear measurement model with PMU's, Contingency analysis, Detection of network problems, Linear sensitivity analysis, AC power flow methods contingency selection, concentric relaxation, Bounding area method.

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

CO1: know about energy control center and security analysis
CO2: understand the concept of state estimation
CO3: apply network Observability and Bad Data Detection techniques in state estimation
CO4: analyze the impact of PMU in State Estimation
CO5: understand the factors effecting power system security
CO6: identify the most appropriate algorithm for network contingency analysis

Topics:
- State Estimation
- Network Observability and Bad data Detection
- Power System Security

Textbook(s):
1. Allen J. Wood and Bruce Woolenberg: Power System Generation, Operation and Control, John Wiley and Sons, 1996.
2. Power system state estimation by Mukhtar Ahmad, Artech House, 2013.

Reference Book(s):
1. John J. Grainger and William D Stevenson Jr.: Power System Analysis, McGraw Hill ISE, 1994.
2. IEEE Proc. July 1974, Special Issue on Computer Control of Power Systems.

EE 4069 Vehicle Charging Technology

Credit: 3
Category: PEC
Prerequisite(s): Basic Electrical Engineering (EE 1003), Chemistry (CH 1007)

Course Description:

EV classification, Charging Equipment's, Slow charger design rating, Fast charger design rating, AC charging and DC charging, Inboard and off board charger specification, Types of Mode of charger, Wireless Charging: static charging and dynamic charging, AC Pile Charger, DC Pile Charger, EVSE Power Module selection and technical specification, Communication gateway, Specification of open charge point protocol, AC001 Charger specification, Communication Interface between charger and CMS, Communication between AC charger and EV, Selection of DC charger connector, Communication methodology of DC fast chargers, standard of Charging topology, Assessment of site Location for Public charging station, Selection and Sizing of: Distribution transformer, Selection of Compact Substation.

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

CO1: understand the basics of Electric Vehicles and its charging
CO2: realize the various components required in EV charging
CO3: demonstrate the types of charging and their modes
CO4: analyze the proper selection and sizing of charging components and connectors
CO5: realize the necessary charging standard and process of commissioning
CO6: estimate the Selection and Sizing of charging station for EVs and HEVs

Topics:
- Components of Electric Vehicle
- Types of EV Chargers
- Selection and sizing of fast and slow charger (AC & DC)
- Selection and sizing of Common types of connectors and applications
- Public Charging infrastructure

Textbook(s):
1. Chris Mi, M. AbulMasrur, David WenzhongGao, Hybrid Electric Vehicles Principles And Applications With Practical Perspectives, Wiley Publication, 2011.
2. C.C. Chan and K.T. Chau, Modern Electric Vehicle Technology, OXFORD University Press, 2001

Reference Book(s):
1. M. Ehsani, Y. Gao, S. Gay and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 2005
2. Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer, 2013.

EE 4070 Smart Grid Technology

Credit: 3
Category: PEC
Prerequisite(s): Power System Operation and Control (EE 3002), Renewable Energy Sources (EE 3017)

Course Description:

Components and architecture of smart grid design, Review of the proposed architectures for smart grid, Transmission automation, Distribution automation, Renewable integration, Synchro Phasor Measurement Units (PMUs), Computational intelligence techniques, Distribution Generation Technologies, Computational techniques, Static and dynamic optimization techniques, Introduction to communication technology, Evolutionary algorithms, Artificial intelligence techniques, 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.

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

CO1: know the different elements of smart grid
CO2: demonstrate on Smart Grid Architecture
CO3: describe in Synchro Phasor Measurement Unit
CO4: understand the communication technology in smart grid
CO5: analyze frequency control in micro grid system
CO6: control of the voltage and reactive power in smart grid

Topics:
- Introduction to Smart Grid
- Tools and Techniques for Smart Grid
- Communication Technologies and Smart Grid
- Control of Smart Power Grid System

Textbook(s):
1. James Momoh, “SMART GRID, Fundamentals of Design and Analysis” IEEE press, 2013.
2. A.G. Phadke and J. S. Thorp, “Synchronized Phasor Measurements and their Applications”, Springer Edition, 2010

Reference Book(s):
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.
4. Stuart Borlase, "Smart Grids, Infrastructure, Technology and Solutions", CRC Press, 2013.

EE 4071 IoT in Electric Vehicles

Credit: 3
Category: PEC
Prerequisite(s): Special Machines, Drives and Smart Inverter (EE 4067), Computer Programming (CS 1093)

Course Description:

Sensing and Actuation, Genesis of the Internet of Things, sensor types and properties, different transducers and actuators, Internet Communications: An Overview, Static and dynamic IP Address Assignment, MAC Addresses, TCP and UDP Ports, MQTT, XMPP, CoAP, IEEE802.15.4, ZigBee, LORA, RFID, Client Server Model, HTTP, Thingspeak, AWS, Cloud MQTT, IoT Gateways, IoT Routing attacks, Fog computing, IoT Fog, vehicle to everything, V2X paradox, VANETs, Information centric networks, CCN for VANET, three layered architecture, intelligent connected vehicles. smart charging, Block-chain IoT for interconnected vehicle, transportation management system, logistic management system.

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

CO1: choose the components of IoT
CO2: know various protocols of internet
CO3: Analyze Various IoT networking techniques and cloud
CO4: comprehend the Security and Privacy in IoT
CO5: Understand the interconnected vehicle technology
CO6: recognize the use cases of IoT in Electric Vehicles

Topics:

- Components in the Internet of Things
- IoT Protocols
- IoT Security
- Connected Vehicle with IoT
- Charging Management System

Textbook(s):

1. “Precision: Principles, Practices and Solutions for the Internet of Things ” Timothy Chou, TMH
2. “Internet of Things Principles and Paradigms”, Rajkumar Buyya & Amir Vahid Dastjerdi,Elsevier.
3. “Designing the Internet of Things”, Adrian McEwen, Hakim Cassimally, Wiley publication, 1st Edition, November 2013.
4. The Internet of Things in the Power Sector Opportunities in Asia and the Pacific, Ramamurthy, A. and Jain, P, 2017.

Reference Book(s):

1. “The Internet of Things: A Survey”, Journal on Networks, Luigi Atzori, Antonio Lera, Giacomo Morabito, Elsevier Publications, October, 2010.
2. "The Internet of Things in the Cloud:A Middleware Perspective”, Honbo Zhou, CRC Press-2012.
3. “Architecting the Internet of Things”, Dieter Uckelmann, Mark Harrison, Springer, 2011.

EE 4072 Grid Integration and Control

Credit: 3
Category: PEC
Prerequisite(s): Power Electronics (EE 2026), Linear Control System (EE 2028)

Course Description:

Active and reactive power in electric system, Voltage sag, Voltage swell, Unbalanced voltage, Notch, Harmonic distortion, Frequency deviations, Abnormal Grid Conditions, International Regulations, The Clarke Transformation, concept of the p-q theory, Grid Synchronization Techniques: Zero crossing detection Technique, Phase-Locked Loop, Control structures for distributed generation system: Synchronously rotating reference frame, Stationary reference frame and Natural reference frame control structure, passive tuned and high-pass filters, Shunt and series active power filters, STATCOM for reactive power compensation, Symmetrical and unsymmetrical grid faults, Synchronous Reference Frame based PLL (SRF-PLL), SOGI-PNSC based grid synchronization technique under grid fault.

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

CO1: recognize the power quality issues in electric systems
CO2: comprehend the basic idea of Instantaneous Power Theory
CO3: analyze different Grid Synchronization structures and control techniques
CO4: understand the design criteria for different filters used for grid connected converters
CO5: compare different faults in grid
CO6: know the synchronization of power converters under grid fault conditions

Topics:
- Overview of Power Quality and International Regulations
- The Instantaneous Power Theory
- Grid Synchronization of three phase systems
- Grid Filter Design
- Grid Synchronization of Power Converters under Grid Faults

Textbook(s):
1. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, Wiley Int. Jan 2011.
2. Hirofumi Akagi, Edson HirokazWatanable , Mauricio Aredes, Instantaneous Power Theory and Applications to Power Conditioning , Wiley- IEEE Press , Feb 2007.

Reference Book(s):
1. Robert W Erickson and Dragan Maksimovic , Fundamentals of Power Electronics, 2nd Ed, Springer (India) Pvt. Ltd. 2005.
2. Wind Power Plants and Project Development by Joshua Earnest, Tore Wizelius, Second Edition, PHI Publication, 2015.
3. F. Gardner, Phaselock Techniques, New York, NY, USA: Wiley, 2005.
4. M. H. J. Bollen, Understanding Power Quality Problems: Voltage Sags and Interruptions. IEEE Press, 2002.

EE 4073 IoT in Industry

Credit: 3
Category: PEC
Prerequisite(s): Electrical Circuits Analysis (EE 2015), Computer Programming (CS 1093)

Course Description:

Components in internet of things, Sensing and Actuation Anywhere, Anytime, Genesis of the Internet of Things, Internet Principles, Internet Communications, Static and dynamic IP Address Assignment, TCP and UDP Ports, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories, Next Generation Sensors, Product Lifecycle Management, Augmented Reality and Virtual Reality, Big Data and Advanced Analysis, Industrial Sensing & Actuation, Industrial Internet Systems. IIoT Reference Architecture, Industrial IoT- Layers, Sensing and Processing,IIoT Communication, Security and Fog Computing in IIoT, Inventory Management & Quality Control, Plant Safety and Security, Industrial IoT- Application.

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

CO1: identify the components of IoT and Industrial IoT
CO2: know various protocols of IIoT
CO3: apply internet of things in smart industry
CO4: comprehend the architecture of IIoT
CO5: understand the Security and Privacy in IIoT
CO6: apply Various use cases of IIoT in different domains

Topics:

- Components in Internet of Things
- Smart Industry
- Industrial IoT Architecture
- Security
- IoT Application

Textbook(s):

1. “Designing the Internet of Things”, Adrian McEwen, Hakim Cassimally, Wiley publication, 1st Edition, November 2013.
2. The Internet of Things in the Power Sector Opportunities in Asia and the Pacific, Ramamurthy, A. and Jain, P, 2017.

Reference Book(s):

1. “The Internet of Things: A Survey”, Journal on Networks, Luigi Atzori, Antonio Lera, Giacomo Morabito, Elsevier Publications, October, 2010.
2. "The Internet of Things in the Cloud:A Middleware Perspective”, Honbo Zhou, CRC Press-2012.
3. “Architecting the Internet of Things”, Dieter Uckelmann, Mark Harrison, Springer, 2011.

EE 4074 Small Hydro Power and Tidal Energy

Credit: 3
Category: PEC
Prerequisite(s): Generation, Transmission and Distribution of Electric Power (EE 2024)

Course Description:

Classification of Hydroelectric power plants, Energy equation, Numerical problems. Tidal power, mean extractable power, Introduction to geothermal energy, Selection of Sites, Turbine Size, Types of Hydraulic turbines, Specific Speed, Selection of turbines, Spillways, Surge Tanks, Water Hammer, Draft Tube, Schemes of Hydro Plants, Run-of-River Plants, Valley Dam Plants, High Head Diversion Plants, Pumped Storage Plants, Tidal characteristics, Tidal range, Components of tidal Power plant, Types of tidal power plants, Nature of geothermal Fields, Hydrothermal (Convective) resources, and Geothermal power generation- Liquid dominated and Vapour dominated geothermal electric power plants.

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

CO1: recall the Basic Working Principles of Small Hydro Power and Tidal Energy systems
CO2: understand the classification of Hydro Power Plant
CO3: select components of hydro power plant based on site condition
CO4: apply the knowledge in selecting different hydro power plant components
CO5: comprehend the characteristics, types and components of Tidal power plant
CO6: know the Geothermal Energy resources

Topics:
- Basic working principle of Hydro Power Plant
- Classification and components of hydro power plant
- Tidal energy
- Geothermal energy

Textbook(s):
1. Nag P.K., “Power Plant Engineering” Tata McGraw Hill, 2nd Edition, 4th Fourth Reprint,2003.
2. Ocean Energy: Tidal and Tidal power- R.H. Charlier, Springer, 2009.

Reference Book(s):
1. Small hydroelectric engineering practice- Bryan Leyland, CRC Press,2014.
2. Harvey, A., Brown, A. and Hettiarachi, P., “Micro Hydro Design Manual”, Intermediate Technologym,1993.
3. GD Rai, “Non-Conventional Energy” Khanna publication, 2011.

EE 4075 IoT Sensors and Protocols

Credit: 3
Category: PEC
Prerequisite(s): Sensors for Engineering Applications (EE 4061), Computer Programming (CS 1093)

Course Description:

Sensor types and properties, different transducers and actuators, IoT sensors :Temperature sensors, Proximity sensor, Pressure sensor, Water quality sensor, Gas sensor, Smoke sensor, IR sensors, Level sensors, Image sensors, Motion detection sensors, Accelerometer sensors, Gyroscope sensors, Humidity sensors, Optical sensors, Static IP Address Assignment, Dynamic IP Address Assignment, IPv6, MAC Addresses, TCP and UDP Ports, MQTT, XMPP, CoAP, IEEE802.15.4, ZigBee, LORA, RFID, System on Chip (SoC), ARM®, Raspberry Pi, Evolution of Pi and technical specification comparative study, GPIO Interfacing Cloud, Analytics & UI, Client Server Model, HTTP, Thingspeak, AWS, Cloud MQTT, network and transport layer challenges, IoT Gateways, IoT Routing attacks.

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

CO1: identify the components of IoT sensors
CO2: analyze various types of actuators for IoT applications
CO3: establish Iot communication system
CO4: comprehend Various Protocols applied in internet of things
CO5: understand the Security and Privacy in IoT
CO6: demonstrate an embedded development platform

Topics:

- Introduction to Sensor
- Communication Protocols
- IoT Protocols
- Advanced Embedded Development Platforms
- IoT Security

Textbook(s):

1. “Internet of Things Principles and Paradigms”, Rajkumar Buyya & Amir Vahid Dastjerdi,Elsevier.
2. “Designing the Internet of Things”, Adrian McEwen, Hakim Cassimally, Wiley publication, 1st Edition, November 2013.
3. The Internet of Things in the Power Sector Opportunities in Asia and the Pacific, Ramamurthy, A. and Jain, P, 2017.

Reference Book(s):

1. “The Internet of Things: A Survey”, Journal on Networks, Luigi Atzori, Antonio Lera, Giacomo Morabito, Elsevier Publications, October, 2010.
2. "The Internet of Things in the Cloud:A Middleware Perspective”, Honbo Zhou, CRC Press-2012.
3. “Architecting the Internet of Things”, Dieter Uckelmann, Mark Harrison, Springer, 2011.

EE 4081 Project -I

Credit: 3
Category: PROJ

Course Description:

Students are required to undertake a final year major project either as an individual or in a group in consultation with the project guide which may be completed in one year. The project should be related to certain research objective or advanced technical domain. The work encompasses two semesters and to be carried out in two phases (Project-I and Project-II). In Project-I, students are expected to complete detailed literature review, identify their objective and start working on the same; perform experiments, carry out analyses and report their findings to their supervisors and the panel.

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

CO1: conduct a detailed research survey or background study and summarize the theory and findings
CO2: formulate a research question or a general objective of the project
CO3: propose and outline the solution to the research question or a pathway for the implementation of the project with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
CO4: conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
CO5: function effectively as an individual, and as a member or leader in a team under multidisciplinary settings following ethical practices
CO6: communicate effectively with a range of audiences and prepare technical reports

EE 4082 Project -II

Credit: 10
Category: PROJ

Course Description:

Project-II is a continuation of Project-I, the second phase of final year major project. Students should complete all related experiments, develop a final solution, product or system and validate the applicability of the same under real time scenario with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. They produce a detailed technical report on their work as well as individual contribution reports. Throughout the implementation of the major final year project, students should demonstrate all cognitive skills and attainment of all program outcomes and student outcomes.

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

CO1: readily apply fundamental concepts in their area of study for executing the projects
CO2: demonstrate skill in using modern technical tools, apply advanced technical knowledge, integrate information from different sources, perform complex experiments and critically analyze the findings to draw conclusions
CO3: provide engineering solutions to predefined research question or project objective; design system components or processes with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
CO4: function effectively as an individual, and as a member or leader in a team under multidisciplinary settings following ethical practices
CO5: communicate effectively with a range of audiences and prepare detailed technical reports
CO6: demonstrate knowledge and understanding of the management principles in executing their project as a member or leader of the team, and willingness to engage in life-long learning

EE 4083 Practical Training

Credit: 2
Category: IE

Course Description:

A student will undergo this training to know the engineering application in real life. They come across the day to day application of his/her leering and how theory is different from the practical applications. Apart from this how the theoretical knowledge is important to understand each and every concepts or engineering in real application. If the industry permits then they will do some hands on in their interest to learn and feel the importance of engineering.

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

CO1: know the importance of safety practices to be adopted in the industry
CO2: comprehend the industrial operations during the training
CO3: utilize the industrial safety paramenter to ensure the smooth operation
CO4: analyse the various operational procedures of an industry to identify imminent problems
CO5: evaluate the policies of human resource managements adopted for optimizing benefits
CO6: create a report reflecting all the findings during the tenures of the training

EE 4092 Drive Laboratory

Credit: 1
Category: PCLC
Prerequisite(s): Basic Electrical Engineering Laboratory (EE 1093)

Course Description:

This course will impart knowledge on performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using power electronics. Students will perform experiments related to topics studied in electric drives like various DC and AC motor drives and their control. Students will be encouraged to focus on industry oriented learning. They will be engaged to evaluate the performance of electrical drives with the use of computer-based analysis tools.

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

CO1: learn the importance of safety practices to be adopted in the laboratory
CO2: understand about the triggering circuit, control circuit and power circuit of a power electronic device
CO3: implement the industrial and domestic applications of various DC and AC motor drives
CO4: analyse the schemes of speed control of various DC and AC drives
CO5: evaluate the electrical and mechanical parameters of a given motor and to find its transfer function
CO6: design different electric drive circuits in Simulink environment and compare the result with experimentations

Topics:

- Determination of parameters of separately excited DC motor and to draw the block diagram to find the transfer function
- Speed control of separately excited DC motor by armature voltage control method using single phase fully controlled AC to DC converter with and without load
- Speed control of 3 phase squirrel cage induction motor using V/F control method
- Speed control of single phase induction motor by stator voltage control using single phase AC to AC converter
- Speed control of PMDC Motor using four quadrants DC chopper

Textbook(s):

1. G.K. Dubey, Fundamentals of Electric Drives, Second Edition, Narosa Publishers, 2007.
2. S. K. Pillai: A First Course On Electrical Drives, New Age International Publishers, 2nd Edition, 2007.

Reference Book(s):

1. Bimal K. Bose, Power Electronics and Motor Drives: Advances and Trends, Academic Press, Har/Cdr edition (13 September 2006).
2. N. K. De, P. K. Sen: Electric Drives, PHI Learning Pvt. Ltd., 7th Edition, 2004.
3. Modern Power Electronics and AC Drives by Bimal. K. Bose, PHI Publisher, 1st Edition, 2013.
4. S.A. Nasar, Boldea , Electrical Drives, CRC Press, Second Edition, 2006
5. M. A. El-Sharkawi , Fundamentals of Electrical Drives , Thomson Learning, 1st Edition, 2000.
6. R. Krishnan, Electrical Motor Drives, PHI, 2003

EE 4093 Energy System Laboratory

Credit: 1
Category: PCLC
Prerequisite(s): Renewable Energy Sourses (EE 3017)

Course Description:

The Energy Systems Laboratory is used to introduce students to basic characteristics of PV module, Wind Energy, and net metering concept in grid integrated system. These concepts are incorporated in selected experiments. The experiments promote a hands-on and team-work oriented experience that introduces students to fundamentals pertaining to the measurement process, data reduction, and interpretation of the measured results. The laboratory supports education and research in this field, primarily at the undergraduate level, post graduate level and Ph.D level .

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

CO1: understand the characteristic of solar PV cell
CO2: analyze the impact of different parameter on the performance of solar PV cell
CO3: understand the basic of a solar thermal System
CO4: find out the different basic characteristic of the wind turbine
CO5: under the various control aspect wind turbine
CO6: analyze the concept of net metering

Topics:

- Study of the solar module and its V-I and P-V Characteristic
- Study of V-I characteristics & P-V Characteristics of a solar PV module using different color spectrum, different connections and Irradiance
- Study of Solar thermal system
- Grid Synchronization of Solar PV Inverter and its Performance Analysis
- Power flow Control of standalone PV system of DC and AC load with battery
- Evaluation of Tip Speed ratio and cut in speed of wind turbine
- Power control of wind turbine at high frequency with ac load
- Evaluation of active, reactive power and apparent energy flow between grid-tied inverter, grid end load and net metering concept

Textbook(s):

1. Renewable energy technologies – A practical guide for beginners – Chetong Singh Solanki, PHI. 5.
2. Non-conventional energy source –B.H. Khan- TMH-2nd edition

Reference Book(s):

1. Renewable Energy- Edited by Godfrey Boyle-oxford university, press, 3rd edition, 2013.
2. Handbook of renewable technology Ahmed and Zobaa, Ramesh C Bansal, World scientific, Singapore.
3. Renewable Energy Technologies /Ramesh & Kumar /Narosa

EE 4095 IoT Laboratory

Credit: 1
Category: PCLC
Prerequisite(s): Basic Electrical Engineering Laboratory (EE 1093)

Course Description:

This Internet of Things (IoT)-lab is the network of physical objects or 'things' embedded with electronics, software, sensors, and connectivity to enable objects to exchange data. IoT allows direct integration between the physical world and computer-based systems, helping to connect people, processes and devices. This course focused on learning methodical and logical idealization of various protocols which is highly essential for solving a network. The course intends to make the students familiar with various parts of sensors and cloud storage and analytic of storage data.

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

CO1: realize the importance of sensors and its parameters
CO2: adopt team working skills as a member of group with common objective
CO3: identify the different protocols and its applications
CO4: identify the different types of cloud storage of things data
CO5: present and Analyze the experimental results through IoT analytic
CO6: design Internet of Things architecture

Topics:

- Familiarisation of ESP32/Raspberry Pi and perform necessary software installation
- To interface analog voltage input to ESP32/Raspberry Pi
- To interface DHT11/DHT22, pressure, voltage and current sensor date input to ESP32/Raspberry Pi
- To interface motor using relay with ESP32/Raspberry Pi
- To interface OLED with ESP32/Raspberry Pi and write a program to print temperature and humidity
- Write a program on ESP32/Raspberry Pi to retrieve tempurature and humidity data from DHT11/DHT22 to Thingspeak Cloud
- Write a program to generate Thingspeak SNS alert service
- Write a program on ESP32/Raspberry Pi to publish DHT11 data through MQTT protocol
- To install MySQL data on ESP32/Raspberry Pi and perform SQL queries
- Write a program to create TCP server on ESP32/Raspberry Pi and transfer data from TCP client

Textbook(s):

1. "Designing the Internet of Things", Adrian McEwen, Hakim Cassimally, Wiley publication, 1st Edition, November 2013.
2. The Internet of Things in the Power Sector Opportunities in Asia and the Pacific, Ramamurthy, A. and Jain, P, 2017.

Reference Book(s):

1. "The Internet of Things: A Survey", Journal on Networks, Luigi Atzori, Antonio Lera, Giacomo Morabito, Elsevier Publications, October, 2010.
2. "The Internet of Things in the Cloud:A Middleware Perspective", Honbo Zhou, CRC Press-2012.
3. "Architecting the Internet of Things", Dieter Uckelmann, Mark Harrison, Springer, 2011.

EE 4097 Sensor and Control Laboratory

Credit: 1
Category: PCLC
Prerequisite(s): Basic Electrical Engineering Laboratory (EE 1093)

Course Description:

The course of Sensor and Control Laboratory comprises of various key technologies used in sensing and control of electric vehicles, like speed, displacement, temperature, etc. It is a specialized practical oriented course which intends to develop and understand various principles of sensors and transducers and also the use in control application. The course focused on learning methodical and logical idealization of various schemes of EV which is highly essential. The course intends to develop the ability of problem solving by analyzing control strategies. This lab helps the students to understand the principle of control operation of various essential parameters.

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

CO1: measure the linear displacement using LVDT and temperature using RTD
CO2: know and realize the impact of stress by measuring the same
CO3: control the speed of PMDC Motor using encoder as feedback sensor.
CO4: identify and monitoring of position control of DC Motor using PID Control
CO5: know controlling a stepper motor using microcontroller
CO6: know and familiarize with the application of embedded MCUs

Topics:

- To study and measure linear displacement using LVDT
- Measure temperature using RTD
- Strain measurement using Strain Gauge
- Speed Measurement using Encoder and control the speed of a PMDC Motor
- Position Control of DC Motor using PID control
- Control of Stepper Motor using Microcontroller
- Familiarization and application of embedded MCUs

Textbook(s):

1. Ian R Sinclair, “Sensors and transducers”, Third Edition, Newness Publishers, 2001.
2. Doebelin E O,” Measurement Systems, Application and Design”, McGraw Hill, Fifth Edition, 2004.

Reference Book(s):

1. Jack P Holman, “Experimental Methods for Engineers”, Seventh Edition, McGraw Hill, USA, 2001.

EE 4099 Electric Vehicles and Smart Inverter Laboratory

Credit: 1
Category: PCLC
Prerequisite(s): Basic Electrical Engineering Laboratory (EE 1093)

Course Description:

The course of Electric Vehicles and Smart Inverter Lab comprises of various key technologies used in electrical vehicle, like traction inverter, electric-motor drive system, battery management systems etc. It is a specialized practical oriented course which intends to develop and understand various principles of power electronics converter and Inverter drive application. The course focused on learning methodical and logical idealization of various schemes of EV which is highly essential. The course intends to develop the ability of problem solving by analyzing drive circuits. This lab helps the students to understand the principle of operation of smart inverter.

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

CO1: realize the importance of sensorless field oriented control (FOC) of PMSM Drive
CO2: know and realize the essential of control of BLDC motor drive
CO3: find the different control parameters of differential induction motor drive for EV
CO4: identify and monitoring of Inverter Operation under variable speed drive of EV
CO5: know SoC Based Battery Management System for EV
CO6: know Condition and Health condition monitoring of different electrical equipment of EV

Topics:

- Sensorless field oriented control (FOC) of PMSM Drive for EV
- Different control technique of BLDC motor drive for EV
- Differential induction motor drive for EV
- Monitoring of inverter operation under variable speed drive of EV
- SoC Based Battery Management System for EV
- Embedded controller for Smart Inverter using Lab-View
- Design of multiphase inverter and drive system for EV
- Condition and health condition monitoring of different electrical equipments of EV

Textbook(s):

1. "Permanent Magnet Synchronous and Brushless DC Motor Drives", by R. Krishnan, CRC publication, 1st Edition 2017.
2. "Power Electronics and Variable Frequency Drives: Technology and Applications", B K Bose, Academic Press, 1st Edition 2006.

Reference Book(s):

1. "Advanced Electric Drive Vehicles"-Ali Emadi, CRC publication, 1st Edition 2017.

COURSES OF OTHER PROGRAMMES

CS 2001 Data Structures And Algorithms

Credit: 4
Category: PCC
Pre-requisite(s): Computer Programming (CS 1093)

Course Description:

This course explores several fundamental algorithms and data structures of computer science. Some of the data structures include arrays, linked lists, stacks, queues, trees, heaps, hash tables, and graphs. Students also study and analyze algorithms for searching, traversing trees, hashing, sorting, finding shortest searching, and much more.

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

CO1: understand the concepts of data structure, data type, abstract data type (ADT) and compute the complexity of different algorithms
CO2: understand, distinguish and implement Array and Linked data structure on different types of problems
CO3: apply different linear data structures such as Stack and Queue to solve various problems
CO4: apply and Evaluate different non-linear data structures such as Tree and Graph on various computing problems
CO5: apply and Evaluate standard algorithms for searching, sorting and hashing
CO6: create the data structure that efficiently models the information in a problem

Topics:

- Introduction
- Arrays
- Linked List
- Stacks and Queues
- Trees
- Graphs
- Sorting
- Searching

Textbook(s):

1. Fundamentals of Data Structures in C, 2nd edition, Horowitz, Sahani, Anderson-Freed, Universities Press.

Reference Book(s):

1. Data Structures, Schaum's OutLines, Seymour Lipschutz, TATA McGRAW HILL
2. Data Structures using C by Aaron M. Tenenbaum, Yedidyah Langsam, Moshe J. Augenstein. Pearson, 1st Edition
3. Data Structures A Pseudocode Approach with C, 2nd Edition, Richard F. Gilberg, Behrouz A. Forouzan, CENGAGE Learning, India Edition
4. Data Structures Using C, Second Edition, Reema Thereja, Oxford University Press
5. Data Structures and Algorithm Analysis in C, Mark Allen Weiss, Pearson Education, 2nd Edition.

CS 2091 Data Structures Laboratory

Credit: 1
Category: PCLC
Prerequisite(s): Computer Programming (CS 1093)

Course Description:

The data structure lab is to develop skills for the design, analysis and implementation of operations like search, insertion, deletion, traversal, and other specified problem definition on various linear and nonlinear data structures. It improves the ability to define, apply the appropriate data structure for the real world problem and various techniques for representation of the data in the real world. In addition, it helps them to gain knowledge of data structure applications related to industry.

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

CO1: understand the importance of structure, unions and abstract data type, and their basic usability in different applications through C programming language
CO2: analyze, differentiate and implement different algorithms based on their time and space complexity
CO3: understand and implement the linked implementation, and its uses both in linear and non-linear data structure
CO4: understand and implement various data structures such as stacks, queues, trees, graphs, etc. to solve various computing problems
CO5: understand and implement various kinds of searching and sorting techniques, and know when to choose which technique
CO6: decide and implement the suitable data structure and algorithm to solve a real world problem

Topics:

- Array, pointer with Dynamic Memory Allocation
- Structure, Single Linked List
- Doubly Linked List, Circular Linked List
- Polynomial Representation, Addition & Multiplication, Sparse Matrix Représentation, Addition & Multiplication
- Stack
- More on Stack & Applications of Stack
- Queue
- Tree
- Graph
- Searching & Sorting

HS 2002 Engineering Economics

Credit: 3
Category: HSMC
Prerequisite(s): Nil

Course Description:

The course on Engineering Economics is a specialized need-based extension of applied Economics which is aimed at developing an understanding of the principles governing Economy's vital parameters like market, finance, Production,consumption and distribution.. The course focuses on learning methodical and rational conceptualization and developing the knowledge for effectively implementing these market principles in actual organizational activities and forums. The course intends to develop the ability of taking decisions related to project selection and implementation, optimization of market vitals like sales, revenue, profit, cost etc. It serves as the base of learning all Economics related elective papers offered in higher semesters as well as preparation for any competitive exams like civil services, MAT etc.
Course Outcomes: At the end of the course, the students will be able to:

CO1: apply economic theory for optimisation of the economic variables of demand, supply,sales,profit, cost and revenue
CO2: apply the budgeting principles in making economic decisions during project appraisals
CO3: develop awareness towards all the economic issues related to the financial market, Budget, Money, Credit and Fiscal Policies etc.
CO4: relate and apply theoretical concepts in Economics with contemporary/modern business practices
CO5: understand the vitals of the financial market, know the source and methods of raising capital for an organization
CO6: understand the depreciation of asset principles and efficient inventory/resource management

Topics:

- An Introduction to Economics and Engineering Economics
- Basic Concepts of Economics: Market equilibrium and Consumers and Producer's equilibrium
- Elasticity and Demand Forecasting
- Optimization of Profit and cost
- Break Even Analysis
- Evaluation of Projects: Economic Appraisal Techniques
- Depreciation calculation and Inventory management
- Vitals of Money and capital market

Textbook(s):

1. Managerial Economics: Principles and Worldwide Applications. Dominick Salvatore,Siddartha K.Rastogi,8th Edition,Pub.Oxford University Press.ISBN: 9780199467068.
2. Engineering Economics –James L.Riggs, DavidD.Bedworth and Sabah U.Randhawa,4th Edition, McGraw Hill Education(India) Private Limited, New Delhi,2016.

Reference Book(s):

1. Principles of economics, Deviga Vengedasalam and Karunagaran Madhavan, Oxford University Press, New York,3rd Edition,2013.
2. Managerial Economics-Principles and Worldwide Applications-Dominick Salvatore, Adapted by Ravikesh Srivastava,7th Edition, Oxford University Press,2012.

3. Micro ECON-A South-Asian Perspective-by William A. McEachern and Simrit Kaur, Cengage Learning, 2013.
4. Engineering Economy-Zahid A. Khan, Arshad Noor Siddiquee, BrajeshKumar, Pearson Publication, 2012.
5. Engineering Economics – R.Panneerselvam, Pub: PHI Learning Private Limited, New Delhi, 9thEdition, 2008.

HS 2008 Economic Environment of India

Credit: 3
Category: HSMC
Prerequisite(s): Nil

Course Description:

The Course on Economic Environment of India is designed to cater encompassing discernment of Indian Economy to the students. The course precisely highlights the role of different sectors in Indian economy and also touches upon the normative aspect of striking balance among different sectors. It covers the status of public economics in Indian context. Besides, it ensures the students to have knowledge on the role of foreign sector.

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

CO1: develop the analytical understanding of the economic situation of the country
CO2: develop the skill to interpret the economic indicators during steady growth path and economic crisis
CO3: acknowledge the role of different policy making bodies in India related to economic affairs
CO4: develop the ability to analyze the occupational structure of the country and sectoral contribution to growth
CO5: examine the extent and role played by foreign sector in the form of exchange rate, FDI etc in the domestic economy
CO6: develop a critical understanding of the fiscal position of the country

Topics:

- Economic Crises and Way out: Economic Crisis of early 1990s-Macro Economic Reforms since 1991
- Primary Sector and Secondary Sector: Agriculture during the Reform Period; New Industrial Policy
- Tertiary Sector and Foreign Sector: Service sector as the engine of growth in India; Trade reforms
- Public Finance: Fiscal reforms in India post 1991; Centre-State Fiscal relationship

Textbook(s):

1. Dutt and Sundaram.Indian Economy. latest edition.

Reference Book(s):

1. Uma Kapila (2019), Indian Economy since Independence, New Delhi, Academic Foundation.
2. Balakrishnan, P. (2010): 'Economic Growth in India: History and Prospect'. Oxford
3. University Press, New Delhi.
4. Bhagwati Jagdish and Arvind Panagariya(2012): ' India's Tryst with Destiny'. Collins Business, Noida, India.
5. Jean Dereze and Amartya Sen (1996): 'Indian Development: Selected Regional
6. Perspectives'. Oxford University Press, New Delhi.
7. Ajijava Raychaudhuri and Prabir De (2012), International Trade in Services in India, New Delhi, Oxford University Press.

HS 2010 Financial Institutions, Markets and Regulations

Credit: 3
Category: HSMC
Prerequisite(s): Nil

Course Description:

The course on Financial Institutions, Markets and Regulations is a specialized need-based extension of Financial Economics. This course is designed to present the fundamental concepts and theories in financial market and promote the application to the workplace and professional practice. It introduces current financial concepts and tools towards money management in organizations participating in the local and global economies. The course covers the current best practices in financial analysis and planning through the application of financial concepts in a nutshell. These include financial vitals relate to money and capital markets, time value of money, cost of capital, risks and return, long-term financial budgeting. Inaddition, the course also introduces topics on lease financing, hybrid securities and derivatives, trust funds, mergers and acquisitions and related issues in current financial sector.

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

CO1: have comprehensive understanding of the nature and functions of the several types of financial institutions operating in the market
CO2: develop critical skills in applying the principles of finance and financial inter-mediation to the real world situations
CO3: effectively interact with the financial markets they need to approach for their future economic endeavors and/or in their place of employment
CO4: make economic decisions and analysis of issues related to security market transactions and policies
CO5: develop the understanding of the structure and functions of Indian financial institutions, instruments and policies
CO6: take decisions regarding saving, investments, portfolio contents and diversification to maximize their return and reduce associated risks

Topics:

- Financial systems: Significance of banks and all other Financial institutions
- Financial Innovations
- Overview of Structure of Financial Debts and Equity markets
- Functions of Financial Intermediaries
- Monetary authority: Reserve Bank of India: Its role, structure and functioning
- Subprime crisis
- Derivative markets
- Capital market authority: structure and functions
- Regulation of Capital market, Role of SEBI

Textbook(s):

1. Madura, Jeff (2008), Financial Markets and Institutions, 8th edition, Thomson Publications.

Reference Book(s):

1. Fabozzi, Frank, Modigliani, Franco, Jones, Frank (Feb 2009), Foundations of Financial Markets.
2. Eakins, Stanley G. (2005), Financial Markets and Institutions (5th Edition), Addison Wesley.
3. Howells, Peter, Bain, Keith (2007), Financial Markets and Institutions, 5th Edition.

4. Barth, James R., Caprio, Gerard, and Levine, Ross (2008), Bank Regulations are Changing: For Better or Worse?, Association for Comparative Economic Studies.
5. Goldstein, Morris (2006), Financial Regulation after the Subprime and Credit Crisis, Washington: Peterson institute.

HS 2012 Development Economics

Credit: 3
Category: HSMC
Prerequisite(s): Nil

Course Description:

The course on Development Economics is a specialized need-based extension of Economics dealing with issues related to economic growth and development. It provides an in depth discussion of the different economic description of development and underdevelopment. It will put a deep insight into the most challenging economic issues of poverty, inequality and underdevelopment faced by the humanity. It will deal with the various existing, modern and developing strategies and policies to tackle these issues and foster the economy onto the path of development. The students will be able to assess the pros and cons of a proposed development intervention and its likely impact on the target population.

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

CO1: develop the understanding of issues related to economic growth and economic development
CO2: relate and apply the major growth theories in their related academic projects
CO3: develop the familiarity with major economic issues faced by the country like poverty, inequality, underdevelopment etc.
CO4: analyse and compare the development paths adopted across countries of the globe
CO5: analyse the empirical evidence on the pattern of growth and development
CO6: develop critical understanding of the existing, adopted and needed policies and strategies for sustainable growth and development

Topics:

- Concepts and difference between growth and development.
- Measures of growth and development
- Models of growth and development
- Poverty and Inequality : Perceptions, estimation and measures of improvement
- Impact of poverty and inequality on growth and development
- Cross country perspectives of development

Textbook(s):

1. Todaro, M. P. & Smith, S. C. (2015), Economic Development, Pearson (12^{th} Edition).
2. Thirlwall A. P. Growth and Development (6 th and 7 th edition)

Reference Book(s):

1. Debraj Ray : Development Economics
2. Meier and Rauch,: Leading Issues in Economic Development, OUP, Latest Edition
3. Kaushik Basu :Analytical Development Economics , OUP
4. Human Development Reports, various years
5. Bagchi A. K. The Political Economy of Underdevelopment, Cambridge University Press 1982.

HS 2081 Business Communication

Credit: 1
Category: HSMC
Prerequisite(s): Nil

Course Description:

This course is designed to give students a comprehensive view of communication, its scope and importance in business. This is an interactive course with a view to enhance language and soft skills with the aid of live demonstration within the framework of the syllabus. It is a foundation building measure to enable the students to excel in the corporate world and in day to day life.

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

CO1: develop competence in reading and comprehension, develop skimming skills for extracting the main idea(s) from the text, and scanning for keywords
CO2: enrich the fluency of the students with Collocations and Phrasal Verbs
CO3: use Email effectively and efficiently as per the organization hierarchy. To retain a logical flow while drafting emails, make aware students about the importance of succinct written expression in modern Business Communication
CO4: write standard and effective Cover Letters and Resume
CO5: bridge the gap between native language and target language i.e. English, make students communicative competent and develop their fluency in public speaking
CO6: prepare effective Power Point Slides. Maintain and arrange proper data structure in presentations. To learn skills of making effective presentation (verbal and non-verbal aspects)

Topics:

- Reading Comprehension – Activity based on BEC Training – Matching, Multiple Choice Questions, Open Close, Giving Appropriate Headings
- Collocation – Activity based on Word-Stock, Phrasal Verbs & Vocabulary Building
- E-mail – Activities based on Writing Appropriate Salutation, Paragraphs & Conclusion
- Resume Writing
- Thematic Discussions
- Speaking in Pairs – Everyday Activities & Detailed Introduction
- Activity based on PowerPoint Presentation

HS 3006 Entrepreneurship

Credit: 3
Category: HSMC
Prerequisite(s): Nil

Course Description:

The course has been designed for the students in order to provide basic knowledge of an entrepreneur and opportunities for new entrepreneurship. To provide idea about various financial sources available for small and medium enterprise by different financial institutions. To provide knowledge how to manage working capital of an organization in an efficient manner. To have an idea about motivational tools for increasing the productivity of employees in an enterprise.

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

CO1: know the contribution of an entrepreneur in growth and development of socioeconomic condition of our country
CO2: understand the role of SSI units in growth and development of socioeconomic condition of our country
CO3: learn market survey, sales promotions and management of working capital through costing and book keeping
CO4: know different decision making technique and benefit of personal management system.
CO5: learn motivational methods of an enterprise
CO6: learn how to prepare a project report and knowledge about different tax system of an enterprise

Topics:

- Introduction to entrepreneurship
- SSI Units
- Market survey and research
- Marketing mix
- Financial management
- Working capital management
- Personnel management
- Motivation

Textbook(s):

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

Reference Book(s):

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

HS 3008 Management Concepts And Practices

Credit: 3
Category: HSMC
Prerequisite(s): Nil

Course Description :

The course curriculum is designed for student in order to provide fundamental knowledge in management area. The students will be able to know about general management concepts and various specialization in management area like marketing, finance, production and strategy management. The marketing management portion of the course will benefit the students to develop their career in marketing line, as most of the organisations give priority for marketing skills. Finance and production management will help the students in their respective domain and serve as a guide in their corporate career. The strategy management portion of this course will serve as a guide for the students to contribute in strategy formulation of the organization and how to achieve that strategy within a stipulated time period.

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

CO1: perform the critical management functions effectively and develop ideas about implementing principles and theories of management in organizations efficiently
CO2: develop various marketing skills in order to be successful in corporate world
CO3: utilize different financial techniques for better management and control of organisational financial resources
CO4: take strategic decision for day to day operation through proper working capital management.
CO5: have competency in production planning as well as control measures will become easy in their professional career
CO6: do strategy formulation of the organization and how to achieve that strategy within a stipulated time period

Topics:

- Introduction to management
- Marketing mix
- Market research
- Financial management
- Working capital management
- Production planning and control
- Inventory management
- Strategy management

Textbook(s)

1. Modern Business Organisation and Management. Sherlekar & Sherlekar, Himalaya Publishing House.
2. Business Organisation and Management. M. C. Shukla, S. Chand

Reference Book(s)

1. Principles & Practices of Management. L. M Prasad
2. A framework for marketing management, Philip Kotler
3. Financial Management. I. M Panday
4. Production and Operation Management, Everett E. Adam Jr. Ronald J. Ebert

HS 3002 Organisational Behaviour

Credit: 3
Category: HSMC
Prerequisite(s): Nil

Course Description:

The course has been designed for the students to provide an understanding about the behaviour of individuals, groups and the system in the organization. The course will help the students how to develop personality and leadership style for achievement of individual and organizational objective. To know about the benefit of motivation for increasing individual and organizational productivity. To Provide knowledge to work in groups and develop techniques for group decision making for organizational development.

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

CO1: know about organization, organizational behaviour its nature, scope and significance
CO2: develop their personality as per industry requirement
CO3: apply motivational techniques to make the employees work with confidence and satisfaction
CO4: develop different leadership style to adjust themselves in different organizational situations
CO5: improve the knowledge of group behaviour and techniques of group decision making
CO6: apply the concepts for managing changes in organization as well as the development of an organization's human resources

Topics:

- Introduction to Organisation and organisational behaviour
- Personality
- Motivation
- Leadership
- Group dynamics
- Organisational change
- Organisational development

Textbook(s) :

1. Organisational behaviour. Stephen P. Robbins, Timothy A. Judg, S. Sanghi, Pearson
2. Organizational Behaviour and Work, F. M. Wilson, Oxford University Press.

Reference Book(s):

1. Organizational Behaviour, Dipak Kumar Bhattacharya, Oxford University Press
2. ORGB, Organizational Behaviour, Nelson, Quick, Khandelwal, Cengage
3. Organisational Behaviour. Dr. S. S Khanka, S. Chand
4. Managing Organisational Behaviour, Moorhead & Griffin, Cengage Learning.

HS 3004 Human Resource Management

Credit: 3
Category: HSMC
Prerequisite(s): Nil

Course Description:

The course has been designed in order to provide knowledge and idea about human resource management and how to become a professional human resource manager. It will help the students to follow different HR processes like recruitment, training, performance appraisal effectively in organizational level. The students will able to learn how to manage industrial dispute and develop industrial relation in corporate sector. The course will enable the students to understand the workers participation in management concept through employee discipline and the process of effective bargaining system in the organisation.

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

CO1: develop personal and professional qualities of a manager in order to manage human resource of an organization effectively
CO2: meet the human resource requirement of the organization for achieving its objective effectively
CO3: follow different HR processes like recruitment, selection, training, performance appraisal effectively in organizational level
CO4: inculcate the sense of inter personal relation required in professional front in handling employer-employee relation effectively for achievement of organizational objectives
CO5: achieve strategic objectives of the organizations, by optimizing the potentiality of the human resource through workers participation in management
CO6: know the technique of managing and being managed by the organisation

Topics:

- Human resource management
- Human resource planning
- Recruitment
- Selection
- Training
- Performance appraisal
- Industrial relation
- Industrila dispute
- Collective bargaining
- Workers participation in management

Textbook(s):

1. Human Resource Management, P. Jyoti & D. N. Venkatesh, Oxford Publication, 2016
2. Human Resource Management, B. Varkkey & G. Dessler, Pearson, 2017

Reference Book(s):

1. Human Resource Management. K. Aswathappa, Mc Graw Hill Education, 2013.
2. Human Resource Management. S. S. Khanka, S. Chand, 2019
3. Human Resource Management. P. Subba Rao, Himalaya Publishing House, 2018.

HS 4001 Professional Practice, Law and Ethics

Credit: 2
Category: HSMC
Prerequisite(s): Nil

Course Description:

The course on Professional Practice, Law and Ethics is designed to cater comprehensive insight of law and ethics to the students for practicing in their professional life. The course incisively highlights the role of morals and ethics in leading a sustainable profession. Besides, by containing different relevant laws like laws of contracts, intellectual property law and information technology law, the course provides foundation in law to the students which will help them a lot to face the real life situations with ease.

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

CO1: select appropriate engineering decisions in consideration of professional ethics in realization of more critical impact of engineering compared to general experiments
CO2: evaluate and prescribe risk reducing measures
CO3: comprehend the dynamics in engineers' roles and responsibilities with emerging issues in global scene
CO4: know the various compliance requirements and the regulatory bodies to protect environment
CO5: have a fair idea to protect their engineering inventions from unauthorized exploitation under intellectual property rights system and laws relating to information communication technologies
CO6: understand, analyze and prevent misuse of IT related transactions

Topics:

- Morals and ethics in engineering
- Engineering as social experimentation
- Engineer's responsibility for safety
- Global issues
- Law of contracts and law of torts
- Environmental laws
- Intellectual property law
- Information technology law

Textbook(s):

1. R. Subramaniam, Professional Ethics, Oxford University Press, 2013
2. Indian Contracts Act 1872
3. Patents Act 1970 (Unit-3)
4. Designs Act 2000 (Unit-3)
5. Information Technology Act 2000 (Unit-4)

Reference Book(s):

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 Concepts and Cases", Thomson Learning, 2000

HS 4003 Legal Issues and Requirements in Engineering

Credit: 1
Category: HSMC
Prerequisite: Nil

Course description:

It depicts on law of contracts and law of torts, Consumer Protection Act 1986, Environmental Protection Act 1986, Environmental Impact Assessment 2006, standards for emission, discharge of environmental pollutants from various industries, Intellectual Property Law, Protecting engineering invention, the U.S Utility model approach and need for Utility model in India, Protecting Software and other engineering technologies in cyberspace, maintaining data security and technological privacy in Cyberspace, e-contracts, electronic and digital signatures.

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

CO1: understand the various legal requirements in terms of contracts
CO2: interpret the product liability which an engineer is required to take care while processing his engineering innovations
CO3: illustrate the various compliance requirements and the regulatory bodies to protect the environment
CO4: demonstrate to protect their engineering inventions from unauthorised exploitation under intellectual property rights system and laws relating to information communication technologies
CO5: identify Legal Issues in a given case
CO6: analyse and prevent misuse of IT related transactions

Topics:

- Law of contracts and law of torts
- Environmental Laws
- Intellectual Property Law
- Information Technology Law

Textbook(s):

1. Gurdeep Singh “Environmental Laws” Eastern Book Company,2nd Edition 2016.
2. V K Ahuja “Law Relating To Intellectual Property Rights”Lexis Nexis, 3rd Edition. July 2017.
3. Pavan Duggal “Cyber Law”-Indian Perspective”. 2nd Edition 2016.
4. Avtar Singh” Law of Contracts” Eastern Book Company,12th Edition, Reprinted 2020.
5. Dr. R K Bangia “Law of Torts”. Allahabad Law Agency; 24th 2019 edition (2019).

Reference Book(s):

1. Rosencranz “Enviromental Law and policy in india”.Oxford University Press, 2001.
2. Howard b rockman “Intellectual Property Law for engineers and scinentists”.ISBN: 978-0-471-69740-4, Wiley-IEEE Press, June 2004.
3. Mireille Hidebrant “ smart technologies and the end of law”. ISBN: 978 1 78643 022 9.

MA 2007 Mathematics-III

Credit: 4
Category: BSC
Prerequisite(s): Nil

Course Description:

The concept of Complex analysis, Residual integration are included to get the knowledge on complex plane. Numerical analysis is inculcated to get approximate solutions to those problems for which analytical solution is difficult to obtain. Also linear programming problem and optimization problem containing two or more variables are included to solve by graphical method and simplex method. . Probability and Statistical knowledge incorporated to use statistical analysis of data.

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

CO1: know Complex plane , Complex functions, their differentiation and integration
CO2: find series expansion of complex functions and evaluate real integrals by residue method
CO3: determine root of algebraic equations by different methods along with their convergence and solve the systems of linear equations
CO4: use eigen values and eigen vectors by power method to solve ODE numerically
CO5: identify LPP and their solution by graphical and simplex method
CO6: solve problems related to probability distribution and concepts of regression and co-relation

Topics:

- Complex
- Numerical Analysis
- Linear programming
- Probability
- Statistics

Textbook(s):

1. Advanced Engineering Mathematics(10th edition) by E. Kreyszig

Reference Book(s):

1. Engineering Mathematics by S. Pal and S.C. Bhunia, Oxford University Press.
2. Grewal B. S., Higher Engineering Mathematics, Khanna Publishers, 44th edition

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