ACADEMIC CURRICULA 2022 - 2023

BACHELOR'S DEGREE PROGRAMME

B. Tech (Hons. / Res.) in Civil 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
2022 - 2023

B. TECH. (Hons. / Res.) In
CIVIL ENGINEERING

Course Structure and Detailed Syllabi
for students admitted in
2022 - 23
Academic Session

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

CONTENT

SCHOOL OF CIVIL ENGINEERING

VISION OF THE SCHOOL

To impart education and research in Civil Engineering, with particular emphasis on their application in the industry, infrastructure building, economic welfare, health, safety and commerce in a diverse society and to create scope for professional engineering licensure and practice.

MISSION OF THE SCHOOL

- To provide students with a broad and in-depth education in civil engineering fundamentals, applications, and design in order to prepare them for the practice of civil engineering at the professional level with the confidence and skill necessary to meet the technical and social challenges of the future
- To prepare students for higher education or entrepreneurship
- To encourage and facilitate students, to involve themselves in continuous learning, to build skills beyond the curriculum
- To inculcate critical thinking and an open-ended problem-solving attitude to build up creative abilities and research spirit
- To impart the essential skills of leadership, teamwork, communication and ethics so that they can interact and communicate effectively (written and/or oral) with others (e.g., supervisor, client and/or team)
- To engage students with alumni, industry, government, and community partners through outreach activities in order to inculcate global perception
- To engage students in creating innovative design solutions that include realistic constraints such as economic, environmental, social, political, ethical, health and safety, constructability, sustainability, and global considerations, and disseminating these designs at national and regional venues
- To provide solutions and propose methodologies in the areas related to structural, geotechnical, water resources and environmental engineering

B.TECH. PROGRAMMES OFFERED BY SCHOOL OF CIVIL ENGINEERING

- B. Tech. (Hons.) or B. Tech. (Res.) in Civil Engineering

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The B. Tech program (Civil Engineering) prepares the graduates who shall:

1. Provide solutions to Civil Engineering problems and allied areas involving structural design, construction, geotechnical, environmental and water resources issues.
2. Reinforce their knowledge through higher educational programs and life-long learning, adapt to rapid changes in technology, perceive the limitation and impact of engineering solutions in social, legal, environmental, economical and multidisciplinary contexts.
3. Demonstrate effective communication skills, professional and ethical responsibilities, awareness of cultural and social issues in their role as a leader, team member and an individual driven by universal human values.

PROGRAM OUTCOMES (POs)

PO1: Ability to apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: 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.

PO3: 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.

PO4: 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.

PO5: 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.

PO6: 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.

PO7: 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.

PO8: Ability to apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Ability to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: 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.

PO11: 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.

PO12: 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.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Ability to select and utilize sustainable low-cost alternate materials contributing to environment friendly construction practices.

PSO2: Ability to understand and adopt methodologies and actions for sustainable environment.

PSO3: Ability to understand and develop strategies for sustainable water resources in the context of climate change.

Guidelines for UG Engineering Curriculum – 2022

The curricula for B.Tech. courses have been designed following the general principles of curricular design and developing certain guiding strategies in order to build in the engineering graduate attributes in the courses.

Principles in Designing the Curricula

The overriding principles in designing the new curricula are that the curricula must (1) Impart specialized and interdisciplinary knowledge and creative problem-solving skills; (2) Reflect aspirations of the society to turn out technology-ready and socially conscious graduates to anticipate and avoid future problems; (3) Leverage the strengths and help making up the weaknesses of the university; (4) Inform the students about new technologies and the emerging social, environmental, and global forces, and (5) Give students the confidence to work in teams and in multi-cultural settings.

Key Graduate Attributes

Engineers are agents of social change. They interact with the common man to know and define the current and the looming future problems, develop sustainable design solutions using their science and engineering skills, and implement sustainable solutions. Thus, the graduating students must (1) Acquire knowledge and skills—both technical and soft skills such as communication, leadership, and skills of working in multi-cultural, interdisciplinary teams; (2) Develop the mental disposition to understand, conceptualize, and define complex, real-world problems; (3) Be independent, critical thinkers to inquire into the root causes of the problems; (4) Analyse the relevant data and social, economic, and political forces influencing these problems; (5) Synthesize knowledge and diverse perspectives and approaches to find technically and financially viable, sustainable, creative, ethical solutions by evaluating novel alternatives; (6) Use project planning and scheduling methods, establish institutional mechanisms, and communicate the plans and schedules and inspire the concerned individuals to implement the solutions; (7) Imbibe professional values and ethics, and (8) Be life-long learners with empathy for others.

Strategies for Curriculum Design

Strategies to design the curricula include (1) Understanding the dominant technological and social changes in the world, (2) Incorporating recommendations of the National Education Policy 2020 with respect to design of curricula, (3) Adding the novel features and best curricular practices of leading universities and institutes in India and abroad, (4) Recognizing the UGC and AICTE guidelines and ABET recommendations; (5) Using the opportunities that KIIT offers for multi- and inter-disciplinarity

education, and (6) Delivering the key attributes and skills which the graduating students should be equipped with.

The Structure of the Curricula

The undergraduate engineering curricula are designed to inculcate in the students the graduate attributes indicated above. The curricula include (1) foundational courses in the fields of humanities, social sciences, science, engineering science, and vocational courses, (2) depth courses—both core and electives related to the respective disciplines, (3) open electives in diverse fields of humanities, arts, science, engineering, social science, management, law, public policy, media studies, etc., and (4) practice-based courses. These courses reflect a mix of theory, hands-on laboratory practice, short- and long-duration projects, field visits, internship, and extra- and co-curricular activities. The Institute has created many avenues for students to organize, lead, and actively participate in social, cultural, and techno-management functions to develop soft social and behavioural skills.

UG Programmes Offered by the Schools of Technology

The B. Tech. (Hons.) and B. Tech. (Res.) programmes offered by various Schools of Technology are tabulated below.

Name of the School	**B. Tech. (Hons.) and B. Tech. (Res.) Programmes Offered**
School of Civil Engineering	Civil Engineering
School of Computer Engineering	Computer Science and Engineering Information Technology Computer Science and Communication Engineering Computer Science and Systems Engineering
School of Electrical Engineering	Electrical Engineering
School of Electronics Engineering	Electronics and Telecommunication Engineering Electronics and Computer Science Engineering Electronics and Electrical Engineering

School of Mechanical Engineering	Mechanical Engineering Mechanical (Automobile Engineering) Mechatronics Engineering Aerospace Engineering

Highlights of the Curricula

1. The curricula allow the students to opt for either a B. Tech. (Hon.) degree or a B. Tech. (Res.) degree.
2. All the B. Tech. curricula have total of 160 – 165 credits.
3. The curricula provide for a Minor in selected areas if students fulfil additional credit requirements.
4. With the inclusion of many Humanities, Arts, and Social Science (HASS) courses, the curricula are HASS-rich.
5. The curricula provide flexibility in many forms. The students can choose courses from a large number science, HASS, and engineering electives. They can also choose courses from lists of professional electives and open electives. The professional electives allow the students to concentrate in selected areas, whereas the open electives allow the students to opt for minors.
6. To ensure an all-round development of students, the curricula have included courses like Yoga, Universal Human Values, a Community/Environment-based Project, a Vocational Elective, Industry 4.0 Technologies, and K-Explore that consider students' co- and extra-curricular activities for evaluation.
7. The curricula have included courses like Scientific and Technical Writing and Research Methods and Ethics to instill research and research communication skills in the students.
8. The curricula have also provided for independent projects in the last three semesters to train the students in the art and science of identifying pressing problems and finding their sustainable solutions.

Notes and Guidelines

<u>Science Core</u>

Science forms the foundation of engineering. Courses related to physical, chemical, biological, environmental, and mathematical sciences are covered in the first four semesters in the form core and elective courses. The core courses in science are the following:

Semester I/II: Physics, Chemistry, Science of Living Systems, Environmental Science, Differential Equations and Linear Algebra, Transform Calculus and Numerical Analysis, Physics Lab, and Chemistry Lab.

Semester III: Probability & Statistics

Semester IV: Selected Topics in Mathematics (Syllabi to be different for different Schools)

Engineering Science Core

Engineering science courses provide a bridge between science and engineering. The related courses are included as both core and electives. The semester-wise distribution of the core engineering science courses is given below.

Semester I/II: Basic Electronics, Programming & Data Structures or Programming Lab, Engineering Drawing & Graphics, Workshop Practice, and Engineering Lab

Half the number of experiments in Engineering Lab will relate to Basic Electronics and the other half to the course the student picks from the list of Engineering Elective I courses.

Semester III: Industry 4.0 Technologies

HASS Core

The curricula include HASS courses as both core and electives. The HASS courses that improve the written and rhetoric skills, life skills and research skills of students are included as core courses. Semester-wise distribution of these courses are given below:

The semester-wise distribution of language- and human values-related courses is given below:

Semester I/II: English (to develop language skills and skills for making critical analysis of English literature)

Semester I/II: Communication Lab (to develop skills of Listening, Speaking, and Writing)

Semester I/II: Yoga (to bring about unity of mind and body)

Semester III: Scientific and Technical Writing (to develop skills of writing varieties of scientific and technical documents)

Semester VI: Universal Human Values (to develop and respect human values)

Semester VII: Engineering Professional Practice to understand roles and responsibilities of engineers and the ethical and selected legal issues

Semester VII: Research Methods and Ethics (for B. Tech. (Res.) students

Professional Core

Professional core courses form the backbone of an engineering discipline. Every School of Technology decides the list of core courses that its students must credit. These can be theory and laboratory courses. These courses are diffused in Semester III through Semester VI.

Engineering Professional Practice, a professional core course, is included as a HASS Elective but will be taught by engineering faculty.

Research Core

Students pursuing B. Tech. (Res.) programme have to go through a course on Research Methods and Ethics, which is offered in Semester VII.

Science, Engineering Science, and HASS Electives

Options are available to the students to choose courses from lists of science, engineering science, and HASS electives. Their distributions in the curricula are as under:

Semester I/II: Science Electives, Engineering Electives I and II, and HASS Electives I.

Semester IV: HASS Electives II

Semester V: HASS Electives III

HASS Elective I includes Community/Environment-based project as one of the courses. Done as a group work, the course gives the students an opportunity to connect with the community and the environment, learn and prioritize their problems, and define them in ways that make them amenable to scientific analysis and pragmatic solution.

The lists of Science, Engineering Science, and HASS electives will be available in the ERP. Before a semester begins the Institute will announce the courses that will be offered in that semester and the students will have to give their choice of electives out of the offered courses.

Vocational Elective

Vocational Elective courses provide engineering students a deeper appreciation of the practical aspects of engineering and allow them to relate their theoretical knowledge with practical skills. This course is included in Semester III. A student must opt for one of the vocational electives which will be announced at the beginning of a semester.

Open Electives

Open electives allow students to choose courses from lists of courses offered by all the Schools. It is through these courses that a student can pursue his or her latent interests in specific areas and work towards earning a Minor in an area which is outside his (or her) major engineering branch (if the courses are selected in specific designated areas). These courses are offered in Semester V through Semester VIII:

Semester V:	K-Explore—Practice-based Open Elective I
Semester VI – VIII:	Open Electives II, III, and IV

K-Explore is a 1-Credit Practice-based Open Elective that allows the students to use the scope that the Clubs and the Societies of KIIT University provides to learn the skills of Dance, Music, Photography, etc. and of conducting seminars and conferences through training, practice, and direct involvement.

Minor

The curricula allow a student to earn a Minor in an area outside the core discipline in which he (or she) has registered. For example, a student doing B. Tech in Mechanical Engineering (his/her parent branch) can choose to have a Minor in Computer Science Engineering. To get a Minor, a student must

(i) Get the fourth semester CGPA of 7.0 or more,

(ii) Successfully fulfill the coursework requirement for at least six theory courses and two credit Lab/project courses in an area or discipline other than the one for which he (or she) is registered, and

(iii) Complete at least 20 Credits of coursework in that area.

Thus, if a student has taken three Open Electives in one area other than his (or her) own then he (or she) must choose three theory courses and two Lab/project courses in that area in the Fourth year.

If no Lab course is available in that Minor, then the student must choose an additional theory course with at least 2 Credits. Students having no backlogs till the end of Semester 4 and a minimum CGPA of 7.0 will only be allowed to opt for the Minor scheme. Students opting for Minor have to mandatorily attend a minimum of 75% Theory and Lab classes (as the case may be) failing which the Minor option will be withdrawn.

Professional Electives

Professional elective courses provide the students the opportunity to concentrate in certain specific areas of their interest. These courses are offered in Semester V through Semester VIII for B. Tech. (Hons.) students (total 15 credits) and in Semester V through Semester VI for B. Tech. (Res.) students (total 9 credits). The distribution of these courses is given below:

Semester V:	Professional Electives (6),
Semester VI:	Professional Electives (3),
Semester VII:	Professional Electives Theory (3 Credits) for only B. Tech (Hons.) students
Semester VIII:	Professional Core Theory (3 Credits) for only B. Tech (Hons.) students

Research Electives

The students pursuing B. Tech. (Res.) degree may need specialized knowledge in the areas of their theses. For this reason, the curriculum provides for two research electives to be selected in Semester VII and Semester VIII. Every School prepares a list of Research Electives and announces, at the beginning of every semester, the course which will be offered in that semester. The student is required to select the electives from out of these offered lists.

Summer Internship

Internship exposes the students to the realities of engineering systems. Every student must go through at least 60 days of internship. It can be taken in an industrial organization or at an institute of higher learning in the summer breaks after the second year and/or after the third year. Internship carries 2 Credits and the grade secured by a student appears in the Semester VII Grade Sheet of the student.

Projects

Projects allow the students to work under the supervision of a faculty advisor and apply their acquired knowledge to solve the real-world problems. They define problems, mine information from past works, conceptualize forces and factors that impact the problems, develop design solutions, and demonstrate the effectiveness of the solutions. Semester-wise distribution of this course is given below:

Semester VI: Mini Project (2 Credits)
Semester VII: Project I (5 Credits)
Semester VIII: Project II (9 Credits for B. Tech. (Hons.) and 12 Credits for B. Tech. (Res.))

Semester-away Provision for Project II

The Institute sometimes allows a student to carry out the fourth-year project (Project II) away from the University campus if the following conditions are satisfied:

- This provision applies to Project II.
- That means a student can avail of this provision in Semester VIII.
- The project must be done either in an industrial unit or in an academic institution.
- The organization in which the student wishes to carry out the project must give in writing that it will provide all facilities (office space, equipment, instrument, data, and travel and stay facilities, if possible) for the student to do the project. In addition, it will also identify a senior and competent employee of the organization to whom the student will report.
- The faculty supervisor must recommend the student's application for availing the semester-away provision.
- A co-supervisor from the organization may be appointed for the project.
- The intending student gives an undertaking that he (or she) will
  - Remain in constant touch with the faculty supervisor,
  - Send monthly progress reports to the supervisor,
  - Give seminar presentations, whenever required.
  - Collect class notes, read books, and prepare for and appear at the examinations (online, if necessary). The student must also do and submit all home assignments given by the teachers and give seminar presentation (online) if necessary.
- Since Semester VIII curricula have one theory coursefor B. Tech. (Res.) and two theory courses for B. Tech. (Hons.) students, a student applying for this provision will be exempted from attending the lectures on these courses. But the student must give an undertaking that it will be his (or her) responsibility to collect class notes, read books and other reading materials, submit all

home assignments, give seminar presentations (online if required) and prepare for and appear at the examinations.

COURSE STRUCTURE
B. Tech. in Civil Engineering

SCHEME I
SEMESTER-I

Theory							
Sl. No.	**Course Code**	**Courses**	**L**	**T**	**P**	**Total**	**Credit**
1	PH10001	Physics	3	0	0	3	3
2	MA11001	Differential Equations and Linear Algebra	3	1	0	4	4
3		Science Elective	2	0	0	2	2
4		Engineering Elective II	2	0	0	2	2
5	LS10001	Science of Living Systems	2	0	0	2	2
6	CH10003	Environmental Science	2	0	0	2	2
Total Credit (Theory Courses)						**15**	**15**
Practical							
1	PH19001	Physics Lab	0	0	2	2	1
2	CS13001	Programming Lab	0	2	4	6	4
Sessional							
1	CE18001	Engineering Drawing & Graphics	0	0	2	2	1
Total Credit (Practical & Sessional subject)						**10**	**6**
Total Credit (Semester)						**25**	**21**

SCHEME I
SEMESTER-II

Theory							
Sl. No.	**Course Code**	**Courses**	**L**	**T**	**P**	**Total**	**Credit**
1	CH10001	Chemistry	3	0	0	3	3
2	MA11002	Transform Calculus and Numerical Analysis	3	1	0	4	4
3	HS10001	English	2	0	0	2	2
4	EC10001	Basic Electronics	2	0	0	2	2
5		Engineering Elective I	2	0	0	2	2
6		HASS Elective I	2	0	0	2	2
Total Credit (Theory Courses)						**15**	**15**
Practical							
1	CH19001	Chemistry Lab	0	0	2	2	1
2	EX19001	Engineering Lab	0	0	2	2	1
Sessional							
1	ME18001	Workshop	0	0	2	2	1
2	YG18001	Yoga	0	0	2	2	1
3	HS18001	Communication Lab	0	0	2	2	1
Total Credit (Practical & Sessional Courses)						**10**	**5**
Total Credit (Semester)						**25**	**20**

SCHEME II
SEMESTER-I

Theory							
Sl. No.	**Course Code**	**Courses**	**L**	**T**	**P**	**Total**	**Credit**
1	CH10001	Chemistry	3	0	0	3	3
2	MA11001	Differential Equations and Linear Algebra	3	1	0	4	4
3	HS10001	English	2	0	0	2	2
4	EC10001	Basic Electronics	2	0	0	2	2
5		Engineering Elective I	2	0	0	2	2
6		HASS Elective I	2	0	0	2	2
Total Credit (Theory Courses)						**15**	**15**
Practical							
1	CH19001	Chemistry Lab	0	0	2	2	1
2	EX19001	Engineering Lab	0	0	2	2	1
Sessional							
1	YG18001	Yoga	0	0	2	2	1
2	ME18001	Workshop	0	0	2	2	1
3	HS18001	Communication Lab	0	0	2	2	1
Total Credit (Practical & Sessional Courses)						**10**	**5**
Total Credit (Semester)						**25**	**20**

SCHEME II
SEMESTER-II

Theory							
Sl. No.	**Course Code**	**Courses**	**L**	**T**	**P**	**Total**	**Credit**
1	PH10001	Physics	3	0	0	3	3
2	MA11002	Transform Calculus and Numerical Analysis	3	1	0	4	4
3		Science Elective	2	0	0	2	2
4		Engineering Elective II	2	0	0	2	2
5	LS10001	Science of Living Systems	2	0	0	2	2
6	CH10003	Environmental Science	2	0	0	2	2
Total Credit (Theory Courses)						**15**	**15**
Practical							
1	PH19001	Physics Lab	0	0	2	2	1
2	CS13001	Programming Lab	0	2	4	6	4
Sessional							
1	CE18001	Engineering Drawing & Graphics	0	0	2	2	1
Total Credit (Practical & Sessional Courses)						**10**	**6**
Total Credit (Semester)						**25**	**21**

SEMESTER-III

Theory							
Sl. No.	**Course Code**	**Courses**	**L**	**T**	**P**	**Total**	**Credit**
1	EX20003	Scientific & Technical Writing	2	0	0	2	2
2	MA21001	Probability & Statistics	3	1	0	4	4
3	CE20001	Solid Mechanics	3	0	0	3	3
4	CE20003	Construction Project Management	3	0	0	3	3
5	CE20005	Surveying & Geomatic Engineering	3	0	0	3	3
6	CE21001	Fluid Mechanics	3	1	0	4	4
Total Credit (Theory Courses)						**19**	**19**
Practical							
1	CE29001	Environmental Quality Analysis Laboratory	0	0	2	2	1
2	CE29003	Material Testing Laboratory	0	0	2	2	1
Total Credit (Practical Courses)						**4**	**2**
Vocational Course							
1	CE28001	Building Drawing, Estimation & Costing (For Civil Engineering Students)	0	0	2	2	1
	CE28003	GIS & GPS Applications (For other branch students)	0	0	2	2	1
Total Credit (Vocational)						**2**	**1**
Total Credit (Semester)						**25**	**22**

SEMESTER-IV

Theory							
Sl. No.	**Course Code**	**Courses**	**L**	**T**	**P**	**Total**	**Credit**
1		HASS Elective - II	3	0	0	3	3
2	MA21004	Vectors, PDEs and Complex Analysis	3	1	0	4	4
3	CE21002	Water Resources Engineering	3	1	0	4	4
4	CE21004	Structural Analysis	3	1	0	4	4
5	CE20002	Soil Mechanics	3	0	0	3	3
6	EX20001	Industry 4.0 Technologies	2	0	0	2	2
Total Credit (Theory Courses)						**20**	**20**
Practical							
1	CE29002	Fluid Mechanics Laboratory	0	0	2	2	1
2	CE29004	Soil Mechanics Laboratory	0	0	2	2	1
3	CE29006	Surveying Field Work	0	0	2	2	1
Total Credit (Practical Courses)						**6**	**3**
Sessional							
1	CE28002	Water Supply, Sewerage & Urban Drainage Design	0	0	2	2	1
Total Credit (Sessional Course)						**2**	**1**
Total Credit (Semester)						**28**	**24**

SEMESTER-V

Theory							
Sl. No.	**Course Code**	**Courses**	**L**	**T**	**P**	**Total**	**Credit**
1		HASS Elective - III	3	0	0	3	3
2	HS30101	Engineering Economics	3	0	0	3	3
3	CE31001	Environmental Engineering	3	1	0	4	4
4	CE30001	Concrete Structure Design	3	0	0	3	3
5	CE30003	Foundation Engineering	3	0	0	3	3
6		**Professional Elective-I**	3	0	0	3	3
Total Credit (Theory Courses)						**19**	**19**
Practical							
1	CE39001	Structural Engineering Laboratory	0	0	2	2	1
2	CE39003	Transportation Engineering Laboratory	0	0	2	2	1
Total Credit (Practical Courses)						**4**	**2**
Sessional							
1	CE38001	Structural Analysis Applications	0	0	2	2	1
2	CE38003	Water Resources Design	0	0	2	2	1
Total Credit (Sessional Courses)						**4**	**2**
K-Explore							
1		K-Explore (Practice-oriented Open Elective I)	0	0	0	-	1
Total Credit (K-Explore)						**0**	**1**
Total Credit (Semester)						**27**	**24**

SEMESTER-VI

Theory							
Sl. No.	**Course Code**	**Courses**	**L**	**T**	**P**	**Total**	**Credit**
1	HS30401	Universal Human Values	3	0	0	3	3
2	CE31002	Transportation Engineering	3	1	0	4	4
3	CE30002	Steel Structure Design	3	0	0	3	3
4		**Professional Elective-II**	3	0	0	3	3
5		**Professional Elective-III**	3	0	0	3	3
6		Open Elective II/(MI-1)	3	0	0	3	3
Total Credit (Theory Courses)						**19**	**19**
Sessional							
1	CE38002	Computer Aided Structural Design and Detailing	0	0	2	2	1
2	CE38004	Highway Design	0	0	2	2	1
3	CE38006	Hydraulic Structure Design	0	0	2	2	1
4	CE37002	Mini Project	0	0	4	4	2
Total Credit (Sessional Courses)						**10**	**5**
Total Credit (Semester)						**29**	**24**

SEMESTER-VII (For Hons. Option Students)

Theory							
Sl. No.	**Course Code**	**Courses**	**L**	**T**	**P**	**Total**	**Credit**
1		**Professional Elective-IV**	3	0	0	3	3
2		Open Elective III / (MI-2)	3	0	0	3	3
3	EX40003	Engineering Professional Practice	2	0	0	2	2
(5)		(MI-3)	(3)	(0)	(0)	(3)	(3)
(6)		(MI-4)	(3)	(0)	(0)	(3)	(3)
Total Credit (Theory Courses)						**8**	**8**
Sessional							
1	CE48001	Internship	-	-	-	-	2
2	CE47001	Project – I	0	0	10	10	5
(3)		(Project//Lab-Minor)	(0)	(0)	(4)	(4)	(2)
Total Credit (Sessional Courses)						**10**	**7**
Total Credit (Semester)						**18**	**15**

SEMESTER-VIII (For Hons. Option Students)

Theory							
Sl. No.	**Course Code**	**Courses**	**L**	**T**	**P**	**Total**	**Credit**
1		**Professional Elective-V**	3	0	0	3	3
2		Open Elective IV/ (MI-5)	3	0	0	3	3
(3)		(MI-6)	(3)	(0)	(0)	(3)	(3)
Total Credit (Theory Courses)						**6**	**6**
Sessional							
1	CE47002	Project – II	0	0	18	18	9
Total Credit (Sessional Course)						**18**	**9**
Total Credit (Semester)						**24**	**15**

SEMESTER-VII (For Research Option Students)

Theory							
Sl. No.	**Course Code**	**Courses**	**L**	**T**	**P**	**Total**	**Credit**
1		**Research Elective-I**	3	0	0	3	3
2		(MI-2)	(3)	(0)	(0)	(3)	(3)
3	EX40003	Engineering Professional Practice	2	0	0	2	2
(4)	EX40001	Research Methods & Ethics	3	0	0	3	3
(5)		(MI-3)	(3)	(0)	(0)	(3)	(3)
(6)		(MI-4)	(3)	(0)	(0)	(3)	(3)
Total Credit (Theory Courses)						**8**	**8**
Sessional							
1	CE48001	Internship	-	-	-	-	2
2	CE47003	Research Project-I	0	0	10	10	5
(3)		(Project/Lab-Minor)	(0)	(0)	(4)	(4)	(2)
Total Credit (Sessional Courses)						**10**	**7**
Total Credit (Semester)						**18**	**15**

SEMESTER-VIII (For Research Option Students)

Theory							
Sl. No.	**Course Code**	**Courses**	**L**	**T**	**P**	**Total**	**Credit**
1		**Research Elective-II**	3	0	0	3	3
2		(MI-5)	(3)	(0)	(0)	(3)	(3)
(3)		(MI-6)	(3)	(0)	(0)	(3)	(3)
Total Credit (Theory Courses)						**3**	**3**
Sessional							
1	CE47004	Research Project-II	0	0	24	24	12
Total Credit (Sessional Course)						**24**	**12**
Total Credit (Semester)						**27**	**15**

ENGINEERING ELECTIVES

Engineering Elective – I

Sl. No.	Course Code	Courses
1	CE10001	Basic Civil Engineering
2	EE10002	Basic Electrical Engineering
3	ME10003	Basic Mechanical Engineering

Engineering Elective – II

Sl. No.	Course Code	Courses
1	EE10001	Elements of Machine Learning*
2	ME10001	Engineering Mechanics
3	EC10003	Biomedical Engineering
4	EE10003	Basic Instrumentation

*Not for students of Computer Engineering

Science Elective

Sl. No.	Course Code	Courses
1	CH10005	Nanoscience
2	PH10003	Smart Materials
3	LS10003	Molecular Diagnostics
4	PE10002	Science of Public Health
5	MA10003	Optimization Techniques

PROFESSIONAL ELECTIVES (PEs)

Professional Elective (PE)	List of Courses
PE – I	• Green Building (CE30021) • Matrix Methods of Structural Analysis (CE30023) • Life Cycle Sustainability Assessment (CE30025) • Pavement Material & Design (CE30027) • Open Channel Hydraulics (CE30029) • Soil Exploration & Field Test (CE30031)
PE – II	• Construction Finance Management (CE30022) • Concrete Technology (CE30024) • Air & Noise Pollution Control (CE30026) • Airport, Railways, Ports &Harbour Engineering (CE30028) • Flood Estimation, Management & Forecasting (CE30030) • Ground Improvement Engineering (CE30032)
PE – III	• Construction Engineering Practices (CE30034) • Prestressed Concrete (CE30036) • Solid & Hazardous Waste Management (CE30038) • Traffic Engineering and Transportation Planning (CE30040) • River Engineering & Morphology (CE30042) • Offshore Geotechnical Engineering (CE30044)
PE - IV	• Repair & Rehabilitation of Structures (CE40021) • Earthquake Engineering (CE40023) • Advanced Wastewater Treatment (CE40025) • Road Safety Engineering (CE40027) • Irrigation Engineering & Hydraulic Structures (CE40029) • Geo-environmental Engineering (CE40031)
PE - V	• Construction Contract Management and Quantity Survey (CE40022) • Bridge Engineering (CE40024) • Circular Economy (CE40026) • Pavement Management System (CE40028) • Groundwater Hydrology (CE40030) • Advanced Foundation Engineering (CE40032)

Combination of Professional Electives (PE-III, PE-IV & PE-V) for Obtaining Track

Track	PE-III		PE-IV		PE-V	
	Course code	**Course**	**Course code**	**Course**	**Course code**	**Course**
Construction Engineering & Management	CE30034	Construction Engineering Practices	CE40021	Repair & Rehabilitation of Structures	CE40022	Construction Contract Management and Quantity Survey
Structural Engineering	CE30036	Prestressed Concrete	CE40023	Earthquake Engineering	CE40024	Bridge Engineering
Environmental Engineering	CE30038	Solid & Hazardous Waste Management	CE40025	Advanced Wastewater Treatment	CE40026	Circular Economy
Transportation Engineering	CE30040	Traffic Engineering and Transportation Planning	CE40027	Road Safety Engineering	CE40028	Pavement Management System
Water Resources Engineering	CE30042	River Engineering & Morphology	CE40029	Irrigation Engineering & Hydraulic Structures	CE40030	Groundwater Hydrology
Geotechnical Engineering	CE30044	Offshore Geotechnical Engineering	CE40031	Geo-environmental Engineering	CE40032	Advanced Foundation Engineering

RESEARCH ELECTIVES

Research Elective-I

SEMESTER-VII

Sl. No.	Course Code	Courses	Credit
1	CE40021	Repair and Rehabilitation of structures	3
2	CE40033	Structural Dynamics	3
3	CE40025	Advanced Wastewater Treatment	3
4	CE40027	Road Safety Engineering	3
5	CE40029	Irrigation Engineering & Hydraulic Structures	3
6	CE40035	Numerical Methods in Geomechanics	3

Research Elective-II

SEMESTER-VIII

Sl. No.	Course Code	Courses	Credit
1	CE40022	Construction Contract Management and Quantity Survey	3
2	CE40034	Finite Element Method	3
3	CE40026	Circular Economy	3
4	CE40028	Pavement Management System	3
5	CE40030	Groundwater Hydrology	3
6	CE40036	Soil Dynamics	3

HASS ELECTIVES

HASS Elective-I
SEMESTER-I/II

Sl. No.	Course Code	Courses	Credit
1	HS10013	Society, Science, and Technology	2
2	HS10202	Essential of Management	2
3	HS10121	Shades of Economics	2
4	HS10123	Indian Economy Post Liberalisation	2
5	SO10043	Socio-Political Environment	2
6	PS10043	Thinking Perspectives	2
7	PS10045	Creativity, Innovation and Entrepreneurship	2
8	EX17001	Community/Environment-based Project	2

HASS Elective-II
SEMESTER-IV

Sl. No.	Course Code	Courses	Credit
1	HS20220	Organizational Behaviour	3
2	HS20120	Economics of Development	3
3	HS20122	International Economic Cooperation	3

HASS Elective-III
SEMESTER-V

Sl. No.	Course Code	Courses	Credit
1	HS30223	Business Ethics and Corporate Governance	3
2	HS30225	Leadership and Team Effectiveness	3
3	HS30125	Market Structure and Pricing Policies	3
4	HS30127	Pragmatic Inquiry	3
5	HS30129	Economic Analysis of Decision Rules	3
6	HS30131	Economics of Health and Education	3
7	HS30421	Gender Studies	3
8	HS30423	Tribal Resource Management	3
9	HS30425	Indian Knowledge System	3

VOCATIONAL ELECTIVES

Vocational courses offered by School of Civil Engineering

Sl. No.	Course Code	Courses
1	CE28001	Building Drawing, Estimation & Costing (For Civil Engineering Students)
2	CE28003	GIS & GPS Applications (For other branch students)

Vocational courses offered by School of Computer Engineering

Sl. No.	Course Code	Courses
1	CS28001	Web Design

Vocational courses offered by School of Electrical Engineering

Sl. No.	Course Code	Courses
1	EE28011	Industrial wiring and control panel design
2	EE28013	Installation, operation and maintenance of solar power system
3	EE28015	Domestic wiring and home automation
4	EE28017	Cyber physics application in industrial IOT
5	EE28019	Industrial Control and Remote Monitoring

Vocational courses offered by School of Electronics Engineering

Sl. No.	Course Code	Courses
1	EC28001	Computational Photography
2	EC28003	Sound Engineering
3	EC28005	Sensors for Automation
4	EC28007	PCB Design

Vocational courses offered by School of Mechanical Engineering

Sl. No.	Course Code	Courses
1	ME28011	Additive Manufacturing (3-D Printing)
2	ME28013	Die development by CNC milling
3	ME28015	Concept Car Manufacturing
4	ME28017	Development of Autonomous Wheeled Robots
5	ME28019	Modelling of Micro-Wind turbine by 3D CAD Design

K-Explore—Practice-based Open Elective I

Sl. No.	Course Code	Course
1	SA38001	Robotics
2	SA38003	Web Designing
3	SA38005	Civil-Tech
4	SA38007	Circuit Design & Control
5	SA38009	Indian Classical, Folk & Bollywood Dance
6	SA38011	Indian Classical & Western Music
7	SA38013	Graphic Designing & Editing
8	SA38015	Art & Craft
9	SA38017	Theatre & Street Play
10	SA38019	Film Making
11	SA38021	Debating, Public Speaking & Anchoring
12	SA38023	Creative Writing
13	SA38025	Photography & Videography
14	SA38027	Fashion Styling
15	SA38029	Culinary Arts
16	SA38031	Quiz Activity
17	SA38033	Social Outreach
18	SA38035	Health & Emergency Care

School of Civil Engineering
Semester-wise Open Elective/Minor Courses

SEMESTER – VI						
Course Code	**Open Elective Courses**	**Pre-requisite**	**Minor in**			
			Water Resources Management	**Urban Environmental Management**	**Geohazard Mitigation & Management**	**Urban Transportation Management**
CE30072	Fundamentals of Project Management	Nil				
CE30074	Elements of Surface Hydrology	Nil				
CE30076	Environmental Pollution and Control	Nil				
CE30078	Municipal Solid Waste Management	Nil				
CE30052	Surface & Groundwater Hydrology	Nil	X			
CE30054	Water Supply & Quality Management	Nil		X		
CE30056	Geomaterial Characterization	Nil			X	
CE30058	Highway Material Characterization	Nil				X
SEMESTER – VII						
CE40081	Disaster Management	Nil				
CE40083	Coastal Management	Nil				
CE40085	Basic Groundwater Hydrology	Nil				
CE40087	Clean water & Sanitation	Nil				
CE40051	Basic Fluid Mechanics & Hydraulics	Nil	X			
CE40053	Introduction to Remote Sensing & GIS	Nil	X	X		
CE40055	Irrigation Water Management	Nil	X			

CE40057	Urban Waste Management	Nil		X		
CE40059	Urban Storm Water Management	Nil		X		
CE40061	Landslide hazards and protection	Nil			X	
CE40063	Earthquake hazards and mitigation	Nil			X	
CE40065	Geo-hazards Risk Management	Nil			X	
CE40067	Traffic Analysis and Management	Nil				X
CE40069	Railway and Airport Planning	Nil				X
CE40071	Road Safety Analysis	Nil				X
SEMESTER – VIII						
CE40082	Global Warming & Climate Change	Nil				
CE40084	Construction Materials & Specifications	Nil				
CE40086	Natural Resources Management	Nil				
CE40088	Basic Transportation Engineering	Nil				
CE40050	Gender & Legal Aspects in Water Resources Management	Nil	X			
CE40052	Environmental Impact Assessment	Nil	X	X		X
CE40054	Air Pollution Control & Management	Nil		X		
CE40056	Groundwater contamination and remediation	Nil			X	
CE40058	Geotechnical instrumentation and monitoring	Nil			X	
CE40060	Fundamentals of Urban	Nil				X

	Transportation Planning					

Minor Laboratory / Project (Students pursuing 4 years B.Tech. Hons or B.Tech. Research program along with Minor program)

Course Code	Course	Pre-requisite	Minor Specialization			
			Water Resources Management	Urban Environmental Management	Geohazard Mitigation and Management	Urban Transportation Management
CE49001	Water Resources Laboratory	Nil	X			
CE49003	Environmental Quality Laboratory	Nil		X		
CE49005	Geomaterial Laboratory	Nil			X	
CE49007	Highway Material Laboratory	Nil				X

Note:

- Students pursuing the 4-year B.Tech. (Hons.) program must opt for three semester-wise Open elective courses, one in each of Semester VI, Semester VII, and Semester VIII.
- Students pursuing the 4-year B.Tech. (Res.) program must opt for one Open elective course in Semester VI.
- Not all courses listed above may be offered in a semester.
- Allocation of courses to the students will be based on a first-come first-serve basis.
- A student with a CGPA of 7.0 after Semester IV must select three additional theory courses and one laboratory course, in Semester VII and Semester VIII to earn a Minor (See Rules for Minor).
- The courses that lead to a particular Minor are marked above with a cross (X).

School of Electrical Engineering
Semester-wise Open Elective/Minor Courses

SEMESTER – VI					
Course Code	**Open Elective Courses**	**Pre-requisite**	**Minor in**		
			Electrical Engineering	**Smart Electric Vehicles**	**Industrial IoT**
EE30034	Network Analysis	Nil	X	X	X
EE30016	Renewable Energy Resources	Nil	X	X	
EE30036	Solar Power Technology	Nil			
EE30038	Introduction to Electrical Machines	Nil	X	X	X
EE30040	Energy and Environment	Nil			
EE20007	Analog and Digital Electronics Circuits	Nil	X	X	
EE20005	Measurements and Sensors Technology	Nil	X		
SEMESTER – VII					
EE40031	Fuel Technology	Nil			
EE40033	Energy Audit and Management	Nil	X		
EE20004	Linear Control System	Nil	X	X	X
EE30012	Sensors and Actuators	Nil		X	X
EE40035	Energy Storage Technology	Nil	X	X	
EE30004	Microprocessors and Embedded System	Nil	X		

EE40020	Digital System Design using FPGA	Nil		X	X
EE30022	Special Machines and Control	Nil		X	
EE40044	Hybrid Electric Vehicles	Nil		X	
EE40042	Robotics and Control	Nil			X
EE40047	Cyber security	Nil			X
EE40048	Wireless network systems	Nil			X
SEMESTER – VIII					
EE30007	Power Transmission and Distribution	Nil	X		
EE30001	Power Electronics	Nil	X		
EE30024	Electric Drives and Control	Nil	X		
EE40041	Power System Protection	Nil	X		
EE40046	IoT in Electric Vehicles	Nil		X	
EE40022	Vehicle Charging Technology	Nil		X	
EE40045	Hydrogen and fuel cell technology for Electric and hybrid Vehicle	Nil		X	
EE40049	IoT in Industry	Nil			X
EE40050	Smart Bio-Medical	Nil			X

	Instruments				
EE40051	Bio-Inspired Algorithm	Nil			X
EE40052	IoT Sensors and Protocols	Nil			X

Minor Lab / Project (Students pursuing 4 years B.Tech. Hons or B.Tech. Research program along with Minor program)

Course Code	Course	Pre-requisite	Minor Specialization		
			Electrical Engineering	**Smart Electric Vehicles**	**Industrial IoT**
EE29002	Electrical Machines Laboratory	Nil	X		
EE39001	Power Electronics Laboratory	Nil	X		
EE49001	Power System Protection Lab	Nil	X		
EE49005	Electric Vehicles Laboratory	Nil		X	
EE49003	IoT Laboratory	Nil		X	X
EE49002	Sensors and Control Laboratory	Nil		X	X
EE39007	PLC Laboratory	Nil			X

School of Electronics Engineering
Semester-wise Open Elective/Minor Courses

SEMESTER – VI

Course Code	Open Elective Courses	Pre-requisite	Minor in			
			Minor in Communication and Networking	Minor in VLSI and Embedded System	Minor in Applied Machine Learning	Minor in Cyberphysical Systems
EC30014	Circuits, Signals and Communication	Nil	X	X	X	X
EC30016	Introduction to Sensor Technology	EC10001				X
EC30018	Evolution of Communication Technology	Nil				
EC30020	Electronics and PCB Design	Nil				
EC40001	Optimization Techniques in Engineering	Nil				

SEMESTER – VII

Course Code	Open Elective Courses	Pre-requisite	Minor in			
			Minor in Communication and Networking	Minor in VLSI and Embedded System	Minor in Applied Machine Learning	Minor in Cyberphysical Systems
EC20007	Semiconductor Technology	Nil		X		

EC30010	Information Theory and Coding	EC20008/ EC30014	X			
EC30011	Digital System Design with Verilog	EC10001		X		
EC30013	Optical and Satellite Communication	EC21002/ EC20008	X			
EC40023	Consumer Electronics	EC30014/ EC10001				
EC40025	Fundamentals of Data Acquisition Systems	NIL				
EC40027	Embedded System Design and Applications	EC10001		X	X	X
EC40029	Communication Network Fundamentals	EC21002/ EC20008/ EC30014	X			
EC40031	Principles of Opto-Electronics	EC30014/ EC10001				
EC40033	Principle of Modern Communication Systems	EC30014/ EC10001				
EM30009	Data Analytics	Nil				X
EM30011	Data Mining	Nil			X	
EM40006	Cybersecurity	Nil				X
EM40008	Bioinformatics	LS10001			X	

SEMESTER – VIII

Course Code	Open Elective Courses	Pre-requisite	Minor in			
			Minor in Communication and Networking	Minor in VLSI and Embedded System	Minor in Applied Machine Learning	Minor in Cyberphysical Systems
EC30019	Mobile Ad Hoc Network	EC21002/ EC20008	X			
EC30021	Industrial IoT	EC20002/ EC30004				X
EC40004	Quantum Engineering	NIL		X		
EC40020	Essence of Biomedical Signal Processing	MA11001 MA11002				
EC40022	Imaging Techniques	NIL				
EM30004	Machine learning based Signal Processing	MA21001/ EC20001	X	X	X	X
EM40010	Optimization Methods in Machine Learning	MA11001 MA11002 MA21001			X	

Minor Lab / Project (Students pursuing 4 years B.Tech. Hons or B.Tech. Research program along with Minor program)

Course Code	Course	Pre-requisite	Minor Specialization			
			Minor in Communication and Networking	Minor in VLSI and Embedded System	Minor in Applied Machine Learning	Minor in Cyberphysical Systems
EC39004	Electronics Design Lab		X	X	X	X
EC47004	Project (Minor Degree)		X	X	X	X

School of Mechanical Engineering
Semester-wise Open Elective/Minor Courses

SEMESTER – VI					
Course Code	**Open Elective Courses**	**Pre-requisite**	**Minor in**		
			Mechanical Engineering	**Manufacturing Engineering**	**Industrial Engineering and Management**
ME30050	Kinematics and Dynamics of Machinery	Nil	X		
ME20005	Material Science and Engineering	Nil		X	
ME30016	Supply Chain Management	Nil			X
ME30052	Introduction to Fluid Mechanics and Heat Transfer	Nil			
ME30054	Renewable Energy Sources	Nil			
ME30056	Finite Element Method for Engineers	Nil			
ME30058	Introduction to Composite Materials	Nil			
SEMESTER – VII					
ME40061	Engineering Metrology	Nil		X	
ME30005	Industrial Engineering and Operations Research	Nil	X	X	

ME40077	Manufacturing Processes	Nil	X	X	
ME40063	Quality Engineering	Nil			X
ME40065	Project Management	Nil			X
ME40067	Operations Research	Nil			X
ME40069	Thermodynamics and Hydraulic Devices	Nil	X		
ME40071	Biomechanics	Nil			
ME40073	Fundamentals of Computational Fluid Dynamics	Nil			
ME40075	Automobile Technology	Nil			
SEMESTER – VIII					
ME40062	Work System Design	Nil			X
ME30018	Power Plant Engineering	Nil	X		
ME40064	Mechanical System Design	Nil	X		
ME30015	Additive Manufacturing	Nil		X	
ME40066	Industrial Automation and Robotics	Nil		X	
ME40068	Production, Planning and Control	Nil			X

ME40070	Mechatronic Systems	Nil			
ME40072	Robotics	Nil			
ME40074	Computer Controlled Manufacturing Systems	Nil			

Minor Lab / Project (Students pursuing 4 years B.Tech. Hons or B.Tech. Research program along with Minor program)

Course Code	Course	Pre-requisite	**Minor Specialization**		
			Mechanical Engineering	**Manufacturing Engineering**	**Industrial Engineering**
ME49011	Thermo fluids Lab	Nil	X		
ME28003	Manufacturing Practices	Nil	X	X	
ME49013	Metrology and Instrumentation Lab	Nil		X	
ME48011	Operations Research Sessional	Nil			X
ME49016	Work System Design Lab	Nil			X

School of Computer Engineering
Semester-wise Open Elective/Minor Courses

Semester VI			
Course Code	**Open Elective Courses**	**Pre-requisite**	**Minor in Computer Science**
CS30001	Design and Analysis of Algorithms	Nil	
CS30018	Software Engineering Fundamentals	Nil	
CS30020	Essentials of Computer Science	Nil	
CS30022	Object Oriented Programming	Nil	
CS30024	Fundamentals of Data Structures	Nil	
CS30011	Computational Intelligence	Nil	
CS40002	Nature Inspired Computing	Nil	
Semester VII			
Course Code	**Open Elective Courses**	**Pre-requisite**	**Minor in Computer Science**
CS30001	Design and Analysis of Algorithms	Nil	
CS30018	Software Engineering Fundamentals	Nil	
CS30020	Essentials of Computer Science	Nil	X
CS30022	Object Oriented Programming	Nil	
CS30024	Fundamentals of Data Structures	Nil	X
CS30011	Computational Intelligence	Nil	
CS40002	Nature Inspired Computing	Nil	
Semester VIII			

Course Code	Open Elective Courses	Pre-requisite	Minor in Computer Science
CS30001	Design and Analysis of Algorithms	Nil	X
CS30018	Software Engineering Fundamentals	Nil	
CS30020	Essentials of Computer Science	Nil	
CS30022	Object Oriented Programming	Nil	
CS30024	Fundamentals of Data Structures	Nil	
CS30011	Computational Intelligence	Nil	
CS40002	Nature Inspired Computing	Nil	

Minor Lab / Project (Students pursuing 4 years B.Tech. Hons or B.Tech. Research program along with Minor program)

Course Code	Courses	Pre-requisite
CS39008	Computing Laboratory	Nil

School of Humanities
Semester-wise Open Elective/Minor Courses

SEMESTER – VI			
Course Code	**Open Elective Courses**	**Pre-requisite**	**Minor in**
			Financial Economics (Using Data Analytics)
HS30150	Foundations of Modern Macroeconomics	Nil	
HS30152	Money and Financial Markets	Nil	X
HS30154	Poverty to Prosperity	Nil	

HS30250	Organizational Change and Development	Nil	
HS30050	Indian Literature in Translation (ILT)	Nil	
HS30052	Climate Change Narratives	Nil	
HS30054	Introduction to Science Fiction	Nil	
SEMESTER – VII			
HS40151	Econometrics for Business Data Analysis	Nil	X
HS40153	Financial Economics	Nil	X
HS40155	Corporate Finance	Nil	X
HS40157	Employment, Employability and Growth	Nil	
SEMESTER – VIII			
HS40156	Public Economics	Nil	X
HS40158	Advanced Econometrics	Nil	X
HS47160	Project	Nil	X
HS40162	Economic Inequality	Nil	
SEMESTER – VI			

Course Code	**Minor Courses**	**Pre-requisite**	**Minor in Sustainable Development**
CE30078	Municipal Solid Waste Management	Nil	
EE30032	Sustainable Energy and Applications	Nil	
HS30154	Poverty to Prosperity	Nil	X
EE30030	Solar Energy Utilization	Nil	
SEMESTER – VII			
CE40087	Clean Water & Sanitation	Nil	X
CE40065	Geo-Hazards Risk Management	Nil	X

EE40013	Wind and Biomass Energy	Nil	X
HS40157	Employment, Employability and Growth	Nil	X
SEMESTER – VIII			
LS30002	Industrial Ecology and Design for Sustainability	Nil	X
EE40018	Waste Management and Energy Recovery	Nil	
HS40162	Economic Inequality	Nil	X

School of Applied Sciences
Semester-wise Open Elective/Minor Courses

Course Code	Courses	Prerequisites
SEMESTER – VI		
MA30002	Advanced Numerical Techniques	Nil
LS30002	Industrial Ecology and Design for Sustainability	Nil
CH30002	Sustainable Energy and Environment	Nil
SEMESTER – VII		
MA40001	Finite Element Analysis	Nil
PH40001	Quantum Computing	Nil
CH40001	Composite Materials and Structures	Nil
SEMESTER – VIII		
CH40002	Solid Waste Management	Nil

School of Management
Semester-wise Open Elective/Minor Courses

Course Code	Courses	Prerequisites
BM30102	Training & Development	Nil
BM30202	Financial Management	Nil
BM30302	Marketing Management	Nil
BM30602	Basics of Management Information System	Nil
BM30702	Entrepreneurship	Nil
BM30802	Production & Operations Management	Nil

School of Rural Management
Semester-wise Open Elective/Minor Courses

Course Code	Courses	Prerequisites
RM30152	Sustainable Rural Development	Nil
RM20152	Food Security	Nil

School of Law
Semester-wise Open Elective/Minor Courses

Course Code	Courses	Prerequisites
LW30910	Law of Patent	Nil
LW30904	Law of Contract	Nil
LW30908	Intellectual Property Rights Law	Nil
LW30914	Environmental Law	Nil
LW30918	Copyright Law	Nil
LW30920	Information Technology Law	Nil

School of Public Health
Semester-wise Open Elective/Minor Courses

Course Code	Courses	Prerequisites
PE30002	Health and Wellbeing	Nil

BASIC CIVIL ENGINEERING

Course Code: CE10001
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

To provide an overview on different aspects of civil engineering profession involving surveying, materials and structural, geotechnical, hydraulics and water resources, environmental, and transportation engineering and their roles in the societal development.

COURSE OUTCOMES

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

CO 1: Understand the importance and practical applications of different types of surveying,
CO 2: Learn about the different construction materials and understand the philosophy of structural analysis and design,
CO 3: Understand engineering behaviour of soil and types of foundations,
CO 4: Understand different hydraulics, hydrological and water resources engineering applications,
CO 5: Learn about the management strategies of wastewater and solid waste, and
CO 6: Understand the basics of different types of highways, railways, ports and harbours.

COURSE DETAILS

Introduction
Role of civil engineers in providing infrastructure, improving quality of life and taking major role in Nation Building, different specializations in the civil engineering and its specific role.
Surveying
Plans, maps, scales, divisions of surveying, classification of surveying, leveling, advanced methods of surveying.

Construction Materials & Structural Engineering
Different construction materials and their uses, **structural analysis and design philosophy.**

Geotechnical Engineering
Overview on origin of soil, engineering properties and its classification; soil exploration; Foundations: their importance and purpose; factors to consider in foundation design and stability of slopes; improving site soils for foundation use.

Hydraulics & Water Resources Engineering
Overview on fluid properties, open channel flow, surface and groundwater hydrology, irrigation infrastructures.

Environmental Engineering
Types of wastewater, principles of wastewater management, Types of solid waste, principles of solid waste management.

Transportation Engineering
Classification of highways, typical construction methods of roads, traffic surveys and their applications in traffic planning, Railways, Ports and Harbours.

Textbooks

1. Er. Shrikrishna A. Dhale and Er. Kiran M. Tajne, Basics of Civil Engineering, S. Chand & Company Pvt. Ltd., 1st Edition, 2014.
2. Lecture Notes to be provided by the concerned Faculty Members.

Reference Book

1. S.S. Bhavikatti, Basic Civil Engineering, New Age International Publisher, 1st Edition, 2021.

ENGINEERING DRAWING & GRAPHICS

Course Code: **CE18001**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to provide students with knowledge and abilities to design a 3D object on 2D paper by hand sketching method and by means of computer aided drafting software.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Use common drafting tools properly,
CO 2: Select, construct and interpret appropriate drawing scale as per the situation,
CO 3: Draw orthographic projections of points, lines and planes,
CO 4: Draw orthographic projection of solids like cylinders, cones, prisms and pyramids,
CO 5: Develop the section of solids for practical situations, and
CO 6: Communicate ideas effectively using Computer Aided Drafting.

COURSE DETAILS

- 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

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

Reference Book

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

SOLID MECHANICS

Course Code: **CE20001**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

In this course, the methods of analysis of deformable bodies will be dealt with. The students will get exposure to the concept of stress, strain due to various types of loading, Shear Force and Bending Moment Diagram for transverse loading, Bending and Shear stress distribution on Beam, Torsional shear stress for shaft, Principal stresses in members due to various loadings and Buckling of the column for different support conditions.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Determine simple stress and strain in materials under axial, shear and thermal loading,
CO 2: Draw shear force and bending moment diagrams of determinate beams and frames,
CO 3: Analyze beams for bending and shear stresses and determine shear centre,
CO 4: Evaluate tangential and normal stresses at different orientations of planes,
CO 5: Analyze torsion in solid and hollow circular shafts, and
CO 6: Estimate critical load of compression members for different support conditions.

COURSE DETAILS

Simple Stress and Strain
Concept of Stress, Properties of ductile and brittle materials, Normal Stress and Shear Stress, Concept of Strain, Stress and Strain in Materials, Elastic Constants, Relationship between Elastic Constants, Strain energy, Thermal Stresses.

Shear Force Diagram (SFD) & Bending Moment Diagram (BMD)
Definition, type of supports, shears force and bending moment diagram of determinate beams and frames.

Bending Stress & Shear Stresses in Beams
Theory of Simple Bending, Section Modulus, Moment of Resistance, Shear stress distribution in beams of different cross-sections. location of Shear Centre.

Transformation of Stresses
Two-Dimensional Stress System, Principal Planes, Principal Stresses, Mohr's Stress Circle, Principal Strains, Mohr's Strain Circle, Principal Stresses computed from Principal Strains.

Torsion
Torsion in Solid & Hollow Circular Shafts, Angle of Twist, Torque and Power Transmitted by Solid and Hollow Shafts, Strength of Shafts, Combined Bending & Torque.

Buckling of Columns
Euler Theory, Column with One end Free & Other end Fixed, Column with Both ends Hinged, Column with both ends fixed, Column with one end fixed and the other end Hinged, Columns with eccentric loading.

Textbooks

1. S. Ramamrutham and R. Narayanan, Strength of Materials, Dhanpat Rai Publishing Company (P) Ltd., 2020.
2. Barry J. Goodno and James M. Gere, Mechanics of Materials, Cengage Learning, 9th Edition, 2018, ISBN: 9781337093521.

Reference Books

1. R.K. Rajput, Strength of Materials (Mechanics of Solids), S. Chand and Company Ltd, 2018, ISBN: 9789352533695.
2. Egor P. Popov, Engineering Mechanics of Solids, Pearson Education India, 2nd Edition, 2015, ISBN-10: 9332550212.

SOIL MECHANICS

Course Code: **CE20002**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to introduce soil as an engineering material and to understand its engineering classification. This course will help the students to understand the various engineering properties of the soil and their application to the real-world geotechnical problems. It will make students familiar with the shear strength and consolidation characteristics of soil.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the soil types and classify based on index properties,
CO 2: Evaluate of hydraulic properties of soil and seepage analysis,
CO 3: Estimate effective stress under various conditions and understand piping,
CO 4: Understand the concept of soil compaction and factors affecting compaction,
CO 5: Determine various shear strength parameters of soil, and
CO 6: Determine the long-term settlement of foundations based on one dimensional consolidation theory.

COURSE DETAILS

Introduction and classification
Introduction, origin & formation of soil, pre and post weathering process, rock types, geological cycles, General types of soil and soil deposits, Cohesive and cohesion less soils. Three phase diagram of soil. Volumetric relationship, Volume-Mass relationship, & inter-relationships. Index properties of soils & their determination. Classification of soil based on grain size and plasticity characteristics.

Permeability and flow through soil
Permeability of soil, Darcy‘s law, Discharge velocity, Seepage velocity. Determination of Coefficient of permeability by constant head permeability and falling head permeability test, Factors affecting permeability and Permeability of stratified soils. Seepage pressure, Effective stress under steady seepage conditions, Quick Sand

Condition. Laplace's equation, Stream and Potential Function, Flow net, characteristics of flow net, uses of flow net, steady state well hydraulics.

Effective stress principle

Effective stress principle, Nature of effective stress. Effect of water table fluctuation on effective stress. Increase in effective stress due surcharge. Capillarity of soil and capillary zones. Effective stress in soils saturated by capillary action**.**

Compaction of soil

Objectives of compaction, determination of OMC & MDD by standard & modified Proctor compaction test. Factors affecting compaction, Zero air voids line. Field compaction method and control measures.

Shear strength

Basic concept, Mohr-Coulomb failure theories and modified Mohr-Coulomb failure theories. Mohr's Circle. Methods of determination of shear strength parameters: Shear tests- Direct shear test, Triaxial compression test, Unconfined compression test, Vane shear test, behavior of soil under cyclic loading, liquification.

Consolidation of soil

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

Textbooks

1. P. Purushothama Raj, Soil Mechanics & Foundation Engineering, Pearson Education India, 2nd Edition, 2013, ISBN: 9788131790816.
2. V.N.S. Murthy, Textbook of Soil Mechanics and Foundation Engineering, CBS, 2018, ISBN-10: 8123913621.

Reference Books

1. B.M. Das, Principles of Geotechnical Engineering, Cengage Learning India Pvt. Ltd., 8th Edition, 2015, ISBN-10: 9788131526132.
2. K.R. Arora, Soil Mechanics and Foundation Engineering, Standard Publisher, 2020, ISBN-10: 8180141128.
3. Gopal Ranjan and A.S.R. Rao, Basic and Applied Soil Mechanics, New Age international Pvt. Ltd., 3rd Edition, 2016, ISBN-10: 8122440398.
4. Joseph E. Bowles. Foundation analysis and design, McGraw-Hill Education, 5th Edition, 2000, ISBN-10: 0071188444.

CONSTRUCTION PROJECT MANAGEMENT

Course Code: CE20003
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course deals with basic construction materials, masonry construction and management theories to deal with construction projects.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify proper construction materials for various uses,
CO 2: Select appropriate materials for making composite materials like mortar and cement concrete,
CO 3: Identify the suitability of various foundations for different ground conditions,
CO 4: Recognize different masonry works in construction processes,
CO 5: Implement project management activities through management tools like CPM and PERT, and
CO 6: Explain the time and cost optimization of a project.

COURSE DETAILS

Bricks
Brick earth, Methods of brick manufacture, Tests for bricks, Classification of bricks.

Cement
Portland cement: Classification, Chemical composition, Hydration process and products, Storage of cement, Tests for cement: fineness test, normal consistency, setting time, soundness, tensile and compressive strength.

Steel
Properties of steel, classification of steel based on uses, Market forms of structural steel, Corrosion and prevention

Mortar
Properties and function of sand for mortar, Preparation and classification of mortar, Tests for mortar

Concrete
Composition of concrete, W/C ratio, Workability, Compressive and tensile strength, Nominal mix and design mix, Elasticity, Shrinkage and Creep of concrete

Foundation
Shallow foundation, Deep foundation, Description and types of spread foundation, Description and types of pile foundations, Methods of pile driving, Excavation and timbering of trenches, Well foundations, Caissons, Cofferdams.

Masonry
Definition of terms; Classification of masonry; stone masonry: classification, dressing, joints, maintenance; Brick masonry: Types of bonds, Brick laying, Structures in brickwork; Partition walls, Earthquake resistant masonry buildings, Importance of architectural features and structural shapes concerning to earthquake resistant structures.

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

Textbooks

1. S.C. Rangwala, Engineering Materials, Charotar Publishing House, 2011.
2. Kumar Neeraj Jha, Construction Project Management, Pearson Education, 2nd Edition, 2015, ISBN-10: 9332542015.

Reference Books

1. S.S. Bhavikatti, Building Material, Vikas Publication, 1st Edition, 2012, ISBN-10: 9789325960442.
2. S.K. Sharma, A Textbook of Building Construction, Revised Edition, S. Chand Publication, 1987
3. Ajay Kumar Singhal, Basics of Construction Management, 1st Edition 2015, ISBN- 978-93-5196-682-1.
4. B.C. Punmia, A.K. Jain and A.K. Jain, Building Construction, Laxmi Publications (P) Ltd, 1987.
5. U.K. Shrivastava, Construction Planning & Management Theory and Practices, Galgotia Publications Pvt. Ltd, May 2010.

SURVEYING & GEOMATIC ENGINEERING

Course Code: CE20005
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

In this course, the fundamentals of surveying measurements will be covered to provide a broad overview of the surveying instrumentation (Total Station, Digital Level), procedures, measurement corrections and reductions, survey datums, and computations that are required to produce a topographical map or a site plan for engineering and design projects.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Apply the concept of chain survey and compass survey in the field,
CO 2: Plan for a survey for applications like road alignment and height of the building,
CO 3: Prepare a contour map using leveling,
CO 4: Use theodolite for preparation of traverse,
CO 5: Apply the concept of tacheometry and geodetic surveying, and
CO 6: Compare the advanced surveying techniques over conventional methods in the field of civil engineering.

COURSE DETAILS

Introduction
Principles of surveying –Introduction to chain surveying – Chaining and ranging.

Compass surveying
Prismatic compass – Bearing of survey lines – Systems and conversions – Local attraction – Latitude and departure – Traversing – Traverse adjustment of closing errors-Plane table Surveying- Two- and Three-Point Problems.

Leveling
Instruments – Temporary and permanent adjustments – Reduction to levels – Correction for curvature and refraction – Classification of leveling – Profile Levelling – Differential levelling – Reciprocal levelling – longitudinal and cross-sectioning.

Tacheometric surveying
Stadia Tachometry-Different types of tachometric measurements– Analytic lens– Tangential method.

Theodolite surveying
Vernier theodolite – Temporary and permanent adjustments– Measurement of horizontal and vertical angles – Methods of repetition and reiteration – Errors in theodolite surveying –Elimination of errors.

Area and volume computation
Area from latitude and departure – Simpson's rule and Trapezoidal rule.

Trigonometrical levelling
Observations for heights and distances – Geodetic observations – Corrections for refraction, curvature, axis signal – Reciprocal observations-Errors – Types of errors.

Introduction to advanced surveying equipment
Total station – GPS – Electronic theodolite.

Textbooks

1. R. Agor, A Textbook of Surveying and Leveling, Khanna Publishers, 1980, ISBN-10: 8174092358.
2. S.K. Duggal, Surveying (Vol. I), McGraw Hill Education (India) Pvt Ltd, 5th Edition, 2019, ISBN-10: 9353167507.

Reference Books

1. B. C. Punmia, Ashok K. Jain & Arun K. Jain, Surveying (Vol. I), Laxmi Publications Pvt Ltd, 17th Edition, 2016, ISBN-10: 9788170088530.
2. R. Subramanian, Surveying and Leveling, Oxford University Press, 2nd Edition, 2012. ISBN-10: 0198085427.
3. T.P. Kanetkar and S.V. Kulkarni, Surveying and Leveling (Part 1), Vidyarthi Griha Prakashan, Pune, 2006, ISBN-10: 8185825114.

FLUID MECHANICS

Course Code: **CE21001**
Credit: **4**
L-T-P: **3-1-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To learn the concept of fluid and its various aspects like static, kinematics, and dynamic behavior; understand and apply concept of pipe flow and its applications; analyze boundary layer flow; dimensional analysis.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Estimate different fluid properties and apply the concept of Newton's law,
CO 2: Determine fluid pressure, forces on planar and curved surfaces submerged in a static fluid; buoyant force and metacentric height,
CO 3: Estimate velocity, acceleration, stream and potential function of fluid in motion,
CO4: Derive Euler's and Bernoulli's equations and demonstrate their applications in venturimeter, orificemeter, and analyze the momentum principles,
CO 5: Determine minor and major head losses in pipes, design pipe water distribution systems and use boundary layer concept to estimate different thicknesses, and
CO 6: Perform dimensional analysis and apply concept of similitude for testing of engineering models.

COURSE DETAILS

Fluid Properties
Concept of continuum, mass & weight density, specific volume and gravity, capillarity, surface tension, viscosity, Newton's Law of viscosity, shear stress in fluids, Newtonian, Non-Newtonian, Ideal Fluids.

Fluid-Statics
Pressure at a point, Pascal's law, absolute, gauge and vacuum pressure, pressure head and piezometric head, measurement of pressure, manometers, U-tube, differential U-tube, inverted U-tube manometers, pressure on plane & curved surfaces, buoyancy, stability of floating bodies, metacenter.

Fluid Kinematics
Fluid motion, types of flows, fluid velocity & acceleration, stream lines, path lines, streak lines, stream tubes, concept of control volume, continuity equation, rotational & irrotational motion, stream function & velocity potential function, potential flow.

Fluid Dynamics
Euler's equation of motion, Bernoulli's equation from Euler's equation, application of Bernoulli's energy equation, pitot tube, venturimeter, orifice meter, momentum principle, application of momentum equation on pipe bend.

Turbulent Flow
Frictional loss in pipes, Darcy-Weisbach formula, friction factor.

Pipe Flow
Major loss of energy in pipes due to fluid friction, minor losses in pipes, loss of head due to sudden expansion, sudden contraction, and loss in fitting etc. determination of TEL and HGL in a pipe flow, pipe network solution using Hardy-Cross Method.

Boundary Layer Flow
Concepts of boundary layer flows, laminar and turbulent boundary layers, boundary Layer thickness, displacement thickness, momentum thickness and energy thickness.

Dimensional and Model Analysis
Dimensions, physical Quantities in fluid flow, dimensionally homogeneous equations, methods of dimensional analysis, Buckingham's Π Theorem, model analysis, similitude, types of forces acting in moving fluid, dimensionless numbers, model laws or similarity laws.

Textbooks

1. Frank M. White, Fluid Mechanics, Tata McGraw-Hill Publication, 9th Edition, 2022.
2. R.K. Bansal, A Textbook of Fluid Mechanics & Hydraulic Machines. Laxmi Publications (P) Ltd., 10th Edition.

Reference Books

1. V.L. Streeter, E.B. Wylie and K.M. Bedford, Fluid Mechanics, Tata McGraw-Hill Publication, 9th Edition.
2. P.N. Modi and S.M. Seth. Hydraulics and Fluid Mechanics including Hydraulics Machines, 22nd Edition, Standard Book Trust, ISBN-13: 9788189401269.
3. Sukumar Pati, Fluid Mechanics & Hydraulic Machines, Tata McGraw-Hill Publication, 1st Edition.

WATER RESOURCES ENGINEERING

Course Code: CE21002
Credit: 4
L-T-P: 3-1-0
Prerequisite: Fluid Mechanics (CE21001)

COURSE OBJECTIVE

To learn the mechanism of hydrologic cycle, precipitation, abstraction from precipitation, runoff process, hydrographs, reservoir capacity, concept of free surface flow, specific energy, critical depth, uniform flow applications, various aspects of canal irrigation system, diversion head works, seepage analysis in permeable foundation, stability analysis of gravity dams and seepage analysis in earth dams.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Undertake hydrological analysis of rainfall and abstractions,
CO 2: Estimate runoff using different methods, prepare FDC and fix the capacity of reservoirs,
CO 3: Develop hydrographs and derive unit hydrographs,
CO 4: Compute specific energy, critical depth, and demonstrate applications of uniform flow,
CO 5: Estimate design discharge, design regime canals, seepage forces in permeable foundation, and
CO 6: Compute forces acting on gravity dams; perform stability analysis of gravity dam, and seepage analysis in earth dams.

COURSE DETAILS

Precipitation
Hydrologic cycle, water-budget equation, precipitation, measurements, consistency analysis, optimum rain gauge network, mean precipitation, DAD Curves and frequency of point rainfall.

Abstractions from Precipitation
Evaporation, evaporimeters, infiltration-process, measurement, infiltration models, infiltration indices.

Runoff
Catchment and stream characteristics, yield of catchment, runoff estimation, rainfall-runoff relationship, NRCS-CN method.

Reservoirs

Flow duration curve, fixing of reservoir capacity.

Hydrograph
Factors affecting shape of hydrograph, components, base flow, effective rainfall, unit hydrograph, derivation, method of superposition and S-curve

Free surface flow
Types of flow, classification of flows, Energy-Depth Relationship, Energy equation, specific energy, critical depth, Uniform flow, Chezy's & Manning's formulae, uniform flow problems, most economical section of channels (Rectangular & Trapezoidal).

Canal Irrigation System
Soil water relationship, delta and duty, classification of canals, alignment, estimation of design discharge, design of regime channel using Kennedy's Theory & Lacey's theory.

Diversion Head Works
Concept of weir and barrage, layout of diversion heads works and its components, Theory of seepage, Bligh's creep theory, Lanes weighted creep theory, Khosla's theory on permeable foundation and its applications.

Dams
Classification, site selection and economic height of dam, Forces acting on gravity dam, modes of failure and criteria for structural stability of gravity dam, stability analysis, elementary profile of gravity dam, high and low gravity dam, earth dams, types, failure aspects, seepage analysis in earth dams.

Textbooks

1. S.K. Garg, Water Resources Engineering, Vol. 2, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 36th Edition, 2020.
2. K. Subramanya, Engineering Hydrology, McGraw Hill, 5th Edition, 2021.

Reference Books

1. V.T. Chow, D.R. Maidment and L.W. Mays, Applied Hydrology, Tata Mc. Graw Hill, 1st Ed., 1st Indian Reprint 2010.
2. L.W. Mays, Water Resources Engineering, Wiley Publication, 2nd Edition, 1st Indian Reprint 2001.
3. B.C. Punmia, Pande B.B. Lal, A.K. Jain and A.K. Jain, Irrigation and Water Power Engineering Laxmi Publishers, 16th Edition, 2009.
4. IS 5477 (1-4): Methods of fixing the capacities of reservoirs.
5. IS 6512: Criteria for design of solid gravity dam.
6. IS 7894: Code of practice for stability analysis of earth dams.

STRUCTURAL ANALYSIS

Course Code: **CE21004**
Credit: **4**
L-T-P: **3-1-0**
Prerequisite: **Solid Mechanics (CE20001)**

COURSE OBJECTIVE

This course provides the knowledge to analyze different types of structural members like determinate and indeterminate beams, plane and space truss, two hinge arches and suspension cables for the slope, deflection and internal forces.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Select appropriate methods to determine slope and deflection of determinate and indeterminate beams and frames,
CO 2: Analyze plane and space truss,
CO 3: Draw Influence line diagrams and determine absolute maximum internal forces for rolling or moving loads,
CO 4: Determine the degree of static and kinematics indeterminacy of various types of structure and selection of method of analysis,
CO 5: Determine the internal force components of beams and frames using slope deflection & moment distribution methods, and
CO 6: Analyze three & two hinged arches and suspension cables.

COURSE DETAILS

Introduction
Definition of determinate and indeterminate structures, Analysis Methods.

Slope and Deflection of Beams
Double integration method. Macaulay's method. Moment area method, Conjugate beam method, Virtual work (Unit Load) method, Strain energy method. Castigliano's theorems of strain energy. Maxwell's and Betti's reciprocal theorem.

Analysis of Trusses
Definition of truss and determination of member forces in a determinate truss by method of joints and sections.

Influence Lines and Rolling Loads
Definition of Influence Line. Influence Line at a particular section of a cantilever beam, simply supported beam or over hanging beam for shear force and bending moment. Position of UDL load for maximum S.F and B.M. Absolute maximum S.F and B.M due to moving loads.

Analysis of Redundant Structures
Determine static and kinematic indeterminacy of 2D and 3D structures. Consistent deformation method / Force method: Propped cantilever beam. Fixed beam, Continues beam by Theorem of three moments.

Slope Deflection Method
Analysis of beams and frames in 2D.

Moment Distribution Method
Analysis of beams and frames in 2D.

Arches and Cables

Analysis of two and three hinged parabolic arches. Analysis of cables, Suspension bridge with two- and three-hinged stiffened girders.

Textbooks

1. G.S. Pandit, S.P. Gupta and R. Gupta, Theory of Structures Volume I and II, McGraw Hill Education, 2017, ISBN-10: 9780074634936.
2. G.S. Pandit, S.P. Gupta and R. Gupta, Theory of Structures Volume II, McGraw Hill Education, 2017, ISBN-10: 0074634984.
3. S. Ramamrutham and R. Narayanan, Theory of Structures, Dhanpat Rai Publishing Company Pvt Ltd, 2017, ISBN-10: 9789352164752.

Reference Books

1. R.C. Hibbeler, Structural Analysis, Pearson, 2019, ISBN: 1292247134,9781292247137.
2. V.N. Vazirani, M.M. Ratwani and S.K. Duggal, Analysis of Structures, Vol. I and Vol. II, Khanna Publisher, New Delhi, 1994.
3. S.S. Bhavikatti, Structural Analysis Vol. I and Vol. II, Vikas Publishing House Pvt, New Delhi, 4th Edition, 2013.

BUILDING DRAWING, ESTIMATION & COSTING

Course Code: **CE28001**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enrich the basic knowledge of engineering students to develop building drawings. The course will also give students exposure about quantity estimation and costing of the building.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Prepare the layout plan, elevation of building,
CO 2: Explain the building drawings and details,
CO 3: Comprehend the basic concept of estimation and its application in real construction projects,
CO 4: Prepare bill of quantities,
CO 5: Analyze the rates of individual items for the preparation of the estimates, and
CO 6: Prepare specifications of construction materials and items.

COURSE DETAILS

Building Drawing
Construction Standards and drawing techniques in projects. Introduction to basic principles of Computer-Aided Design (CAD), Orthographic projection including sectional views of buildings and parts of buildings and building details, e.g. foundations, walls (including openings), jambs, sills, lintels and arches, floors and roofs, doors and windows, simple stairs. Preparation of simple working drawings and details from free-hand sketches.

Estimation
Estimation, units, item work, different kinds of estimates, different methods of estimation, estimation of materials in building, with different sections of walls, foundation. Bar Bending Schedule, Estimation of finishing works.

Rate analysis
Procedure of rate analysis for items - Earth work, concrete works, R.C.C works, reinforced brick work, plastering.

Specification of Works
Necessity of specification types of specification, general specification, specification of bricks, cement, sand, reinforcement, detailed specification for earthwork, cement, concrete, brickwork, flooring, D.P.C, R.C.C, cement plastering, white and colour washing, distempering, painting.

Textbooks

1. B.N. Dutta, Estimating and Costing in Civil Engineering – Theory & Practice, CBS Publishers & Distributors Pvt Ltd, 28th Edition, 2020.
2. M. Chakraborty, Estimating & Costing, Specification and Valuation in Civil Engineering, Chakraborty, 29th Edition, 2006, ISBN-10: 818530436X.

Reference Book

1. B.S. Patil, Civil Engineering Contracts and Estimates, Universities Press, 3rd Edition, 2006, ISBN-10: 8173715599.

WATER SUPPLY, SEWERAGE & URBAN DRAINAGE DESIGN

Course Code: **CE28002**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enable the students to design systems for water supply, sewerage and urban drainage.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Estimate the water demand for a particular area and design transmission main for transportation of water,
CO 2: Select pump for transportation of water at a particular head and discharge,
CO 3: Estimate capacity of service reservoirs for Storage and supplying of treated water to individual households,
CO 4: Design water distribution network for supplying water to individual households,
CO 5: Design sanitary and stormwater sewers, and
CO 6: Select proper sewer appurtenances.

COURSE DETAILS

Water Supply Engineering

- General requirement of water supply, sources of water supply, Estimation of water demand
- Pumps for transportation of water, selection of pumps
- Types of Service Reservoirs, Estimation of capacity of Service Reservoirs
- Types of Water distribution system, designing of water distribution system

Wastewater Engineering

- Generation and collection of wastewaters; sanitary, storm and combined sewerage systems.
- Estimation of quantities of sewage and storm water
- Design of sanitary sewer
- Design of stormwater sewer
- Sewer Appurtenances

Textbooks

1. S.K. Garg, Environmental Engineering (Vol. I) Water Supply Engineering, Khanna Publishers, 35th Edition, ISBN-13: 978-81-7409-120-8.
2. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 41st Edition, ISBN-13: 978-81-7409-230-4.
3. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, ISBN-13: 978-9351340263.
4. CPHEEO, Manual on sewerage and sewage treatment, Ministry of Urban Development, GoI, New Delhi, 2013.
5. CPHEEO, Manual on storm water drainage systems, Ministry of Urban Development, GoI, New Delhi, 2019.
6. CPHEEO, Manual on water supply and treatment, Ministry of Urban Development, GoI, New Delhi, 1999.

Reference Books

1. M.L. Davis & D.A. Cornwell, Introduction to Environmental Engineering, 4th Edition, Tata McGraw Hill, 2010.
2. Metcalf & Eddy, Inc., Wastewater Engineering: Treatment and Reuse, Tata McGraw- Hill, 5th Edition, New Delhi, 2013.

GIS & GPS APPLICATIONS

Course Code: **CE28003**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of the course is to understand the GIS principles, applications, preparation of study maps, creation of interpolation maps, delineation of watershed, explain the functions of GPS and operation of GPS.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain the fundamentals of GIS,
CO 2: Comprehend the operations of ArcGIS tools and prepare the layout of study area,
CO 3: Create interpolation maps,
CO 4: Delineate watershed using ArcGIS,
CO 5: Describe the principles and functions of GPS, and
CO 6: Operate GPS in the field for navigation.

COURSE DETAILS

- Overview of Geographic Information System (GIS)
- Familiarization to ArcGIS Interface
- Layout of study area
- Preparation of interpolation map
- Watershed delineation
- Remote sensing satellites
- Basics of Global position system
- Basic operations of GPS Handset
- GPS field surveying and data processing

Reference Books

1. Principles of geographical information systems by P.A. Burrough and R. A. McDonnell, Oxford University Press, UK.
2. Geographic information systems and science by M.F. Goodchild, P.A. Longley, D.J. Maguire and D.W. Rhind, John Wiley & Sons Ltd., England.
3. Global Positioning system: Principles and Applications by Satheesh Gopi, McGraw Hill Education.

ENVIRONMENTAL QUALITY ANALYSIS LABORATORY

Course Code: **CE29001**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enable the students to determine the physical, chemical and biological characteristics of water and wastewater and assess the noise pollution at a particular place.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Determine pH, turbidity and different types of solids present in a water sample,
CO 2: Determine alkalinity, hardness and chlorides present in a water sample,
CO 3: Fix optimum dosage of coagulant needed for a water sample by Jar Test,
CO 4: Determine dissolved oxygen, BOD and COD present in a water sample,
CO 5: Assess the bacteriological quality of water sample using MPN Technique, and

CO 6: Assess the noise pollution at a particular place.

COURSE DETAILS

- Introduction to various physical, chemical and biological parameters of water and wastewater and their significances as per the IS Codes and CPCB Standards
- Determination of pH and turbidity of water sample
- Determination of Total Suspended Solids, Total Dissolved Solids and Total Solids present in water sample
- Determination of Total Alkalinity of water sample
- Determination of Total Hardness of water sample
- Determination of concentration of chlorides in water sample
- Determination of Optimum coagulant dosage based on the solids present
- Determination of dissolved oxygen and BOD in a water sample
- Assessment of bacteriological quality using MPN Technique
- Assessment of Noise Pollution using Sound Level Meter

Textbooks

1. IS: 3025 – 2019, Methods of sampling and test (Physical and Chemical) for water and wastewater.
2. IS: 10500 – 2012 Indian Standard Drinking Water — Specification.
3. S.K. Garg, Environmental Engineering (Vol. I) Water Supply Engineering, Khanna Publishers, 36th Edition, 2022, ISBN-13: 978-81-7409-120-8.

Reference Book

1. C.N. Sawyer and Perry L. McCarty, Chemistry for Environmental Engineering, 5th Edition, McGraw-Hill Education, 2002, ISBN-10: 0072480661.

FLUID MECHANICS LABORATORY

Course Code: **CE29002**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Fluid Mechanics (CE21001)**

COURSE OBJECTIVE

To learn about the principle of buoyancy & metacentre, flow kinematics, dynamics, flow measuring devices and also explain about various losses in pipes.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Determine the metacentric height of floating body,
CO 2: Identify the different regimes of flow using Reynold's apparatus,
CO 3: Verify Bernoulli's theorem,
CO 4: Compute the coefficient of discharge of venturimeter, orificemeter & notches,
CO 5: Estimate major and minor losses through pipes, and
CO 6: Verify the impulse-momentum principle.

COURSE DETAILS

- Determination of Metacentric height of a floating body
- Determination of different regimes of flow by Reynold's apparatus
- Verification of Bernoulli's theorem
- Determination of Coefficient of Discharge (C_d) of Venturi meter
- Determination of Coefficient of discharge (C_d) of Orifice meter
- Determination of hydraulic coefficients (C_c, C_v, C_d) of Circular Orifice
- Determination of Coefficient of Discharge (C_d) of Triangular Notch
- Determination of Coefficient of Discharge (C_d) of Rectangular Notch
- Determination of Darcy's friction factor for different pipes
- Determination of Minor losses in pipes
- Verification of impulse momentum principle for impact of Jet on vane
- Operation & Demonstration of Turbines

Reference Books

1. Hydraulics and Water resources Engg. Laboratory Manual, School of Civil Engineering, KIIT Deemed to be University, Bhubaneswar.
2. R. K. Bansal, A Textbook of Fluid Mechanics & Hydraulic Machines, Laxmi Publications (P) Ltd., 10th Edition.

MATERIAL TESTING LABORATORY

Course Code: **CE29003**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course has been prescribed to enhance the understanding of the behaviour of basic construction materials like cement, sand, brick and concrete and their optimum usage and quality control in construction and field application.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Test and analyze significant physical properties of OP Cement,
CO 2: Test and analyze significant mechanical properties of OP Cement,
CO 3: Test and determine absorption and strength properties of standard clay brick,
CO 4: Test and analyze significant physical property of fine aggregate/natural sand,
CO 5: Test and learn significant fresh property of normal concrete, and
CO 6: Test and learn significant hardened property of normal concrete.

COURSE DETAILS

- Fineness of cement by Sieve analysis (IS 4031, Part-1:1988)
- Specific gravity of cement (IS 4031, Part-11:1988)

- Consistency and Setting times of cement (IS 4031, Part-4:1988)
- Soundness of cement (IS 4031, Part-3:1988)
- Compressive strength of cement (IS 4031, Part-6:1988)
- Water absorption of brick (IS 3495, Part-2:1992)
- Compressive strength of brick (IS 3495, Part-3:1992)
- Fineness modulus of sand (IS 383, 2016)
- Water absorption and Bulking of sand (IS: 2386, Part-3:1963)
- Workability of concrete (IS: 7320-1974)
- Compressive strength of concrete (IS: 516 - 1959)

Textbook

1. Concrete Technology: Theory and Practice by M S Shetty, S Chand & Company, 8th Edition, 2018.

Reference Books

1. Material Testing Laboratory Manual, School of Civil Engineering, KIIT Deemed to be University, Bhubaneswar.
2. BIS Codes: IS 4031, Part-1, 3, 4, 6 and11:1988; IS 3495, Part-2 & 3: 1992; IS: 2386, Part-3:1963; IS: 7320-1974 and IS: 516 – 1959.

SOIL MECHANICS LABORATORY

Course Code: **CE29004**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

This laboratory encompasses basic tests to ascertain soil properties like Atterberg limits, in-situ density, specific gravity, permeability, determination of soil's consolidation parameters, determination moisture content and dry density relationship and shear strength parameters of soil using direct shear, Uunconfined shear, vane shear and triaxial shear method.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the types of soil,
CO 2: Determine the change in properties of soil with the water content,
CO 3: Learn various laboratory test procedures normally used in geotechnical engineering,
CO 4: Determine index and shear strength properties of soils,
CO 5: Determine hydraulic properties of soils, and
CO 6: Determine compaction and consolidation properties of soils.

COURSE DETAILS

- Introduction to different types of soil, soil-water interaction, various soil properties and their test methods
- Determination of Specific Gravity of soil by pycnometer test
- Grain size Analysis (Dry and Wet sieving method)
- Determination of Atterberg Limit
- Determination of Dry Density of Soils in place by the core-cutter and sand replacement method
- Determination of Permeability of soil (falling head or constant head method)
- Determination of relative density of soil
- Determination of compaction property of soil
- Determination of shear parameters by direct shear test
- Determination of shear parameters by unconfined compression test
- Determination of shear parameters by triaxial (unconsolidated undrained) shear test
- Determination of consolidation and creep parameters of soil
- Consolidated drained triaxial test
- Consolidated undrained triaxial test
- Plate load test
- Hydrometer test
- Field stiffness measurement

Textbook

1. B.C. Punmia, Ashok K. Jain & Arun Kumar Jain, Soil Mechanics & Foundation Engineering., Laxmi Publication, New Delhi, 17th Edition, 2017.

Reference Books

1. Geotechnical Engineering Laboratory Manual, School of Civil Engineering, KIIT Deemed to be University Bhubaneswar.
2. IS: 2720 (Part 2) (1973). Methods of test for soils: Laboratory determination of Water Content.
3. IS: 2720 (Part 3) (1980). Methods of test for soils: Laboratory determination of Specific Gravity.
4. IS: 2720 (Part 4) (1985). Methods of test for soils: Grain size Analysis.
5. IS: 2720 (Part 5) (1985). Methods of test for soils: Laboratory determination of Liquid Limit and Plastic Limit.
6. IS: 2720 (Part 29) (1975). Methods of test for soils: Determination of Dry Density of Soils in place by the core-cutter method.
7. IS: 2720 (Part 28) (1974). Methods of test for soils: Determination of Dry Density of Soils in-place by the sand-replacement method.
8. IS: 2720 (PART-17) (1986). Methods of test for soils: Determination of Permeability of soil.
9. IS: 2720 (PART-14) (1983). Methods of test for soils: Determination of relative density of soil.
10. IS:2720 (PART-7) (1980). Methods of test for soils: Determination of compaction property of soil.
11. IS: 2720 (PART-13) (1986). Methods of test for soils: Determination of shear parameters by direct shear test.
12. IS: 2720 (PART-13) (1991). Methods of test for soils: Determination of shear parameters by unconfined compression test.
13. IS: 2720 (PART-11) (1993). Methods of test for soils: Determination of shear parameters by triaxial shear test.
14. IS: 2720 (PART-30) (1980). Methods of test for soils: Determination of shear parameters by direct shear method.
15. IS: 2720 (PART-15) (1965). Methods of test for soils: Determination of consolidation property of soil.

SURVEYING FIELD WORK

Course Code: **CE29006**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course will enable the students to perform field survey works such as (i) Closed traversing using chain and prismatic compass, (ii) Fly leveling (iii) Longitudinal and cross-sectional profile making using auto level (iii) Plotting of contour map (iv) Theodolite survey (v) Plotting of road profile using total station and (vi) Preparation of the maps using GPS.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Apply the basic principles of surveying to carry out a closed traversing survey using a metric chain, prismatic compass and plane table,
CO 2: Apply the knowledge of levelling in making roads and buildings using Auto level,
CO 3: Prepare a contour map of a locality,
CO 4: Perform layout of horizontal and vertical angles using Transit theodolite and determine horizontal distance using a Tacheometer,
CO 5: Prepare Road profile using a Total station, and
CO 6: Prepare a map using GPS.

COURSE DETAILS

- Study of conventional signs of survey
- Closed traversing using Metric chain
- Closed traversing using a Prismatic compass
- Fly leveling by Auto level
- Profile and cross-sectional leveling by auto level
- Plotting of a contour map of an area by using the direct method
- Determination of horizontal and vertical angles by using Transit theodolite
- Determination of tacheometric constants and horizontal distance using a Tacheometer
- Preparation of road profiles using a Total station
- Handling of GPS and determination of generics (Point generic, line generic, area generic)

Textbook

1. B.C. Punmia, Er. Ashok K. Jain, Dr. Arun K. Jain, Surveying Volume I, Laxmi Publication (P) Ltd., New Delhi.18th Edition, 2023, ISBN: 9788170088530.

Reference Books

1. R. Agor, A Textbook of Surveying and Levelling, Khanna Publishers, New Delhi, ISBN 9788174092359.
2. Surveying & Geomatics Laboratory Manual, School of Civil Engineering, KIIT Deemed to be University, Bhubaneswar.

CONCRETE STRUCTURE DESIGN

Course Code: **CE30001**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Solid Mechanics (CE20001), Structural Analysis (CE21004)**

COURSE OBJECTIVE

In this course, design of different components of a R.C.C Building like slab, beam, column, footing and staircase using limit states method will be covered.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend the basic concepts of working stress and limit state methods and determine the moment of resistance as per limit state methods,
CO 2: Design of reinforced concrete beams (flexure & torsion) at various support conditions as per Limit state design,
CO 3: Design reinforced concrete slabs (one-way and two-way) for different loadings as per Limit state design,
CO 4: Design staircases for different support conditions as per Limit state design,
CO 5: Design different types of reinforced concrete compression members as per Limit state design, and
CO 6: Design different types of footings as per Limit state design.

COURSE DETAILS

Introduction
Materials, Basic properties of concrete and reinforcement, Basic working stress and limit state design concepts.

Analysis & Design of R.C. Beams
Analysis of singly-doubly reinforced sections, flanged sections, Design of simply supported subjected to flexure, shear and torsion by limit state methods.

Design of Slabs
Design of one-way and two-way slab (simply supported & restrained) by limit state methods.

Design of staircases
Different components of Staircase, Design Of dog-legged staircase by limit state methods.

Design of column
Design of short Column with axial load, uniaxial & biaxial moment by limit state methods.

Design of Footing
Design of isolated footing (square and rectangular) by limit state methods.

Textbooks

1. S.U. Pillai and D. Menon, Design of Concrete Structures, McGraw Hill Education, 3rd Edition, 2017, ISBN-10: 007014110X.
2. A. K. Jain, Reinforced Concrete Limit State Design, Nem Chand & Bros, 7th Edition, 2012, ISBN-10: 9788185240664.

Reference Books

1. S. Ramamrutham, Design of Reinforced Concrete Structures, Dhanpat Rai Publishing Company Pvt Ltd, 2016, ISBN-10: 9352161327.
2. P.C. Varghese, Limit State Design of Reinforced Concrete, Prentice Hall India Pvt Ltd, 2nd Edition, 2008, ISBN-10: 8120320395.

STEEL STRUCTURE DESIGN

Course Code: **CE30004**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Structural Analysis (CE21004)**

COURSE OBJECTIVE

In this course, the designing of different components of steel structure as per limit state method and analysis of beams and frames using plastic theory will be covered.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Design different types of connections (bolted & welded) as per Limit State Design,
CO 2: Design different types of steel structural members for axial tension as per Limit State Design,
CO 3: Design different types of steel structural members for axial compression as per Limit State Design,
CO 4: Analyze beams and frames using plastic theory,
CO 5: Design different types of beams as per Limit State Design, and
CO 6: Design beam-column and select appropriate column bases for steel columns.

COURSE DETAILS

Introduction
Properties of structural steel, IS rolled section.

Connections
Simple and moment resistant bolted and welded connections.

Tension members
Design of tension members.

Compression members
Design of compression members, single angle, column with cover plate, lacings and battens.

Plastic analysis
Plastic analysis of beams and frames.

Beams
Design of laterally supported and unsupported beam.
Beam-column
Design of beam-column.

Column bases
Design of slab base, gusseted base, and grillage footing.

Textbooks

1. S.K. Duggal, Limit State Design of Steel Structures, Mc Graw Hill Education, 3rd Edition, 2019, ISBN-10: 9353164877.
2. N. Subramanian, Design of Steel Structures – Limit States Method, Oxford University Press, 2018, ISBN-10: 9780199460915.

Reference Books

1. S.S. Bhavikatti, Design of Steel Structures by Limit State Method as per IS 800-2007, I.K International Publishing House Pvt. Ltd., 5th Edition 2019.
2. S. Ramchandra and V. Gehlot, Design of Steel Structures-1, Scientific Publishers (India) 13th Edition, 2019.

FOUNDATION ENGINEERING

Course Code: CE30003
Credit: 3
L-T-P: 3-0-0
Prerequisites: Soil Mechanics (CE20002)

COURSE OBJECTIVE

The objective of this course is to introduce the students on the principles and practices of foundation engineering, The course will teach basic concept and geotechnical practices normally used in stress distribution in soil mass, shallow foundation, pile foundation, retaining wall and stability analysis of finite and infinite slopes.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Determine the vertical stress distribution below the ground surface,
CO 2: Select suitable foundation type based on soil strata and foundation load,
CO 3: Evaluate the bearing capacity of a shallow foundations,
CO 4: Determine the load carrying capacity of pile foundations,
CO 5: Determine type of earth pressures behind retaining structures, the intensity of earth pressure and distribution of earth pressure, and
CO 6: Evaluate the stability of finite and infinite slope.

COURSE DETAILS

Stress Distribution
Introduction, Boussinesq's Equation, stress distribution by a concentrated load, stress distribution by a uniformly loaded circular area, stress distribution by a uniformly loaded rectangular area, stress distribution by an embankment load, stress Isobar, equivalent point load method, stress distribution under rigid and flexible pavement, field application of stress distribution in settlement analysis.

Bearing Capacity of Shallow Foundations
Introduction, Rankine's analysis for cohesion less soils, Selection of type of foundations, Terzaghi's bearing capacity equation for strip and isolated footings, effect of water table on bearing capacity of soil , eccentrically loaded footing, discus IS 6403: 1981 method to determine bearing capacity using laboratory test data and SPT data, plate load test, selection of depth of foundation, selection of factor of safety, best practices on foundation as per IS 1904:1986 and National Building Code (2016).

Pile Foundations
Classification of piles, Load carrying capacity of piles by dynamic formula, Load carrying capacity of piles by static formula for sand and clay , Group action of piles, Negative skin friction and drag load, uplift capacity of group of piles.

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

Stability of Slopes
Introduction, Infinite and finite slope, Stability of infinite slopes, Swedish, slice method and Bishop's simplified method of slice, stability of homogeneous finite earth slopes without surcharge with steady seepage and under sudden drawdown condition.

Textbooks

1. P.C. Varghese, Foundation Engineering - Geotechnical Aspects, PHI Learning Pvt. Ltd, 2014.
2. B.M. Das, Principles of Foundation Engineering, Cengage India Pvt. Ltd, New Delhi, 8th Edition, 2017, ISBN-10: 9386650959.

Reference Books

1. Joseph E. Bowles. Foundation analysis and design, McGraw-Hill Education, 5th edition, 2000, ISBN-10: 0071188444.
2. Gopal Ranjan and A.S.R. Rao, Basic and Applied Soil Mechanics, New Age international Pvt. Ltd., 3rd Edition, 2016, ISBN-10: 8122440398.
3. K.R. Arora, Soil Mechanics and Foundation Engineering, Standard Publisher, 2020, ISBN-10: 8180141128.
4. V.N.S. Murthy, Textbook of Soil Mechanics and Foundation Engineering, CBS, 2018, ISBN-10: 8123913621.

GREEN BUILDING

Course Code: **CE30021**
Credit: **3**
L-T-P: **3-0-0**

Prerequisites: Nil

COURSE OBJECTIVE

This course is designed to enable the students to understand and appreciate the importance of green buildings, learn about different rating systems available around the globe and design a green building considering IGBC rating system.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain necessity and role of green buildings and different green building rating systems,
CO 2: Apply site selection & planning and water conservation concept of green building,
CO 3: Select appropriate material suitable for green building from local resources,
CO 4: Apply energy efficiency and passive solar design concept of green building,
CO 5: Identify factors affecting Indoor Environmental Quality, and
CO 6: Design a green building considering environment and economical aspects.

COURSE DETAILS

Introduction to Green Buildings
Definition of Green Buildings, requirement of Green Building, Benefits of Green Buildings, Requisites for Constructing a Green Building.

Green Building Rating systems
Indian Green Building Council (IGBC), GRIHA, USGBC, LEED rating system, overview of the criteria as per these rating systems, procedure to get IGBC certification.

Site selection and planning
Criteria for site selection, site development and layout, preservation of landscape, soil erosion control, minimizing urban heat island effect.

Water conservation and efficiency
Watershed protection, drainage of concentrated Runoff, water efficiency and conservation, rain water harvesting, water reclamation, water efficient plumbing systems, water metering, waste water treatment, recycle and reuse systems.

Sustainable materials
Reduce / Reuse / Recycle, Natural Sources, concrete, masonry, metals, wood and plastic, finishes.

Energy Efficiency
Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy. Methods to reduce operational energy: Energy efficient building envelopes, Passive solar design, Day lighting, efficient lighting technologies, zero ozone depleting potential (ODP) materials, Renewable energy, energy metering and monitoring, concept of net zero buildings.

Indoor Environmental Quality
Significance, design principle, ventilation control, occupant activity control, significance of acoustics.

Societal aspects of Green Building
Economics of green buildings, Selecting environmentally and economically balanced building materials, Project cost, Income and expenses.

Textbooks

1. R.K. Gautham, Green homes, BS publications, 2009, ISBN-10: 817800173X.
2. Public Technology Inc., US Green Building Council, Sustainable building technical manual- green building design, constructions and operation.
3. Indian Green Building Council (IGBC), IGBC Green new buildings rating system Version 3.0 – A bridged reference guide 2016.

Reference Books

1. Tree Hugger Consulting, Green Building- a Basic Guide to Building and Remodeling Sustainably
2. GRIHA version 2015, GRIHA rating system, Green Rating for Integrated Habitat Assessment.

CONSTRUCTION FINANCE MANAGEMENT

Course Code: CE30022
Credit: 3
L-T-P: 3-0-0
Prerequisites: Nil

COURSE OBJECTIVE

The course attempts to give student understanding of economics and finance in managing construction projects. It is aimed to make student capable to analyze and understand income statement and balance sheet of the companies. Students are given exposure on different financial analysis method to make decision making easy for the management. Different analytical methods are taught to understand student the effect of finance in construction projects.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain accounting method & learn to analyze financial statements in construction projects,
CO 2: Choose best alternatives for financial investments and assess financial health of organization in a given environment,
CO 3: Apply the concept of depreciation, taxation, and inflation for any construction project,
CO 4: Explain capital budgeting and working capital management parameters, risks,
CO 5: Explain the cost elements associated with the contract bidding and tendering, and
CO 6: Perform the detailed financial analysis of sample construction projects data.

COURSE DETAILS

Construction accounting
Construction accounting methods, Profit & Loss, Balance sheet, Income statement, Ratio analysis.

Decision making methods
Depreciation, Engineering economics, time value of money, discounted cash flow, NPV, ROR, PI, comparison, incremental rate of return, benefit-cost analysis, replacement analysis, break even analysis, risks and un-certainties, Management decision in capital budgeting, taxation and inflation, project cash flow.

Work pricing
Work pricing, cost elements of contract bidding and award, revision due to unforeseen causes, escalation, working capital management finance.

Budget planning and control
Budgeting and budgetary control, Performance budgeting appraisal through financial statements.

Case studies
Practical problems and case studies.

Textbooks

1. R. Pannerselvam, Engineering Economics, P.H.I, N.D. 2012.
2. J.L. Riggs, Engineering Economics, McGraw Hill, 1976.

Reference Books

1. U. K. Shrivastava, Construction Planning & Management, Galgotia N.D, 2012.
2. Prasanna Chandra, Project Planning, Analysis, Selection, Implementation & Review, Tata McGraw Hill Publishing Co Ltd, 2010.
3. B.P. Singh and J.N Chhabra, Essentials of Management, South Western College Publishing-1991.
4. B. Sengupta and H. Guha, Construction Management and Planning, Tata Mc Graw Hill, ND 1995.
5. Pilcher, Principle of Construction Management, McGraw Hill, 1981.

MATRIX METHODS OF STRUCTURAL ANALYSIS

Course Code: **CE30023**
Credit: **3**
L-T-P: **3-0-0**
Prerequisites: **Structural Analysis (CE21004)**

COURSE OBJECTIVE

Analysis of determinate and indeterminate structural systems using matrix method.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain the applications of matrix in structural analysis,
CO 2: Develop flexibility matrix,
CO 3: Analyze indeterminate beams using flexibility matrix method,
CO 4: Develop stiffness matrix,
CO 5: Analyze truss, beams and frames using stiffness matrix method and
CO 6: Analyze truss, beams and frames using direct stiffness matrix method.

COURSE DETAILS

Introduction
Matrix algebra, basic concepts of structural analysis.

Flexibility matrix method
Introduction to flexibility approach, derivation of flexibility matrix for bar and beam structures, analysis of indeterminate beams using flexibility matrix method.

Stiffness matrix method
Introduction to stiffness approach, derivation of stiffness matrix for bar, truss, beam, and frame structures, analysis of determinate and indeterminate structures using stiffness matrix method.

Direct stiffness method
Use of direct stiffness method for analysis of bar, truss, beam, and frame structures of determinate and indeterminate ones.

Textbooks

1. G.S. Pandit and S. P. Gupta, Structural Analysis: A Matrix Approach, McGraw-Hill Education, 2nd Edition, 2008, ISBN-10: 0070667357.
2. C.K. Wang, Intermediate Structural Analysis, McGraw Hill Education, 1st Edition, 2017, ISBN-10: 0070702497.

Reference Books

1. M.F. Rubinstein, Matrix Computer Analysis of Structures, Prentice Hall, 1st Edition, 1966, ISBN-10: 0135654815.
2. H.C. Martin, Introduction to Matrix Methods of Structural Analysis, McGraw-Hill Inc, 1966, ISBN-10: 0070406332.
3. M.B. Kanchi, Matrix Methods of Structural Analysis, New Age International Pvt. Ltd., 2016, ISBN-10: 812244041X.

CONCRETE TECHNOLOGY

Course Code: CE30024
Credit: 3
L-T-P: 3-0-0
Prerequisite: Construction Project Management (CE20003)

COURSE OBJECTIVE

In this course, the students will be introduced to the concepts of concrete technology and procedure to determine various properties of concrete like workability, mechanical properties and design concrete mixes.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify different types of cement and its properties,
CO 2: Explain the different process to determine the workability of concrete,
CO 3: Explain the process to determine strength and durability of concrete,
CO 4: Design concrete mixes for the given conditions,
CO 5: Explain the process of destructive and non-destructive testing of hardened concrete, and
CO 6: Select types of admixtures and special concrete for given condition.

COURSE DETAILS

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

Concrete
Workability, Factors affecting workability, type of tests.

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

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

Concrete Mix design
Concept & types, example.

Destructive and non-destructive testing of hardened concrete
Admixtures.

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

Textbooks

1. M S Shetty, Concrete Technology: Theory and Practice, S Chand & Company, 8th Edition 2018.
2. A.M. Neville, Properties of concrete, Pearson Education Pvt. Ltd., New Delhi, 4th Edition, 2002.
3. M.L. Gambhir, Concrete Technology, McGraw Hill Education, New Delhi, 4th Edition, 2017.

Reference Books

1. Jimmy W. Hinze, Construction Safety, Prentice Hall Inc, 1997.
2. S. Bhavikatti, Concrete Technology, I. K. International Pvt. Ltd., 2015.

LIFE CYCLE SUSTAINABILITY ASSESSMENT

Course Code: CE30025
Credit: 3
L-T-P: 3-0-0
Prerequisites: Nil

COURSE OBJECTIVE

The course will introduce students to the fundamental concepts of Life Cycle Assessment (LCA) with reference to sustainability.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain the concepts of life cycle analysis (LCA) in the context of sustainability,
CO 2: Realize the importance of environmental risk assessment,
CO 3: Define a goal and scope statement of an LCA,
CO 4: Carry out ISO compliant LCA,
CO 5: Perform life cycle impact analysis (LCIA), and
CO 6: Design a product based on the concept of sustainability.

COURSE DETAILS

Life Cycle Analysis (LCA) and Sustainability concepts
Material flow and waste management, Concept of Sustainability, Water energy and food nexus.

Risk and Life Cycle Framework for Sustainability
Introduction, Risk, Environmental Risk Assessment.

LCA Methodology
Overview of LCA Methodology - Goal Definition, Life Cycle Inventory, Life Cycle Impact Assessment, Life Cycle Interpretation, LCA Software tools. Life Cycle Assessment – Detailed Methodology and ISO Framework, LCA Benefits and Drawbacks, Historical Development and LCA Steps from ISO Framework.

Life Cycle Inventory and Impact Assessments
Unit Processes and System Boundary Data Quality, Procedure for Life Cycle Impact Assessment, LCIA in Practice with Examples, Interpretation of LCIA Results.

Design for Sustainability
Economic, Environmental Indicators, Social Performance Indicators, Sustainable Engineering Design Principles and Environmental Cost Analysis.

Textbooks

1. H. Scott Mathews, Chris T. Hendrickson, Deanna H. Matthews, Life Cycle Assessment: quantitative approaches for decisions that matter, 2014. Open access textbook, retrieved from https://www.lcatextbook.com/ .
2. David T. Allen and David R. Shonnard, Sustainable Engineering: Concepts, Design and Case studies, Pearson, 2011, ISBN-9780132756563.

Reference Book

1. Walter Klöpffer, Birgit Grahl, Life Cycle Assessment (LCA): A Guide to Best Practice, Wiley, 2014, ISBN: 978-3-527-32986-1.

AIR & NOISE POLLUTION CONTROL

Course Code: CE30026
Credit: 3
L-T-P: 3-0-0
Prerequisite: Environmental Engineering (CE31001)

COURSE OBJECTIVE

The course is designed to enable the students to know the sources, characteristics and effects of air and noise pollution, their effects on environment and human health and the methods of controlling the same.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the sources of air pollutants, understand the effects of air pollutants on health and environment and classify the air pollutants,
CO 2: Explain the meteorological parameters and their effect on dispersion of air pollutants into the atmosphere and predict air quality based on Gaussian dispersion model,
CO 3: Learn about air quality standards and determine the air quality index,
CO 4: Adopt suitable measures for air pollution control,
CO 5: Learn about the various sources of noise pollution and its health effects, and
CO 6: Adopt suitable measures for noise pollution control.

COURSE DETAILS

Introduction to Air Pollution
Structure of the atmosphere, Natural and anthropogenic sources of pollution, Atmospheric sources, Effects of air pollution on human health, vegetation and animals, building materials and structures, atmosphere, soil and water bodies, Gaseous and particulate matter, Primary pollutants, Secondary pollutants, Criteria pollutants, Hazardous pollutants, greenhouse gases.

Meteorological parameters and Air Pollution
Lapse rates, atmospheric stability, plume behaviour, boundary layer, mixing height, stack height and Plume rise.

Air Quality Modeling and Standards
Gaussian Dispersion Model for Point Source, Line Source and Area Source, Determination of concentration of pollutants using Gaussian Dispersion Model, Assimilative Capacity of an Airshed, Air Quality Index (AQI), Air Quality Standards, Air Pollution Legislations and Regulations.

Control of Air Pollutants

- **Particulate pollutants -** Control of particulate air pollutants using gravitational settling chambers, cyclone separators, wet collectors, fabric filters (Bag-house filter), electrostatic precipitators (ESP).

- **Gaseous Pollutants -** Control of gaseous contaminants: absorption, adsorption, condensation and combustion; Control of sulfur oxides, nitrogen oxides, carbon monoxide, and hydrocarbons.

Noise pollution
Definition, Effects of noise, Levels of noise, Noise rating systems, Sources of Noise, Noise abatement and control.

Textbooks

1. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
2. Daniel Vallero, Fundamentals of Air Pollution, Academic Press, 5th Edition, 2014, ISBN: 978-0-12-401733-7.
3. Enda Murphy and Eoin A. King, Environmental Noise Pollution: Noise Mapping, Public Health, and Policy, Elsevier, 2nd Edition, 2022, ISBN: 9780128201008.

4. Wark, K., Warner, C.F., and Davis, W.T., Air Pollution: Its Origin and Control, Addison-Wesley Longman. 1998.
5. Boubel, R.W., Fox, D.L., Turner, D.B., Stern, A.C., Fundamentals of Air Pollution, Academic Press. 2005.
6. Gurjar, B.R., Molina, L., Ojha, C.S.P. (Eds.), Air Pollution: Health and Environmental Impacts, CRC Press. 2010.

Reference Books

1. Karl B. Schnelle, Jr. and Charles A. Brown, Air Pollution Control Technology Handbook, CRC Press, 1st Edition, 2001.
2. Air Pollution by Jeremy Colls, SPON Press, 2nd Edition, 2003.
3. Seinfeld, J.H., Pandis, S.N., Atmospheric Chemistry and Physics, John Wiley, 2006.

PAVEMENT MATERIAL & DESIGN

Course Code: CE30027
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The objective of pavement material and design is to provide students with a comprehensive understanding of basic characterisation of pavement materials such as subgrade soil, bound and unbound subbase and bases and bituminous mixtures, the principles and practices of pavement design.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the types and materials used in various types of pavements,
CO 2: Evaluate characteristics of subgrade soil, bound and unbound bases for design of pavement,
CO 3: Know the design of bituminous mixes,
CO 6: Explain the modern methods of testing of pavement materials,
CO 4: Explain the fundamental concepts of pavement design, including traffic loads, pavement materials, and environmental factors that impact pavement performance,
CO 5: Design flexible pavement using mechanistic-empirical methods, and
CO 6: Design rigid pavements using IRC code.

COURSE DETAILS

Introduction
Types and Component Parts of Pavements and Materials used in Pavements.

Soil Properties
Basic soil properties relevant to Pavement Applications, Resilient Modulus, Modulus of Sub-Grade Reaction.

Unbound and Bound Subbase and Base
Physical Properties of Aggregates, Grading and Blending, Resilient Modulus of Unbound subbase and base, Resilient Modulus of Bound subbase and base.

Bituminous Mixtures
Basic Properties of Bitumen, Polymer and Rubber Modified Bitumen, Testing and Evaluation, Dynamic Modulus, Flow Time and Flow Number of Bituminous Mixes.

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

Principles of Pavement Design
Concept of pavement performance, Structural and Functional failures of pavements, Different types of pavement performance criteria.

Traffic Considerations in Pavement Design
Vehicle types, Axle configurations, Contact shapes and contact stress distributions, Concept of standard axle load, Vehicle damage factor, Axle load surveys, Lateral placement characteristics of wheels, Estimation of design traffic.

Design of Flexible Pavements
Analysis of flexible and concrete pavements, analysis of layered flexible pavement systems using linear elastic layered theory. Design of flexible pavements as per Indian Roads Congress guidelines - IRC:37 (2018).

Analysis of Concrete Pavements
Types of concrete pavements, Analysis of wheel load stresses, curling/warping stresses due to temperature differential, critical stress combinations, Discussion of the need for use of advanced analytical techniques for concrete pavements. Design of flexible pavements as per Indian Roads Congress guidelines - IRC:58 (2015).

Textbook

1. P. Chakraborty and A. Das, Principles of Transportation Engineering, PHI Publication, 2nd Edition, 2017, ISBN: 978-8120353459.

Reference Books

1. G.V. Rao, Principles of Transportation and Highway Engineering, McGraw Hill Education India Pvt Ltd, 2000, ISBN: 978-0074623633.
2. N.J. Garber and L. A. Hoel, Traffic and Highway Engineering, Wadsworth Publishing Co Inc, 5th Edition, 2014, ISBN:978-1133605157.
3. R. B. Mallick and T. El-Korchi, Pavement Engineering: Principles and Practice, CRC Press, 3rd Edition, 2017, ISBN:978-1498758802.
4. S.K. Khanna and CEG Justo, A. Veeraragavan, Highway Engineering, Nem Chand & Bros., Roorkee, India, 10th Edition, ISBN: 9788185240930.
5. Relevant IRC, ASTM and AASHTO codes and specifications.

AIRPORT, RAILWAYS, PORTS & HARBOUR ENGINEERING

Course Code: CE30028
Credit: 3
L-T-P: 3-0-0

Prerequisites: Nil

COURSE OBJECTIVE

The objective of this course is to provide the students with a comprehensive understanding of the planning, design, and construction of transportation infrastructure systems such as airports, railways, ports, and harbors.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know the function of various components of permanent way,
CO 2: Understand the geometric design of railway track,
CO 3: Know the layout and planning of airport,
CO 4: Understand the geometric design of airport,
CO 5: Know the components of ports and harbours, and
CO 6: Know the principles of layout of ports and harbours.

COURSE DETAILS

Introduction to Railway Engineering
Role of Indian Railways in National Development – Railways for Urban Transportation – LRT & MRTS - Engineering Surveys for track alignment (Conventional and modern methods), Permanent way components – Cross section of Permanent Way – Function of various components like rails, sleepers and ballast, Gauge – Creep of rails – Theories related to creep – Sleeper density.

Geometric Design of Railway Track
Gradients – Grade compensation – Cant and negative super elevation – Cant deficiency – Degree of curve, Points and Crossing, Rail joints & welding of joints, Railway station & yards, Signalising & interlocking.

Airport Planning
Air transport characteristics, airport classification, airport planning: objectives, components, layout characteristics, and socio-economic characteristics of the catchment area, criteria for airport site selection and ICAO stipulations, typical airport layouts, Parking and circulation area.

Airport Design
Runway Design - Orientation, Wind Rose Diagram, Runway length, Problems on basic and Actual Length, Geometric design of runways, Configuration and Pavement Design Principles, Elements of Taxiway Design, Airport Zones, Passenger Facilities and Services, Runway and Taxiway Markings and lighting.

Port and Harbour Engineering
Definition of Basic Terms –Harbor, Port, Satellite Port, Docks, Waves and Tides, Planning and Design of Harbours – Requirements, Classification, Location and Design Principles, Harbour Layout and Terminal Facilities – Coastal Structures: Piers, Break waters, Wharves, Jetties, Quays, Spring Fenders, Dolphins and Floating Landing Stage –Inland Water Transport.

Textbooks

1. S Chandra and M. M. Agarwal, Railway Engineering, Oxford University Press India, 2nd Edition,2013, ISBN: 9780198083535.
2. S.K. Khanna, M.G. Arora and S.S. Jain, Airport Planning and Design, Nem Chand & Bros., Roorkee, India, 6th Edition, 2012, ISBN: 81-85240-68-10.
3. S.P. Bindra, A Course in Docks and Harbour Engineering, Dhanpat Rai Publishing Co Pvt. Ltd, New Delhi, ISBN: 9788189928858.

Reference Books

1. S.C. Saxena and S.P. Arora, A Textbook of Railway Engineering, Dhanpat Rai Publishing Co Pvt Ltd, 2015, ISBN: 9789383182923.
2. R.M. Horonjeff and F.X. Mckelvey, Planning and Design of Airports, McGraw-Hill Education, New York, 5th Edition, 2010, ISBN: 9780071446419.
3. R.L. de Neufville and A. R. Odoni, Airport Systems - Planning, Design and Management, McGraw-Hill Education, New York, 2nd Edition, 2013, ISBN:978-0071770583.
4. H.P. Oza and G.H. Oza, Dock & Harbour Engineering, Charotar Publishing House Pvt. Ltd., 8th Edition, 2017, ISBN: 978-9385039256.

OPEN CHANNEL HYDRAULICS

Course Code: **CE30029**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Fluid Mechanics (CE21001)**

COURSE OBJECTIVE

To learn and use the concept of free surface flow hydraulics and its applications, computation of gradually varied flow and hydraulic jump, spatially varied flow and unsteady flow phenomenon.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Analyze specific energy, critical depth and transitions, uniform flow computation,
CO 2: Solve problems on dynamics of gradually varied flow,
CO 3: Solve problems on spatially varied flow,
CO 4: Analyze rapidly varied flow calculations in open channels,
CO 5: Solve the dynamics of gradually varied unsteady flow, and
CO 6: Apply the dynamics of gradually and rapidly varied unsteady flow.

COURSE DETAILS

Introduction
Open channel flow, classification, velocity and momentum correction, energy equation, specific energy, critical depth, transitions.

Uniform flow
Determination of roughness coefficients and the factors affecting the roughness, computation of uniform flow, flood discharge, determination of normal depth and velocity, flow in composite roughness; Design of channels for uniform flow in non-erodible and erodible with grassed channels.

Gradually Varied Flow
Dynamics of Gradually varied flow and classification of flow profile, methods of computation, Dynamics of spatially varied flow - analysis of flow profile and computation by method of numerical integration.

Rapidly Varied Flow
Classification, flow over spillway, Hydraulic Jump, characteristics of jump, surface profile and location of the jump, jumps as energy decapitator, Overview on rapidly varied flow through non-prismatic channels.

Spatially Varied Flow
SVF with increasing discharge, SVF with decreasing discharge, side weirs.

Unsteady flow
Dynamics of gradually varied unsteady flow, development of St-Venant equations, solution of unsteady flow equations, finite difference method of solution, rapidly varied unsteady flow, positive and negative surges, hydraulic flood routing, principle and methods.

Models
Models used to solve open channel flow problems (steady and unsteady) (HEC-RAS & MIKE-HYDRO).

Textbook

1. K. Subramanya, Flow in Open Channel‖, McGraw Hill, 5th edition, 2019.

Reference Books

1. F.M. Henderson, Open Channel Flow, MacMillan Publishing Company, 1996.
2. K.G. Rangaraju, Flow through Open Channel, Tata McGraw Hill, New Delhi.
3. V.T. Chow, Open Channel Hydraulics, McGraw-Hill Publishing Company, New Delhi, 1993.

FLOOD ESTIMATION, MANAGEMENT & FORECASTING

Course Code: **CE30030**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Water Resources Engineering (CE21002)**

COURSE OBJECTIVE

Learn about the stream flow measurements, synthetic unit hydrographs, design storm, flood estimation, hydrologic and hydraulic routing, river classification, flood classification, river training works and forecasting methods.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Measure flood flow in the streams & develop rating curve,
CO 2: Develop unit hydrograph and synthetic unit hydrograph,
CO 3: Estimate flood flow using rational, empirical and unit hydrographs,
CO 4: Determine flood peak using extreme value distribution methods,
CO 5: Prepare flood routing of both reservoir & channel, and
CO 6: Design river training work & prepare flood forecasting.

COURSE DETAILS

Stream flow measurement
Measurement of stage, velocity, area-velocity method, slope-area method, stage-discharge relationship (rating curve), and extrapolation of rating curves.

Hydrograph
Unit hydrograph, Synthetic unit hydrograph, Design storm.

Flood Estimation
Estimation of flood, peak-rational method, empirical methods, unit hydrograph method, Statistics in hydrology, flood frequency methods-log normal, Gumbel's extreme value, Log –Pearson type-III distribution, flood classification- probable maximum flood, standard project flood, risk and reliability.

Flood Routing
Hydrologic Reservoir routing, Modified Pul's method, Goodrich Method, Channel routing, Muskingum method, Hydraulic Channel Routing: Unsteady flow in open channel, solution of St. Venant Equations, Finite Difference Methods, Kinematic method of flood routing.

Flood control
History of flood control, structural and non-structural measures of flood control, storage and detention reservoirs, levees, channel improvement.

River Training
Rivers and its characteristics & classification, Design of River training works.

Flood Forecasting
Importance, Methods and approaches, telemetry system and application of simulation, flood hazard mapping, role of GIS and remote sensing in flood hazard mapping.

Textbooks

1. S.K. Garg, Water Resources Engineering Vol. 2, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 35th Edition, 2019.
2. K. Subramanya, Engineering Hydrology, McGraw Hill, 5th Edition, 2016.

SOIL EXPLORATION AND FIELD TEST

Course Code: **CE30031**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Soil Mechanics (CE20002)**

COURSE OBJECTIVE

The course includes methods of geotechnical exploration, sampling methods, laboratory and field-testing methods of soil & rock, and field instrumentation and monitoring.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand geomaterial formation,
CO 2: Understand the geotechnical stratification of sub surface soil strata,
CO 3: Understand various boring techniques and sampling procedure,
CO 4: Learn various field tests,
CO 5: Learn Application of field test, and
CO 6: Understand various field instrument and its monitoring.

COURSE DETAILS

Geologic material formation
Formation of rock, type of rock, weathering process, sedimentation process, subsurface stratification, geological features of rock, joints in rock, classification of rock, basic geotechnical properties of soil and rocks.

Sub surface exploration
Propose of soil exploration, stages of sub soil exploration, Planning of exploration, Methodology of exploration, geophysical investigation, Different types of borings., soil and rock sampling, groundwater measurement, bore log preparation, report preparation and data interpretation.

Field test
Standard penetration test, , Plate load test, Cone penetration test, cross bore hole test, pressure meter test, field vane shear test, block vibration test, in-situ compression , tension and shear strength of rock mass, In-situ permeability test.

Field instrumentation and monitoring
Application of field instrumentation, Load cell, stress meter, strain meter, field and laboratory pore water pressure measurement, embedment gauge, inclinometer, settlement monitoring, surface extensometer, Terrestrial, deflectometer, surface movement monitoring using field instrument and GPS system.

Textbooks

1. V.N.S. Murthy, Textbook of Soil Mechanics and Foundation Engineering, CBS, 2018, ISBN-10: 8123913621.
2. B.M. Das, Principles of Geotechnical Engineering, Cengage Learning India Pvt. Ltd, 8th Edition, 2015, ISBN-10: 9788131526132.

Reference Books

1. Hunt, R.E., Geotechnical Engineering Investigation Handbook, CRC Press Inc., 2nd Edition, 2005, ISBN-10: 0849321824.
2. J.E. Bowles, Foundation Analysis and Design, McGraw-Hill Education, 5th Edition, 2001, ISBN-10: 0071188444.
3. Gopal Ranjan and A.S.R. Rao, Basic and Applied Soil Mechanics, New Age international Pvt. Ltd., 3rd Edition, 2016, ISBN-10: 8122440398.
4. B.C. Punmia, Ashok K. Jain & Arun Kumar Jain, Soil Mechanics & Foundation Engineering, Laxmi Publication, 4th Edition, 2017, ISBN-10: 8170087910

GROUND IMPROVEMENT ENGINEERING

Course Code: **CE30032**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Soil Mechanics (CE20002)**

COURSE OBJECTIVE

This course addresses the selection, cost, design, construction, and monitoring of ground improvement methods for problematic soils and rock.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain the objective of ground improvement to improve bearing capacity and reduce settlement of soft ground using mechanical modification and deep compaction methods of improvement,
CO 2: Explain concepts of Drainage methods such as Well point systems, deep well drainage, vacuum dewatering system, design of dewatering system,
CO 3: Identify methods to accelerate the consolidation settlement of cohesive soil using preloading methods and vertical drains,
CO 4: Apply the ground improvement technique using admixtures and advanced technique using grouting,
CO 5: Identify the relevance of reinforcing elements to resist the lateral earth pressures and perform design of RE wall, and
CO 6: Use geosynthetics in ground improvement to satisfy the various functional requirements.

COURSE DETAILS

Introduction
Need – methods – suitability – Mechanical modification: principle - Surface compaction: Field compaction and equipment, compaction specification and controls. Vibration methods: compaction piles in sand – impact compaction / dynamic compaction of sands – vibratory compaction in sand – vibro-flotation in sand – explosions in sand.

Drainage methods
Well point systems, deep well drainage, vacuum dewatering system, design of dewatering system – field permeability tests, dewatering by electro osmosis. Preloading, sand drains, wick drains- Thermal methods & case studies.

Introduction to soil improvement by adding materials

Lime stabilization: Mechanism, optimum lime content, lime fixation point, effect of lime on physical and engineering properties of soil, stabilization of soft clay or silt with lime; stabilization with cement -suitability for soils and effect on properties of soils. Grouting: types, desirable characteristics of grouts, grouting methods, grouting pressure, grouting materials, grouting technology – permeation grouting, compaction grouting, hydro fracture grouting, jet grouting – application and limitations – slab jacking, grouted columns – application to dams.

Soil improvement using reinforcing elements

Introduction to reinforced earth – load transfer mechanism and strength development – soil types – reinforcing materials – Reinforced earth retaining walls – reinforced embankments – soil nailing.

Geosynthetics

Types – general applications – types of geotextiles and geo-grids – physical and strength properties of geotextiles and geogrids – behavior of soils on reinforcing with geotextiles and geogrids – design aspects with geotextiles and geogrid.

Textbooks

1. Shashi K. Gulhati and Manoj Datta, Geotechnical Engineering, McGraw Hill Education, 2017, ISBN-10: 9780070588295.
2. P. Purushothama Raj, Ground Improvement Techniques, Laxmi Publications, 2nd Edition, 2016, ISBN-10: 9788131805947.
3. N.R. Patra, Ground Improvement Techniques, Vikas Publishing House, 1st Edition, 2012, ISBN-10: 9789325960015.
4. B.M. Das, Principles of Foundation Engineering, Cengage India Pvt. Ltd, New Delhi, 8th Edition, 2017, ISBN-10: 9386650959.

Reference Books

1. Joseph E. Bowles. Foundation analysis and design, McGraw-Hill Education, 5th Edition, 2000, ISBN-10: 0071188444.
2. Willem van Impe, Soil Improvement techniques and their evolution, CRC Press; 1st Edition, 1989, ISBN-10: 9061918057.
3. Swami Saran, Reinforced soil and its engineering applications, Dreamtech Press, 2019, ISBN-10: 9389307902.

CONSTRUCTION ENGINEERING PRACTICES

Course Code: CE30034
Credit: 3
L-T-P: 3-0-0
Prerequisite: Construction Project Management (CE20003)
COURSE OBJECTIVE

The primary goal of this course is to educate the students about construction industry and to familiarize them about the works that is executed in construction projects. This course gives understanding about
the methods of construction and challenges during execution and the latest technology used for construction and its significance.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Design formwork system,
CO 2: Explain methods of concreting in extreme weather conditions,
CO 3: Explain fabrication and erection of structures by special construction methodology,
CO 4: Explain the method of construction of special structures like bridges, high rise buildings etc.,
CO 5: Propose solutions for the challenges in executing construction projects in special structures, and
CO 6: Explain the prefabrication technology, its needs and benefits.

COURSE DETAILS

Formwork System & Design
Form work & its types, design of form work, scaffolding & its type, De-shuttering of formwork, Failure of formwork, slip form and other moving forms.

Method of concreting in different climate
Pumping of concrete and grouting, mass concreting (roller compacted concrete), ready mixed concrete. Various methods of placing and handling concrete, hot and cold weather concreting, under water concreting.

Different method of curing
Method of Curing and Accelerated curing.

Fabrication and erection of steel
Steel and composites construction methods, Fabrication and erection of structures including heavy structures.

Special construction methods and its challenges
Prefab construction, Industrialized construction, Modular coordination, Special construction methods, Construction in Marine environments, high rise construction, Bridge construction including segmental construction, incremental construction and push launching techniques.

Textbook

1. Robert L Peurifoy & Garold D. Oberiender, Formwork for Concrete Structures, McGraw-Hill, 1996.

Reference Books

1. M.K Hurd, Formwork for Concrete, 5th Edition, Special Publication No-4, (American Concrete Institute, Detroit, 1980).
2. American Concrete Institute, Guide for Concrete Formwork, Box No 19150, Detroit, Michigan-48219.

PRE-STRESSED CONCRETE

Course Code: CE30036
Credit: 3
L-T-P: 3-0-0
Prerequisites: Structural Analysis (CE21004), Concrete Structure Design (CE30003)

COURSE OBJECTIVE

This course deals with the concepts of pre-stressed concrete and its application in designing of various structural members.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain prestressing systems and materials and analyze prestressed concrete members under various loading,
CO 2: Compute losses of prestressed concrete members,
CO 3: Determine short term and long-term deflections in prestressed concrete members,
CO 4: Compute flexural strength, shear & torsional resistance of prestressed concrete members,
CO 5: Design end blocks of a post tensioned prestressed concrete member, and
CO 6: Design sections for flexure and axial tension.

COURSE DETAILS

Introduction
Prestressing Systems and Characteristics of concrete and steel, other suitable materials.

Analysis of Members
Analysis of Members under Axial Load (at transfer and service load), Analysis of Member under Flexure (stress concept, force concept and load balancing concept, Cracking moment, Kern point, Pressure line).

Losses in Prestress
Elastic shortening, Friction, Anchorage slip, Creep of concrete, Shrinkage of concrete, Relaxation of steel.

Calculations of Deflection
Importance of Control on Deflection, Factors Influencing Deflections**,** Short term as well as Long-term Deflections of Uncracked members.

Flexural strength of Prestressed concrete section
Types of flexural failure, Simplified code procedure.

Shear and Torsional resistance of prestressed concrete members
Shear and Principal stresses, Ultimate Shear Resistance of Prestressed Concrete Members, Design of Shear Reinforcements, Prestressed Concrete Members in Torsion, Design of reinforcements for Torsion Shear and Bending.

Anchorage Zone Stresses in Post-tensioned members
Introduction, Stress distribution in End block, Investigations on Anchorage Zone stresses, Anchorage Zone Reinforcement.

Design of Members

Design of Sections for Flexure, Design of Sections for Axial Tension.

Textbooks

1. N. Krishna Raju, Prestressed Concrete, McGraw Hill Education, 6th Edition, 2018, ISBN-10: 9387886204.
2. T.Y. Lin and Ned H. Burns, Design of Prestressed Concrete Structures, Wiley India Pvt. Ltd., 3rd Edition, 2010, ISBN-10: 9788126528035.

Reference Books

1. Y. Guyon, Limit State Design of Prestressed Concrete, John Wiley & Sons, 1972, ISBN-10: 9780470337905.
2. N. Raja Gopalan, Prestressed Concrete, Narosa, 2010, ISBN-10: 8173195439.

SOLID & HAZARDOUS WASTE MANAGEMENT

Course Code: CE30038
Credit: 3
L-T-P: 3-0-0
Prerequisite: Environmental Engineering (CE31001)

COURSE OBJECTIVE

This course is designed to enable the students to understand different types of solid and hazardous waste, different waste management rules, characterize wastes and select proper methods for collection, transportation and treatment, design waste containment systems for disposable wastes and learn about different management strategies for hazardous wastes.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Appreciate the importance of solid and hazardous waste management hierarchy in the context of environmental pollution,
CO 2: Explain the different waste management rules,
CO 3: Characterize waste based on physical and chemical properties and select proper methods for collection of wastes,
CO 4: Apply proper biochemical technologies and thermal technologies for conversion of waste to wealth,
CO 5: Design engineered landfills for disposable wastes, and
CO 6: Characterize different types of hazardous waste and learn about the different management strategies.

COURSE DETAILS

Introduction to Solid and Hazardous Waste Management
Introduction, different types of solid and hazardous waste, Different Waste Management rules, Waste Management hierarchy – prevention, reduce, reuse, recycle, energy recovery and disposal.

Waste Management Rules

Solid waste management rules 2016, Plastic waste management rules 2016, Construction & demolition waste management rules 2016, Electronic waste management rules 2016, Biomedical Waste Management rules 2016, Hazardous & other wastes (management and transboundary movement) rules, 2016.

Sampling and characterization of solid waste
Waste composition, sampling, characterization based on physical and chemical properties.

Collection and transportation of solid wastes
Basic waste collection system, Collection methods – Hauled Container System (HCS), Stationary Collection System (SCS), Transfer and Transport, Transfer stations, Economic comparison of transport alternatives.

Biochemical conversion technologies for Organic Fraction of Municipal Solid Waste (OFMSW)
Aerobic stabilization - composting, important design considerations, stages of composting, factors affecting composting process, oxygen requirement for compete aerobic stabilization, composting techniques.
Anaerobic stabilization - Anaerobic digestion, Stages and operational parameters of anaerobic digestion, Process technologies, categories of anaerobic digestion, different types of digesters, design of digester, Estimation of biogas production.

Thermal conversion Technologies
Fundamentals of thermal processing, Incinerable waste, Refuse derived fuel, Process description of combustion, gasification and pyrolysis.

Engineered landfills
Selection criteria of landfill site, Principles of landfill design, essential components of landfill, different types of landfill, Landfill planning and design, Leachate control, gas collection system.

Hazardous waste management
Different types of hazardous wastes, properties of hazardous wastes, labelling requirement, waste management hierarchy, co-processing of hazardous waste, recycling and reusing opportunities.

Textbooks

1. CPHEEO, Manual on Municipal Solid Waste, Ministry of Urban Development, GoI, New Delhi, 2016.
2. Sunil Kumar, Municipal Solid Waste Management in Developing Countries, CRC press Reference -178 -42B/W illustrations, 2016, ISBN 978498737746-CAT# K26553.

Reference Books

1. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
2. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, ISBN-13: 978-9351340263.

TRAFFIC ENGINEERING AND TRANSPORTATION PLANNING

Course Code: CE30040
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The objective of this course is to enable the student to understand, examine, and analyze various aspects of traffic engineering. Students shall be able to understand the technicalities of traffic congestion, safety and LOS determination. Students shall also be able to understand the transportation planning process and assess the 4 steps of the planning process. The students can schedule bus timings, forecast future trips, and assign trips to different routes.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the different aspects of traffic engineering,
CO 2: Determine traffic RU characteristics at various sections of road,
CO 3: Perform highway capacity analysis,
CO 4: Explain the concept of transportation planning,
CO 5: Understand about traffic control system, and
CO 6: Explain the economic evaluation of transportation plan.

COURSE DETAILS

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

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

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

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

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

Textbooks

1. L.R Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, India, 9th Edition, 1999, ISBN: 978-81-7409-220-5.
2. C.S. Papacostas and P.D. Prevedouros, Transportation Engineering and Planning, Pearson,3rd Edition, 2015, ISBN: 9789332555150.

Reference Books

1. C. J. Khisty & B. K. Lall, Transportation Engg: An introduction, Pearson Education, 3rd Edition, 2017, ISBN: 978-9332569706.
2. P. Chakraborty and A. Das, Principles of Transportation Engineering, PHI Publication, 2nd Edition, 2017, ISBN: 978-8120353459.

3. S.K. Khanna and CEG Justo, A. Veeraragavan, Highway Engineering, Nem Chand & Bros., Roorkee, India, 10th Edition, ISBN:9788185240930.

RIVER ENGINEERING & MORPHOLGY

Course Code: CE30042
Credit: 3
L-T-P: 3-0-0
Prerequisite: Fluid Mechanics (CE21001)

COURSE OBJECTIVE

To understand different types of river systems, its flow hydraulics, river morphology, river training works and reservoir sedimentation

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand and explain different types of flow in the river system,
CO 2: Explain different types of sediment and its hydraulics,
CO 3: Design different types of canals,
CO 4: Use and explain different approaches for river morphological study,
CO 5: Design different types of river training works, and
CO 6: Formulate solution for reservoir sedimentation, and explain modeling approaches for river & sedimentation study.

COURSE DETAILS

Introduction
Catchment, Rivers, Types, classification, Behavior of rivers.

River Flow Hydraulics
Flow Characteristics (Laminar and Turbulent Flows,) Velocity Distribution, Bed Shear Stress, Depth-Discharge Relationship for steady and unsteady flow conditions.

Sediment Transport
Sediment Sources and Sediment Characteristics: Initiation of Motion of Sediment Transport, Mode of Sediment Transport, Estimation of Sediment Transport and Alluvial Roughness: (Flow Regimes and Bed Forms, Sediment Transport Formulas for Bed Load and Total Load, Suspended Load Formula, Alluvial Channel Roughness.

Design of Channel
Design of Stable Channels, Flow and Sediment Transport Measurements.

River Engineering Works/River Training
River Engineering Works, Flow Regime Control Structures, Sediment Control Devices for Intake Structures, River Training Works.

Sedimentation in Reservoirs

Distribution of Sediment deposition in Reservoirs, Erosion of Sediment Deposits in Reservoirs, Computation of Sedimentation Volume in Reservoirs, Sedimentation Distribution in Reservoirs, estimation of life span of reservoirs,

Modeling

Modeling of Sediment Transport and River Morphology: (Governing Equations of Flow and Sediment Transport, Propagation of Bed Forms, Analytical Models of Sediment Transport and River Morphology.

Reference Books

1. S.K. Garg, Water Resources Engineering Vol. 2, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 35th Edition, 2019.
2. K.D. Gupta, River Engineering by, Vayu Education of India, 2014.
3. A.A. Khan and W. Wu, Sediment Transport: Monitoring, Modeling and management, Earth Sciences in the 21st Century by, NOVA Science Publishers, 2013.
4. P.Y. Julien, River Mechanics, Cambridge University Press, 2002.
5. C.T. Yang, Sediment Transport: Theory and Practice, Mcgraw-Hill, 1996.
6. Howard H. Chang, Fluvial Processes in River Engineering, Krieger Publishing Company.

OFFSHORE GEOTECHNICAL ENGINEERING

Course Code: **CE30044**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Soil Mechanics (CE20002)**

COURSE OBJECTIVE

The course includes basic foundation concept and geotechnical practices normally used in offshore loading and site condition. Students shall learn about offshore environment, wave wind and current loads on structure, and various offshore foundation system including deep water anchor.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand Offshore topographic features and environmental loads,
CO 2: Understand Offshore site investigation,
CO 3: Design pile foundation under offshore environmental load,
CO 4: Design gravity foundation,
CO 5: Understand the concept of anchoring and preliminary design of anchor system, and
CO 6: Understand Offshore pipeline and issues of offshore construction.

COURSE DETAILS

Offshore environments

Introduction, Feature of offshore engineering, Types of offshore foundation, Introduction to the topographical feature of ocean floors, Marine sediments, Environmental loads, wind, wave, current.

Offshore site investigation
Geophysical investigation (Bathymetric mapping), Geotechnical investigation, Investigation platforms, In situ testing, Cone penetrometer, T- bar & Ball penetrometer, field vane shear tests, Brief discussion on laboratory test, fabric study.

Pile Foundations
Wave, wind, and current force on structures, Ultimate lateral load carrying capacity of short and long piles, Elastic analysis of lateral load vertical piles, Problem solving and doubt clearing, Uplift load carrying capacity of single pile and group of piles, Pile group analysis with vertical load, horizontal load and moment acting on the pile cap.

Gravity foundation
Types of shallow foundation in offshore condition, Basics of design of shallow foundation, cyclic loading and uplift, Bearing capacity under drained and undrained and undrained condition, factor of safety, settlement criteria.

Offshore anchoring system
Introduction, Buoyant platform, mooring system, Types of anchor, Anchor line response for embedded anchors, installation of drag anchors, design overview of drag anchor and dynamically installed anchor, Design overview of drag anchor and dynamically installed anchor.

Offshore pipeline
Introduction, pipeline network, Geotechnical input to pipeline design, design issue, Pipe soil interaction.

Offshore construction
Construction vessel, offshore construction planning and scheduling, issues of offshore construction.

Textbook

1. Mark Randolph & Susan Gourvenec, Offshore Geotechnical Engineering, CRC Press, 1st Edition, 2011, ISBN-10: 0415477441.

Reference Books

1. Michael Tomlinson and John Woodward, Pile design and construction practices CRC Press, 6th Edition, 2014, ISBN-10: 9781466592636.
2. Charles Aubeny, Geomechanics of Marine anchors, CRC Press, 1st Edition, 2017, ISBN-10: 1498728774.

SURFACE & GROUNDWATER HYDROLOGY

Course Code: **CE30052**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To learn and use the knowledge to analyze hydrological cycle, precipitation, abstractions, runoff, groundwater hydrology, well hydraulics and recharging of groundwater.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Estimate water balance, optimal rain gauge network, consistency of rainfall data,
CO 2: Determine the mean rainfall and probability of rainfall events,
CO 3: Estimate infiltration capacity, infiltration indices and apply infiltration models,
CO 4: Compute runoff from the catchments,
CO 5: Understand groundwater concept as well as properties, and
CO 6: Analyze well hydraulics, open wells and recharge of aquifers.

COURSE DETAILS

Surface Water Hydrology
Hydrologic cycle
Water-Budget Equation and Applications in Engineering.

Precipitation
Forms and weather systems of precipitation, Measurement, preparation and presentation of rainfall data, Mean precipitation over an area, Frequency of point rainfall.

Abstractions
Different types of abstractions, Evaporation, Evaporimeters, Transpiration, Evapo-transpiration, Interception and Depression storage, Infiltration-process, measurement, Modelinginfiltration capacity.

Runoff
Catchment characteristics, Runoff estimation methods, NRCCS-CN method.

Ground Water Hydrology
Introduction, Forms of sub surface water, Saturated formation, Aquifer properties - Porosity, Specific yield, Darcy's law, Coefficient of permeability and Stratification.

Well Hydraulics
Steady flow into a well - Confined flow and Unconfined flow, Open wells, Recharge and Artificial Recharge Methods.

Textbook

1. K. Subramanya, Engineering Hydrology, Tata McGraw Hill, 5th Edition, 2019.

Reference Books

1. V.T. Chow, D.R. Maidment and L.W. Mays, Applied Hydrology, Tata McGraw Hill, 1st Edition, 1st Indian Reprint, 2010.
2. L.W. Mays, Water Resources Engineering, Wiley Publication, 2nd Edition, 1st Indian Reprint, 2001.
3. D.K. Todd and L.W. Mays, Groundwater Hydrology, John Wiley and Sons, 3rd Edition, 2011.
4. H.M. Raghunath, Ground Water, New Age International Publishers, 3rd Edition, Dec 2007.

WATER SUPPLY & QUALTY MANAGEMENT

Course Code: CE30054
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course is designed to enable the students to understand the basic of water supply system, characterize water based on physical, chemical and biological parameters and select the specific treatment units required in a water treatment plant.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Estimate the water demand for a particular area,
CO 2: Select a pump for transportation of water at a particular head and discharge,
CO 3: Size service reservoirs for Storage and supplying of treated water to individual households,
CO 4: Size water distribution network pipe for supplying water to individual households,
CO 5: Identify the physical, chemical and biological parameters of water, and
CO 6: Select the different components of a water treatment plant.

COURSE DETAILS

Basics of Water Supply System
General requirement of water supply, sources of water supply, Estimation of water demand, Pumps for transportation of water, selection of pumps, Types of Service Reservoirs, Estimation of capacity of Service Reservoirs, Types of Water distribution system, designing of water distribution system.

Water Quality Parameters
Physical, chemical, and biological characteristics of water as per IS 10500: 2012.

Basics of Water Treatment
Introduction to water treatment system, schematic of water treatment plant for ground water and surface water, Aeration, coagulation, softening: lime-soda process and ion exchange process, flocculation, sedimentation, filtration, disinfection - chlorination and ozonation.

Textbooks

1. S.K. Garg, Environmental Engineering (Vol. I) Water Supply Engineering, Khanna Publishers, 36th Edition, 2022, ISBN-13: 978-81-7409-120-8.
2. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
3. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, ISBN-13: 978-9351340263.

Reference Books

1. L.D. Benefield, J. F. Judkins and B.L. Weand, Process chemistry for water and wastewater treatment, Prentice - Hall Series, 1st Edition, 1981.
2. M.L. Davis & D.A. Cornwell, Introduction to Environmental Engineering, 4th Edition, Tata McGraw Hill, 2010.
3. T.D. Reynolds & P.A. Richards, Unit Operations and Processes in Environmental Engineering, PWS Publishing Company, CENGAGE Learning, 2nd Edition, 2009.
4. CPHEEO, Manual on water supply and Treatment, Ministry of Urban Development, GoI, New Delhi, 2009.
5. Metcalf & Eddy, Inc., Wastewater Engineering: Treatment and Reuse, Tata McGraw- Hill, 5th Edition, New Delhi, 2013.

GEOMATERIAL CHARACTERIZATION

Course Code: **CE30056**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to introduce the characterization of geomaterials. This course will help the students to characterize the geomaterials based on the geology, morphology, mineralogy. This course will introduce the concept of geotechnical characterization and various problems related to it.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the origin of soil and rock,
CO 2: Classify rock and soil,
CO 3: Make the geotechnical and mineralogical characterization of soil and rock,
CO 4: Calculate the index properties and can perform grain size analysis,
CO 5: Characterize the geomaterial based on morphology, physical and chemical properties, and
CO 6: Characterize the geomaterials based on field data.

COURSE DETAILS

Origin of rock and soil
Rock cycle and the origin of soil, geological classification of rocks, basic terminology, index properties of rock and soil, unit weight, porosity, permeability.

Classification of rock and soil
Classification of rock for engineering properties, soil classification and grain size analysis.

Geomaterial characterization-I of soil

Need for geomaterial characterization, geotechnical characterization-void ratio and porosity, compaction, consolidation and compressibility, hydraulic conductivity, shear strength, Mineralogical characterization- X-ray diffraction (XRD).

Geomaterial characterization-II of rock

Morphological characterization- Scanning electron microscopy (SEM), Physical characterization- Gradational analysis, Chemical characterization- X-ray fluorescence (XRF), Case studies based geomaterial characterization.

Textbooks

1. K.R. Arora, Soil Mechanics and Foundation Engineering, Standard Publisher Dist, New Delhi, 7th Reprint Edition, 2019, ISBN- 978-8180141126.

2. B.P. Verma, Engineering Geology and Rock Mechanics, Khanna Publishers, New Delhi, 4th Edition 2017, ISBN-978-9387394155.

Reference Book

1. K.R Saxena and V.S. Sharma, In-situ Characterization of Rocks, A A Balkema Publishers; 1st Edition, 2002, ISBN-978-9058092373.

HIGHWAY MATERIAL CHARACTERISATION

Course Code: **CE30058**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To introduce the technologies in pavement engineering materials and to make the students conversant with characterization of various conventional and alternative road construction materials.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the types and materials used in various types of pavements,
CO 2: Know the basic soil properties related to pavement applications,
CO 3: Identify properties of aggregate and bituminous binders used in pavement,
CO 4: Evaluate bituminous mixes for non-stabilized and stabilized roads,
CO 5: Learn about cement concrete, semi rigid, non-conventional and new pavement materials, and
CO 6: Know about various alternative pavement materials.

COURSE DETAILS

Introduction

Types of pavements, pavement layers, pavement materials in various layers.

Soil
Classification of soil, Identification, and strength tests- Atterberg limits, compaction tests, California Bearing Ratio (CBR), Unconfined Compressive Strength (UCS), Modulus of subgrade reaction, Resilient Modulus, Permeability, Free Swelling Index (FSI), Soil stabilization techniques.

Aggregates
Origin and Classification, physical, mechanical and durability properties, sampling techniques, aggregate texture and skid resistance, Polish Stone Value, Alkali-aaggregate reactivity.

Bitumen
Bitumen sources and manufacturing, Bitumen constituents and its properties, Structure and Rheology, tests on bitumen-emulsions & cutback, modified bitumen and its types, goals of modification, properties of modified bitumen, separation test, long-term and shorter aging of bitumen, Elastic recovery test of modified bitumen.

Cement
Origin, composition, Types of cement, physical properties of cement consistencyy, setting times, soundness and strength of cement, flow test, alternative Pavement Materials - Recycled Concrete aggregates, Reclaimed asphalt pavement materials, use of industrial and agricultural wastes for pavement construction, chemical and mineral admixtures.

Textbook

1. P. Chakraborty and A. Das, Principles of Transportation Engineering, PHI Publication, 2nd Edition, 2017, ISBN: 978-8120353459.

Reference Books

1. G. V. Rao, Principles of Transportation and Highway Engineering, Tata Mc. Graw Hill, 1st edition 1995. ISBN: 978-0074623633.
2. S. K. Khanna and CEG Justo, A. Veeraragavan, Highway Engineering, Nem Chand & Bros., Roorkee, India, 10th Edition, ISBN:9788185240930.
3. Relevant IRC, ASTM and AASHTO codes and specifications.

FUNDAMENTALS OF PROJECT MANAGEMENT

Course Code: CE30072
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course is designed to enable the students to understand and appreciate the importance of concepts of project management. The students would be able to investigate complex business problems and propose project-based solutions

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Appreciate the importance of various aspects of project management,
CO 2: Apply knowledge of various domains of the project to address specific management needs,
CO 3: Understand the concepts related to time management of the project,

CO 4: Learn the aspects related to the optimization of project time and cost,
CO 5: Understand the facts concerning resource management, and
CO 6: Learn about the various concepts related to cost management and engineering economy.

COURSE DETAILS

Introduction to project management
Introduction to project management, Purpose of project management, Process of project management, Objectives of project management, Elements of a network diagram, Rules of a network diagram, Constraints of a network diagram, Errors in a network diagram.

Performance domains of the project
Different performance domains of the project – Stakeholders, Team, Development approach and life cycle, Planning, Project work, Delivery, Measurement, Uncertainty.

Time management of the project
Critical path method (CPM) – Critical path analysis, Activity times and floats, Project evaluation review technique (PERT) – Three times estimates, Beta-distribution curve, Critical path analysis for PERT network, Probability of completion of the project, Differences between CPM and PERT.

Optimization of time and cost of the project
Various costs associated with the project, Variation of various costs of the project concerning the time of completion, Cost slope, Optimization of the mathematical model of network.

Resources management of the project
Resource allocation, Resource smoothening, Resource levelling.

Finance management of the project
Principles of engineering economy, Interest and interest formulae, Comparison of alternatives, Minimum cost point analysis, Breakeven point analysis, Depreciation, Depletion.

Textbooks

1. A Guide to The Project Management Body of Knowledge (Pmbok® Guide), Project Management Institute, 7th Edition, 2021, ISBN 9781628256642.
2. U.K. Shrivastav, Construction Planning and Management, Galgotia Publications Pvt. Ltd, 3rd Edition, 2005, Reprint 2015, ISBN-978-81-7515-246-5.

Reference Books

1. C.F. Gray and E.W. Larson, Project Management, the Managerial Process, McGraw-Hill, 6th Edition, 2017, ISBN-13 - 978-9339212032.
2. K.N. Jha, Construction Project Management, Pearson Education, 2nd Edition, 2015, ISBN-10 – 9332542015.

ELEMENTS OF SURFACE HYDROLOGY

Course Code: CE30074
Credit: 3

L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

To learn and use the knowledge of hydrology through understanding different components of hydrological cycle and use different techniques to develop and implements hydrological analysis.

COURSE OUTCOMES

At the end of the course, the student will be able to

CO 1: Estimate the water balance of a catchment,
CO 2: Perform consistency of rainfall data and estimate missing & mean rainfall,
CO 3: Perform frequency analysis of point rainfall and estimate evaporation,
CO 4: Determine infiltration capacity, fit infiltration model and estimate infiltration indices,
CO 5: Find out run off from catchment using different methods; properties, and
CO 6: Analyze hydrographs, and develop & derive different durations of unit hydrographs.

COURSE DETAILS

Hydrologic cycle
Components & Description, Catchment, Water-Budget Equation and Applications in Engineering.

Precipitation
Forms and weather systems for precipitation, measurement, preparation and presentation of rainfall data, Mean precipitation over an area, DAD curves, Frequency of point rainfall, IDF Curve.

Abstractions
Different types of abstractions, Evaporation, Evaporimeters, Transpiration, Evapo-transpiration, Interception and Depression storage, Infiltration-process, measurement, Modelinginfiltration capacity.

Runoff
Catchment characteristics, Runoff estimation methods, NRCS-CN method forestimation of runoff, Drought, Classification of Drought.

Hydrograph
Factors affecting runoff hydrograph, Components, Base flow, Baseflow Separation, Effective rainfall, Unit Hydrograph, Definition, Development, Unit Hydrographs of Different Durations, Superposition Method, S-Curve technique.

Textbook

1. Engineering Hydrology by K. Subramanya, Tata Mc-Graw Hill, 5th Edition, 2019.

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Reference Books

1. V.T. Chow, D.R. Maidment and L.W. Mays, Applied Hydrology, Tata Mc. Graw Hill, 1st Ed., First Indian Reprint 2010.
2. L.W. Mays, Water Resources Engineering, Wiley Publication, 2nd Edition, First Indian Reprint 2001.

ENVIRONMENTAL POLLUTION AND CONTROL

Course Code: **CE30076**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course is designed to enable the students to know the sources, characteristics and effects of air and noise pollution, their effects on environment and human health and the methods of controlling the same.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the importance of global bio-geochemical cycles,
CO 2: Characterize physical, chemical and biological parameters responsible for water pollution,
CO 3: Understand the various water and wastewater treatment processes,
CO 4: Learn about the parameters responsible for air pollution and their control processes,
CO 5: Learn about the parameters responsible for noise pollution and their control processes, and
CO 6: Learn about the parameters responsible for Soil pollution and their control processes.

COURSE DETAILS

Global biogeochemical cycles
Carbon Cycle, Nitrogen Cycle, Oxygen Cycle, Phosphorus Cycle and Sulfur Cycle.

Water chemistry
Physical, chemical and biological properties of water and their significances.

Water and wastewater treatment processes
Water treatment - schematic diagram, intake structure, aeration, sedimentation, coagulation, flocculation, filtration, disinfection.
Wastewater treatment - schematic diagram, Primary Treatment: screen, grit chamber, primary, sedimentation tank, Secondary Treatment: suspended growth system – activated sludge process, attached growth system – trickling filter, rotating biological contactor, Tertiary Treatment – Nutrient removal.

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

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

Soil Pollution
Types of soil pollutants, Processes of soil pollution, Effect of soil pollution on human beings, plants and animals, Control measures for soil pollution.

Textbook

1. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, ISBN-13: 978-9351340263.

Reference Book

1. T.D. Reynolds & P.A. Richards, Unit Operations and Processes in Environmental Engineering, PWS Publishing Company, CENGAGE Learning, 2nd Edition, 2009.

MUNICIPAL SOLID WASTE MANAGEMENT

Course Code: CE30078
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course is designed to enable the students to understand different types of solid waste, learn about the different waste management rules, characterize wastes and select proper methods for collection, transportation and treatment and size waste containment systems for disposable wastes.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Appreciate the importance of municipal solid waste management hierarchy in the context of environmental pollution,
CO 2: Learn about the different waste management rules,
CO 3: Characterize waste based on physical and chemical properties,
CO 4: Understand methods of waste sampling, segregation and collection,
CO 5: Recognize proper biochemical and thermal technologies for conversion of waste to wealth, and
CO 6: Size engineered landfills for disposable wastes.

COURSE DETAILS

Introduction to Municipal Solid Waste Management
Introduction, different types of municipal solid waste, Waste Management hierarchy – prevention, reduce, reuse, recycle, energy recovery and disposal.

Waste Management Rules
Solid waste management rules 2016, Plastic waste management rules 2016, Construction & demolition waste management rules 2016, Electronic waste management rules 2016, Biomedical Waste Management rules 2016, Hazardous & other wastes (management and transboundary movement) rules, 2016.

Sampling and characterization of solid waste
Waste composition, sampling, characterization based on physical and chemical properties.

Collection and transportation of solid wastes
Basic waste collection system, Collection methods – Hauled Container System (HCS), Stationary Collection System (SCS), Transfer and Transport, Transfer stations.

Biochemical conversion technologies

Aerobic stabilization - composting, important design considerations, stages of composting, factors affecting composting process, different composting techniques.
Anaerobic stabilization - Anaerobic digestion, Stages and operational parameters of anaerobic digestion, Different types of digesters.

Thermal conversion Technologies
Fundamentals of thermal processing, Incinerable waste, Refuse derived fuel, Process description of combustion, gasification and pyrolysis, co-processing of hazardous waste.

Engineered landfills
Selection criteria of landfill site, Principles of landfill design, essential components of landfill, different types of landfill, Landfill planning and design. Leachate control, gas collection system.

Textbooks

1. CPHEEO, Manual on Municipal Solid Waste, Ministry of Urban Development, GoI, New Delhi, 2016.
2. Sunil Kumar, Municipal Solid Waste Management in Developing Countries, CRC press Reference -178 -42B/W illustrations, 2016, ISBN 978498737746-CAT# K26553.

Reference Books

1. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
2. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, ISBN-13: 978-9351340263.

ENVIRONMENTAL ENGINEERING

Course Code: CE31001
Credit: 4
L-T-P: 3-1-0
Prerequisite: Environmental Quality Analysis Laboratory (CE29001), Water Supply, Sewerage & Urban Drainage Design (CE28002)

COURSE OBJECTIVE

This course is designed to enable the students to design water and wastewater treatment plant, understand and apply the principles of solid waste management and identify and control the parameters responsible for air and noise pollution.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Plan and design water treatment units,
CO 2: Plan and design aerobic wastewater treatment systems,
CO 3: Plan and design anaerobic wastewater and sludge treatment systems,
CO 4: Assess the impact of sewage discharge on land and water bodies,
CO 5: Characterize solid wastes and plan suitable engineering systems for their treatment and disposal, and
CO 6: Identify sources of air and noise pollution and propose appropriate control strategies.

COURSE DETAILS

Engineered systems for water treatment
Introduction to water treatment system, schematic of water treatment plant for groundwater and surface water, Aeration, coagulation, softening: lime-soda process and ion exchange process, flocculation, sedimentation, filtration – slow sand and rapid gravity, disinfection - chlorination and ozonation.

Wastewater Treatment Systems
Primary: Screening, grit chamber, skimming tanks, sedimentation.
Secondary: Basics of microbiology, classification of secondary treatments.
(i) Aerobic Wastewater Treatment Systems
Suspended growth - Activated sludge process, oxidation pond, aerated lagoon
Attached growth - trickling filter, rotating biological contactor.
Tertiary: Removal of nitrogen and phosphorus.
(ii)Anaerobic Wastewater and Sludge Treatment Systems
Wastewater treatment options for non-sewered areas, Septic tank, Imhoff tank and their design considerations. Sludge, Sludge characteristics, Sludge processing – thickening, digestion, disinfection, dewatering, Sludge digestion process, designing of sludge digestion tank.

Disposal of effluent and sludge in land and water bodies
Self-purification of rivers, oxygen sag curve, Streeter Phelps equation, Wastewater disposal standards.

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

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

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

Textbooks

1. S.K. Garg, Environmental Engineering (Vol. I) Water Supply Engineering, Khanna Publishers, 36th Edition, 2022, ISBN-13: 978-81-7409-120-8.
2. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
3. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, 2017, ISBN-13: 978-9351340263.

Reference Books

1. Metcalf & Eddy, Inc., Wastewater Engineering: Treatment and Reuse, Tata McGraw- Hill, 5th Edition, New Delhi, 2017, ISBN-10: 9780070495395.
2. L.D. Benefield, J.F. Judkins and B.L. Weand, Process chemistry for water and wastewater treatment, Prentice - Hall Series, 1st Edition, 1981.
3. M.L. Davis & D.A. Cornwell, Introduction to Environmental Engineering, Tata McGraw Hill, 4th Edition, 2010.
4. T.D. Reynolds & P.A. Richards, Unit Operations and Processes in Environmental Engineering, PWS Publishing Company, Cengage Learning, 2nd Edition, 2009.

5. CPHEEO, Manual on water supply and Treatment, Ministry of Urban Development, GoI, New Delhi, 1999.
6. CPHEEO, Manual on sewerage and sewage treatment systems, Ministry of Urban Development, GoI, New Delhi, 2013.
7. CPHEEO, Manual on municipal solid waste management, Ministry of Urban Development, GoI, New Delhi, 2016.

TRANSPORTATION ENGINEERING

Course Code: CE31002
Credit: 4
L-T-P: 3-1-0
Prerequisite: Nil

COURSE OBJECTIVE

This course aims to provide a coherent development to the students for the courses in sector of Engineering like Transportation & Traffic Engineering etc. and to give an experience in the implementation of Engineering concepts which are applied in field of Transportation Engineering such as, highway geometric design, traffic engineering, traffic operations, management, pavement materials and design of flexible and rigid pavements along with their construction.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand various highway components,
CO 2: Design various geometrical features of highway such as horizontal and vertical curves,
CO 3: Evaluate various parameters of traffic flow (speed, volume and density),
CO 4: Design traffic control devices,
CO 5: Characterize various pavement materials, and
CO 6: Design flexible and rigid pavements.

COURSE DETAILS

Introduction
Importance of various modes of Transportation, Road development plans and programs, PMGSY, Classification of roads.

Highway Geometric Design
Highway alignment & survey, Importance of geometric design, design control and criteria, Highway cross section element, Sight distance, Design of horizontal alignment, Design of vertical alignment, Grade compensation, Summit curve and Valley curve.

Traffic engineering
Fundamentals of Traffic flow: Road user and vehicle characteristics, Speed flow and density concepts, Microscopic and macroscopic parameters of traffic flow, fundamental relationships between speed flow and density, Traffic studies, PCU, peak hour factor.

Traffic Operation and Control: Delay concepts, Highway capacity and level of service of different traffic facilities, Traffic control and regulation devices, Signal design by Webster's method, Types of intersections and channelization.

Pavement Engineering

Pavement Materials: Subgrade soil, aggregates and bituminous materials, bituminous mix design, materials for paving concrete, modern materials in pavement.

Pavement Design: Introduction to Mechanistic-Empirical Pavement Design, Traffic consideration in Pavement Design, Design of Flexible pavement as per IRC: 37-2018 and Design of Rigid pavement as per IRC: 58-2015.

Highway Construction: Construction of Flexible Pavements and Rigid Pavements.

Textbooks

1. Partha Chakraborty & Animesh Das, Principles of Transportation Engineering, 2nd Edition, PHI Learning Pvt Ltd, New Delhi 2017.
2. S.K. Khanna, C.E.G. Justo & A. Veeraragavan, Highway Engineering, 10th Edition (revised), Nemchand, Roorkee, ISBN 13: 9788185240930.

Reference Books

1. S.K. Sharma, Principles, Practice and Design of Highway Engineering (Including Airport Pavements), S. Chand Publishers, ISBN: 9788121901314.
2. Y.H. Huang, Pavement Analysis and Design, Pearson Prentice Hall, New Jersey, USA, 2004.
3. C.J. Khisty and B. K. Lall, Transportation Engineering – An Introduction, 3rd Edition, Prentice Hall.
4. Kadiyali L.R., Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, India, 1997
5. IRC:58-2015, Guidelines for the design of plain jointed rigid pavements for Highways, Third Revision, Indian Roads Congress 2011.
6. IRC: 37-2018, Guidelines for the design of flexible pavements, 3rd Revision, Indian Roads Congress July 2012.

MINI PROJECT

Course Code: **CE37002**
Credit: **2**
L-T-P: **0-0-4**
Prerequisite: **Nil**

COURSE OBJECTIVE

Students are required to undertake a min**i** project either as an individual or in a group in consultation with the project supervisor 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. **S**tudents will demonstrate higher level learning outcomes and cognitive skills in the implementation of the project.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Perform a background study on certain technical aspect and formulate a project objective,
CO 2: Outline a pathway for the implementation of the project within the time line,
CO 3: Apply fundamental engineering concepts, advanced technical know-how, use modern engineering tools, perform experiments and critically analyze the data,
CO 4: 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,
CO 5: Function effectively as an individual, and as a member or leader in a team under multidisciplinary settings following ethical practices, and
CO 6: Communicate effectively with a range of audiences and prepare technical reports.

STRUCTURAL ANALYSIS APPLICATIONS

Course Code: CE38001
Credit: 1
L-T-P: 0-0-2
Prerequisites: Solid Mechanics (CE20001), Structural Analysis (CE21004)

COURSE OBJECTIVE

In this course, students will apply the techniques of analysis of different kind of civil engineering structures like beam, frames, and truss, arch and suspension cables.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Determine slope and deflection of determinate and indeterminate beams and frames,
CO 2: Determine internal forces in members of plane, space truss, three, two hinged arches and suspension cables,
CO 3: Determine absolute maximum internal forces due to Influence line diagrams rolling or moving loads,
CO 4: Determine the degree of static and kinematics indeterminacy of various types of structure and selection of method of analysis,
CO 5: Determine the internal force components of beams and frames using slope deflection and moment distribution, and
CO.6: Determine the internal force components of beams and frames using strain energy and consistent deformation method.

COURSE DETAILS

- Slope and deflection of determinate and indeterminate beams and frames using various methods.
- Analysis of plane & space truss, three, two hinged arches and suspension cables.
- Analysis of beam using Influence line diagrams for rolling or moving loads.
- Determination of degree of static and kinematic indeterminacy.
- Analysis of Beam and frame using slope deflection, moment distribution, strain energy and consistent deformation method.

Textbooks

1. G.S. Pandit, S.P. Gupta and R. Gupta, Theory of Structures Volume I and II, McGraw Hill Education, 2017, ISBN-10: 9780074634936.

2. G.S. Pandit, S.P. Gupta and R. Gupta, Theory of Structures Volume II, McGraw Hill Education, 2017, ISBN-10: 0074634984.
3. S. Ramamrutham and R. Narayanan, Theory of Structures, Dhanpat Rai Publishing Company Pvt Ltd, 2017, ISBN-10: 9789352164752.

Reference Books

1. R.C. Hibbeler, Structural Analysis, Pearson, 2019, ISBN: 1292247134,9781292247137.
2. V.N. Vazirani, M.M. Ratwani and S.K. Duggal, Analysis of Structures, Vol. I and Vol. II, Khanna Publisher, New Delhi, 1994.
3. S.S. Bhavikatti, Structural Analysis Vol. I and Vol. II, Vikas Publishing House Pvt, New Delhi, 4th Edition, 2013.

COMPUTER AIDED STRUCTURAL DESIGN AND DETAILING

Course Code: CE38002
Credit: 1
L-T-P: 0-0-2
Prerequisites: Structural Analysis (CE21004), Concrete Structure Design (CE30001)

COURSE OBJECTIVE

In this course, the students will learn about the complete structural design of framed R.C.C building using STAAD PRO Software and limit state method of design.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Idealize the RCC building frames to satisfy the functional requirement,
CO 2: Determine the various loads on buildings as per relevant Indian Standards,
CO 3: Model and analyze building frame structure in STAAD PRO,
CO 4: Prepare design table of the structural components of the building from STAAD PRO output,
CO 5: Design structural components of a building based on the design table, and
CO 6: Prepare a design report of the R.C.C framed buildings.

COURSE DETAILS

- Preparation of column and beam plan from an architectural plan
- Calculation of dead load and live load on R.C.C frame manually
- Manual design of Slab
- Modeling and analysis of building frame in STAAD PRO
- Preparation of Design table from STAAD PRO
- Manual design of beam, column, footing and staircase
- Preparation of Final Design Report

Textbook

1. S.U. Pillai and D. Menon, Design of Concrete Structures, McGraw Hill Education, 3rd Edition, 2017, ISBN-10: 007014110X.

Reference Books

1. A.K. Jain, Reinforced Concrete Limit State Design, Nem Chand & Bros, 7th Edition, 2012, ISBN-10: 9788185240664.
2. S. Ramamrutham, Design of Reinforced Concrete Structures, Dhanpat Rai Publishing Company Pvt Ltd, 2016, ISBN-10: 9352161327.

WATER RESOURCES DESIGN

Course Code: **CE38003**
L-T-P: **0-0-2**
Credit: **1**
Prerequisite: **Water Resources Engineering (CE21002)**

COURSE OBJECTIVE

To learn and analyze different aspects of precipitation, infiltration models, determine the surface runoff, derive unit hydrograph, fix reservoir capacity, design of canal irrigation networks, seepage analysis in permeable foundation, estimate the forces involved in the gravity dam, stability analysis, and seepage analysis in earth dams.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Perform consistency of rainfall data, develop DAD curve and fit infiltration capacity models,
CO 2: Estimate the surface runoff by Rainfall-Runoff relation, NRCS-CN method and fixing of reservoir capacity,
CO 3: Derive and apply the concept of unit hydrograph and development of flood hydrographs,
CO 4: Design irrigation canals and longitudinal section,
CO 5: Analyze seepage forces on foundation of weirs/barrages, and
CO 6: Stability analysis of low gravity dam.

COURSE DETAILS

- Analysis of hydrological cycle and water resources data base of country
- Test of consistency of rainfall data & development of DAD curve
- Frequency analysis of point rainfall and development of IDF curve
- Development of infiltration capacity curve using Infiltrometer data
- Fitting infiltration capacity models based on observed data
- Fixing the reservoir capacity for different demand situations
- Derivation of unit hydrograph & application of unit hydrograph
- Development of specific energy curve and applications to transitions
- Design of the canals in alluvial regions and preparation of LS section
- Seepage Analysis of diversion structures
- Stability analysis of Gravity Dams
- Seepage Analysis in earth dams

Reference Books

1. K. Subramanya, Engineering Hydrology, McGraw Hill, 5th Edition, 2021.
2. S.K. Garg, Water Resources Engineering Vol. 2, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 36th Edition, 2020.

HIGHWAY DESIGN

Course Code: CE38004
Credit: 1
L-T-P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE

The course aims to equip students with knowledge on various guidelines present in IRC codes to design various highway infrastructures and help them to design and analyze the same.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand various IRC and Indo-HCM guidelines for specific design and analysis of Highway infrastructure,
CO 2: Design flexible and rigid pavements, rotaries and roundabouts,
CO 3: Designate LOS categories to various traffic facilities,
CO 4: Design complex highway traffic signaling system,
CO 5: Design rotaries and roundabouts, and
CO 6: Recognize the use and placement of various traffic signs and road markings at various traffic facilities.

COURSE DETAILS

- Learning of IRC codes for design of various transportation facilities and Indo-HCM Manual for LOS estimation of various traffic facilities.
- Designing a vertical and horizontal curve using IRC:38-1988 Guidelines for Design of Horizontal Curves for Highways and Design Tables and IRC:73-1980 Geometric Design Standards for Rural (Non- Urban) Highways
- Designate LOS categories for motorized vehicles and pedestrians on various types of roads using the Indo-HCM guidelines.
- Designing of 3 phase and 4 phase signaling system using IRC:93-1985 Guidelines on Design and Installation of Road Traffic Signals.
- Planning and Design of roundabouts and rotaries as per IRC:65-2017 Guidelines for Planning and Design of Roundabouts (First Revision).
- Placement of various traffic signs and road markings at intersections, median openings, roundabouts, etc. based on IRC:67-2012
- Code of Practice for Road Signs (Third Revision) and IRC: SP:44-1996 Highway Safety Code.
- Design and analysis of flexible pavement (including stress calculation) utilizing the IRC:37-2012. Guidelines for the Design of Flexible Pavements (with CD).

- Design and analysis of rigid pavements (including dowel bars and tie bars) using IRC:58-2015 Guidelines for the Design of Plain Jointed Rigid Pavements for Highways (Fourth Revision) (with CD).

Reference Books

1. Indo HCM Manual (2016).
2. IRC Codes
   i. IRC:38-1988 Guidelines for Design of Horizontal Curves for Highways and Design Tables.
   ii. IRC:73-1980 Geometric Design Standards for Rural (Non- Urban) Highways.
   iii. IRC:37-2012 Guidelines for the Design of Flexible Pavements (with CD).
   iv. IRC:58-2015 Guidelines for the Design of Plain Jointed Rigid Pavements for Highways (Fourth Revision) (with CD).
   v. IRC:93-1985 Guidelines on Design and Installation of Road Traffic Signals.
   vi. IRC:65-2017 Guidelines for Planning and Design of Roundabouts (First Revision).
   vii. IRC:67-2012 Code of Practice for Road Signs (Third Revision).
   viii. IRC: SP:44-1996 Highway Safety Code.

HYDRAULIC STRUCTURE DESIGN

Course Code: **CE38006**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Water Resources Engineering (CE21002)**

COURSE OBJECTIVE

To learn, analyze and apply different hydraulic principles and design different hydraulic infrastructure like weirs/barrages, canal head & cross regulators, river training work, gravity dams and Ogee spillway.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Design weirs/barrages on permeable foundation,
CO 2: Design canal head regulator,
CO 3: Design canal cross regulator,
CO 4: Design river training work,
CO 5: Design low & high gravity dam, and
CO 6: Design ogee spillway

COURSE DETAILS

- Hydraulic design & drawing of vertical drop weir-I
- Hydraulic design & drawing of vertical drop weir-II
- Hydraulic design & drawing of canal head regulator-I
- Hydraulic design & drawing of canal head regulator-II
- Hydraulic design & drawing of canal cross regulator-I

- Hydraulic design & drawing of canal cross regulator-II
- Hydraulic design & drawing of river training work (Guide bank)-I
- Hydraulic design & drawing of river training work (Guide bank)-II
- Hydraulic design & drawing of gravity dam-I
- Hydraulic design & drawing of gravity dam-II
- Hydraulic design & drawing of Ogee spillway-I
- Hydraulic design & drawing of Ogee spillway-II

Reference Book

1. S.K. Garg, Water Resources Engineering Vol. 2, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 35th Edition, 2019.

STRUCTURAL ENGINEERING LABORATORY

Course Code: CE39001
Credit: 1
L-T-P: 0-0-2
Prerequisite: Structural Analysis (CE21004)

COURSE OBJECTIVE

In this laboratory course, the students will perform mix design of concrete and test & determine the different strength of concrete and steel.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn the application and handling of equipment to minimize experimental error,
CO 2: Prepare the concrete mix design,
CO 3: Test and determine the compressive strength of concrete specimen as per the relevant standard,
CO 4: Test and determine the Splitting tensile strength of concrete specimen as per the relevant standard,
CO 5: Test and determine the flexural strength of concrete specimen as per the relevant standard, and
CO 6: Test and prepare the tensile load response behavior of steel bar.

COURSE DETAILS

- Introduction and equipment study
- Concrete mix design, Mix trials and cube testing (IS: 10262 – 2019, IS: 456 – 2000)
- Splitting tensile strength of cylindrical concrete specimens (IS: 516 - 1959, IS: 1199-1959, IS: 10086-1982)
- Flexural tensile strength of prismatic concrete specimens (IS: 516-1959)
- Flexural test of reinforced concrete beam (IS: 456 – 2000)
- Tensile strength of steel bar (IS: 1608 Part 1: 2018)

Textbooks

1. M.S. Shetty, Concrete Technology Theory and Practice, S. Chand Publishing, 8th Edition, 2018, ISBN-10: 9352533801.
2. S.U. Pillai and D. Menon, Design of Concrete Structures, McGraw Hill Education, 3rd Edition, 2017, ISBN-10: 007014110X.

Reference Books

1. Structural Engineering Laboratory Manual by School of Civil Engineering, KIIT Deemed to be University, 2019.
2. BIS Codes: IS: 10262 – 2019; IS: 456 – 2000; IS: 516 – 1959; IS: 1199-1959; IS: 10086-1982; IS: 1608 Part 1: 2018.

TRANSPORTATION ENGINEERING LABORATORY

Course Code: **CE39003**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course will enable the students to determine the characteristics and behaviour of pavement materials based on their properties. The students will learn the required quality of pavement materials for various types of roads, traffic conditions and environmental conditions. They will also learn standard procedure for the selection of materials for the design of pavement according to the IS codes.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand various parameters and standards for the selection of pavement materials,
CO 2: Characterize aggregate for pavement application,
CO 3: Characterize bitumen for pavement application,
CO 4: Characterize soil for pavement application,
CO 5: Design bituminous mix, and
CO 6: Perform quality control tests on pavements and pavement materials.

COURSE DETAILS

- Learning of IRC codes for design of various transportation facilities and Indo-HCM Manual for LOS estimation of various traffic facilities.
- Determination of grain size distribution of coarse and fine aggregate and soil.
- Determination of specific gravity and water absorption of coarse aggregate.
- Determination of flakiness index and elongation index of coarse aggregate.
- Determination of aggregate impact value.
- Determination of aggregate crushing value.
- Determination of Los Angeles abrasion value of aggregates.
- Determination of penetration value of bitumen.
- Determination of softening point value of bitumen.
- Determination of ductility value of bitumen.
- Determination of CBR value of soil.
- Bituminous Mix Design by Marshall Method.

- Determination of DCP number using Dynamic Cone Penetrometer.

Reference Books

1. Transportation Engineering Laboratory Manual, 2022, School of Civil Engineering, KIIT Deemed to be University.
2. S.K. Khanna, C.E.G. Justo & A. Veeraragavan, Highway Engineering, 10th Edition (revised), Nemchand, Roorkee, ISBN 13: 9788185240930.
3. Partha Chakroborty & Animesh Das, Principles of Transportation Engineering, 2nd Edition, PHI Learning Pvt Ltd, New Delhi 2017.
4. S.K. Khanna, Highway Materials and Pavement Testing, 2013.

REPAIR AND REHABILITATION OF STRUCTURES

Course Code: **CE40021**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enable the students to understand and appreciate the importance of repair and rehabilitation of structures, thereof learn the various methods for making the structure safe for use. The students shall learn to diagnose the defects of structures and apply different techniques of rehabilitation of various structures made of different building materials like stone, brick and concrete.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the causes of the dilapidation of structures,
CO 2: Learn about the rehabilitation of various foundations,
CO 3: Know about the rehabilitation of masonry structures,
CO 4: Understand methods of rehabilitation for reinforced concrete structures,
CO 5: Gain basic knowledge on repairs to various joints of structures, and
CO 6: Understand the different methods of repair and repair materials.

COURSE DETAILS

Introduction to repair and rehabilitation

Maintenance and repair strategies - Maintenance, repair and rehabilitation - Types of maintenance, Causes of dilapidation of structures - Mechanism of deterioration of structures, Effects of deterioration - Types of damages to different structures - Seismic damage - Fire damage - Damage to framed structures.

Repair and renovation of foundations

Causes of failure of different foundations - Foundations in made-up soils – Methods of improvement to bearing capacity of made-up soils – Foundations in expansive soils – Examination and condition assessment of existing foundations - Repair and rehabilitation methods for different foundations.

Repair and renovation of masonry structures

Investigation of defects in stone and brick masonry structures – Dampness (Causes, prevention and remedial measures) – Efflorescence (Causes, prevention and remedial measures) – Waterproofing systems to structures – Investigation of cracks in masonry structures – Causes of cracks – Classification of cracks - Prevention methods for cracks – Remedial measures for masonry cracks.

Repair and renovation of concrete structures

Damages and causes of damages to concrete structures – Controlling and remedial measures – Shrinkage – Carbonation – Alkali silica reaction - Sulphate and acid attack – Corrosion - Different types of crack, prevention and remedial measures.

Repairs to joints

Types of joints – Causes of defects in joints – Joints of buildings - Joints in concrete floors and pavements – Joints in reservoirs and tanks – Methods of repair to various types of joints.

Materials and techniques of repair

Special concretes and mortars - concrete chemicals - Polymer concrete - Sulphur infiltrated concrete - Ferrocement - Vacuum concrete - Gunite and Shotcrete - Epoxy injection, Mortar repair for cracks -Shoring and underpinning - Methods of corrosion protection - Corrosion inhibitors - Corrosion resistant steels - Cathodic protection.

Textbook

1. B.L. Gupta and A. Gupta, Maintenance and Repair of Civil Structures, Standard Publishers Distributors, 1st edition-2007, Reprint Edition, 2009, ISBN: 81 - 8014 -102-0.

Reference Books

1. B. Vidivelli, Rehabilitation of Concrete Structures, Standard Publishers Distributors; 1st Edition-2009, ISBN-81 - 8014 -110-1.
2. P.K. Guha, Maintenance and Repairs of Buildings, New Central Book Agency (P) Ltd, 2nd edition-2006, Reprint Edition, 2011, ISBN-81: 7381-073-7.

CONSTRUCTION CONTRACT MANAGEMENT & QUANTITY SURVEYING

Course Code: **CE40022**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Construction Project Management (CE20003)**

COURSE OBJECTIVE

The course deals with contract management and quantity surveying. The students will learn contract agreement and the interpretation of clauses in dealing the projects between client and contractor. The students are made familiar with tendering and bidding process. The students will also learn to estimate quantity and cost for the project.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the types of contract and common contract clauses,
CO 2: Understand the roles and responsibilities of employer, engineer/consultant and contractor,
CO 3: Learn the process of tendering including evaluation of the bid,
CO 4: Read working drawings for civil engineering projects,
CO 5: Evaluate the quantity of major civil engineering items, and
CO 6: Understand and carry out rate analysis of civil engineering item.

COURSE DETAILS

Contracts
Definition, Essential elements of a valid contract, about Indian Contract Act, Classification of contracts, Types of construction contracts, Contract documents, Salient features of the contract.

Clauses under contracts
Various important clauses of contracts related to time extension & cost compensation stated in GCC, SCC, ITB, Minutes of pre-bid meeting, addendum etc.

Arbitration and dispute settlement
Important submittal, Employer's claim, Role & responsibility of Employer, Engineer / Consultant & Contractor, Settlement of disputes including ADR Mechanism, about Indian Arbitration & Conciliation Act, Types of construction claims & its origin.

Tendering and bidding process
Definition, Types of tenders including its advantage and disadvantage, Typical stages of tendering process, Important terms in tendering, Presentation of bid & its evaluation. Registration of vendors of the required goods and services and their pre – qualification criteria, preparing prequalification documents. Preparation of tender documents and invitation to bid.

Quantity estimation of structure
Types of estimation, Steps in estimation process, Methods of taking off quantities, Standard forms for entering detailed measurements, abstracting and billing, Methods of building estimate, Estimates of RCC works, Methods of measurement of major works in accordance of IS: 1200 and other important components.

Cost estimations
Analysis of rates, Schedule of rates, Use of cost data in estimation. Fixed & flexible budgets.

Textbooks

1. Dutta B.N., Estimating and Costing in Civil Engineering – Theory and Practical, UBS Publishers Distributors Pvt. Ltd., New Delhi, 2002.
2. Patil, B.S., Civil Engineering Contracts and Estimates, University Press, 4th Edition 2015.

Reference Books

1. Ajay Kumar Singhal, Basics of Construction Management, SEA, 2014.

2. McCaffer R. & Baldwin A.N., Estimating & Tendering for Civil Engineering Works, Thomas Telford, London,1991.
3. M. Chakraborti, Estimating, Costing Specification & Valuation in Civil Engineering, S. Chand Publisher, 1999.

EARTHQUAKE ENGINEERING

Course Code: CE40023
Credit: 3
L-T-P: 3-0-0
Prerequisite: Solid Mechanics (CE20001), Structural Analysis (CE21004)

COURSE OBJECTIVE

Dynamic analysis of frames and determination of the earthquake force on structure as per Indian Standard.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the parameters of earthquake and seismic zones of India,
CO 2: Determine dynamic responses of free vibration and forced vibration (un-damped & damped) for single degree of freedom systems,
CO 3: Construct response spectra and select proper value for design from given dynamic properties,
CO 4: Determine dynamics responses of un-damped free vibration for multi degree of freedom systems,
CO 5: Use standard earthquake codes for design of structure, and
CO 6: Design earthquake resistant detailing as per Indian standards.

COURSE DETAILS

Seismology
Earth and its interior, continental drift, Plate Tectonics, Convection Currents, The Earth quake, Inter Plate Earthquake (Convergent Boundaries, Divergent Boundaries and Transform Boundaries), Intra Plate Earthquake (Faults and Types of Faults), Seismic Waves, Basic Terminology, Measuring Units and Instruments, intensity and magnitude of earthquake.

Fundamentals of vibration responses of Structure
Static Load v/s Dynamic Load, equation of motion, responses of single degree of freedom system (undamped & damped free vibration, undamped and damped under harmonic load), undamped free responses of multi- degree of freedom system.

Concepts of Earthquake resistant design of R.C.C. Building
Static and dynamic equilibrium, seismic methods of analysis, seismic design methods, response control concepts.

Earthquake Response of linear systems
Response spectra, factors influencing, construction of response spectra, elastic design spectrum, comparison of design and response spectra.

Codal procedure for calculation of earthquake load
Seismic coefficient method, response spectrum method.

Ductile detailing of structure
Flexural members (longitudinal and web), column (longitudinal and transverse).

Textbook

1. Pankaj Agarwal & Manish Shrikhande, Earthquake resistance design of structures, Prentice Hall India Learning Ltd., 2006, ISBN-10: 9788120328921.

Reference Book

1. Anil K. Chopra, Dynamics of structures: Theory and applications to Earthquake Engineering, Pearson Education Ltd, 4th Edition, 2014, ISBN-10: 9780132858038.

BRIDGE ENGINEERING

Course Code: CE40024
Credit: 3
L-T-P: 3-0-0
Prerequisite: Solid Mechanics (CE20001), Structural Analysis (CE21004)

COURSE OBJECTIVE

Design of different components of a R.C.C bridge.

COURSE OUTCOMES

After successfully completing the course, the students will be able to:

CO 1: Identify suitable site for a new bridge considering type of bridge, loads on bridge and the I.R.C. specifications for road bridges,
CO 2: Design a R. C. Slab Culvert,
CO 3: Design deck slab of a R. C. C. T-Beam type bridge,
CO 4: Design longitudinal Girder of a R. C. C. T-Beam type bridge,
CO 5: Design pier and abutment of a R. C. C. T-Beam type bridge, and
CO 6: Understand different types of foundations used for bridge and their components.

COURSE DETAILS

Introduction
Different types of bridges, criteria for site selection, different types of load acting on bridges, I.R.C. specifications for road bridges.

Design of R.C Slab Culvert
Loads considered for design, Design of a R.C. slab culvert.

Design of T – Beam Bridge
Pigeaud's method for computation of slab moments; design of slab, courbon's method for computation of moments in girders; Design of simply supported T-beam for bridge.

Design of Sub Structure for Bridges
Pier and abutment caps; Materials for piers and abutments', Design of pier; Design of abutment.

Foundations for Bridges
Types of foundations; Details of well and pile foundation.

Textbooks

1. Essentials of Bridge Engineering, D. J. Victor, Oxford and IBH.
2. Design of Bridge Structures, by T. R. Jagadeesh & M. A. Jayaram, 2nd Edition, PHI Learning Pvt. Ltd.

Reference Books

1. Design of Bridges, N. Krishna Raju, Oxford and IBH.
2. Concrete bridge Practice: Analysis, Design and Economics‖, V. K. Raina, Tata McGraw Hill.
3. Dynamics of Railway Bridges, L. Fryba, Thomas Telford Ltd, April 1996.
4. Concrete Bridges by P.E. Mondorf, Taylor & Francis.
5. Bridge Engineering by S. Ponnuswamy, Tata Mc-Graw Hill.

ADVANCED WASTEWATER TREATMENT

Course Code: CE40025
Credit: 3
L-T-P: 3-0-0
Prerequisite: Environmental Engineering (CE31001)

COURSE OBJECTIVE

This course is designed to enable the students to apply the various advanced treatment processes for removal of various contaminants from wastewater.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Appreciate the need for advanced wastewater treatment,
CO 2: Apply membrane filtration processes for removal of contaminants,
CO 3: Apply adsorption process for designing activated carbon adsorption system,
CO 4: Apply the concept of gas stripping for designing of stripping towers,
CO 5: Apply ion exchange process for designing of ion-exchange resins, and
CO 6: Apply advanced oxidation process for removal of emerging contaminants.

COURSE DETAILS

Introduction to Advanced Wastewater Treatment
Need for advanced wastewater treatment, Technologies used for advanced treatment.

Membrane filtration
Membrane process, membrane configurations, membrane operation, membrane fouling, Applications of membranes, reverse osmosis, electrodialysis.

Adsorption

Types of adsorbents, fundamentals of adsorption, activated carbon adsorption kinetics, activated carbon treatment process applications.

Gas stripping
Analysis of gas stripping, design of stripping towers, Application.

Ion Exchange
Ion-exchange materials, Exchange capacity of ion-exchange resins, Ion-exchange chemistry, Applications.

Advanced Oxidation Process
Theory of advanced oxidation, technologies used to produce of hydroxyl radical, applications, operational problems.

Textbooks

1. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, ISBN-13: 978-9351340263.
2. T.D. Reynolds & P.A. Richards, Unit Operations and Processes in Environmental Engineering, PWS Publishing Company, CENGAGE Learning, 2nd Edition, 2009.
3. Metcalf & Eddy, Inc, Tchobanoglous G. and Burton, F.L., Wastewater Engineering: Treatment, Disposal and Reuse, 5th ed., Tata McGraw Hill, New Delhi, 2017, ISBN-10: 9780070495395, ISBN-13: 978-0070495395.

Reference Books

1. L.D. Benefield, J. F. Judkins and B.L. Weand, Process chemistry for water and wastewater treatment, Prentice - Hall Series, 1st Edition, 1981.
2. M.L. Davis & D.A. Cornwell, Introduction to Environmental Engineering, 4th Edition, Tata McGraw Hill, 2010.
3. CPHEEO, Manual on water supply and Treatment, Ministry of Urban Development, GoI, New Delhi, 2009.
4. Metcalf & Eddy, Inc., Wastewater Engineering: Treatment and Reuse, Tata McGraw- Hill, 5th Edition, New Delhi, 2013.

CIRCULAR ECONOMY

Course Code: **CE40026**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enable the students to explore the advantages of Circular Economy over the linear economy. Circular economy provides multiple economic, social, and environmental benefits, all of which are central to growing economies. This course focusses on how businesses can create value by reusing and recycling products, how designers can come up with amazingly clever solutions, and how we all can contribute to making the Circular Economy happen.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Acquire comprehensive knowledge and understand the methodologies associated with Circular Economy,
CO 2: Apply knowledge to identify, formulate and analyze new circular business models,
CO 3: Apply knowledge of 3R's, principles of circularity for development of circular business models,
CO 4: Design system thinking and life cycle assessment with realistic constraints, including operational and environmental,
CO 5: Acquire skills for developing circular techniques, resources and business models, and
CO 6: Understand and solve practical problems related to product life extension, reducing negative externalities and designing out waste.

COURSE DETAILS

Basics of Circular Economy
Linear Economy and its emergence, Economic and Ecological disadvantages of linear economy, Replacing Linear economy by Circular Economy, Development of Concept of Circular Economy, A differential - Linear Vs Circular Economy.

Characteristics of Circular Economy
Material recovery, Waste Reduction, reducing negative externalities, Explaining Butterfly diagram.

Advances in a Circular Economy
Concept of Loops, Explaining circularity, Life Cycle Analysis (LCA), Importance of LCA.

Pushing Circular Agenda
Circular Business models, Policies in circular economy, India's journey towards building a circular economy.

Textbooks

1. Shalini Goyal Bhalla, Circular Economy: (Re) Emerging Movement, Invincible Publisher, 2020, ISBN-10: 8194924391, ISBN-13: 978-8194924395
2. Walter R Stahel, The Circular Economy A User's Guide, Routledge; 1st Edition, 2019.
3. Peter Lacy, Jessica Long, Wesley Spindler, The Circular Economy Handbook: Realizing The Circular Advantage, Palgrave Macmillan UK

Reference Books

1. María-Laura Franco-García, Jorge Carlos Carpio-Aguilar, Hans Bressers, Towards Zero Waste: Circular Economy Boost, Waste to Resources, Springer International Publishing, 2019.
2. Marcello Tonelli, Nicolo Cristoni, Strategic Management and the Circular Economy, Routledge, 2018.
3. Lerwen Liu, Seeram Ramakrishna, An Introduction to Circular Economy, Springer Singapore, 2021.

ROAD SAFETY ENGINEERING

Course Code: CE40027
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

To introduce the concepts of traffic safety on highways and to make students familiar with related analytical methods and remedial measures.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know the scenario of road crashes in India and deaths accompanied,
CO 2: Understand the steps of crash investigation,
CO 3: Learn various statistical techniques to model road crashes,
CO 4: Know various traffic management techniques to improve road safety,
CO 5: Understand the process of road safety auditing, and
CO 6: Know about various Indian and international guidelines and codes targeting improvement of road safety.

COURSE DETAILS

Introduction
Road traffic accidents scenario in India, characteristics of accidents, accident vs. crash, effect of human factors, planning for road network, land use and road environment for safety, designing for road safety — links and junctions, road safety improvement strategies.

Crash investigation and analysis
Steps in treatment of crash locations, diagnosing crash problem and solutions, accident report form, storing of data, using and interpreting crash data, identifying and prioritizing hazardous locations, condition and collision diagrams; Vulnerable Road users: crashes related to pedestrian and bicyclists, their safety, provision for disabled.

Statistical analysis of accidents
Descriptive statistics, confidence interval, hypothesis testing, models related to accident frequency, accident severity.
Before-after methods in crash analysis: Before and after study, before and after study with control sites, comparative parallel study, before, during and after study.

Traffic management system
Traffic flow improvements, expressway patrol, public transit, ridesharing, mobility rest areas, park-and-ride lots, bus bays, signage, markings; ITS applications - vehicular navigation, crash avoidance system, incident management, traffic management centre, highway side communication.

Road safety audits
Procedure, aims and objectives, roles and responsibility, history of road safety audit, design standards, tasks, various stages of safety audits; common identifiable problems, structuring of report, identifying common problems.

Textbook

1. L.R Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, India, 9th Edition, 1999, ISBN: 978-81-7409-220-5

Reference Books

1. American Association of State Highway and Transportation Officials (AASHTO), Highway Safety Manual, AASHTO, 1st Edition, 2010, ISBN: 978-1560514770.

2. R. B. Mallick and T. El-Korchi, Pavement Engineering: Principles and Practice, CRC Press, 3rd Edition, 2017, ISBN:978-1498758802.
3. M. Y. Shahin, Pavement Management for Airports, Roads and Parking Lots, Springer, 2nd Edition, 2006, ISBN:978-0387234649.
4. Y. H. Huang, Pavement Analysis and Design, Pearson Education, 2nd Edition, 2008, ISBN: 978-8131721247.
5. D. Croney and P. Croney, Design and Performance of Road Pavements, McGraw-Hill Education, 3rd Edition, 1997, ISBN: 978-0070144514.
6. D. Pearson, Deterioration and Maintenance of Pavements, ICE Publishing, 1st Edition, 2011, ISBN:978-0727741141.
7. Relevant AASHTO/ IRC and other Codes and Specifications.

PAVEMENT MANAGEMENT SYSTEM

Course Code: CE40028
Credit: 3
L-T-P: 3-0-0
Prerequisite: Transportation Engineering (CE31002)

COURSE OBJECTIVE

The objective of this course is to provide students with a comprehensive understanding of the principles and practices of managing and maintaining pavement infrastructure systems. This course will cover techniques of functional and structural evaluation of pavement. life cycle cost analysis of pavement, network and project-level pavement management processes, incorporation of pavement preservation into pavement management systems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Evaluate functional health of pavement,
CO 2: Evaluate the structural health of pavement by using BBD or FWD,
CO 3: Collect data and develop models for pavement deterioration,
CO 4: Design PMS and implement them,
CO 5: Learn life cycle cost analysis of pavement, and
CO 6: Compare different strategies of pavement maintenance by LCCA tools.

COURSE DETAILS

Pavement Surface Condition & Its Evaluation
Various Aspects of Surface and their Importance; Causes, Factors Affecting, Deterioration and Measures to Reduce Pavement Slipperiness, Unevenness, Ruts, Pot holes and Cracks; Methods of Measurement of Skid Resistance, Unevenness, Ruts and Cracks. Pavement Surface Condition Evaluation by Physical Measurements, by Riding Comfort and Other Methods; their applications.

Pavement Structure & Its Evaluation
Factors affecting Structural Condition of Flexible and Rigid Pavements; Effects of Subgrade Soil, Moisture, Pavement Layers, Temperature, Environment and Traffic on Structural Stability, Pavement Deterioration; Evaluation by Non-Destructive Tests such as FWD, Benkelman Beam Rebound Deflection, Plate Load Test,

Wave Propagation and other methods of Load Tests; Evaluation by Destructive Test Methods, and Specimen Testing.

Pavement Management Process & Data Requirements - Establishing criteria – development of models for pavement deterioration – determining the future needs – rehabilitation and maintenance strategies – developing combined programmes for maintenance & rehabilitation.

Project Level Design

Framework for pavement design, characterization of physical design inputs, basic structural response models – variability, reliability and risk – generating alternate design strategies – pavement analysis & design of AC & PC, - rehabilitation design procedures – economic evaluation of alternate pavement design strategies – selection of optimal design strategy.

Implementation

Major steps in implementing PMS – pavement construction management & pavement maintenance management – information's, research needs – cost and benefit of pavement management – future directions and need for innovations in pavement management.

Textbook

1. R.S. Kumar, Pavement Evaluation and Maintenance Management System, Universities Press (India) Private Limited, 2014, ISBN: 978-8173719226.

References Books

1. R. B. Mallick and T. El-Korchi, Pavement Engineering: Principles and Practice, CRC Press, 3rd Edition, 2017, ISBN:978-1498758802.
2. M. Y. Shahin, Pavement Management for Airports, Roads and Parking Lots, Springer, 2nd Edition,2006, ISBN:978-0387234649.
3. Y. H. Huang, Pavement Analysis and Design, Pearson Education, 2nd Edition, 2008, ISBN: 978-8131721247.
4. D. Croney and P. Croney, Design and Performance of Road Pavements, McGraw-Hill Education, 3rd Edition, 1997, ISBN: 978-0070144514.
5. D. Pearson, Deterioration and Maintenance of Pavements, ICE Publishing, 1st Edition, 2011, ISBN:978-0727741141
6. Relevant AASHTO/ IRC and other Codes and Specifications.

IRRIGATION ENGINEERING & HYDRAULIC STRUCTURES

Course Code: **CE40029**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To learn and use the knowledge of planning and design of canal irrigation projects, water logging remedies, design of irrigation related hydraulic structures

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Estimate crop water requirement,
CO 2: Prepare field irrigation schedule,
CO 3: Design irrigation canals and lining of canals,
CO 4: Design canal head works,
CO 5: Design regulators, modules and cross drainage works, and
CO 6: Prepare drainage plan and design surface and sub-surface drainage system.

COURSE DETAILS

Overview
Irrigation and various terminologies and methods.

Water Requirement of Crop
Soil Water Relationship, Delta and Duty, Field Irrigation Schedule.

Canal Irrigation Systems
Estimation of design discharge, classification of canals, alignment, different types of canals, distribution system, design of regime channel, Kennedy‘s theory, Lacey‘s theory diversion.

Lining of Irrigation Canals
Advantages, hard surface lining, earth lining, design & estimation.

Head Works
Concept of weir and barrage, Layout of diversion heads works and its components, Theory of seepage, Bligh's creep theory, Lanes weighted creep theory, Khosla's theory on permeable foundation, Design of weirs & barrages.

Regulator & Modules
Modular, non-modular structures and semi-modular outlets and design.

Cross-Drainage Work
Types, selection, Design of different CD Works.

Reclamation of water logged and saline soils
Definition of salinity, water logging, leaching, design of surface and sub-surface drainage system.

Textbooks

1. S.K. Garg, Water Resources Engineering Vol. 2, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 35th Edition, 2019.
2. A.K. Bhattacharya and A M Michael, Land Drainage: Principles, Methods and Applications, Vikas Publishing, 2018.

GROUNDWATER HYDROLOGY

Course code: **CE40030**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To learn various aspects of groundwater hydrology including well hydraulics, survey & investigation, construction methods, artificial recharge and management of groundwater contamination

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Analyze different formation and estimate hydraulic conductivity,
CO 2: Analyze well hydraulics for steady and unsteady flow in aquifer,
CO 3: Explain the construction of shallow and deep wells,
CO 4: Identify modern methods of groundwater exploration,
CO 5: Describe various methods of artificial recharge of ground water, and
CO 6: Analyze and manage groundwater contamination.

COURSE DETAILS

Introduction
Role of groundwater in the hydrologic cycle, problems and perspectives.

Occurrence and movement of groundwater
Hydrogeology of aquifers, Darcy's law, general flow equations.

Groundwater and Well Hydraulics
Steady and unsteady radial flows in aquifers, partially penetrating wells, characteristic well losses, specific capacity.

Surface and Subsurface investigations of Groundwater
Geologic methods, remote sensing, geophysical exploration, electrical resistivity and seismic refraction, logging techniques.

Water wells
Methods of construction, yield tests, protection and rehabilitation of wells.

Management of Groundwater
Concepts of basin management, conjunctive use, mathematical modeling.

Artificial groundwater recharge
Concepts, recharge methods, recharge mounds, induced recharge. Saline water intrusion in aquifers.

Pollution and Quality Analysis of Ground Water
Municipal /industrial /agricultural /miscellaneous sources & causes of pollution, physical /chemical /biological analysis of ground water quality.

Textbook

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

Reference Books

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

GEO-ENVIRONMENTAL ENGINEERING

Course Code: **CE40031**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Soil Mechanics (CE20002)**

COURSE OBJECTIVE

This course will provide learners with an in-depth understanding of modern geo-environmental engineering abilities, allowing them to solve environmental concerns and sustainable approaches associated to infrastructure development. It will also help to identify, formulate and solve complex geotechnical/geo-environmental problems. Learners will gain knowledge on the practical aspects related to various geotechnical characteristic of waste and waste containment, transport process of contaminants on the subsurface, design and stability of waste containment facilities and methods of contaminant site remediation. Learners will also gain a basic understanding of slurry waste, related case studies, characterization, reclamation, and re-use.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the importance, principle and scope of geo-environmental engineering,
CO 2: Understand the soil mineralogical characterization and its significance in determining soil-water-contaminant interaction,
CO 3: Identify contaminant transport mechanisms in soils,
CO 4: Understand the concept of engineered landfills and waste containment facilities,
CO 5: Explain various remediation methods for contaminated soil and groundwater, and
CO 6: Understand reclamation, restoration and re-utilization of waste dump.

COURSE DETAILS

Fundamentals of Geo-environmental Engineering
Introduction to fundamentals, importance, and scope of geo-environmental engineering. Soil properties based on its formation (or type of weathering process). Sources, type, and impact of ground contamination on geo-environment.

Soil-Water-Contaminant Interaction
Soil mineralogy characterization and its significance in determining soil behavior; soil-water interaction and concepts of double layer; forces of interaction between soil particles, soil-water-contaminant interaction, theories of ion exchange.

Waste Containment Facilities

Evolution of waste containment and disposal practices. Contaminant transport and retention mechanism.

Landfills
Methods for landfill site selection, Liner for landfills, Liner components, Liner system, Design process of landfill liners. Landfill gas management, Landfill cover, Surface water drainage system, Closure and post closure plan. Design of landfills, Case study on landfills, Contaminant transport and retention.

Contaminant Site Remediation
Site characterization; risk assessment of contaminated site. Different in-situ and ex-situ remedial approaches for soil and groundwater.

Advanced Soil Characterization
Advanced soil characterization and properties of slurry deposited waste. Case study on failures of slurry pond, control and reuse of waste, end review.

Textbooks

1. H.D. Sharma and Krishna R. Reddy, Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, Wiley Publication, 2004, ISBN: 978-0-471-21599-8.
2. L.N. Reddi and H. I. Inyang, Geoenvironmental Engineering, Principles and Applications, Marcel Dekker Inc. New York, 2000, ISBN: 0-8247-0045-7.

Reference Books

1. R.K. Rowe, Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publications, London, 2000, ISBN: 978-1-4615-1729-0.
2. R.N. Yong, Geoenvironmental Engineering, Contaminated Soils, Pollutant Fate, and Mitigation, CRC Press, New York, 2001, ISBN:9780429075100
3. H.D. Sharma and K.R. Reddy, Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, John Wiley & Sons, Inc., USA, 2004, ISBN: 978-0-471-21599-8.
4. J.K. Mitchell, Fundamentals of Soil Behavior, Wiley, 2005, ISBN: 978-0-471-46302-3.
5. D. Hillel, Introduction to Environmental Soil Physics, Academic Press, New York, 2003, ISBN: 9780080495774.

ADVANCED FOUNDATION ENGINEERING

Course Code: **CE40032**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Soil Mechanics (CE20002), Foundation Engineering (CE30003)**

COURSE OBJECTIVE

This course is designed to provide advanced knowledge in the field of foundation engineering. The course will not only help the student to estimate the settlement for different kind of shallow foundation, it will also help the

student to design deep foundation in terms of pile raft foundation and well foundation. The course will also help the student to design machine foundation by incorporating dynamic loading.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Estimate the short term and long-term settlement of shallow foundation,
CO 2: Solve the problem related to single degree and multi degree freedom system,
CO 3: Understand the principle of machine foundation design,
CO 4: Estimate the liquefaction potential of soil and suggests its remediation,
CO 5: Analyze and design well foundation including complete stability analysis, and
CO 6: Understand the working principle of Well Foundations.

COURSE DETAILS

Settlement of Shallow Foundation
General comments. Permissible settlement. Components of total settlement. Settlements of foundation on cohesive soils. Settlement of foundations on cohesionless soils. Settlement of foundation due to creep.

Machine Foundation
Basic definition, Fundamentals of vibration, Free vibration and Forced vibrations with and without damping for SDOF system. Rotating mass type excitation. Force isolation, Motion isolation. Theory of Vibration measuring instruments. Vibration of multi degree freedom system.

Types of machine and machine foundations. General criteria for machine foundations. Elastic half space theory, Mass-spring-dashpot model, Foundation of reciprocating machine, Foundation of impact type machine. Vibration isolation and screening.

Liquefaction of Soil and Remediation
Mechanism of liquefaction, Laboratory studies of cyclic triaxial test and simple shear test. Standard curves and correlations for liquefactions. Evaluation of zone of liquefaction in field. Factors affecting liquefactions. Anti-liquefaction measures. Effects of liquefaction.

Well Foundation
Types, components, construction methods, design methods (Terzaghi, IS and IRC approaches), check for stability, base pressure, side pressure and deflection. Construction and sinking of well

Soil-Foundation Interaction
Idealized soil, foundation and interface behavior. Elastic models of soil behavior; Elastic-plastic and time dependent behavior of soil. Beams and plates on elastic foundation, numerical analysis of beams and plates resting on elastic foundation.

Textbooks

1. Swami Saran, Soil Dynamics and Machine Foundations, Galgotias Publication, New Delhi, 3rd Edition 2016, ISBN-978-81-7515-727-9
2. Kramer, Geotechnical Earthquake Engineering, Pearson Publications, New Delhi, 1st Edition 2003, ISBN- 978-8131707180

Reference Books

1. Braja M. Das, Principles of foundation engineering, Cengage India, 8th Edition, 2017. ISBN: 978-9386650955.

2. Joseph E. Bowles, Foundation analysis and design, Tata McGraw-Hill Publications, 5th Edition, 2014, ISBN- 978-1259061035.

STRUCTURAL DYNAMICS

Course Code: CE40033
Credit: 3
L-T-P: 3-0-0
Prerequisites: Solid Mechanics (CE20001), Structural Analysis (CE21004)

COURSE OBJECTIVE

In this course, dynamic analysis of structures with single degree and multi degrees of freedom at different loading condition are covered.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Analyze single degree of freedom (SDOF) system for damped and undamped free vibration systems,
CO 2: Analyze single degree of freedom system for damped and undamped forced vibration for harmonic loads,
CO 3: Analyze single degree of freedom system for damped and undamped forced vibration for periodic, loads,
CO 4: Analyze multi degree of freedom (MDOF) system for undamped free vibration systems,
CO 5: Analyze multi degree of freedom (MDOF) system for damped free vibration systems, and
CO 6: Analyze free vibration of distributed mass system of beam.

COURSE DETAILS

Introduction
Basic concepts of structural dynamics; single degree of freedom system, force displacement relationship, damping force, equation of motion, mass-spring-damper system, methods of solution of differential equation.

Free Vibration
Undamped free vibration, viscously damped free vibration, energy in free vibration.

Response to Harmonic and Periodic Excitations
Harmonic vibration of undamped systems, Harmonic vibration with viscous damping, response to vibration generator, natural frequency and damping from harmonic test, force transmission and vibration isolation, vibration measuring instruments, energy dissipated in viscous damping. Response to periodic force.

Numerical Evaluation of Dynamic Response
Time stepping methods, methods based on interpolation of excitation, central difference method, Newmark's method, stability and computational error, analysis of nonlinear response by **N**ewmark's method.

Earthquake Response to Linear Systems
Earthquake excitation, equation of motion, response quantities, response history, response spectrum concept, deformation, pseudo-velocity and pseudo acceleration response spectra, peak structural response from the response spectrum, response spectrum characteristics, elastic design spectrum, comparison and distinction between design and response spectra.

Generalized Single Degree of Freedom Systems

Generalized SDOF systems, rigid body assemblages, systems with distributed mass and elasticity, lumped mass system-shear building, natural vibration frequency by Rayleigh's method. Selection of shape functions.

Multi -Degree of Freedom Systems
Simple system-two storey shear building, general approach for linear systems, static condensation, symmetric plan systems: ground motion. Multiple support excitation, methods of solving the equation of motions.

Free Vibration
Natural frequencies and modes: systems without damping, modal and spectral matrices, orthogonality of modes, normalization of modes. Solution of undamped free vibration systems, solution methods for eigenvalue problem. Analysis of 2-storey frame excited by harmonic force.

Textbook

1. Anil K. Chopra, Dynamics of structures: Theory and applications to Earthquake Engineering, Pearson Education Ltd, 4th Edition, 2014, ISBN-10: 9780132858038.

Reference Book

1. R.W. Clough and J. Penzien, Dynamics of structures, Computers & Structures, Inc, 3rd Edition, 2003.

FINITE ELEMENT METHOD

Course Code: CE40034
Credit: 3
L-T-P: 3-0-0
Prerequisites: Solid Mechanics (CE20001), Structural Analysis (CE21004)

COURSE OBJECTIVE

This course will enable the students to formulate finite element models and determine forces and deformations of structure.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: understand the fundamentals of finite element method,
CO 2: derive and know various types of finite elements and its application,
CO 3: analyze truss structures using finite element method,
CO 4: understand different Formulation Techniques,
CO 5: analyze beam with different support conditions using finite element method, and
CO 6: analyze frames with different support conditions using finite element method.

COURSE DETAILS

Fundamentals of finite element

Equations of Equilibrium, Elements, Degrees of freedom, Stiffness matrices, Different steps involved in finite element analysis, Finite Element modeling, Shape functions, Strain displacement relations, Constitutive relations, Boundary Conditions, Loading type, Solution technique, Convergence criteria.

Formulation Techniques
Potential energy, Variation methods, Gelerkin method, Weighted residual methods.

One Dimensional Element: Analysis of member subjected to axial load.
Truss
Analysis of 2-D and 3-D truss.

Two dimensional Elements
Constant strain triangular element and rectangular element.

Beams and Frames
Analysis of Beams and frames for different support conditions.

Three-dimensional Element
Tetrahedral element.

Textbooks

1. T.R. Chandrupatla and A.D. Belegundu, Introduction to Finite Elements in Engineering, Pearson, 4th Edition, 2011, ISBN-10: 0132162741.
2. R. D. Cook, Concepts and Applications of Finite Element Analysis‖, John Wiley & Sons Inc, 4th edition, 2001, ISBN-10: 0471356050.

Reference Book

1. O.C. Zienkiewicz, The Finite Element Method: Its Basics and Fundamentals, Butterworth-Heinemann Ltd; 7th edition, 2013, ISBN-10: 1856176339.

NUMERICAL METHODS IN GEOMECHANICS

Course Code: CE40035
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course aims to introduce various numerical method use in geotechnical engineering. This course will help the students to understand plasticity theory, critical state soil mechanics, and limit analysis. It will make students familiar with the various techniques of numerical method used in geotechnical application.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand stress-strain relationship of a geomaterials,
CO 2: Learn about importance of soil model,
CO 3: Learn about critical soil mechanics and its application,

CO 4: Learn about application of elastic plastic theory in cavity expansion theory,
CO 5: Understand application of limit equilibrium theory, and
CO 6: Learn about upper and lower bound analysis.

COURSE DETAILS

Theory of plasticity

Introduction, elastic plastic stress strain relationship, continuum verses discrete approach, stress state and equilibrium, strain and compatibility, elastic stress strain relationship, yield criteria, plastic potential and plastic flow rule, strain hardening drucker's stability postulate, isotropic and kinematic hardening, elastic plastic theorems, plasticity model (Tresca, Mohr-coulomb, Drucker pager model).

Critical state soil mechanics

Introduction to Critical state theory, cam clay and modify cam clay model.

Elastic-plastic analysis

Rigorous analysis of elastic plastic problem: example spherical cavity expansion.

Limit analysis

Limit equilibrium analysis with example, Lower bound method of analysis with example, upper bound analysis with example.

Finite element and finite difference analysis

Introduction to FE & FD analysis in geotechnical problem.

Textbook

1. Hai Sui Yu, Plasticity and geotechnics, Springer, 1st Edition, 2006. 978-0-387-33599-5.

Reference Book

1. Ronald B.J. Brinkgreve, Alexander Rohe, Numerical methods in geotechnical engineering, CRC Press, ISBN 10: 1138001465.

SOIL DYNAMICS

Course Code: **CE40036**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Soil Mechanics (CE20002), Foundation Engineering (CE30003)**

COURSE OBJECTIVE

The objective of this course is to introduce the effect of dynamic loading on the behavior of strength properties of soil. This course will help the students to estimate appropriate dynamic elastic constants for design of machine foundation. This course will introduce the concept of liquefaction and as well as the concept of ground motion and its related parameters.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Solve the problem related to single degree and multi degree freedom system,
CO 2: Estimate the propagation of wave through elastic medium,
CO 3: Suggest suitable elastic constants of soil for dynamic analysis,
CO 4: Predict liquefaction and suggest mitigation,
CO 5: Understand the measurement of earthquake magnitude and intensities and different parameter of Ground motions, and
CO 6: Understand the principle of machine foundation design.

COURSE DETAILS

Theory of Vibrations

Basic definition, Fundamentals of vibration, Free vibration and Forced vibrations with and without damping for SDOF system. Rotating mass type excitation. Force isolation, Motion isolation. Theory of Vibration measuring instruments. Vibration of multi degree freedom system.

Wave Propagation in an Elastic Homogeneous and Isotropic Medium

Stress, Strain and Elastic Constants. Longitudinal Elastic Waves in a Rod of Infinite Length. Torsional Vibration of a Rod of Infinite Length. Longitudinal Vibrations of Rods of Finite Length. Torsional Vibrations of Rods of Finite Length. Wave Propagation in an Infinite, Homogeneous, Isotropic, and Elastic Medium. Wave Propagation in Elastic Half Space.

Dynamic Soil Properties

General nature of soil behaviour under cyclic/dynamic loading; Field and Laboratory tests for measurement of small strain and large strain, dynamic properties of soils. Stress-strain behaviour of cyclically loaded soils, Strength of cyclically loaded soils. Geophysical Prospecting.

Liquefaction of Soil and Remediation

Mechanism of liquefaction, Laboratory studies of cyclic triaxial test and simple shear test. Standard curves and correlations for liquefactions. Evaluation of zone of liquefaction in field. Factors affecting liquefactions. Antiliquefaction measures. Effects of liquefaction.

Ground motion characterization

Earthquake Magnitude. Intensity Categories, Peak Ground Motions, Peak Ground Motions and Its Relationship with Magnitude and Intensity. Contribution of Body and Surface Wave to Ground Motions. Attenuation Relationship and Uncertainties. Approximation of Ground Motion Duration.

Machine Foundation

Types of machine and machine foundations. General criteria for machine foundations.. Elastic half space theory, Mass-spring-dashpot model, Foundation of reciprocating machine, Foundation of impact type machine. Vibration isolation and screening.

Textbooks

1. Swami Saran, Soil Dynamics and Machine Foundations, Galgotias Publication, New Delhi, 3rd Edition 2016, ISBN-978-81-7515-727-9.
2. Kramer, Geotechnical Earthquake Engineering, Pearson Publications, New Delhi, 1st Edition 2003, ISBN- 978-8131707180.

Reference Book

1. Junbo Jia, Modern Earthquake Engineering, Springer-Verlag Berlin and Heidelberg GmbH & Co. KG, 1st Edition, ISBN 978-3-642-31853-5.

GENDER & LEGAL ASPECTS IN WATER RESOURCES MANAGMENT

Course Code: CE40050
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

To learn various legal provisions in managing water resources and to understand the gender aspects in the water resources management

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the basics of water law, in the context of historical development and evolving, recognition of issues related to human and ecological needs of water,
CO 2: Understand how the policies, laws and judicial approaches tackle the recent water issues,
CO 3: Help formulate recommendations/responses that could resolve/avoid disputes,
CO 4: Emphasize water as a finite common property resource that must be used in public interest,
CO 5: Understand the legal perspective of Water Resources Management, and
CO 6: Undertake critical analysis of water conflict.

COURSE DETAILS

Gender Approach to Water Management
Drinking and Domestic Water - Sanitation and Hygiene -Gender Policies in Water Management - Country Experiences.

Historical Background and Current Challenges on Legal Aspects
Policy, Law, Bill, Act, Rules, Notifications –Nature of Rights: Natural Rights -Doctrine of Equality – Doctrine of Equitable Apportionment – Public Trust Doctrine -Challenges in Water Management – Physical and Technical Challenges – Social and EconomicChallenges - Role of Law in Water Management, Conceptions of Water: Commodity, Service, Human Right Water Legislation in India.

Pre-Constitutional Water Laws
Constitutional Provisions: Article 14, Article 21, Directive Principles of State Policy, Fundamental Duties, Article 262 – Legislative Process: Legislative, Judicial, Executive – Natural Justice – Delegation of Powers - Tribunals – Post-Constitutional Water Laws – National-Level Enactments - Protection of Water Sources – Groundwater – Drinking and Domestic Water Supply, – Industrial Use – Water Pollution.

Water Governance
Policies And Legal Frameworks: Water Governance and Water Policy – Legal Framework of Water – Substance

of National Water Laws – Other key issues – Changing incentives through Regulation - National Water Policy – National-Level Commissions – Irrigation Management Transfer Policies and Activities.

Legal Changes in Water Allocation

Water Conflicts in India: Water conflicts and Tribunals - Contending Water Uses – Equity, Access and Allocation - Water Quality Conflicts - Sand Mining - Micro-level Conflicts, Dams and Displacement – Privatization – Case Studies.

Reference Books

1. Singh, Chhatrapati –Water Rights in India, Ed: Chhatrapati Singh. Water Law in India*:* The Indian Law Institute, New Delhi,1992.
2. Law for Water Management – A Guide to Concepts and Effective Approaches‖, Ed: Jessica Vapnek, Brace Aylward, Christie Popp and Jamie Bartram, FAO, Rawat Publications, New Delhi, 2011.
3. Water Conflicts in India – A Million Revolts in the Making‖ , Ed: K. J. Joy, Biksham Gujja, Subas Paranjape, Vinod Goud, Shruti Vispute, Routledge, New Delhi, 2008.
4. Groundwater Management and Ownership‟, Report of the Expert Group, New Delhi: Government of India, Planning Commission, http: // planning commission.nic.in / reports / genrep / rep_grndwat.pdf, 2007.
5. Irrigation Management Transfer in India – Policies and Performance, Brewer, J., S. Kolavalli, A. H. Kalru, G. Naik, S, Ramnarayan, K.V. Raju and R. Sakthivadivel, Oxford and IBH Publishing Company, New Delhi,1999.
6. The Politics of Irrigation Reform – Contested Policy Formulation and Implementation in Asia, Africa and Latin America‖, Mollinga, Peter P., and Alex Bolding, Ashgate, England.
7. Commentaries on The Indian Easements Act, 1882 and Licences‖, Row, Sanjiva, 5th Edition, Delhi Law House, New Delhi, 2006.
8. The Politics of Water – A Survey**,** Ed: Kai Wegerich and Jeroen Warner, Taylor and Francis Group, London, 2010.

BASIC FLUID MECHANICS & HYDRAULICS

Course Code: CE40051
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

To learn and use the concept of fluid and its various aspects like static, kinematics, dynamic behavior; concept of free surface flow, specific energy, critical depth, uniform flow and most efficient open channel section, computation of GVF profiles.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Ascertain different fluid properties, velocity, shear force,
CO 2: Apply the basic equations of fluid statics to determine pressure, forces on planar and curved surfaces submerged in a static fluid,
CO 3: Determine the buoyant force, develop and apply the concept of fluid kinematics,

CO 4: Use the Euler‘s and Bernoulli‘s equations and its application in venturimeter, orificemeter, and analyze the momentum principles,
CO 5: Analyze specific energy, critical depth and transitions, uniform flow computation, and
CO 6: Solve problems on dynamics of gradually varied flow.

COURSE DETAILS

Introduction
Properties of Fluids, Newton's law of viscosity, Newtonian & Non-Newtonian Fluids.
Fluid-Statics
Fluid Pressure, Pascal‘s Law, Manometers, Pressure on Plane Surface, Buoyancy and Floatation of Bodies, Stability of Floating Bodies, Metacentre.

Fluid Kinematics
Types of fluid Flows, Continuity Equation, Rotational and Irrotational Motion.

Fluid Dynamics
Bernoulli‘s Energy Equation, Application of Bernoulli‘s Energy Equation in Venturimeter and Orifice Meter.

Free Surface Flow
Introduction, Types of channels, Classification of flows.

Energy Principles
Energy equation, specific energy, critical depth, transitions.

Uniform flow
Chezy's equation, Manning's formula, hydraulically efficient channel section.

Gradually Varied Flow
Governing equation, types of flow profiles, computation of gradually varied profile using standard step method.

Textbooks

1. R.K. Bansal, A Textbook of Fluid Mechanics & Hydraulic Machines. Laxmi Publications (P) Ltd., 10th Edition.
2. K. Subramanya, Flow in Open Channels, McGraw Hill, 5th Edition, 2019.

ENVIRONMENTAL IMPACT ASSESSMENT

Course Code: CE40052
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course will enable the students to define and classify Environmental Impacts, understand the environmental Impact assessment procedure, and explain the EIA methodology.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explain key concepts in environmental impact assessment & Management,
CO 2: Understand the importance of various rules & regulation in EIA,
CO 3: Evaluate the Impact on various environments and role of stake holders in EIA,
CO 4: Apply various techniques in Impact Assessment studies,
CO 5: Identify most suitable tool for assessment process and make suggestions for solutions, and
CO 6: Evaluate a project using EIA with one or more management tools.

COURSE DETAILS

Introduction to EIA
Ecology and the environment. Ecosystem and its characteristics, Structure of Ecosystem; Food chains, Food webs and Tropic levels, Energy and energy flows; Elemental cycles, Concept of Succession; Role of succession in restoration and recovery of ecosystem, Ecosystem disturbances and their causes; natural causes and anthropogenic causes, Ecosystem and Ecological Footprints, Definition and concepts of EIA, ethics and environment, EIA for civil engineers, Types of EIA: Rapid; Comprehensive; Strategic; Sectoral; Regional - Rationale and scope of each type.

Evolution of EIA
Evolution of EIA worldwide; Evolution of EIA in India, EIA Regulations in India Overview of Indian laws – Constitutional Provisions (Water, Air, Forest, Hazardous etc), Overview of- EPA 1986 & EIA Notification 2006, Environmental Risk Assessment, Environmental management: Principles, problems and strategies; Review of political, ecological and remedial actions, Environmental audit: Definitions and concepts, partial audit, compliance audit, Overview of methodologies and regulations, Environmental management systems in local government, Sustainable development – Definitions, Charter and Global Conventions; Future scenarios.

Assessment Techniques
Components of the Environment: Water Standards pertaining to water quality, Components of the Environment: Air & Noise- Standards pertaining to Air & Noise quality, Components of the Environment: Soil- Soil quality, Landuse Criteria, Components of the Environment: Biosphere (Macro, Micro)- Introduction to Hazard Exposure levels for biota, Components of the Environment: Socioeconomic, Components of the Environment: Cultural and Aesthetics, Role of Public Participation in EIA, Role of Public Participation in EIA, Role of stakeholders.

EIA Methodologies
Initial Environmental Examination; Screening, Scoping Analysis of alternatives, Mitigation- Definition, options for mitigation of impact on water, air and land, water, energy, flora and fauna, Environmental Impact Statement- Document planning - collection and organization of relevant information, Environmental Assessment- Base line, Construction Phase, Post Construction/ Operational phase scenario, Impact Assessment Methodologies: Checklists- Simple, Descriptive, Scaling Checklist.

Textbooks

1. L.W. Canter, Environmental Impact Assessment, 2nd Ed., McGraw-Hill, 1997.
2. Y. Anjaneyalu, ValliManickam, Environmental Impact Assessment Methodologies, 2nd Ed., BS Publications, 2007.
3. B.M. Noble, Introduction to Environmental Impact Assessment: A Guide to Principles and Practice. Oxford University Press, USA, 2005.

Reference Books

1. G. Burke, B. R. Singh and L. Theodore, Handbook of Environmental Management and Technology, 2nd Ed., John Wiley & Sons, 2000.
2. R. Therivel, John Glasson, Andrew Chadwick, Introduction to Environmental Impact Assessment (Natural and Built Environment), Routledge, 2005.

INTRODUCTION TO REMOTE SENSING & GIS

Course Code: **CE40053**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course will enable the students to understand and apply the principles of remote sensing and GIS in various fields of Civil Engineering.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the concept, principle and application of remote sensing,
CO 2: Know the various types of platforms and sensors used in remote sensing,
CO 3: Interpret satellite images,
CO 4: Explain the fundamental operations of GIS,
CO 5: Manage GIS data files, and
CO 6: Analyze the spatial and attribute data.

COURSE DETAILS

Introduction to Remote Sensing system
Data acquisition and processing, Applications, Multi concept in remote sensing.

Physical Basis of Remote Sensing
EMR nature, definition, nomenclature and radiation laws. Interaction in atmosphere-nature, its effects in various Wave-length regions, atmospheric windows; Interaction at ground surface soils Geometric basis of interaction.

Platform and Sensors
Terrestrial, aerial and space platforms, Orbital characteristics of space platforms, sun-and geo-synchronous; Sensor systems-radiometers, opto-mechanical and push broom sensor.

Resolution
Spectral, spatial, radiometric and temporal; IFOV, FOV, GRE; geometric characteristics of scanners, V/H and S/N ratio; Data products from various air and space borne sensors-aerial photographs, LiDAR, Landsat, SPOT, IRS, ERS, IKONOS etc.

Image Interpretation
Elements of interpretation; digital image processing and interpretation, Field verification.

Geographical Information systems
Components of GIS-data acquisition, spatial and attribute data, pre-processing, storage and management; data structures raster and vector data.

GIS analysis functions
Errors and corrections; data presentation and generation of thematic maps.

Textbooks

1. Basudev Bhatta, Remote Sensing and GIS, by Oxford, 2013.
2. M. Chandra and S. K. Ghosh, Remote Sensing and GIS, Narosa Pub, 2007.
3. S.K. Duggal, Surveying Volume -II, 3rd Edition, Tata McGraw Hill- 2011.

Reference Books

1. I. Heywood, S. Cornelius and S. Carver, An Introduction to GIS, 2nd Edition, Pearson Education, 2002.
2. George Joseph, Fundamentals of Remote Sensing, Universities Press, 2nd Edition, 2011.

AIR POLLUTION CONTROL & MANAGEMENT

Course Code: CE40054
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course is designed to enable the students to know the sources, characteristics and effects of air pollution, their effects on environment and human health and the methods of controlling the same.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the structure of atmosphere and identify the sources of air pollutants,
CO 2: Classify the air pollutants and understand the effects of air pollutants on health and environment,
CO 3: Understand the meteorological parameters and their effect on dispersion of air pollutants into the atmosphere,
CO 4: Learn about air quality standards and determine the air quality index,
CO 5: Adopt suitable measures for controlling particulate air pollutants, and
CO 6: Adopt suitable measures for controlling gaseous air pollutants.

COURSE DETAILS

Introduction to Air Pollution
Structure of the atmosphere, Natural and anthropogenic sources of pollution, Atmospheric sources.

Air Pollutants and their effects
Gaseous and particulate matter, Primary pollutants, Secondary pollutants, Criteria pollutants, Hazardous pollutants, greenhouse gases, Effects of air pollution on human health, vegetation and animals, building materials and structures, atmosphere, soil and water bodies.

Meteorological parameters and Air Pollution
Lapse rates, atmospheric stability, plume behaviour, boundary layer, mixing height, stack height and Plume rise.

Air Quality Standards
Air Quality Index (AQI), Air Quality Standards, Air Pollution Legislations and Regulations

Control of Air Pollutants
- **Particulate pollutants -** Control of particulate air pollutants using gravitational settling chambers, cyclone separators, wet collectors, fabric filters (Bag-house filter), electrostatic precipitators (ESP).
- **Gaseous Pollutants -** Control of gaseous contaminants: absorption, adsorption, condensation and combustion; Control of sulfur oxides, nitrogen oxides, carbon monoxide, and hydrocarbons.

Textbooks

1. Daniel Vallero, Fundamentals of Air Pollution, Academic Press, 5th Edition, 2014, ISBN: 978-0-12-401733-7
2. Wark, K., Warner, C.F., and Davis, W.T., Air Pollution: Its Origin and Control, Addison-Wesley Longman. 1998.
3. Boubel, R.W., Fox, D.L., Turner, D.B., Stern, A.C., Fundamentals of Air Pollution, Academic Press. 2005.
4. Gurjar, B.R., Molina, L., Ojha, C.S.P. (Eds.), Air Pollution: Health and Environmental Impacts, CRC Press. 2010.

Reference Books

1. Karl B. Schnelle, Jr. and Charles A. Brown, Air Pollution Control Technology Handbook, CRC Press, 1st Edition, 2001.
2. Jeremy Colls, Air Pollution, SPON Press, 2nd Edition, 2003.
3. Seinfeld, J.H. and Pandis, S.N., Atmospheric Chemistry and Physics, John Wiley, 2006.

IRRIGATION WATER MANAGEMENT

Course Code: CE40055
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

To learn and apply the various concepts of management of irrigation water including soil water-plant relationship, crop water requirement, irrigation methods, efficiency and scheduling and participatory irrigation management

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn about irrigation and also explain the various aspects of soil water,
CO 2: Describe the relationship between soil, plant and water,
CO 3: Compute the water requirement of various crops,
CO 4: Understand about the various irrigation methods and compute irrigation efficiency,
CO 5: Schedule irrigation, and
CO 6: Understand about the participatory irrigation management.

COURSE DETAILS

Introduction
Importance and harmful effects of irrigation, sources of water to crop plants.

Issues in Water Management
Multiple use of water – Issues in Inter-sectoral Water Allocation - domestic, irrigation, industrial sectors - modernization techniques – Rehabilitation – Command Area Development - Water delivery systems.

Soil water relationship
Basic soil physical properties, Forms, occurrence and classification of soil water, Soil water constants, Energy concept of soil water, Forces acting on soil water, Soil water potential, Infiltration, permeability, movement of water in soils and methods of soil water measurement.

Soil Water-Plant relationship
Water absorption and conduction by plant, Transpiration, Soil water availability, soil water extraction pattern of plants.

Crop water requirement
Evapotranspiration, effective rainfall, percolation loss, Irrigation requirement, duty of water.

Irrigation methods
Classification of Irrigation methods, Surface, Subsurface, Sprinkler and Drip irrigation and methods of water measurement.

Irrigation efficiency and scheduling
Irrigation efficiency, time of irrigation, Criteria for scheduling of irrigation, depth, frequency and interval of irrigation.

Participatory irrigation management
Sociology – Basic concepts – Perspectives- Social Stratification – Irrigation as a Socio technical Process - Participatory concepts– Objectives of participatory approach. Farmers participation –need and benefits – Comparisons of cost and benefit -Sustained system performance - Kinds of participation – Context of participation, factors in the environment – WUA - Constraints in organizing FA – Role of Community Organizer – Case Studies.

Textbook

1. D.K. Majumdar, Irrigation Water Management, Principles and Practice, PHI Learning Private Limited, 2014.

Reference Book

1. Robert Chambers, Managing Canal Irrigation, Cambridge University Press, 1989

GROUNDWATER CONTAMINATION AND REMEDIATION

Course Code: CE40056
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course will provide learners with an in-depth understanding of modern geo-environmental engineering abilities, allowing them to solve environmental concerns and sustainable approaches associated to groundwater development. It will also help to identify, formulate and solve complex problems associated with groundwater. Learners will gain knowledge on the practical aspects related to various characteristics of interaction of containment, its biogeochemistry, transport process of contaminants on the subsurface, and methods of groundwater remediation.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the fundamentals, importance, and scope of geo-environmental engineering,
CO 2: Understand the importance, occurrence, and assessment of groundwater engineering,
CO 3: Understand the groundwater movement in porous media under different conditions and its significance in determining groundwater-contaminant interaction,
CO 4: Identify the contaminant transport mechanisms in groundwater and understanding the contaminants interaction along with the biogeochemistry of groundwater,
CO 5: Identify the various remediation techniques for contaminated groundwater, and
CO 6: Perform the Economic assessment of groundwater remediation.

COURSE DETAILS

Fundamentals of Geo-environmental Engineering
Introduction to fundamentals, importance, and scope of geo-environmental engineering. Soil properties based on its formation (or type of weathering process). Sources, type, and impact of ground contamination on geo-environment.

Groundwater-Contaminant Interaction
Introduction to groundwater and its significance; study of groundwater known as hydrogeology; water-contaminants interaction; forces of interaction between groundwater-contaminant interaction, theories of ion exchange, contaminant transport mechanism and retention.

Groundwater Remediation
Site characterization; risk assessment of groundwater. Different in-situ and ex-situ remedial approaches for groundwater.

Economic Assessment of Groundwater Remediation
Cost analysis of various remedial measures of groundwater.

Textbooks

1. H.D. Sharma and Krishna R. Reddy, Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies HandBook, Wiley Publication, 2004.
2. James E. Landmeyer, Introduction to Phytoremediation of Contaminated Groundwater, Historical Foundation, Hydrologic Control, and Contaminant Remediation, Springer. 2011.

Reference Books

1. Rowe R.K., Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publications, London, 2000.
2. Yong, R. N., Geoenvironmental Engineering, Contaminated Soils, Pollutant Fate, and Mitigation, CRC Press, New York, 2001.
3. Sharma H.D. and Reddy K.R., Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, John Wiley & Sons, Inc., USA, 2004.
4. Landmeyer, J.E., Introduction to phytoremediation of contaminated groundwater, historical foundation, hydrologic control, and contaminant remediation. Springer Science & Business Media, 2011.

URBAN WASTE MANAGEMENT

Course Code: **CE40057**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enable the students to understand different types of solid waste, different waste management rules, characterize wastes and select proper methods for collection, transportation and treatment and size waste containment systems for disposable wastes.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Appreciate the importance of various types of liquid and solid waste in urban context,
CO 2: Identify the physical, chemical and biological parameters of wastewater,
CO 3: Understand the various strategies used for treatment of wastewater,
CO 4: Learn about the different solid waste management rules,
CO 5: Characterize solid wastes based on physical and chemical properties, and
CO 6: Identify proper technologies for conversion of solid wastes to wealth.

COURSE DETAILS

Introduction to Urban Waste Management
Introduction to different types of liquid and solid waste.

Wastewater Management
Introduction to wastewater, Class of water based on designated-best-use, different types of wastewaters, Physical, chemical and biological characteristics of wastewater.
Treatment and Reuse strategies for different types of wastewaters, Treatment options for sewered areas – primary, secondary and tertiary treatment units: description and applications.
Treatment options for non-sewered areas - oxidation ponds, Septic tank, Imhoff tank.

Sampling and characterization of solid waste
Waste composition, sampling, characterization based on physical and chemical properties.

Collection and transportation of solid wastes
Basic waste collection system, Collection methods – Hauled Container System (HCS), Stationary Collection System (SCS), Transfer and Transport, Transfer stations, Economic comparison of transport alternatives.

Biochemical conversion technologies for Organic Fraction of Municipal Solid Waste (OFMSW)
Aerobic stabilization
composting, important design considerations, stages of composting, factors affecting composting process, oxygen requirement for compete aerobic stabilization, composting techniques.
Anaerobic stabilization
Anaerobic digestion, Stages and operational parameters of anaerobic digestion, Process technologies, categories of anaerobic digestion, different types of digesters, design of digester, Estimation of biogas production.

Thermal conversion Technologies
Fundamentals of thermal processing, Incinerable waste, Refuse derived fuel, Process description of combustion, gasification and pyrolysis.

Engineered landfills
Selection criteria of landfill site, Principles of landfill design, essential components of landfill, different types of landfills, Landfill planning and design. Leachate control, gas collection system.

Hazardous waste management
Different types of hazardous wastes, properties of hazardous wastes, labelling requirement, waste management hierarchy, co-processing of hazardous waste, recycling and reusing opportunities.

Textbooks

1. CPHEEO, Manual on Municipal Solid Waste, Ministry of Urban Development, GoI, New Delhi, 2016.
2. Sunil Kumar, Municipal Solid Waste Management in Developing Countries, CRC press Reference -178 -42B/W illustrations, 2016, ISBN 978498737746-CAT# K26553.

Reference Books

1. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
2. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, ISBN-13: 978-9351340263.

GEOTECHNICAL INSTRUMENTATION AND MONITORING

Course Code: CE40058
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course aims to introduce various geotechnical instrumentation used to monitor geohazards. This course will help the students to understand how to plan and install monitoring systems at potential geohazard sites. It will make students familiar with the various field instrument and data acquisition systems generally used in geohazards sites.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand how to plan a monitoring program and learn the method of monitoring,
CO 2: Learn about various groundwater monitoring systems and stress measurement equipment,
CO 3: Learn about various deformation measurement equipment,
CO 4: Learn about earthquake measuring instruments and tsunami observation,
CO 5: Understand field equipment and GPS system, and
CO 6: Understand IoT for disaster management.

COURSE DETAILS

Introduction, Planning monitoring program, benefit of using geotechnical instrumentation, systematic approach to planning monitoring program, Monitoring methods, measurement uncertainty, instrumentation transducer and data acquisition, Measurement of groundwater pressure, observation well, piezometer, types of piezometer, arrangement of piezometers, installation of piezometer, Measurement of total stress in soil, types & method, embedment earth pressure cell, contact earth pressure cell, Measurement of stress change in rock, categories, inclusion of gages, Measurement of deformation: surveying method, extensometer, tiltmeters, inclinometers, transverse deformation gauge, Earthquake measuring instrument, Surface movement monitoring using field instrument and GPS system, Tsunami observation, Wireless sensor networks and IoT in disaster management.

Textbook

1. Geotechnical Instrumentation for monitoring field performance by J. Dunnicliff & G. E. Green John Wiley & Son, 1st Edition, 2007. 978-0471005469.

Reference Book

1. Geological disaster monitoring based on sensor networks by T.S. Durrani, W. Wang and S.M. Forbes, Springer Nature Hazards, 2365-0664.

URBAN STORMWATER MANAGEMENT

Course Code: **CE40059**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course will introduce students to the concepts, theories, and design methodologies for green stormwater infrastructure specifically aimed at managing urban storm water.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the basics of water and wastewater management,
CO 2: Demonstrate a functional knowledge base of the challenges and opportunities presented by urban stormwater management,
CO 3: Estimate storm water quantity using various methods,
CO 4: Plan and size different storage facilities for stormwater,
CO 5: Explore a variety of urban stormwater management Best Management Practices, and
CO 6: Size, and grade different urban storm water infrastructure.

COURSE DETAILS

Introduction – Historical Development
Basics of Water and wastewater management in urban areas: water cycle, water sources, water treatment and supply system, wastewater generation, collection and treatment approaches. Different types of wastewaters – domestic, industrial and storm water and their management, Importance of storm water management.

Estimation of Urban Storm water
Estimation of urban storm water quantity, catchment characteristics, process parameters, hydrological losses in developing, watersheds, design period, calculation of runoff and peak flow. Rational method, NRCS curve number method.

Stormwater Storage Facilities
Planning for local disposal by infiltration and percolation, roof top storage, detention ponds, storage at sewer treatment plants. Estimating the storage volumes – sizing of infiltration and percolation basins, detention facilities.

Stormwater Management
Best Management Practices (BMPs) including urban design considerations, treatment sizing and capacity, water quality benefits, maintenance, and costs. urban storm water infrastructure features - green roofs, rain gardens, bioswales, and storm water treatment wetlands.

Textbooks

1. Hormoz Pazwash, Urban storm water management, CRC Press, 2nd Edition, 2016, ISBN: 978-1-4822-9896-3.
2. Benedict, Mark A. and McMahon, Edward T. Green Infrastructure: Linking Landscapes and Communities. Washington: Island Press, 2006.
3. CPHEEO, Manual on Storm Water Drainage Systems, Ministry of Urban Development, GoI, New Delhi, 2019.
4. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
5. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, ISBN-13: 978-9351340263.

Reference Books

1. Metcalf & Eddy, Inc., Wastewater Engineering: Treatment and Reuse, Tata McGraw- Hill, 5th Edition, New Delhi, 2013
2. Sarté, S.B. Sustainable Infrastructure: The Guide to Green Engineering and Design. Hoboken, NJ: Wiley Press, 2010.

FUNDAMENTALS OF URBAN TRANSPORTATION PLANNING

Course Code: **CE40060**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course shall help students to deal with the different types of rapid transit system and public transportation systems, various planning strategies which are employed for the selection of schedule for any public transit system, and various mathematical models for urban transportation planning.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Justify the need for urban transportation system planning,
CO 2: Undertake transport surveys followed by a report,
CO 3: Plan the process of trip generation and distribution,
CO 4: Justify the need of a modal split,
CO 5: Prepare the transportation plans for urban mass rapid transit systems, and
CO 6: Prepare an optimal bus schedule according to demand of the locality.

COURSE DETAILS

Introduction
Transport and socio-economic activities, freight transportation system, future development of transportation system: BRTS, MRTS, ITS. Urban structure: urban activity system, urban movement hierarchies. Goods movement: broad classes of urban goods movement demand, classification of urban goods movement, methodology of approach to analysis of goods movement, modeling demands for urban goods transport.

Classification of roads
Arterial roads, secondary or sub-arterial roads, local road, other road: bypass road, outer and inner ring road, express way, freeway types of urban or road systems.

Urban transportation planning
Trip generation analysis, introduction, types of trip, methods of trip generation, trip production statistical analysis, category analysis or cross classification.

Mode choice and modal split
modelling, influencing factors, socioeconomic characteristic of the trip makers, characteristics of the trip, characteristics of the transportation system. factor affecting modal split, modal split in transportation planning process: trip end type modal split modal, Rip interchange modal split modal. trip interchange modal split modal, binary choice model, logit model.

Trip distribution
methods of trip distribution, uniform constant factor method, average factor method, Fractar method, Furness method, growth factor model, Gravity model, etc.

Route assignment
Objective of traffic assignment, principle of traffic assignment, assignment technique, all-or-nothing assignment, multiple route assignment, capacity restrain assignment, application of route assignment.
Optimal Bus Scheduling.

Textbooks

1. L.R Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, India, 9th Edition, 1999, ISBN: 978-81-7409-220-5.
2. C.S. Papacostas and P. D. Prevedouros, Transportation Engineering and Planning, Pearson,3rd Edition, 2015, ISBN: 9789332555150.

Reference Books

1. C.J. Khisty & B. K. Lall, Transportation Engg: An introduction, Pearson Education, 3rd Edition, 2017, ISBN: 978-9332569706.
2. P. Chakraborty and A. Das, Principles of Transportation Engineering, PHI Publication, 2nd Edition, 2017, ISBN: 978-8120353459.

LANDSLIDE HAZARDS AND PROTECTION

Course Code: **CE40061**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course aims to introduce to students on landslide phenomena and their risk evaluation. This course will help the students understand the cause of landslides, the mechanism of landslides, the prediction of landslides, and the risk assessment.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know the causes of landslides and their prediction,
CO 2: Learn various types of landslides,
CO 3: Investigate and identify Landslides,
CO 4: Learn different stability methods for rock and soil,
CO 5: Understand the concept on stabilization of soil slope as well as rock slope, and
CO 6: Understand landslide risk evaluation process and management.

COURSE DETAILS

Landslide phenomenon
Types and causes of slope failures, significance of landslide, landslide classification and processes, the impact of landslide.

Investigation of landslide phenomena

Mechanism of landslides, factor of safety, organization of investigation process, slope instability recognition and subsurface exploration, prediction of landslides.

Strength and stability analysis
Concept of instability, stability factors, soil and rock strength properties, soil slope stability analysis, rock slope stability analysis.

Landslide mitigation
Important consideration in slope design, stabilization of soil slope, stabilization of rock slope.

Landslide risk evaluation
Landslide risk perception, associated risk management, landslide protection, different case studies.

Textbooks

1. Thomas Glade, Malcolm Anderson, Michael J. Crozier, Landslide hazard and risk, John Willey and Sons Ltd., 2005.
2. John F. Shroder, Tim Davies, Landslide hazards, risk and disasters, Elsevier, 2015.

Reference Books

1. T.W. Lambe and R V Whitman, Soil Mechanics, John Wiley & Sons, 1979.
2. A. Keith Turner, Robert L. Schuster, Landslide investigation and mitigation.

EARTHQUAKE HAZARDS AND MITIGATION

Course Code: **CE40063**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to offer a methodical presentation of essentials of earthquake engineering, based on understandable mathematics and mechanics with an emphasis on engineering application. This course will help the student to understand seismic ground motions and loading on structures due to earthquake shaking. This course will also help the student to understand how the mitigation measures are taken to increase the seismic resistance of structures.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the causes and consequences of earthquake,
CO 2: Identify different types of waves generated due to earthquake,
CO 3: Understand the measurement of earthquake magnitude and intensities and different parameter of ground motions,
CO 4: Determine the liquefaction potential of a site,
CO 5: Understand seismic hazard and risk assessment, and
CO 6: Understand different type of earthquake mitigation measures.

COURSE DETAILS

Introduction to earthquake

Historical Earthquake Events. Consequences of Earthquakes. Causes of Earthquakes. Tectonic Plate Boundaries and Fault Zones, Relation of Plate Boundaries with Earthquake Occurrences.

Ground motion characterization

Definition of Earthquake Locations. Body waves, Surface Waves, Guided Waves, Measuring Seismic Motions Using Seismogram, Torsional Seismic Motions. Earthquake energy.

Magnitude and Intensity

Earthquake Magnitude. Intensity Categories, Peak Ground Motions, Peak Ground Motions and Its Relationship with Magnitude and Intensity. Contribution of Body and Surface Waveto Ground Motions. Attenuation Relationship and Uncertainties. Approximation of Ground Motion Duration.

Liquefaction

Definition of liquefaction. Mechanism of liquefaction, Factors affecting liquefaction. Evaluation of liquefaction potential. Evaluation of the effects of liquefaction.

Seismic Hazard and Risk Assessment

Identification and evaluation of earthquake source. Hazards due to earthquakes. Introduction to deterministic and probabilistic seismic hazard analysis. Seismic Hazard Map.

Earthquake Mitigation Measures

Mitigation of Tsunami Hazard, Mitigation Measures of Soil Liquefaction: Soil compaction, Grouting and chemical stabilization, Application of surcharge, Drainage using coarse Materials. General Principles of Earthquake-Resistance Design.

Textbook

1. Steven Lawrence Kramer, Geotechnical Earthquake Engineering, Pearson Education India, 1st Edition, 2003, ISBN-13: 978-8131707180.

Reference Book

1. Junbo Jia, Modern Earthquake Engineering, Springer-Verlag Berlin and Heidelberg GmbH & Co. KG, 1st Edition, 2017, ISBN-13: 978-3642318535.

GEO-HAZARDS RISK MANAGEMENT

Course Code: **CE40065**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to introduce various geohazards. This course will help the students to understand the various engineering and scientific concept behind the geohazards. This course primarily focused on geohazards like earthquake, lands slides and groundwater contamination. It will make students familiar with the various causes and mitigation of various geohazards.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn various types geohazards,
CO 2: Understand the characterization of geomaterial,
CO 3: Understand the various causes of landslides and methods of slope protection,
CO 4: Understand earthquake hazards and mitigation,
CO 5: Learn groundwater contamination and remediation, and
CO 6: Learn about various instrumentation and monitoring system for geohazards.

COURSE DETAILS

Introduction
Introduction to various geological hazards like earthquake, landslides, tsunami, volcanic eruption, flood, drought, and meteorite impact.

Geomaterial characterization
Formation of rock, type of rock, weathering process, geological cycle, geological features of rock, joints in rock, classification of rock, basic geotechnical properties of soil and rocks.

Landslide hazards and protection
Introduction, causes of landslides, landslides type and predictability, factor effecting landslides, mechanism of landslides, methods of slope protection, mitigation measures.

Earthquake hazards and mitigation
Historical data on earthquake, Introduction to the seismology, tectonic plates movement, types of waves, quantification of earthquake, site response, liquification assessment and its remediation, concept of earthquake resistance building design, Micro-zonation and earthquake risk assessment. Strengthening of earthquake damage structures.

Groundwater contamination and remediation
Origin of Groundwater Contamination, Classification of Groundwater Contamination, Transport Mechanism, GE for Contaminant Transport in Saturated Porous Media, remedial measures for contaminated ground water.

Instrumentation and monitoring
Field and laboratory pore water pressure measurement, embedment gauge, inclinometer, settlement monitoring, surface extensometer, Terrestrial, deflectometer, earthquake measuring instrument, surface movement monitoring using field instrument and GPS system.

Textbook

1. F.G. Bell, Geological hazards their assessment, avoidance and mitigation, E & FN Spon London, 1st Edition, 1999, ISBN:0-419-16970-9.

Reference Books

1. B.A. Bolt, W.L. Horn, G.A. Macdonald and R.F. Scott, Geological hazards, Springer-Verlag, New York, 2nd Edition, 1977, ISBN: 978-0-387-90254-8.
2. S.L. Kramer, Geotechnical earthquake engineering, Prentice Hall, 3rd Edition, 2009, ISBN: 9788131707180, 8131707180.

TRAFFIC ANALYSIS AND MANAGEMENT

Course Code: **CE40067**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To introduce the advances in traffic engineering analysis and design and to make the students conversant with relevant field applications.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Describe the main characteristics of traffic flow,
CO 2: Represent traffic phenomena using different methods and tools,
CO 3: Recognize how traffic congestion starts and propagates,
CO 4: Select and apply appropriate methods and techniques for analyzing traffic-related problems,
CO 5: Interpret and elaborate different type of traffic data, and
CO 6: Learn the elements of design of various traffic facilities.

COURSE DETAILS

Introduction
Elements of traffic engineering, road users, vehicles, highways and control devices.

Fundamentals of Traffic flow
Road user and vehicle characteristics, Speed flow and density concepts, Microscopic and macroscopic parameters of traffic flow, fundamental relationships between speed flow and density, Traffic studies, PCU, peak hour factor, accident study and analysis.

Traffic Operation and Control
Delay concepts, Highway capacity and level of service of different traffic facilities, Traffic control and regulation devices, Signal design by Webster's method, Types of intersections and channelization, Introduction to Intelligent Transportation System.

Management Techniques
Traffic calming devices, Traffic signs, Congestion, and road user pricing; priority movements; traffic regulations and control systems; use of intelligent systems.

Textbooks

1. S.K. Khanna, M.G. Arora and S.S. Jain, Airport Planning and Design, Nem Chand & Bros., Roorkee, India, 6th Edition, 2012, ISBN: 81-85240-68-10.
2. L.R Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, India, 9th Edition, 1999, ISBN: 978-81-7409-220-5.

Reference Books

1. C.J. Khisty & B. K. Lall, Transportation Engg: An introduction, Pearson Education, 3rd Edition, 2017, ISBN: 978-9332569706.
2. P. Chakraborty and A. Das, Principles of Transportation Engineering, PHI Publication, 2nd Edition, 2017, ISBN: 978-8120353459.

RAILWAY AND AIRPORT PLANNING

Course Code: **CE40069**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course helps students to understand about the technical aspects of railway, and airport engineering. The students are made familiar with the design of railway tracks, the concepts of gauges and elements of design. In airport engineering, the students learn the factors affecting site selection of airports, the design of runways, and taxiway.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn the basics of Airport and Railway Engineering,
CO 2: Know the function of various components of permanent way,
CO 3: Understand the geometric design of railway track,
CO 4: Know the layout and planning of airport,
CO 5: Understand the elements of geometric design of airport, and
CO 6: Know the design of runway and taxiway.

COURSE DETAILS

Introduction to Railway Engineering
Role of Indian Railways in National Development – Railways for Urban Transportation – LRT & MRTS - Engineering Surveys for track alignment (Conventional and modern methods), Permanent way components – Cross section of Permanent Way – Function of various components like rails, sleepers and ballast, Gauge – Creep of rails – Theories related to creep – Sleeper density.

Geometric Design of Railway Track
Gradients – Grade compensation – Cant and negative super elevation – Cant deficiency – Degree of curve, Points and Crossing, Rail joints & welding of joints, Railway station & yards, Signalising & interlocking.

Airport Planning

Air transport characteristics, airport classification, airport planning: objectives, components, layout characteristics, and socio-economic characteristics of the catchment area, criteria for airport site selection and ICAO stipulations, typical airport layouts, Parking and circulation area.

Airport Design: Runway Design: Orientation, Wind Rose Diagram, Runway length, Problems on basic and Actual Length, Geometric design of runways, Configuration and Pavement Design Principles, Elements of Taxiway Design, Airport Zones, Passenger Facilities and Services, Runway and Taxiway Markings and lighting.

Textbooks

1. S Chandra and M.M. Agarwal, Railway Engineering, Oxford University Press India, 2nd Edition, 2013, ISBN: 9780198083535.
2. S.K. Khanna, M.G. Arora and S.S. Jain, Airport Planning and Design, Nem Chand & Bros., Roorkee, India, 6th Edition, 2012, ISBN: 81-85240-68-10.

Reference Books

1. S.C. Saxena and S.P. Arora, A Textbook of Railway Engineering, Dhanpat Rai Publishing Co Pvt Ltd, 2015, ISBN: 9789383182923.
2. R.M. Horonjeff and F.X. Mckelvey, Planning and Design of Airports, McGraw-Hill Education, New York, 5th Edition, 2010, ISBN: 9780071446419.
3. R.L. de Neufville and A.R. Odoni, Airport Systems - Planning, Design and Management, McGraw-Hill Education, New York, 2nd Edition, 2013, ISBN:978-0071770583.

ROAD SAFETY ANALYSIS

Course Code: **CE40071**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To introduce the concepts of traffic safety on highways and to make students familiar with related analytical methods and remedial measures.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know the scenario of road crashes in India and deaths accompanied,
CO 2: Understand the steps of crash investigation,
CO 3: Learn various statistical techniques to model road crashes,
CO 4: Know various traffic management techniques to improve road safety,
CO 5: Understand the process of road safety auditing, and
CO 6: Know about various Indian and world guidelines and codes targeting improvement of road safety.

COURSE DETAILS

Introduction

Road traffic accidents scenario in India, characteristics of accidents, accident vs. crash, effect of human factors, planning for road network, land use and road environment for safety, designing for road safety — links and junctions, road safety improvement strategies.

Crash investigation and analysis
Steps in treatment of crash locations, diagnosing crash problem and solutions, accident report form, storing of data, using and interpreting crash data, identifying and prioritizing hazardous locations, condition and collision diagrams; Vulnerable road users: crashes related to pedestrian and bicyclists, their safety, provision for disabled.

Statistical analysis of accidents
Descriptive statistics, confidence interval, hypothesis testing, models related to accident frequency, accident severity.

Before -after methods in crash analysis
Before and after study, before and after study with control sites, comparative parallel study, before, during and after study.

Traffic management system
Traffic flow improvements, expressway patrol, public transit, ridesharing, mobility rest areas, park-and-ride lots, bus bays, signage, markings; ITS applications - vehicular navigation, crash avoidance system, incident management, traffic management centre, highway side communication.

Road safety audits
Procedure, aims and objectives, roles and responsibility, history of road safety audit, design standards, tasks, various stages of safety audits; common identifiable problems, structuring of report, identifying common problems.

Textbook

1. L.R Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, India, 9th Edition, 1999, ISBN: 978-81-7409-220-5.

Reference Books

1. American Association of State Highway and Transportation Officials (AASHTO), Highway Safety Manual, AASHTO, 1st Edition, 2010, ISBN: 978-1560514770.
2. Relevant AASHTO/ IRC and other Codes and Specifications.

DISASTER MANAGEMENT

Course Code: CE40081
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course shall inculcate deep knowledge about various types of disasters like Flood, Cyclone, and Earthquake. It shall help students to learn about the causes that lead to disaster and understand the quantitative analysis of

losses caused by disaster. It shall also help students to learn about the methodology and techniques used in disaster management.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand foundations of hazards, disasters and associated natural/social phenomena,
CO 2: Familiar with disaster management theory (cycle, phases),
CO 3: Learn about the technological innovations in Disaster Risk Reduction (DRR),
CO 4: Know about humanitarian assistance before and after disaster,
CO 5: Know various methods of community involvement as an essential part of successful DRR, and
CO 6: Gain experience on conducting independent DM study including data search, analysis, and presentation of disaster case study.

COURSE DETAILS

Introduction to Disaster Management
Hazards and Disasters, Introduction, Types of Disasters, Major disasters in history, Developing appropriate technology for disaster mitigation, Role of management teams, Importance of awareness alertness and preparedness camp.

Earthquake
Causes of earthquake, Plate tectonics, Seismic zoning map, Characteristics of strong, ground motions& attenuation damage assessment.

Tsunami
Formation of Tsunami, Warning systems for Tsunami, Prevention measures before Tsunami, After-effects of Tsunami.

Flood
Hydrograph - concept and uses, Flood and its estimation, Flood early warning system, Flood protection measures, After-effects of floods and disaster mitigation strategies.

Cyclones
Introduction to cyclone, wind speed, eye of the storm, formation of cyclone and anticyclones, types of cyclones and nomenclature, cyclone warning system, prevention measures for cyclones, after-effects of cyclones.

Textbook

1. R. Subramanian, Disaster Management, Vikas Publishing House, 2018, ISBN-13: 978-9352718702.

Reference Books

1. K Subramanya, Engineering Hydrology, McGraw Hill, 5th Edition (20 September 2020), ISBN-13: 978-9390177509.
2. Neelam Sharma, Earthquake Resistant Building Construction, S.K. Kataria & Sons; Reprint 2013 Edition (1 January 2013), ISBN-13: 978-9350142042.
3. NDRF report on “SOP for Capacity Building of State Disaster Response force”.
4. NDRF report on “SOP for Effective Coordination and Cooperation During Disaster Response”.

GLOBAL WARMING AND CLIMATE CHANGE

Course Code: **CE40082**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course deals with various environmental issues and their adverse effects on ecosystem. It also includes basics of atmosphere, atmospheric stability assessment, pollution dispersion and the radiative effects of air pollutants (gases and particulate matter). In addition to that it covers greenhouse gases, global warming phenomenon, causes and effects of global warming, climate change consequences and mitigation measures.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the sources of air pollutants and understand the effects of air pollutants on health and environment,
CO 2: Classify the air pollutants and understand their impacts on global warming,
CO 3: Understand the meteorological parameters and their effect on dispersion of air pollutants into the atmosphere,
CO 4: Acquire knowledge on fundamentals of climate change due to global warming,
CO 5: Understand the issues of climate change, and
CO 6: Understand the social and economic impacts of climate change.

COURSE DETAILS

Atmosphere and Air Pollutants
Structure of the atmosphere, Natural and anthropogenic sources of pollution, Atmospheric sources, Effects of air pollution on human health, vegetation and animals, building materials and structures, atmosphere, soil and water bodies, Gaseous and particulate matter, Primary pollutants, Secondary pollutants, Criteria pollutants, Hazardous pollutants, greenhouse gases.

Meteorological parameters and Air Pollution
Lapse rates, atmospheric stability, plume behaviour, boundary layer, mixing height, stack height and Plume rise.

Climate Science & Fundamentals of Climate Change
Weather, Climate and Climate Change – An Introduction, Basic Elements of Global Climate, Solar Radiation & Energy Balance, Inter-Year Climate Change.

Anthropogenic Global Warming & Climate Change
Anthropogenic Character of Global warming, Intergovernmental Panel on Climate Change, UNFCCC 1992 & International Conferences on Climate Change, Major UN Climate Change Conferences till date.

Social and Economic Impacts of Climate Change
Elements of Economics of Climate Change, Carbon Trading, Urban Climate Change, Climate Change & Human Migration.

Textbook

1. M.K. Ghosh Roy, Global Warming and Climate Change, Medtech, 1st Edition, 2023, ISBN: 9789384007737.

Reference Books

1. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
2. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, 2017, ISBN-13: 978-9351340263.
3. Gopal Bhargava, Global Warming and Climate Changes Transparency and Accountability (Vol. 3), Gyan Publishing House 2004.

COASTAL MANAGEMENT

Course Code: CE40083
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course deals with the needs to create balance knowledge between coastal zone development and protection of natural resources. The goals are to "preserve, protect, develop, enhance, and restore" the coastal resources wherever possible.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn about estuaries, wetlands, lagoons, and of the uses of and stresses on the coastal zone,
CO 2: Study the classification, characteristics, and theories of waves, tides and currents,
CO 3: Learn about coastal erosion, sea level change, and coastal structures,
CO 4: Study seawater intrusion, desalination, and anthropogenic impacts on wetlands, mangroves and coral reefs,
CO 5: Learn about coastal zone management and the applications of remote sensing and geographical information systems in coastal zone management, and
CO 6: Understand social impact assessment and other developmental activities.

COURSE DETAILS

Introduction
Origin of coasts, wind, waves, ocean currents, tides, wave theories (basics), wave forces.

Coastal process
wave shoaling, wave refraction, wave diffraction, wave reflection, wave breaking, types of breakers, Wave run-up, beach profile, beach process.

Coastal erosion & protection
Erosion process, causes for erosion, littoral drift, protection works using seawall, Groins, Jetties, off-shore breakwaters, artificial beach nourishment, new technologies of shore protection.

Coastal Zone Management
Coastal Zone Management and Remote Sensing & GIS Applications, Concepts and Development, Database for Coastal Zone Management.

Remote Sensing Data for CZM, GIS
Concepts and Models Used in Coastal Zone.

Environmental impact assessment
Concept of coastal eco-systems, coastal pollution and its implications, Environmental Impact Assessment (EIA), Evaluation and Methodology, Social Impact Assessment and other developmental activities.

Textbooks

1. Herbich, Hand Book of Coastal and Ocean Engineering, Gulf publishing Company, 1st Edition, 2000, ISBN:9780071508230, 0071508236.
2. Beatley, Brower, and Schwab, An Introduction to Coastal Zone Management, Island Press, 2nd Edition, 2002, ISBN: 9781559639156, 1559639156.

Reference Books

1. Bartlett and Smith, GIS for Coastal Zone Management, United Kingdom: CRC Press LLC, 2019, ISBN: 9780367393977, 0367393972.
2. Sundar and Sannasiraj, Coastal Engineering: Theory And Practice, World Scientific Publishing Company, 2019, ISBN:9789813275928, 9813275928.
3. Brunn, Port Engineering, 4th ed. (Vol 1 & 2), Gulf Publishing Company, 1981.

CONSTRUCTION MATERIALS AND SPECIFICATIONS

Course Code: **CE40084**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enable the students to understand the various type of construction materials such as bricks, cement, concrete, bitumen, geosynthetic along with non-structural materials used for construction purpose and their specifications.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know and understand the necessities of specifications of the materials with respect to quality and quantity for a construction work,
CO 2: Know the engineering specifications containing detailed description of all workmanship and materials for a complete project in accordance with plan and drawings,
CO 3: Know the specifications regarding the quality of workmanship to be achieved during construction,
CO 4: Manage creative teams and project processes effectively and efficiently,
CO 5: Understand the specification and applications of geosynthetic materials, and
CO 6: Know the specification of materials used for thermal insulation, acoustic, water proofing and flooring.

COURSE DETAILS

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

Cement and concrete
Classification, Chemical composition, Cement manufacturing process, Tests on cement. Composition of concrete, W/C ratio, Nominal mix design, pozzolanic concrete, Light weight and high density concrete, Tests on concrete.

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

Bitumen
Manufacturing of Bitumen, Tests on bitumen, Grades of bitumen.

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

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

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

Textbooks

1. M.L. Gambhir, Neha Jamwal, Building Material, 1st Edition, TMH Education, New Delhi, 2017.
2. P.C. Verghese, Building Material, PHI Learning (P) Ltd., New Delhi, 2005.

Reference Books

1. S.K. Sharma, A Textbook of Building Construction, Revised Edition, S. Chand Publication.
2. S.S. Bhavikatti, Building Material, 1st Edition, Vikas Publication.
3. B.C. Punmia, Jain and Jain, Building Construction, Jain and Jain, 10th Edition, Laxmi Publication, New Delhi.
4. P.C. Verghese, Building Material, PHI Learning (P) Ltd., New Delhi, 2005.
5. S.C. Rangwala, Engineering Materials, Charotar Publishing House, 2011.

BASIC GROUNDWATER HYDROLOGY

Course Code: **CE40085**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To learn and use the knowledge of groundwater hydrology and understand the formations, well hydraulics, groundwater pollution and artificial recharge

COURSE OUTCOMES

At the end of the course, the student will be able to

CO 1: Analyze different formations and estimate hydraulic conductivity,
CO 2: Analyze well hydraulics for steady and unsteady flow in aquifer,
CO 3: Explain the construction of shallow and deep wells,
CO 4: Analyze pollution and quality of groundwater,
CO 5: Identify modern methods of groundwater exploration, and
CO 6: Describe various methods of artificial recharge of groundwater.

COURSE DETAILS

Occurrence and Movement of Ground Water
Origin & age of ground water, rock properties affecting groundwater, zones of aeration & saturation, aquifers and their characteristics/classification, groundwater basins & springs, Darcy's Law, permeability & its determination, Dupuit assumptions, heterogeneity &anisotropy, Ground water flow rates & flow directions, general flow equations through porous media.

Well Hydraulics
steady/ unsteady, uniform/ radial flow to a well in a confined/ unconfined /leaky aquifer, well flow near aquifer boundaries/ for special conditions, partially penetrating/horizontal wells & multiple well systems, well completion/ development/ protection/ rehabilitation/ testing for yield.

Pollution and Quality Analysis of Ground Water
Municipal / industrial / agricultural / miscellaneous sources & causes of pollution, attenuation / underground distribution / potential evaluation of pollution, physical /chemical /biological analysis of ground water quality, criteria & measures of ground water quality, ground water salinity & samples.

Artificial Ground Water Recharge
Concept & methods of artificial ground water recharge, recharge mounds & induced recharge, wastewater recharge for reuse, water spreading.

Textbook

1. D.K. Todd and L.F. Mays, Groundwater Hydrology, John Wiley and sons.

Reference Books

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

NATURAL RESOURCES MANAGEMENT

Course code: **CE40086**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

To learn and use the knowledge for planning, management, utilization and sustainability of natural resources.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand ecological footprint & interrelationship among different natural resources,
CO 2: Identify basic management issues related to forest and land,
CO 3: Prepare strategies related to water and minerals,
CO 4: Prepare approaches for NRM,
CO 5: Implement PRA concept, and
CO 6: Identify technology and methods for NRM.

COURSE DETAILS

Introduction to Natural Resource Bases
Concept of resource, carrying capacity, ecological foot print and sustainability; Natural resources of different geographical regions of India; Factors influencing resource availability, distribution and uses; Interrelationships among different types of natural resources; Concern on productivity issues.

Resource Management Paradigms
Evolution of resource management paradigms, resource extraction, access and control system, Basic management issues, associated with key natural resources viz. Forest, Land, Water, and Minerals.

Approaches in Resource Management
Ecological approach; economic approach; ethnological approach; implications of the approaches; participatory rural appraisal (PRA); role of indigenous knowledge in Natural Resources Management (NRM).

Technologies for NRM
Farmers' field-based technologies and tools for NRM; Case studies from few agro-ecological zones of India; Various crop models, land-use models, nutrient models; Multi-criteria-decision analysis (MCDA); Precision farming technologies (PFT); Information Communication Technologies (ICT) for NRM.

Textbooks

1. E.P. Odum, Fundamentals of Ecology: W.B. Saunders Co. USA, 574p (Indian Edition), 2005.
2. D.R. Lynch, Sustainable Natural Resource Management: For Scientists and Engineers, Publisher: Cambridge University Press, 2009.

References Books

1. M.C. Dash, Concepts of Environmental Management for Sustainable Development Publisher: I K International Publishing House Pvt. Ltd., 2013.

CLEAN WATER & SANITATION

Course Code: **CE40087**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enable the students to understand and appreciate the importance of clean water and sanitation with special reference to Sustainable Development Goal 6.0, and learn the various treatment strategies to provide safe and affordable drinking water to all and treated wastewater for safe recycling or reuse.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Appreciate the importance of water as recognized in Sustainable Development Goal 6.0,
CO 2: Recognize the parameters responsible for pollution of water,
CO 3: Understand the physical, chemical and biological parameters of water,
CO 4: Learn about the various strategies used for safe and affordable drinking water,
CO 5: Understand the physical, chemical and biological parameters of wastewater, and
CO 6: Learn about the various sanitation systems and adopt strategies used for improving the wastewater treatment and safe recycling or reuse.

COURSE DETAILS

Introduction to Clean Water and Sanitation
Introduction to Sustainable Development Goal 6.0, Current scenario in accessibility to safe and affordable drinking water and the future needs, Need for reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, treatment and recycling or reusing of treated wastewater.

Drinking water quality as per Indian & International standards
Physical, chemical and biological characteristics of water as per IS 10500: 2012 and WHO 2017.

Treatment strategies for drinking water
Introduction to water treatment system, schematic of water treatment plant for ground water and surface water, Aeration, coagulation, softening: lime-soda process and ion exchange process, flocculation, sedimentation, filtration, disinfection - chlorination and ozonation.

Wastewater characteristics and discharge standards
Physical, chemical and biological characteristics of wastewater, Discharge standards as per The Environment (Protection) Rules, 1986 and USEPA.

Introduction to Sanitation Systems and Treatment strategies of Wastewater for recycling or safe reuse
Sanitation systems - Introduction to wastewater, Class of water based on designated-best-use, different types of wastewaters, Conservancy system of sanitation, water carried sewerage system.

Treatment strategies - (1) Treatment options for sewered areas – primary, secondary and tertiary treatment units: description and applications. (2) Treatment options for non-sewered areas - oxidation ponds, Septic tank, Imhoff tank.

Textbooks

1. S.K. Garg, Environmental Engineering (Vol. I) Water Supply Engineering, Khanna Publishers, 36th Edition, 2022, ISBN-13: 978-81-7409-120-8.
2. S.K. Garg, Environmental Engineering (Vol. II) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, 42nd Edition, 2022, ISBN-13: 978-81-7409-230-4.
3. H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Environmental Engineering, McGraw Hill, 7th Edition, ISBN-13: 978-9351340263.

Reference Books

1. IS: 10500 – 2012 Indian Standard Drinking Water – Specification.
2. The Environment (Protection) Rules 1986, General Standards for Discharge of Environmental Pollutants Part-A: Effluents, Schedule VI.

BASIC TRANSPORTATION ENGINEERING

Course Code: **CE40088**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enable the students to understand and appreciate the importance of transportation engineering and learn the various modes of transportation. The students shall learn the basic technicalities of highway engineering, railway engineering, airport, tunnel, dock, and harbor engineering.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand highway system,
CO 2: Learn about the different materials used in highway construction,
CO 3: Know about the other modes of transportation engineering,
CO 4: Gain basic knowledge about railway system,
CO 5: Understand airport system, and
CO 6: Understand docks & harbours system.

COURSE DETAILS

Highway Engineering
Introduction to Transportation Systems, Road Development in India, Highway Engineering – Classification of Roads, Highway Planning - Road cross section - camber, gradient, Super elevation - Sight distance - Horizontal and Vertical curve, Highway Materials- Soil & Soil properties, Bitumen and bituminous mixes – sources, composition, characterization, various forms - Tests on bitumen- Aggregate test, mix design - Types of

pavement – pavement construction and maintenance, Traffic engineering- various studies, Level of Service, Intersections, Road signs, markings & signals, Highway Parking.

Railway Engineering
Introduction, Development & Administration of Indian Railway, Railway surveying, Rolling Stock & track resistances, Tractive power & Tractive resistances, Permanent way, Railway gauges, Sleepers, Ballast, Track design, Stations & yards, Station Equipment, Signalling, High speed Trains, Train Accidents-Causes & Prevention.

Airport Engineering
Administration, Advantages & Disadvantages of Air transport, Aircraft Characteristics, Airport Obstructions, Typical layout of Airports – Component parts – Objectives of components – Runways – Taxiways – Aprons – Landing, Helicopters, Air traffic control, Airport Marking & Lightning.

Tunnel Engineering
Introduction-Advantages, disadvantages, economics & selection, Classification of tunnels, Design of shape & size of tunnels, Components of Tunnel, Methods of tunneling, Precautions, Tunnel Lining & drainage.

Docks & Harbor Engineering
Introduction, Classification & Requirements of ports, harbor, docks, Maintenance of ports & harbours, advantages of docks, Transit shed & warehouse, Tides, wind & waves, Different components of docks, Navigational aids, Breakwater.

Textbook

1. S.P. Chandola, A Textbook of Transportation Engineering, S. Chand (G/L) & Company, 1st Edition, 2001, Revised 2016, ISBN-13: 978-8121920728.

Reference Books

1. V.N. Vazirani & S. P. Chandola, Transportation Engineering Vol. I, Khanna Publishers, 5th Edition (1 January 1998), ISBN-13: 978-9387394292.
2. Amit Gupta & B.L. Gupta, Roads, Railways, Bridges, Tunnels & Harbour Dock, Standard Publishers Distributors (1 January 2009), ISBN-13: 978-8180140099.
3. Rangwala, Highway Engineering, Charotar Publishing House Pvt. Ltd., 10th edition (1 January 2015), ISBN-13: 978-9385039096.
4. S. C. Saxena and S. P. Arora, A Textbook of Railway Engineering, Dhanpat Rai Publications, New Delhi, (1st January 2010), ISBN-13: 978-8189928834.
5. Norman J. Ashford, Saleh Mumayiz, Paul H. Wright, Airport Engineering: Planning, Design, and Development of 21st Century Airports, Wiley, 4th Edition.
6. Rangwala, Railway Engineering, Charotar Publishing House Pvt. Ltd, 27th Edition, ISBN-13: 978-9385039249.
7. H.P. Oza & G.H. Oza, Dock & Harbour Engineering, Charotar Publishing House Pvt Ltd, 7th Edition, ISBN-13: 978-9380358789.

PROJECT - I

Course Code: CE47001
Credit: 5
L-T-P: 0-0-10

Prerequisite: Nil

COURSE OBJECTIVE

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 advanced technical domain. The work encompasses two semesters and to be carried out in two phases. 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

After successfully completing the course, the students will be able to

CO 1: Conduct a detailed research survey or background study and summarize the theory and findings,
CO 2: Formulate a general objective of the project,
CO 3: Propose and outline the solution to the 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,
CO 4: Conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions,
CO 5: Function effectively as an individual, and as a member or leader in a team under multidisciplinary settings following ethical practices, and
CO 6: Communicate effectively with a range of audiences and prepare technical reports.

PROJECT - II

Course Code: CE47002
Credit: 9
L-T-P: 0-0-18
Prerequisite: Nil

COURSE OBJECTIVE

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

After successfully completing the course, the students will be able to

CO 1: Readily apply fundamental concepts in their area of study for executing the projects,
CO 2: Demonstrate skill in using modern technical tools, apply advanced technical knowledge and integrate information from different sources, perform complex experiments and critically analyze the findings to draw conclusions,
CO 3: Provide engineering solutions to predefined 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,

CO 4: Function effectively as an individual, and as a member or leader in a team under multidisciplinary settings following ethical practices,
CO 5: Communicate effectively with a range of audiences and prepare detailed technical reports, and
CO 6: 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.

RESEARCH PROJECT - I

Course Code: **CE47003**
Credit: **5**
L-T-P: **0-0-10**
Prerequisite: **Nil**

COURSE OBJECTIVE

Students are required to undertake a final year major project either as an individual or in a group in consultation with the project supervisor which may be completed in one year. The project should be related to certain research objective. The work encompasses two semesters and to be carried out in two phases. In Research 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 supervisor and the panel.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Conduct a detailed research survey or background study and summarize the theory and findings,
CO 2: Formulate a research question of the project,
CO 3: Propose and outline the solution to the research question with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors,
CO 4: Conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions,
CO 5: Function effectively as an individual, and as a member or leader in a team under multidisciplinary settings following ethical practices, and
CO 6: Communicate effectively with a range of audiences and prepare technical reports.

RESEARCH PROJECT - II

Course Code: **CE47004**
Credit: **12**
L-T-P: **0-0-24**
Prerequisite: **Nil**

COURSE OBJECTIVE

Research Project-II is a continuation of Research Project-I. 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 research report on their work as well as individual contribution

reports. Throughout the implementation of the project, students should demonstrate all cognitive skills and attainment of all program outcomes and student outcomes.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Readily apply fundamental concepts in their area of study for executing the projects
CO 2: 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
CO 3: Provide engineering solutions to predefined research question**,** design system components or processes with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
CO 4: Function effectively as an individual, and as a member or leader in a team under multidisciplinary settings following ethical practices
CO 5: Communicate effectively with a range of audiences and prepare detailed technical reports
CO 6: 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

INTERNSHIP

Course Code: CE48001
Credit: 2
L-T-P: ---
Prerequisite: Nil

COURSE OBJECTIVE

In this course, the students will get opportunity to explore career augmentation aspects prior to graduation, integrate theory and practice, assess interests and abilities in their field of study, learn to appreciate work and its function in the economy, develop work habits and attitudes necessary for job success, develop communication, interpersonal and other critical skills in the job interview process and build a record of work experience.

COURSE OUTCOMES

On completion of the internship, the students will be able to

CO 1: Apply engineering knowledge in solving real-life problems,
CO 2: Acquire new skills in the engineering disciplines of their own interest,
CO 3: Get exposure to real-life-working environment practices, and to attain the professionalisms,
CO 4: Work with multi-tasking professionals and multidisciplinary team,
CO 5: Prepare a technical report, to improve presentation and other soft skills, and
CO 6: Learn to appreciate work and its function in the economy.

WATER RESOURCES LABORATORY

Course Code: CE49001
Credit: 2
L-T-P: 0-0-4

Prerequisite: Nil

COURSE OBJECTIVE

To learn different principles of flow, flow measuring devices, various losses in pipes and perform statistical analysis of hydrological time series, uses of GPS and GIS in water resources domain.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Determine the metacentric height of floating body & different regimes of flow using Reynold's apparatus,
CO 2: Verify Bernoulli's theorem and determine coefficient of discharge of venturimeter, orificemeter and notches,
CO 3: Estimate major and minor losses through pipes,
CO 4: Perform different statistical analysis of hydrological time series using excel,
CO 5: Use GPS system and GIS principles for area delineation, and
CO 6: Perform spatial interpolation of hydrological data.

COURSE DETAILS

Part-I: Hydraulics & WR Lab: (2 hours per week)

- Determine the metacentric height of floating body
- Determination of different regimes of flow by Reynold's apparatus
- Verification of Bernoulli's theorem
- Determination of Coefficient of Discharge (C_d) of Venturi meter
- Determination of Coefficient of discharge (C_d) of Orifice meter
- Determination of hydraulic coefficients (C_c, C_v, C_d) of Circular Orifice
- Determination of Coefficient of Discharge (C_d) of Triangular Notch
- Determination of Coefficient of Discharge (C_d) of Rectangular Notch
- Determination of Darcy's friction factor for different pipes
- Determination of Minor losses in pipes

Part-II: Water Resources Computational Lab: (2 hours per week)

- Excel based hydrological data Analysis-I (Basic Statistics)
- Excel based hydrological data Analysis-II (Probability Analysis)
- Excel based hydrological data Analysis-III (DAD curve preparation)
- Excel based hydrological data Analysis-IV (IDF curve preparation)
- Infiltration Analysis & Model Fitting-I (Experiment based infiltration capacity)
- Infiltration Analysis & Model Fitting-II (Fitting different infiltration models)
- Use of GPS system for area delineation
- GIS based delineation of catchment-I
- GIS based delineation of catchment-II
- Spatial Interpolation of hydrological data using GIS

Reference Books

1. Hydraulics and Water resources Engineering Laboratory Manual, School of Civil Engineering, KIIT Deemed to be University, Bhubaneswar

2. R.K. Bansal, A Textbook of Fluid Mechanics & Hydraulic Machines, Laxmi Publications (P) Ltd., 10th Edition.
3. P.A. Burrough and R.A. McDonnell, Principles of Geographical Information Systems, Oxford University Press, UK.
4. M.F. Goodchild, P.A. Longley, D.J. Maguire and D.W. Rhind, Geographic Information Systems and Science, John Wiley & Sons Ltd., England.
5. Satheesh Gopi, Global Positioning System: Principles and Applications by, McGraw Hill Education.

ENVIRONMENTAL QUALITY LABORATORY

Course Code: **CE49003**
Credit: **2**
L-T-P: **0-0-4**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enable the students to determine the physical, chemical and biological characteristics of water and wastewater. and assess the noise pollution.

COURSE OUTCOMES

After successfully completing the course, the students will be able to
CO 1: Determine pH and turbidity of a water sample,
CO 2: Determine alkalinity, hardness and chlorides present in a water sample,
CO 3: Determine optimum dosage of coagulant based on the solids present in a water sample,
CO 4: Determine dissolved oxygen present in a water sample,
CO 5: Determine BOD present in a water sample, and
CO 6: Assess the noise pollution through measurement of sound pressure level.

COURSE DETAILS

- Determination of pH of water sample
- Determination of turbidity of water sample
- Determination of Total Alkalinity of water sample
- Determination of Total Hardness of water sample
- Determination of concentration of chlorides in water sample
- Determination of Total Suspended Solids, Total Dissolved Solids and Total Solids present in water sample
- Determination of Optimum coagulant dosage based on the solids present
- Determination of dissolved oxygen in water sample
- Determination of BOD in water sample
- Measurement of sound pressure levels using Sound Level Meter

Textbooks

1. IS: 3025 – 2019, Methods of sampling and test (Physical and Chemical) for water and wastewater.
2. IS: 10500 – 2012 Indian Standard Drinking Water – Specification.

3. S.K. Garg, Environmental Engineering (Vol. I) Water Supply Engineering, Khanna Publishers, 36th Edition, 2022, ISBN-13: 978-81-7409-120-8.

Reference Book

1. C.N. Sawyer and Perry L. McCarty, Chemistry for Environmental Engineering, 5th Edition, McGraw-Hill Education, 2002, ISBN-10: 0072480661.

GEOMATERIAL LABORATORY

Course Code: **CE49005**
Credit: **2**
L-T-P: **0-0-4**
Prerequisite: **Nil**

COURSE OBJECTIVE

This laboratory encompasses basic tests to ascertain soil and rock properties like Atterberg limits, in-situ density, specific gravity, water absorption, porosity, permeability, determination of soil's consolidation parameters, determination moisture content and dry density relationship and shear strength parameters of soil using direct shear, uunconfined shear, vane shear, unconfine compression strength of rock and triaxial shear method.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the types of soil and rock,
CO 2: Determine the change in properties of soil with the water content,
CO 3: Learn various laboratory test procedures normally used in geotechnical engineering for soil and rock,
CO 4: Determine index and shear strength properties of soils,
CO 5: Determine hydraulic properties of soils and
CO 6: Determine compaction and consolidation properties of soils.

COURSE DETAILS

- Introduction to different types of soil, rock, soil-water interaction, various soil properties and their test methods.
- Determination of Specific Gravity of soil and rock by pycnometer test.
- Grain size Analysis (Dry and Wet sieving method).
- Determination of Atterberg Limit.
- Determination of Dry Density of Soils in place by the core-cutter and sand replacement method.
- Determination of Permeability of soil (falling head or constant head method).
- Determination of basic properties of rock (water absorption, density, porosity etc.).
- Determination of compaction property of soil.
- Unconfine compression test of rock core.
- Determination of shear parameters by direct shear test.

- Determination of shear parameters by unconfined compression test.
- Determination of shear parameters by triaxial (unconsolidated undrained) shear test.
- Determination of consolidation parameters of soil.

Textbook

1. B.C. Punmia, Ashok K. Jain & Arun Kumar Jain, Soil Mechanics & Foundation Engineering, Laxmi Publication, New Delhi, 17th Edition, 2017.

Reference Books

1. Geotechnical Engineering Laboratory Manual, School of Civil Engineering, KIIT (DU).
2. IS: 2720 (Part 2) (1973). Methods of test for soils: Laboratory determination of Water Content.
3. IS: 2720 (Part 3) (1980). Methods of test for soils: Laboratory determination of Specific Gravity.
4. IS: 2720 (Part 4) (1985). Methods of test for soils: Grain size Analysis.
5. IS: 2720 (Part 5) (1985). Methods of test for soils: Laboratory determination of Liquid Limit and
    a. Plastic Limit.
6. IS: 2720 (Part 29) (1975). Methods of test for soils: Determination of Dry Density of Soils in place by the core-cutter method.
7. IS: 2720 (Part 28) (1974). Methods of test for soils: Determination of Dry Density of Soils in-place by the sand-replacement method.
8. IS: 2720 (PART-17) (1986). Methods of test for soils: Determination of Permeability of soil.
9. IS: 2720 (PART-14) (1983). Methods of test for soils: Determination of relative density of soil.
10. IS:2720 (PART-7) (1980). Methods of test for soils: Determination of compaction property of soil.
11. IS: 2720 (PART-13) (1986). Methods of test for soils: Determination of shear parameters by direct shear test.
12. IS: 2720 (PART-13) (1991). Methods of test for soils: Determination of shear parameters by unconfined compression test.
13. IS: 2720 (PART-11) (1993). Methods of test for soils: Determination of shear parameters by triaxial shear test.
14. IS: 2720 (PART-30) (1980). Methods of test for soils: Determination of shear parameters by direct shear method.
15. IS: 2720 (PART-15) (1965). Methods of test for soils: Determination of consolidation property of soil.

HIGHWAY MATERIAL LABORATORY

Course Code: **CE49007**
Credit: **2**
L-T-P: **0-0-4**
Prerequisite: **Nil**

COURSE OBJECTIVE

This laboratory course is designed for students to perform experiments on materials used for designing of highway infrastructures. Students are taught to test the characteristics and behaviour of pavement materials based on their properties. The students also learn the required quality of pavement materials for various types of roads, traffic conditions and environmental conditions. They also learn standard procedure for the selection of materials for the design of pavement according to the IS codes.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the field applications of Transportation Engineering,
CO 2: Describe various parameters and standards for the selection of pavement materials,
CO 3: Know the usage of test equipment/machines to determine engineering properties of pavement materials,
CO 4: Write formal technical report & convey engineering message efficiently,
CO 5: Understand the codes and specifications required for the tests to be conducted, and
CO 6: Perform the experiments to test properties of aggregates, soil, and bitumen.

COURSE DETAILS

- Learning of IRC codes for design of various transportation facilities and Indo-HCM Manual for LOS estimation of various traffic facilities.
- Determination of grain size distribution of coarse and fine aggregate.
- Determination of specific gravity and water absorption of coarse aggregate.
- Determination of flakiness index and elongation index of coarse aggregate.
- Determination of aggregate impact value.
- Determination of aggregate crushing value.
- Determination of Los Angeles abrasion value of aggregates.
- Determination of penetration value of bitumen.
- Determination of softening point value of bitumen.
- Determination of ductility value of bitumen.
- Determination of CBR value of soil.

Reference Books

1. Transportation Engineering Laboratory Manual, School of Civil Engineering, KIIT Deemed to be University, 2022.
2. S.K. Khanna and CEG Justo, A. Veeraragavan, Highway Engineering, Nem Chand & Bros., Roorkee, India, 10th Edition, ISBN:9788185240930.
3. P. Chakraborty and A. Das, Principles of Transportation Engineering, PHI Publication, 2nd Edition, 2017, ISBN: 978-8120353459.
4. S.K. Khanna, C. E. G. Justo and A. Veeraragavan, Highway Materials and Pavement Testing, Nem Chand & Bros, 5th Edition, 2013, ISBN: 978-81-85240-58-9.

CHEMISTRY

Course Code: CH10001
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course is designed to enrich the students with the basic concepts in Chemistry and to strengthen their fundamentals which will support them to pursue education and research in engineering. The course will help the students to conceptualize alternative sources of energy by electrochemical means and use the instrumental techniques to explore chemical products.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Rationalize bulk properties and processes using thermodynamic consideration and apply the knowledge to decide the feasibility of a given process,
CO 2: Analyze the kinetics of multistep reactions as well as the theories of reaction rates,
CO 3: Understand the importance of catalysis and their mechanism of action and applications,
CO 4: Apply the principles of electrochemistry to evaluate properties, such as pH, solubility product, etc. and understand the working principle of modern batteries,
CO 5: Apply different spectroscopic techniques, such as UV-Vis, IR and NMR, for structural elucidation, and
CO 6: Differentiate between smart and intelligent materials.

COURSE DETAILS

Chemical Equilibrium and Thermodynamics
Introduction, Internal energy, Enthalpy, Entropy and free energy, Dependence of free energy on temperature and pressure, Gibbs-Helmholtz equation, Free energy change and equilibrium constants, Van't Hoff isotherm and isochore, Clapeyron- Clausius equation, Partial molar properties, Chemical potential, and Gibbs-Duhem equation.

Chemical Kinetics
Rate of reaction and rate laws of multiple reactions (steady-state approximation), and of parallel, opposing and consecutive reactions; Theories of reaction rate: Collision theory, Lindemann modification, Absolute reaction rate; Catalysis: Types, theories, and kinetics of enzyme catalysis (Michaelis-Menten mechanism).

Spectroscopy
UV-Vis spectroscopy: Beer-Lamberts law, Types of transition, Concept of auxochrome and chromophores, Factors affecting λ_{max} and, Woodward-Fieser rules for calculation of λ_{max} in diene systems; IR spectroscopy: Types of vibration, Hooks law, detection of functional groups like C=C, -OH, -NH_2 and -C=O**.**

NMR Spectroscopy
Basics of NMR Spectroscopy: Theory, Chemical shift, Shielding-deshielding effect, Structural elucidation of simple compounds.

Electrochemical Energy Systems
Types of electrodes, electrode/cell potential; Nernst equation and application to: find electrode and cell potential, equilibrium constant, solubility product and pH; Modern batteries: Fuel cells (AFCs, PEMFs, SOFCs, MCFCs), Zn-air battery, Li-ion battery, Na-ion battery, Ni-MH battery.

Smart and Intelligent Materials
Introduction to smart materials, Properties and types of smart materials, Structures, System intelligence-components and classification of smart structures, Common smart materials and associated stimulus-response, Application areas of smart systems.

Textbook

1. S Chawala, Engineering Chemistry, Dhanpat Rai and Co, 4th Edition, ISBN: 9788177001938.

Reference Books

1. S Agarwal, Engineering Chemistry: Fundamentals and Applications, Cambridge University Press, ISBN: 9781107476417.

2. S. Chakroborty, S. Sen, and S. Mittal, Engineering Chemistry, Cengage Learning India Pvt. Ltd., ISBN: 9386668645.
3. B.R. Puri, L.R Sharma, and M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co., 47th Edition, ISBN: 978-9382956013.
4. R.M. Silverstein, Fransis X, Webster, D.J. Kiemle, Spectrometric Identification of Organic compounds, -Jhon Wiley& Sons, INC, 7th Edition.
5. S. Glasstone, Elements of Physical chemistry-, Macmillan publishers, 2nd Edition ISBN: 978-0333038437.
6. D.J. Leo, Engineering Analysis of Smart Material Systems, Wiley 2007, 1st Edition ISBN: 978-0471684770.

ENVIRONMENTAL SCIENCE

Course Code: **CH10003**
Credit: **2**
L-T-P: **2-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to create awareness in the students on monitoring, assessment, and management of environmental pollutants. The course will also make the students aware of more benign chemistry, i.e., green chemistry, and help them to understand the implementation of Environmental Impact Assessment (EIA).

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the components and composition of the environment along with the radiation balance model,
CO 2: Rationalize the different types of pollutants, their sources, effects, and control measures,
CO 3: Develop the idea of water purification strategies,
CO 4: Identify toxic wastes and conceptualize the principles of solid waste management,
CO 5: Conceptualize the principles of green chemistry and implement them in the synthesis of advanced material, to reduce pollution, and
CO 6: Provide for Environmental Impact Assessment (EIA) requirements before planning a project.

COURSE DETAILS

Overview of the Environment
Overview of the environment, terminologies, Components of Earth: Lithosphere, atmosphere, hydrosphere and biosphere, Concept of black body radiation and albedo, eZro-dimensional energy balance model.

Air Pollution and Control
Primary and secondary air pollutants, CFC, Smog (oxidizing and reducing), Important environmental issues: Depletion of the ozone layer, Acid Rain, Greenhouse effect and global warming, Control measures: Baghouse filter, Cyclone separator, Electrostatic precipitator, Catalytic converter, and Scrubber.

Water Pollution and Control
Types and sources of water pollutants, wastewater treatment techniques: Ultrafiltration, aerobic and anaerobic treatment, Reverse osmosis, Electrodialysis, Disinfection by chlorination, Ozonation, Modern water purification

system, Water quality parameters like hardness, Water softening process (permutit), WHO guidelines for drinking water.

Soil Pollution and Solid Waste Management

Soil pollution: Sources of pollutants and mitigation measures. Types of solid wastes: Heavy metal, bio-medical and radioactive wastes, Toxic and biochemical effects of solid wastes, Solid waste management (landfilling, incineration, and composting).

Green Chemistry and EIA

Basic principles of green chemistry with examples, Matrices to explain greenness, R^4M^4 model, life cycle analysis. Importance, scope and principles of EIA with a case study.

Textbook

1. A.K. De, Environmental Chemistry, New Age International Publishers, 9th Edition.

Reference Books

1. S. Chakraborty, D. Dave, and S.S. Katewa, Environmental Chemistry-, Cengage Learning India Pvt. Ltd., 1st Edition.
2. Aloka Debi, Environment Science and Engineering, Universities Press, 2nd Edition.
3. Erach Bharucha, Textbook of Environment studies for undergraduate courses, Universities Press, 2nd Edition.
4. D. De and D. De, Fundamentals of Environment and Ecology, S. Chand & Co, 2013.
5. Jain and Jain, Engineering Chemistry, Dhanpat Rai Publishing Company.
6. S.C. Santra, Environmental Science, New Central Book Agency, ISBN: 9788173814044.

NANOSCIENCE

Course Code: **CH10005**
Credit: **2**
L-T-P: **2-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to educate, inspire, and motivate young students about nanoscience, nanotechnology, and their applications. The course provides information on the latest innovations in this field to get insights into the nanomaterials synthesis/fabrication and applications that can be achieved at a nanoscale.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn fundamental aspects of nanoscience,
CO 2: Classify different types of nanomaterials based on their dimension and composition
CO 3: Understand different synthesis techniques to grow nanomaterials,
CO 4: Analyse nanomaterials using different characterization techniques,
CO 5: Apply the acquired knowledge to design new materials, and
CO 6: Evaluate the importance of nanoscience in engineering applications.

COURSE DETAILS

Introduction
Concept and Classifications based on dimensions and compositions, Significance of nano-size: Surface area to volume changes; Properties changing with size (reactivity, melting point, catalytic,
electrical, optical), Nanoscience in nature, and Quantum dots as data storage.

Synthesis of nanomaterials
Top-down synthesis (Mechanical method-ball milling, Photolithography, Laser ablation, sputtering), Bottom up (pyrolysis, sol-gel, CVD, self-assembly), Green synthesis (metallic nanoparticles, metal oxides), Biosynthesis.

Characterization
XRD-X-ray generation, Working principle (Bragg's law), Peak broadening in nanomaterials (Scherrer formula), Electron microscopy (SEM, TEM)—high energy electron generation, electron optics, Scanning Electron Microscopy (SEM)—secondary, back scattered, EDX, Transmission Electron Microscopy (TEM)—bright field imaging, dark field imaging, and Selected area diffraction pattern.

Applications
Cosmetics—ZnO, SiO_2, TiO_2 Nanoparticles in cosmetics, SiO_2 TiO_2 in toothpaste, silver, gold, copper nanoparticles in skin care product; ***Medical Fields*—**MRI, CT scan contrast enhancement agent, Drug and gene delivery system, Magnetic hyperthermia treatment; ***Agriculture*—**Nano-pesticides, herbicides, and fungicides, Food packaging**;** ***Aerospace and Aviation Industries*—**Carbon nanotubes (CNT)nanocomposites, Metal Nanoparticle-Polymer composites, SiC Nanoparticle reinforced alumina (high temperature strength, creep resistance); and ***Nanomaterials for Environmental Remediation*—**Degradation/removal of pollutants.

Textbook

1. B.S. Murty, P. Shankar, Baldev Raj, B.B. Rath and James Murday, Textbook of Nanoscience and Nanotechnology, 1st Edition, 2012, ISBN-13: 978-8173717383.

Reference Books

1. Luisa Filipponi and Duncan Sutherland, Nanotechnologies: Principles, Applications, Implications and Hands-on Activities, Edited by the European Commission Directorate-General for Research and Innovation Industrial technologies (NMP) program, 2012, ISBN: 978-92-79-21437-0.
2. Charles P. Poole Jr., Frank J. Owens., Introduction to Nanoscience and Nanotechnology, An Indian Adaptation, 3rd Edition, 2020, ISBN-13: 978-9354240201.
3. P.I. Varghese, T. Pradeep. A Textbook of Nanoscience and Nanotechnology, Tata McGraw Hill Education, 2017, ISBN: 9781259007323.

CHEMISTRY LABORATORY

Course Code: CH19001

Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

This lab course covers different types of chemical experiments ranging from volumetric analysis to spectroscopic techniques. This course provides the students with hands-on training in many of the advanced spectroscopic and analytical techniques in chemistry. The experiments in the course span over diverse applications in chemistry. It contains experiments dealing with environmental chemistry, volumetric analysis, organic and inorganic synthesis, electrochemistry, and spectroscopy**.**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Handle different chemicals with proper safety protocols in an advanced Chemistry laboratory,
CO 2: Learn and apply basic techniques used in Chemistry laboratory for preparation, purification and identification,
CO 3: Analyze the kinetics of 1^{st} order reactions and estimate the rate constant,
CO 4: Use different instrumental techniques such as Conductometry, pH-metry, Potentiometry and Colorimetry,
CO 5: Analyse basic water quality parameters like hardness, dissolved oxygen, alkalinity, chloride, ferrous iron contents etc, and
CO 6: Rationalize and learn the spectroscopic and synthesis techniques in chemistry.

COURSE DETAILS

- Estimation of total hardness in a given water sample in terms of calcium and magnesium hardness by EDTA method
- Estimation of the amount of NaOH and Na_2CO 3 present in a given mixture solution
- (a) Determination of the strength of $KMnO_4$ solution by using standard sodium oxalate solution. (b) Determination of the amount of Ferrous (Fe^{2+}) ions present in the Mohr's salt solution by using standard $KMnO_4$ solution
- Determination of the amount of dissolved oxygen present in a given water sample by Winkler's method
- Finding the strength of Fe^{2+} present in the supplied Mohr's salt solution by potentiometric titration
- Determination of the rate constant of acid-catalyzed hydrolysis of ethyl acetate
- Determination of the chloride ion (Cl^-) present in a given water sample by the argentometric method
- Finding the strength of supplied acid by pH-metric titration against a standard alkali
- Finding the strength of a given hydrochloric acid solution by titrating it against standard sodium hydroxide solution conducto-metrically
- Verification of Beer Lambert's Law and application of this law to determine the unknown concentration of a given solution
- Determination of the concentration of ferric ions (Fe^{3+}) in a given water sample by a spectrometric method using KCNS as color developing agent
- Determination of the Isoelectric point (pI) of glycine amino acid
- Synthesis of transition metal complexes and characterization by using IR and ^{1}H-NMR. (Open ended)
- Determination of the concentration of different ions (cations and anions) in a given water sample by colorimetry. (Open ended)
- Application of potentiometric titrations (Open ended)

Reference Books

1. Chemistry laboratory Instruction manual, School of Applied Sciences, KIIT Deemed to be University.

2. Vogel's Quantitative Chemical Analysis, J. Mendham, R.C. Denney J. D. Barnes, M.J.K. Thomas, 6th Edition, Longman.
3. Standard methods for examination of water and wastewater, 23rd Edition, APHA.

SUSTAINABLE ENERGY AND ENVIRONMENT

Course Code: CH30002
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course has been designed to make the learners understand principles of sustainable energy sources, their working principles, and their conversion systems. It also explores society's present needs; future energy demands and different energy conservation methods.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Explore different renewable energy sources available in present scenario,
CO 2: Understand the mechanism of harvesting solar energy, its use and future prospective,
CO 3: Understand biomass energy generation and its technologies,
CO 4: Realize energy generation principles and techniques of hydrogen and hydro power,
CO 5: Explore energy generation from wind, wave and geothermal sources, and
CO 6: Apply the renewable energy technologies to solve various environmental problems.

COURSE DETAILS

Introduction of renewable energy
Introduction, Principles of renewable energy, Role of energy in economic development and social transformation, Energy Scenario (Classification of Energy Sources, advantages and disadvantages of conventional sources), Salient features of nonconventional energy sources, Energy efficiency and security, Energy and its environmental impacts, Importance of renewable energy sources, Standards and regulations, social implications.

Solar energy
Solar radiation and its nature, fundamentals of solar transmission, absorption and reflection, basics of solar thermal conversion, fundamentals of solar heating, principle and working of solar collectors, basics of solar photovoltaics, Solar photovoltaic energy conversion and utilization, materials and device design, P-N junction, Solar thermal applications to water desalination, refrigeration, and cooling, future prospects of solar energy.

Biomass energy
Basic principles of photosynthesis, photosynthesis and its mechanism at cellular level, Usable forms of biomass, Classification, Chemical composition, fuel properties of biomass, Concept of bio-refinery: Bio-fuels, Bio based chemicals and materials, Biomass conversion routes; biological (Aerobic and Anaerobic conversion, Fermentation), chemical (hydrolysis and hydrogenation) and chemical (Pyrolysis, Combustion, Gasification, and Liquefaction), production of biogas, alcohols, hydrogen, biodiesel and green diesels.

Hydrogen and hydro energy
Hydrogen as a renewable energy source, Sources of Hydrogen, Hydrogen Production: Direct electrolysis of water, thermal decomposition of water, biological and biochemical methods, Storage of Hydrogen: Gaseous, Cryogenic and Metal hydride, Principles of hydropower and types of turbines. Social and environmental aspects of hydrogen fuel and hydropower.

Alternate sources of renewable energy
Wind: Wind resources, characteristics of wind, classification of wind energy conversion systems. Ocean and tidal: Principle of tides and tidal power, ocean thermal energy conversion (OTEC), Energy and Power forms of waves, Wave energy conversion devices. Geothermal Energy: Geothermal Sources, Geothermal energy conversion and aquifer analysis, harnessing of geothermal resources, Social and environmental aspects of wind energy, wave energy and geothermal energy.

Textbook

1. John Twidell and Tony Weir, Renewable Energy Resources-3e, Routledge-Taylor and Francis.

Reference Books

1. D.P. Kothari, K.C. Singal, Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies-3e, PHI Learning.
2. N.S Rathore and N.L. Panwar, Renewable Energy Sources For Sustainable Development-3e, New India Publishing Agency.

COMPOSITE MATERIALS AND STRUCTURES

Course Code: **CH40001**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The main objective of this course is to increase student knowledge in design, manufacture and analysis of composite materials that can have better structural, thermal, electrical, mechanical, dielectric, magnetic, optical, electrochemical and biomedical properties.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Define and classify composites,
CO 2: Evaluate the relative merits of using composites with respect to conventional materials for important engineering and other applications,
CO 3: Quantify physical and mechanical properties of composite materials as a function of parameters such as volume fraction, orientation and arrangement,
CO 4: Design and prepare composite structures,
CO 5: Apply XRD, SEM and TEM in micro- structural analysis of composites, and
CO 6: Understand the concept of green composite and their processing techniques.

COURSE DETAILS

Classifications and Industrial Applications of Composite
General introduction, classification of composites, matrix materials (polymer, metal and ceramics) and reinforcement materials (fibres-glass, Aramid, Carbon, Boron), microstructure of composite, applications: in civil constructions, aerospace industries, automobile, packing industry, advantages and limitations of composite materials.

Performance of structural composites
Matrix/reinforcement interface, reinforcement mechanism, combination effects (law ofmixtures, weight fraction, volume fraction), effect of voids in composites, fracture mechanics of composites, strengthening mechanisms, stress-strain relations (generalized Hooke's law), stress distribution in fibre and the matrix (shear stress and axial tensile stress in the fibre along its length), critical length of fibre for full strengthening, estimation of the critical amount of fibre to gain a composite strength.

Fabrication of composites
Fabrication of metal matrix composites, fabrication of polymer matrix composites, fabrication of ceramic matrix composites, selection of constituents, solidification processing of composites, synthesis of in situ composites, various techniques of vapor deposition, liquid phase method and hot pressing etc.

Characterization
Characterization methods of composites (x-ray diffraction (XRD), Electron microscopy (SEM, TEM) analysis of composites, Thermal Analysis, Fire retardancy test for polymer composites.

Green Composite
Introduction, Composition of green composite, bio-degradable reinforcement fibre (cellulose, starch, wool/silk, carbon nanotube, nano-clay, biodegradable matrix (cellulose, starch, chitin, protein), applications of green composite.

Textbooks

1. Krishan K. Chawla, Composite Materials. 2nd Edition, Springer Press, 2001
2. Deborah D. L. Chung, Composite Materials: Science and applications, Springer, 2004.

References Books

1. T.W. Clyne, and D. Hull, An Introduction to Composite Materials, Cambridge University Press, Cambridge, 1996
2. Bhagwan D. Agarwal, Lawrence J. Broutman and K. Chandrashekhar, *Analysis and* Performance of Fibre Composites, John Wiley And Sons. Inc., New York, 1995.
3. Susheel Kalia, Biodegradable Green Composites, John Wiley & Sons Inc., 2016, eBook.
4. Composite Materials Properties, Characterization, and Applications, Ed. Amit Sachdeva, Pramod Kumar Singh, Hee Woo Rhee, CRC press, broken sound parkway NW, 2021.

SOLID WASTE MANAGEMENT

Course Code: CH40002
Credit: 3
L-T-P: 3-0-0

Prerequisite: Nil

COURSE OBJECTIVE

The uncontrolled consumption lifestyle is the root cause of the huge waste generation problem of our modern world. According to WHO report, world cities are producing 1.3 billion tonnes of solid waste per year and will be nearly double by the end of 2025. This course aims to cover different solid waste management techniques for sustainability and at the same time it also deals with the legal institutional framework for the same.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand integrated solid waste management concepts and its requirement,
CO 2: Understand waste prevention at different levels such as production, supply, consumption and disposal,
CO 3: Understand the importance of public engagement in sustainable waste management,
CO 4: Implement waste reduction and recycling policies,
CO 5: Explore modern treatment techniques for solid wastes, and
CO 6: Understand the legal and institutional framework for sustainable solid waste management.

COURSE DETAILS

Waste management and sustainability
Solid waste and types, source and characteristics of waste, toxic and hazardous waste, generations of wastes, waste testing and analysis. Environmental health, driving force for sustainability, integrated waste management and sustainability.

Waste storage, segregation, collection and prevention
Introduction, source segregation, waste storage, waste collection, waste separation, Health and Safety issue, waste prevention, The growing burden of waste, waste prevention in the context of sustainability, The policy context, waste prevention at the level of production and supply, Waste prevention at the level of consumption and household, Barriers to waste prevention, best practice in developed countries.

Public Engagement for Implementation of Waste Reduction and Recycling Policies
Introduction, Defining Public Participation, Public participation in waste management systems, Public participation policy in Global context, typical areas of Public participation in waste management systems, Key Ingredients in Public Participation, selected Examples of Public participation in Waste Reduction and Recycling in Asia.

Treatment Techniques
Incineration, Gasification, Pyrolysis, Aerobic and Anaerobic Digestion as well as co-digestion, Plasma Arch Gasification, Bio-hydrometallurgical Processing of Metallic Components of E-Wastes, s/s immobilization of toxic/hazardous wastes.

Legal and Institutional Framework
Introduction, Why Legal Framework Matters, Nature and Characteristics of Legal Framework, Scientific and policy judgments in risk assessment, Trajectory of US Experience, European Union's Legislative Effort, South Asia.

Textbooks

1. Jonathan W. C. Wong, Rao Y. Surampalli, Ammaiyappan Selvam, Rajeshwar D. Tyagi, Tian C. Zhang; Sustainable solid waste management, American Society of Civil Engineers, 2016.

2. Freeman H.M. (1988) Standard Handbook of Hazardous Waste Treatment and Disposal, McGraw Hill. New York.

Reference Books

1. G., Theissen H., Eliassen R., Solid waste Engineering-Principles and Management, 1991.
2. McBean, Edward A., Frank A. Rovers, and Grahame J. Farquahar. Solid waste landfill; engineering and design. Prentice Hall, 1995.
3. Sharma, Hari D. Waste containment systems, waste stabilization, and landfills: design and evaluation. John Wiley & Sons, 1994.
4. Bruner, C. R., Hazardous Waste Incineration, 2nd Edition, McGraw-Hill, Inc., New York, 1993.

PROGRAMMING LABORATORY

Course Code: **CS13001**
Credit: **4**
L-T-P: **0-2-4**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course aims to provide exposure to problem-solving through programming. It aims to train the student 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.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Have fundamental knowledge of computers hardware and number systems with commands in Linux,
CO 2: Write, compile and debug programs in C language.
CO 3: Design programs involving decision structures, loops, and functions.
CO 4: Construct arrays to store, manipulate, search and display data.
CO 5: Apply the dynamics of memory by the use of pointers, and
CO 6: Use different data structures and create/update basic data files.

COURSE DETAILS

- 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

WEB DESIGN

Course Code: CS28001
Credit: 1
L-T-P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE

Web design and programming is a large field, with different types of technologies implemented by different tools. HTML, CSS, and JavaScript are known to be the three pillars of client-side web programming. After finishing this course, a student should be prepared to write nicely formatted, interactive web pages, with no dependencies on server-side technologies.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO1: Understand the basics of web page design,
CO2: Use formatting instructions of HTML,
CO3: Apply the style formats using CSS,
CO4: Write basic scripts using JavaScript,
CO5: Apply DOM in web pages, and
CO6: Create dynamic web pages using HTML and JavaScript.

COURSE DETAILS

HTML Fundamentals
HTML: Structure of a program, various tags and their roles in HTML programs, Lists: ordered, unordered, definition, Table.

More with HTML
Form design, Frames, link and it's types, Images.

CSS Essentials
Style sheets: Inline, Internal, External.

JavaScript Basics
Introduction, characteristics, Variables, Data types, Type casting and conversion Functions. Primitives, operators, Control statements, Array, Function, Function – Parameter Passing and dynamic argument and return statement

More with JavaScript
DOM - browser, window, document, image and form object, Properties and Methods of different objects, Predefined Java Script Object - Array, String and Date Object and their methods, Event handling – Link, Body, Image and events associated with different HTML tags

Textbook

1. MASTERING HTML, CSS & Java Script Web Publishing, Laura Lemay, Rafe Colburn and Jennifer Kyrnin, BPB Publications.

Reference Books

1. HTML, CSS and JavaScript All in One, Sams Teach Yourself, Julie C. Meloni and Jennifer Kyrnin, Pearson Education.
2. HTML 5 Black Book, DT Editorial Services, Dreamtech Press.

BASIC ELECTRONICS

Course Code: EC10001
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course is designed to familiarize students of all branches to the all-pervasive field of Electronics, enable them to carry out research in interdisciplinary fields involving semiconductor devices, and utilize the knowledge in solving practical problems in real life in today's age of electronics.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the properties of semiconductor and current conduction mechanism,
CO 2: Comprehend the working of P-N junction diodes; identify different diode circuits and analyze them,
CO 3: Understand the working of different types of transistors,
CO 4: Know about OP-AMP and its applications,
CO 5: Analyze the working of op-amp using either inverting or non-inverting configurations, timing circuit, regulated power supply ICs, and their applications, and
CO 6: Realize the importance of various analog and digital electronic systems and electronic devices.

COURSE DETAILS

Semiconductors, Diodes and Transistors
Properties of semiconductor materials, Applications of semiconductors as p-n junction diode, Diode characteristics and breakdown mechanisms, Half-wave and full-wave rectifiers with filters, Zener diode, Transistor constructions, operations and their characteristics. Transistor biasing, amplifiers, and load line analysis, Concepts of JFET and MOSFET.

Operational Amplifier (Op-amp) and applications
Introduction to Op-amp and its Characteristics. Application of Op-Amp as Inverting amplifier, Non-inverting Amplifier, Summing, Difference amplifier and comparator.

Introduction to Digital Electronics
Different number systems and its conversions, Logic gates and truth tables of OR, AND, NAND, EX-OR. Combinational circuit and Sequential circuit.

Miscellaneous Electronic Devices

SCR, Opto-electronic devices and fiber techniques, Introduction and description of sensor performance, Fundamentals of analog communication techniques (AM and FM).

Textbook

1. J. Millman, Christos C. Halkias & C.D. Parikh, Integrated Electronics: Analog and digital circuits and Systems, 9th Edition, 2021.

Reference Books

1. R.L. Boylestad & L. Nashelsky, Electronic Devices & Circuits, PHI, 7th Edition, 2021.
2. D.A. Bell. Electronic Devices and Circuits (Oxford), 5th Edition,2021.
3. D. Chattopadhyay and P. C. Rakshit. Fundamentals & Applications, New Age International, 15th Edition 2021.

BIOMEDICAL ENGINEERING

Course Code: **EC10003**
Credit: **2**
L-T-P: **2-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

Biomedical Engineering is a multidisciplinary field that combines knowledge available in a wide range of disciplines such as engineering, medicine, and societal science. The course focuses on innovating newer equipment and technologies to improve human health and enhance health care facilities in a holistic manner.

COURSE OUTCOMES

At the end of this course, the students will be able to

CO 1: Apply knowledge of basic engineering and biology to solve the problems,
CO 2: Acquire knowledge of human body about cell, potential and organs of body,
CO 3: Develop a thorough understanding on principles of bio-instrumentation,
CO 4: Explain the role of bio-potential electrodes, and design of sensors,
CO 5: Differentiate and analyse the biomedical signal sources, and
CO 6: Acquire knowledge about imaging techniques used in hospital.

COURSE DETAILS

Introduction and Overview
Introduction to biomedical engineering, Applications of biomedical engineering.

The Human Body
Cell-structure and function, Tissue & organs, Bio-potentials, Action potential, Major human systems (musculoskeletal, circulatory, nervous, and respiratory system).

Bio-instrumentation

Instruments in medical practice, Man-instrumentation system, Basic components, Linear network analysis, Bioelectric amplifier (OpAmp, isolation amplifier, instrumentation amplifier), Bio-instrumentation design, and Intelligent medical instrumentation.

Biomedical Electrodes and Sensors
Signal acquisition, Bio-potential measurements, Active and passive sensors, and Electrodes for biophysical sensing (Ag-AgCl, surface electrodes, microelectrodes), transducers, sensors.

Biomedical Signals, Imaging and Informatics
Bioelectric phenomena, Sources of biomedical signals, Origin of biopotentials, Basics of bio-signal processing, noise, Interference, Electrical safety issues, Principle of medical imaging techniques, such as X-ray, US, MRI, CT scan, and nuclear imaging, and Fundamentals of bio-informatics.

Textbook

1. John D. Enderle & Joseph D. Bronzino Introduction to Biomedical Engineering, Academic press, 3rd Edition, 2012.

Reference Books

1. Joseph D. Bronzino, Donald R. Peterson, The Biomedical Engineering Handbook, CRC press, 4th Edition 2015.
2. G.S. Sawhney, Fundamentals of Biomedical Engineering, New Age International (P) Ltd, 2011.

COMPUTATIONAL PHOTOGRAPHY

Course Code: **EC28001**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Differential Equations and Linear Algebra (MA11001)**

COURSE OBJECTIVE

Computational photography (CP) is the fusion of computer graphics, computer vision, optics and imaging. The role of CP is to overcome the limitations of traditional cameras by combining imaging and computing to enable new and improved ways to capture, represent and interact with the physical world. The course provides and overview of elements photography, which includes digital image capturing mechanisms, lighting controls, effect of focal length and aperture and various lossy and lossless image storage mechanisms. Objective is to briefly explain computational methods used to enhance photographs.

COURSE OUTCOMES

At the end of this course, the students will be able to

CO 1: Appreciate concept of photography, and digital camera technology,
CO 2: Understand types of cameras and their mechanisms,
CO 3: Demonstrate computational image processing,
CO 4: Apply computational photography methods for photo composition and panoramic,
CO 5: Apply computational image processing for photography quality enhancement, and
CO 6: Explain various image filtering techniques.

COURSE DETAILS

Introduction to Computational Photography

History of Photography and Computational Photography, Digital Representation of Images, Cameras, Difference between Full frame, APSC and Medium format sensors, scaling, crop sensor advantages/disadvantages.

Digital photography

Principle of Operation of DSLR camera, Aperture, ISO, Shutter speed and Angle Control, Camera Calibration and Tethering, Computational Cameras, Image Storage formats: Compressed vs uncompressed formats, Basics of Lenses: Wide angle, Telephoto, Prime lenses, Macro lenses. Difference in angle, Depth of field control.

Computational Techniques

Concept of Color, color models, noise, its types, image histogram, Image Processing software: Licensed and Open Source.

Training on Computational Photography

Shooting with wide angle lenses, Shooting with Telephoto lens, zooming, changes in angle, Shooting with Prime lenses and constant aperture lenses, Shooting with Macro lenses, microscopic photography.

Training on Digital Imaging-I

Photography Genres, Scene Composition, Dynamic Range improvement, Portraits, Photographing scenes, crowd and people, Shooting Portraits, group photos and events.

Training on Digital Imaging-II

Long exposure, Brenizer's Method, Sports High Shutter speed, Burst, fisheye, architecture photography, Macro, Basics of Long exposures, using polarizing filters Shooting panorama, Brenizer's method and other photographing techniques, Shooting sports, high shutter speed.

Training on Digital Imaging-III:

Use of lights, soft box and flashes, guide number etc., product photography, computational photography, E-commerce photography, Use of Lights, Flash, wireless flash, Basics of product photography, photography for e-commerce and computational photography.

Training on Post Processing-I

RAW image processing, Basic adjustments and correction, Lens Distortion and color correction using Adobe Photoshop, Monochrome image processing, color image processing batch processing using Light-room.

Training on Post Processing-II

Image enhancement operations, noise removal, Artistic filtering, cosmetic filtering, and other post processing methods. Post Processing III: Background removal, artificial coloring.

Training on Post Processing-III

Open Source and free software for image post processing and computational photography, their usage and capabilities.

Photography Ethics

Photography ethics: empathy, consent, integrity, ethical decision making, privacy.

Textbook

1. Richard Szeliski, Computer Vision: Algorithms and Applications, 2nd Edition.

Reference Books

1. Ayush Bansai, Achuta Kadambi, and Ramesh Raskar, Computational Imaging Book.
2. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision.
3. David Forsyth and Jean Ponce, Computer Vision: A Modern Approach.
4. Steven Gortler, Foundations of 3D Computer Graphics.
5. Rafael Gonzalez and Richard Woods, Digital Image Processing.
6. Barbara London and John Upton, Photography.

SOUND ENGINEERING

Course Code: **EC28003**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

It elaborately covers in various aspects of sound (physical and mechanical behavior), equipment used for recording/ reproducing and basic idea for the preparation of final sound track in film or television production.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Recognize, define, and explain the principles of sound engineering related to signal flow, microphones, recording, mixing, production, and mastering,
CO 2: Demonstrate practical, imaginative understanding and fluency on sound engineering technologies and procedures,
CO 3: Solve problems independently, imaginatively, and creatively in the field of sound engineering will be demonstrated by students,
CO 4: Learn how to conduct research and have a critical comprehension of sound engineering and its related fields,
CO 5: Understand the basic techniques of sound recording, and
CO 6: Understand the working of different types microphone and loudspeakers and their applications in industry.

COURSE DETAILS

- Introduction to technology of sound
- Analysis of pre-recorded speech, music and effects
- Observation of the installation of PA System in a large auditorium
- Study and analysis of different microphones
- Study the feature of 2 channel digital sound recorder
- Study about the effect of loudness in relation with the distance from source to the listener
- Sound recording and reproduction practice by using recorder in PA system chain

- Study of sound in different environmental situation
- Study and analysis on Modulated Radio wave AM and FM in Live streaming radio stations
- Study the effect of Bass and Treble (Concept of Equalization)

Textbook

1. Glyn Alkin, Sound Recording and Reproduction.

Reference Book

1. Michael Talbot Smith, Sound Assistance.

SENSORS FOR AUTOMATION

Course Code: EC28005
Credit: 1
L-T-P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE

Sensors and automation are revolutionizing the technology in the areas like consumer electronics, automotive industry, healthcare, and in other settings. The course will provide an opportunity for students to learn different sensors and its application in real world problems. It will empower the students to develop their knowledge regarding operation, application and integration of sensors to enable the design and realization of complete systems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn about the microcontroller, its hardware interfacing and programming,
CO 2: Understand the working principle and characteristics of different types of sensor,
CO 3: Interface various sensor interfacing with microcontroller and display devices,
CO 4: Understand the basic principles of analog to digital conversion and its application with different sensors,
CO 5: Gain knowledge about various types of automation system, and
CO 6: Develop and implement sensor for final products in real time applications.

COURSE DETAILS

- Introduction to microcontroller, platform of operations with basic programming techniques
- Interfacing of serial and parallel device with microcontroller
- Interfacing of microcontroller with display devices
- Use of ADC to interface various analog sensors with microcontroller
- Introduction to sensor, measurement of physical parameters like temperature and humidity
- Application of ultrasonic and proximity sensor
- Application of gas and pressure sensor
- Application of IR sensor and RFID
- Interfacing actuators to drive DC motor (application of touch switch as actuators)

- Implement sensor in final products for real time solution

Textbook

1. T. Karvinen, and K. Karvinen, Getting started with sensors, Shroff Publishers, 2014.

Reference Books

1. J.S. Katre, Sensors in Automation, Tech Knowledge Publications, 1st Edition, 2023
2. D. Patranabis, Sensors and Transducers, PHI Learning, 2nd Edition, 2003.

PCB DESIGN

Course Code: **EC28007**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Basic Electronics (EC10001)**

COURSE OBJECTIVE

Over the years, printed circuit board manufacturing has continued to grow in order to keep up with the increasing demands of newer, faster, and more complex electronic circuitry. This course will familiarize students to design, simulate electronics circuit and fabricate PCB for prototyping using CAD tool. This program is designed to provide a balanced foundation of theoretical knowledge and practical skills in printed circuit board design.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand and evaluate different electronics components,
CO 2: Create schematic and simulate the circuit using OrCAD or any other CAD tools,
CO 3: Understand single- and double-layer PCB,
CO 4: Create and fabricate PCB and analyze the PCB using screen printing method,
CO 5: Understand assembly of electronics component by soldering, and
CO 6: Analyze and test the circuit for any error.

COURSE DETAILS

Description of different Electronics Component and their Identification:
Passive and active components, component identification, Color code for resistor and disc capacitors, Inductor and their types, simple air core and iron core inductor design.

Circuit Design and Simulation using CAD tool (OrCAD): Design of a simple electronics circuit using data sheet and circuit schematic and simulation.

Schematic to PCB transfer and routing:
Schematic to PCB transfer (assigning foot prints to various components, transfer to PCB), routing, DRC, ERC, EMC.

Screen Printing Procedure

Preparation of screen, mask transfer

PCB preparation and Checking of Routing
transfer of layout to PCB using screen printing methods, etching, cleaning, error checking of routing, component mounting, soldering

Testing and Verification
Testing the circuit with the help of multi-meter and CRO

Textbooks

1. Chris Robertson, Printed Circuit Board, PHI, 2003.
2. Elaine Rhodes, Developing Printed Circuit Assemblies: From Specifications to Mass Production, 2008, ISBN: 978-1435718760.

Reference Books

1. Douglas Brooks, Signal Integrity Issues and Printed Circuit Board Design, PHI, 2003.
2. Kraig Mitzner, Complete PCB Design Using OrCAD Capture and PCB Editor, Newnes, 2009.
3. Open source EDA Tool KiCad Tutorial: http://kicad-pcb.org/help/tutorials/

ELEMENTS OF MACHINE LEARNING

Course Code: **EE10001**
Credit: **2**
L-T-P: **2-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

Today, we have access to massive data which get generated through information and computer technology in our connected world. Most of these data lie unused and often overwhelm us due to their size and variety. The objective of this course is to introduce to the students to the field of learning from data, discovering data patterns, converting them into knowledge, and applying it to solve real-world problems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Demonstrate fundamentals of machine learning,
CO 2: Identify data types, apply suitable processing and visualize using suitable methods,
CO 3: Describe Unsupervised Learning and apply clustering techniques,
CO 4: Describe Supervised Learning and apply classification techniques,
CO 5: Demonstrate perceptron and Multi-layer Perceptron models, and

CO 6: Apply machine learning techniques for real world requirement.

COURSE DETAILS

Introduction
Importance and Applications of Machine Learning, Supervised, Unsupervised, Reinforcement Learning and Evolutionary Learning.

Data Analysis
Measurement Scales and Data Types; Visualization, Pre-processing and Transformation of Data; Dimensionality Reduction; and Data (Dis)Similarity.

Unsupervised Learning
K-means and Density-based, Clustering Methods.

Supervised Learning
K-Nearest Neighbour, Decision Tree by Qualitative and Quantitative (information Gain method); Evaluation by Confusion Matrix of Supervised Learning Methods.

Learning with Neural Networks
Perceptron, Multi-layer Perceptron and, Error Backpropagation Learning.

Textbooks

1. Gopal, M., Applied Machine Learning, McGraw Hill Education, 2018.
2. Pradhan, M. and U. D. Kumar, Machine Learning Using Python, Wiley India Pvt. Ltd, 2019.

Reference Books

1. Alpaydin, E., Introduction to Machine Learning, 3rd Edition, The MIT Press, 2014.
2. Bishop. C M, Pattern Recognition and Machine Learning, Springer, 2006.
3. Jain, V. K., Big Data Science Analytics and Machine Learning, Khanna Publishers, 2021
4. Mitchell, T. M.,Machine Learning, McGraw Hill, 1997.
5. Müller, A. C.,Introduction to Machine Learning with Python, O'Reilly Media, Inc, 2016
6. Raschka, S. and V. Mirjalili, Python Machine Learning, 3rd Edition, Packt Publishing, 2019.
7. Shalev-Shwartz, S. and S. Ben-David, Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2014.

BASIC ELECTRICAL ENGINEERING

Course Code: **EE10002**
Credit: **2**
L-T-P: **2-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course is designed to provide to the students a comprehensive overview of the basics of the electrical engineering discipline. In particular, the course includes fundamental aspects of DC, AC and magnetic circuit

analysis, working principles and applications of machines, and safety measures used in various electrical apparatus and appliances.

COURSE OUTCOMES

At the end of the course the students will be able to

CO 1: analyze the concept of DC circuit,
CO 2: understand the concepts of AC circuits,
CO 3: analyze the three phase circuit,
CO 4: interpret the behavior of magnetic circuits,
CO 5: remember the principles and operation of electrical machines, and
CO 6: know the concepts of electrical safety and protection systems.

COURSE DETAILS

D. C. Circuits
Kirchhoff's law, Source transformation, Star-delta transformation and equivalent resistance of the circuits, Mesh and Nodal analysis, Superposition theorem.

A.C. Circuits
Peak, average, R.M.S. values of sinusoidal quantities, Peak factor, Form factor, Phase difference, Phasor representation, AC through R, L, C, AC Series Circuit (RL, RC, RLC), Three-phase AC circuits: Voltage, current and power in star and delta connections.

Electromagnetic Circuits
Magnetizing Force, Reluctance, Permeance, Magnetic field, Magnetic permeability, Analogy between Electric Circuits and Magnetic Circuits. Series magnetic circuit, BH curve.

Scope and Safety Measures
Electrical Energy Scenario in India, Application of Transformer, Three-phase and single-phase induction Motors, Power ratings of air conditioners, PCs, laptops, printers, refrigerator, washing machine, different lamps, electricity tariff, calculation of electricity bill for domestic consumer.

Personal Safety Measures
Electric Shock, Earthing and its types, Safety Precautions to avoid shock.

Equipment Safety Measures
Working principles of fuse and miniature circuit breaker (MCB), Residual Current Circuit Breaker (RCCB).

Textbooks

1. V.K. Mehta, Rohit Mehta, Principles of Electrical Engineering and Electronics S. Chand and Company, New Delhi, Revised Edition 2013.
2. D.C. Kulshreshtha, Basic Electrical Engineering, Tata McGraw publication, 1st Edition 2011.
3. T.K. Nagasarkar and M.S. Sukhija, Basic Electrical Engineering, , Oxford University press, 3rd Edition 2017.

Reference Book

1. Sanjeev Sharma, Basics of Electrical Engineering, I.K. International, New Delhi, 3rd Reprint 2010.

BASIC INSTRUMENTATION

Course Code: **EE10003**
Credit: **2**
L-T-P: **2-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course is designed to impart, to the students, the principles of analog and digital measuring instruments which include the working mechanisms of sensors and transducers and their applications in industrial and biomedical systems.

Course Outcome

At the end of this course, the students will be able to

CO 1: Know the basics of measuring instruments,
CO 2: Measure different electrical quantities,
CO 3: Understand the working principles of optical and electrical transducers and sensors,
CO 4: Understand the working of electrical transducers and sensors,
CO 5: Apply the transducers in industrial applications, and
CO 6: Use instruments in biomedical applications.

COURSE DETAILS

Analog and Digital Instruments
Basics of measuring instruments, Types of analog instruments, Measurement of voltage, current, power and energy in single and three phase circuits; Digital Instruments: Digital voltmeter, Digital multimeter, Timer/counter, and Time, phase and frequency measurements in oscilloscope.

Sensors and Transducers
Optical sources and detectors: LED, photo-diode, light dependent resistor; Basics of fiber optic sensing, IR Sensors. Resistive, capacitive, inductive, piezoelectric, and Hall effect sensors, Temperature transducers: Thermocouple, RTD, and thermistor.

Transducers in Industrial Applications
Measurement of displacement (linear and angular), velocity, acceleration, force, torque, vibration, shock, pressure, flow, liquid level, pH, conductivity and viscosity.

Instruments in biomedical applications
ECG, Blood Pressure measurement, CT scan, and Sonography

Textbook

1. R.K. Rajput, Electrical and Electronic Measurements and Instruments, S. Chand Publication, 4th Edition, 2015, William David Cooper, Electronic Instrumentation and Measurement Techniques, by PHI, 2010.

Reference Books

1. R.K. Jain, Mechanical and Industrial Measurements (Process Instrumentation and Control), Khanna Publishers, 1995.
2. A.K. Sawhney, A course in Electrical and Electronics Measurements and Instrumentation Dhanpat Rai Publication, 10th Edition, 2012.
3. D. Patranabis, Sensors and Transducers, PHI Publication, 2nd Edition, 2017.

INDUSTRIAL WIRING AND CONTROL PANEL DESIGN

Course Code: **EE28011**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

This vocational course will provide an overview of electrical occupations, including the training and the employment options available in electrical industry. It is also designed to provide related training in the electrical trade that will give students the proper coursework in installation and designing of control panel.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Realise the purpose and general principles of control components and circuits,
CO 2: Install Industrial wiring circuits according to given specification and plan,
CO 3: Analyze circuit operations on basic motors (3ø induction Motor),
CO 4: Interpret and install circuits according to rules and regulations of the National Electrical Codebook,
CO 5: Connect motor controllers for specific applications with emphasis on safety practices and in accordance with National Electrical Code (NEC) requirements, and
CO 6: Select and size contactors, relays and timing relays and overload relays both physically and schematically and describe their operating principles.

COURSE DETAILS

- Design multiwire circuit for a direct motor starter (DoL) with one operating (forward) direction using QElectrotech software.
- Design multiwire circuit for a direct motor starter (DoL) with two operating (forward & reverse) direction using QElectrotech software.
- Design multiwire circuit for a Star – Delta motor stator with one operating (forward) direction using QElectrotech software.
- Design multiwire circuit for a Star – Delta motor stator with two operating (forward & reverse) direction using QElectrotech software.
- Design & connect for a direct motor starter (DoL) with one operating (forward) direction in modular set up.
- Design & connect for a direct motor starter (DoL) with two operating (forward & reverse) direction in modular setup.
- Design & connect for a Star – Delta motor stator with one operating (forward) direction in modular set up.
- Design & connect for a Star – Delta motor stator with two operating (forward& reverse) direction in modular set up.

- Install & wire for a direct motor starter (DoL) with one operating (forward) direction in Industrial Control Panel.
- Install & wire for a direct motor starter (DoL) with two operating (forward & reverse) direction in Industrial Control Panel.
- Install & wire for a Star – Delta motor stator with one operating (forward) direction in Industrial Control Panel.
- Install & wire for a Star – Delta motor stator with two operating (forward & reverse) direction in Industrial Control Panel.

Reference Books

1. Tarlok Singh, Installation, commissioning and maintenance of electrical equipment.
2. B.P. Patel and M.A. Chaudhari, Industrial Electrical Systems.

INSTALLATION, OPERATION AND MAINTENANCE OF SOLAR POWER SYSTEM

Course Code: EE28013
Credit: 1
L-T-P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE

To impart job-oriented training to students and make them well convergent on Installation, operation & maintenance of solar PV system. This vocational course is based on study of solar photovoltaic (PV) cells, modules, and system components; electrical circuits; PV system design and sizing for use on homes, commercial building etc., understanding energy conversion from sunlight to electricity, and working with solar conversion equipment. This Course will give students the book knowledge and hands on experience needed to become entrepreneur / self-employed.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Demonstrate and apply the knowledge of solar electric systems terms and concepts,
CO 2: Size and design a photo voltaic system,
CO 3: Mount, ground, position, install, wire and connect a photo voltaic system,
CO 4: Test voltage generated by photo voltaic system,
CO 5: Learn different types of solar PV modules and batteries used in solar PV plant, and
CO 6: Design of solar PV plant based on estimated loads.

COURSE DETAILS

- To demonstrate the I-V and P-V Characteristics of PV module with varying radiation and temperature level.
- To demonstrate the I-V and P-V characteristics of series and parallel combination of PV modules.
- To show the effect of variation in tilt angle on PV module power.
- To demonstrate the effect of shading on module output power.
- To demonstrate the working of diode as bypass diode and blocking diode.
- To draw the charging and discharging characteristics of battery.

- Observe the output waveform of the inverter in auto mode.
- Workout power flow calculations of standalone PV system of AC load with battery.
- Workout power flow calculations of standalone PV system of DC load with battery.
- Find the MPP manually by varying the resistive load across the PV panel.

Reference Books

1. Chetan Singh Solanki, Solar Photo Voltaic Technology and Systems.
2. B.H. Khan, Non-Conventional Energy Resources.
3. P. Sukhatme, Solar Energy - Principles of Thermal Collection and Storage.
4. G.N. Tiwari, Solar Energy: Fundamentals, Design, Modelling and Applications.

DOMESTIC WIRING AND HOME AUTOMATION

Course Code: **EE28015**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

This vocational course will provide an overview of electrical occupations, including the training and the employment options available in electrical consultancy. It is also designed to provide related training in the electrical wing that will give students the proper coursework in installation and designing of domestic wiring and home automation.
To develop electrical wiring skills in students through systematic training that would enable the students to construct and test various electrical circuits using appropriate electrician tools, wires, protective devices and wiring accessories as per IS standards.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Use appropriate electrician tools, wires, protective devices and wiring accessories,
CO 2: Rig up wiring diagrams using conduit system of wiring,
CO 3: Apply IS standards for electrical wiring,
CO 4: Prepare different types of wiring joints,
CO 5: Well convergent in drawing electrical wiring circuit, and
CO 6: Enhancement of knowledge regarding specification and application of different electrical devices.

COURSE DETAILS

- Perform the assembly, wiring and implementation of a single switch (SPST Switch) in circuit.
- Perform the assembly, wiring and implementation of a Double switch (SPST Switch) in circuit.
- Perform the assembly, wiring and implementation of a power socket in circuit.
- Perform the assembly, wiring and implementation of a controlled power socket circuit in housing.
- Perform the assembly, wiring and implementation of a two ways switches (SPDT Switch) in circuit.
- Perform the assembly, wiring and implementation of a impulse relay in circuit.

- Perform the assembly, wiring and implementation of a time switch in circuit
- Perform the assembly, the wiring and the implementation of a timer lighting in circuit.
- Perform the assembly, the wiring and the implementation of a twilight switch in circuit in house or in a shop.
- Perform the assembly, wiring and implementation of a controlled lighting in circuit (time switch, timer, twilight switch).
- Perform the assembly, the wiring and the implementation of a water heater in circuit.
- Perform the assembly, wiring and implementation of a central impulse relay in circuit.
- Study and implementation of Light sensitive switch.
- Perform the assembly, wiring and implementation of a fan in circuit.
- Perform the assembly, wiring and implementation of a distribution panel.
- Home automation using KNX technology.
- Application of Load shedding contactor and programmable time switch.

Reference Books

1. Frederic Marsh, Home Automation - A Smart Home Guide: The Beginner's Manual Including Google Home, Echo Dot and Amazon Alexa. Easy Instructions, Directions and Commands ... and Home Automation Guide Series Book 1, Kindle Edition.
2. James Gerhart, Home Automation and Wiring.

CYBER PHYSICS APPLICATION IN INDUSTRIAL IOT

Course Code: **EE28017**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

The students will utilize the principles of Cyber-Physical Systems (CPS) and Internet of Things (IoT) to develop applications, implement IoT applications by selecting appropriate hardware and software platform and also Develop IoT applications using open-source platforms.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Basics of cyber physics components,

CO 2: Understanding of sensors and actuators,

CO 3: Layout diagram of open source microcontroller board,

CO 4: Understanding of analog and digital I/O for cyber-physics,

CO 5: Understanding of different protocols for IoT connectivity, and

CO 6: Basic architecture for IoT enabled Cyber Physics.

COURSE DETAILS

1. CYBER PHYSICAL SYSTEM (THEORY)

- CPS Realworld.
- Design and Validation of CPS.
- Smart city application CPS.
- CPS Hardware Platforms (Process, Sensors and Actuators).

2. Industry 4.0

- IOT Fundamentals and protocols including layers.
- Sensor and Interfacing.

Hands on Practice

- Architecture and pin diagram of Arduino UNO/MEGA and ESP8266
- IDE installation for open source C++ or Phython
- Analog and Digital voltage sensing and processing through Firmware
- Analog and Digital voltage based actuator through Firmware
- Display OLED/Seven segment integration through IDE
- PCB Design Concept and implementation with uC.
- Implementation of UI/UX through RestAPI based Thing speak
- DATA logging and Generating CSV through Rest API
- Writing a Firmware for ESP-8266 or NODEMCU (programming based knowledge)
- IoT based transformer / condition monitoring system

Reference Books

1. Adrian McEwen, Hakim Cassimally, Designing the Internet of Things.
2. Asoke K Talukder and Roopa R Yavagal, Mobile Computing, Tata McGraw Hill, 2010.
3. Tanenbaum, Andrew S, Computer Networks, Pearson Education Pte. Ltd., Delhi, 4th Edition
4. Stallings, William, Data and Computer Communications, Pearson Education Pte. Ltd., Delhi, 6th Edition.
5. F. Adelstein and S.K.S. Gupta, "Fundamentals of Mobile and Pervasive Computing," McGraw Hill, 2009.

INDUSTRIAL CONTROL AND REMOTE MONITORING

Course Code: **EE28019**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

To provide hands on experience in developing Industrial Control and remote monitoring by using PLC (Programmable logic Controller), thus by utilizing it in Process control applications.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know about typical components of a Programmable Logic Controller,
CO 2: Know the concept of Electrical ladder logic and its relationship to PLC instructions,
CO 3: Understand the concept of digital electronics and data acquisition,
CO 4: Program PLC logical switching circuits for industrial applications,
CO 5: Choose and utilize Timer, Counter, and other intermediate programming functions, and
CO 6: Design and program automated industrial production line.

COURSE DETAILS

1. Programmable logic Controller SYSTEM. (THEORY)

- Introduction to Industrial Automation.
- Introduction to PLC programmable logic controller
- PLCs & related software and its major Components
- Relay logic Hardware Platforms (Switches, Sensors and Actuators).
- Study of Contactors, Timers, Counter and Comparator

2. Human Machine interface

- Introduction to HMI Communication with PLC
- HMI tags and Assignments
- Project on Industrial load sequential feedback control Using PLC HMI

Hands on Practice

- Introduction of PLC SOFTWARE as TIA Portal
- Ladder Programming for Basic gates logics by using SPST Contacts
- Ladder Programming on SPDT
- Latching Concept and related Latching program
- Study of program memory and Programming on Memory Bits
- Study of TIMER BLOCKs and its Programming
- Introduction to COMPARATOR BLOCK and its Programming
- Introduction to COUNTER BLOCK and its Types with Programming
- Project on Industrial Load OFF/ON control Using PLC and HMI
- Introduction to analog Logic in PLC and its Programming

Reference Books

1. Vijay R. Jadhav, Programmable logic Controller, KHANNA PUBLISHERS, 2nd Edition, 2012.
2. R.G Jamkar, Industrial Automation Using PLC, SCADA and DCS, Laxmi Publications Private Limited.
3. PLC and SCADA by Prof Rajesh Mehra and Er. Vikrant Vij Published by University Science Press.
4. John R Hackworth and Frederick D. Hackworth Jr., Programmable logic Controller: Programming methods and Applications, PEARSON Edition: 1st Edition, 2006.

COMMUNITY/ENVIRONMENT-BASED GROUP PROJECT

Course Code: EX17001
Credit: 2

L-T-P: **0-0-4**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is offered to give the students an opportunity to connect with the community and the environment, learn and prioritize their problems, and define the problems in ways that make them amenable to scientific analysis and pragmatic solution. Appreciating the community problems, visualizing and experiencing them in person, self-learning, applying to realities, searching for and finding implementable solutions are the primary benefits of this project-based course.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify need of the community,
CO 2: Formulate objective of a project,
CO 3: Communicate orally and through formal technical write-ups,
CO 4: Analyze and interpret data wherever essential,
CO 5: Provide an implementable solution to the problem, and
CO 6: Work in team following ethical manners.

COURSE DETAILS

The projects will be applied to problems uppermost in the minds of the community regarding the problems that they confront regularly. The problems may range from social inequality and social justice to lack of common services such as health, education, water, power, banking, and from lack of access to government subsidies and policies to deforestation and environmental problems.

INDUSTRY 4.0 TECHNOLOGIES

Course Code: **EX20001**
Credit: **2**
L-T-P: **2-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The current manufacturing industries and businesses are moving from the third industrial revolution of the computers and automation to the fourth where the automation becomes even smarter fueled by data analytic and artificial intelligence. This course is designed to offer learners an introduction to use of Internet and Digital technology for better manufacturing and business. Learners will gain deep insights into how smartness is being harnessed from data and appreciate what needs to be done in order to overcome some of the challenges.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the key components and enablers of Industry 4.0 Technology,
CO 2: Appreciate the smartness in Smart Factories, smart products and smart Services,
CO 3: Outline Smart Factory technologies and their role in an Industry 4.0 world,

CO 4: Outline IoT technology and scope of implementing IoT in Industries and businesses,
CO 5: Comprehend distributed cyber-physical and digital manufacturing system, and
CO 6: Demonstrate the opportunities, challenges brought about by Industry 4.0 and how organizations and individuals should prepare to reap the benefits.

COURSE DETAILS

Introduction
The Fourth Industrial Revolution, Difference between conventional automation and Industry 4.0, Case Studies: Health, Agriculture, Manufacturing.

Industry 4.0 and its components
Internet of Things (IoT) & Industrial Internet of Things (IIoT), Internet of Services, Value chains in manufacturing companies, Digital Twins.

Digital Manufacturing and Design
Cyber Physical Systems and Next Generation sensors, Collaborative Platform and Product Life-cycle Management, Robotics and Automation.

Industrial IoT
Cloud Computing, Big Data Analytic, AI & ML, Virtual and Augmented Reality, Block-chain.

Challenges & Opportunities in Industry 4.0
A Digital Strategy alongside Resource Scarcity, Standards and Data security, Financing conditions, availability of skilled workers, Comprehensive broadband infra- structure, Legal framework, protection of corporate data, liability, handling personal data.

Textbooks

1. D. Pyo, J. Hwang, and Y. Yoon, Tech Trends of the 4th Industrial Revolution, Mercury Learning & Information publisher, 2021.
2. Bruno S. Sergi, Elena G. Popkova, Aleksei V. Bogoviz, and Tatiana N. Litvinova Understanding Industry 4.0: AI, the Internet of Things, and the Future of Work, Pub: Emerald Publishing Limited, 2019.

Reference Books

1. S. Misra, A. Mukherjee, and A. Roy, Introduction to IoT. Cambridge University Press, 1st Edition, 2021.
2. Dac-Nhuong Le, Chung Van Le, Jolanda G. Tromp, Gia Nhu Nguyen, Emerging Technologies for Health and Medicine: Virtual Reality, Augmented Reality, Artificial Intelligence, Internet of Things, Robotics, Industry 4.0, John Wiley publisher, 2018.
3. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress Berkeley publisher, CA 1st Edition, 2016.

SCIENTIFIC AND TECHNICAL WRITING

Course Code: EX20003
Credit: 2
L-T-P: 2-0-0

Prerequisite: Nil

COURSE OBJECTIVE

Technical documents take many forms depending on their purpose and the audience. A technical document can be a project proposal, minutes of a meeting, an advertisement in a newspaper, or even a research paper. A scientific document is a form of technical document where both the author and the audience are experts. The writing styles and the document density of technical documents depend on the nature of the document. The objective of this course is to train the students in the art and science of writing a range of scientific and technical documents.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Articulate the purpose of a document, identify its audience, and decide the density of information to be included in scientific and technical documents,

CO 2: Use language appropriately in technical writing,

CO 3: Prepare a variety of technical documents,

CO 4: Write prefatory materials of scientific documents,

CO 5: Derive a novel, meaningful, informed, and testable hypothesis from a literature review, and

CO 6: Prepare a variety of scientific documents, including laboratory and project reports.

COURSE DETAILS

Introduction

Forms and features of creative, technical, scientific, and science writing; Audience types (general and specific experts, technicians, managers, laypersons, and mixed audience); Examples of documents for technical, professional, and scientific communications; Characteristics of effective technical writing: Accuracy, clarity, conciseness, coherence, appropriateness, and readability.

Language Issues

Revisiting English grammar; Punctuation (period, comma, colon, semicolon, question mark, exclamatory mark, apostrophe, quotation marks, hyphen, dash, parentheses, and brackets); Mechanics (capitalization, italics, abbreviations, acronyms); Latin terms used popularly in English texts; Informal and colloquial English; Dangling modifiers, Faulty parallelism, Judicious use of common words and phrases; Active and passive voice; Nominalization; Common English errors; Pitfalls in writing; Adapting texts to issues of gender, race, and ethnicity; and Guarding against Plagiarism.

Paragraphing

Unity of idea, topic sentence, logical and verbal bridges through use of signposts, transitions, and link words; Patterns of development of an idea; and Lists.

Structure of Scientific Documents

Prefatory Materials: Title, Copyright Notice, Declaration and Certificates, Abstract, Keywords, Acknowledgements and Conflict of Interest Statement, Symbols and Abbreviations, and Table of Contents.

Body of Scientific Documents: Introductory Materials—Context, problem and current response, research questions, hypotheses, and objectives and scope; Literature Review—Presentation styles, citations and referencing systems, quoting, paraphrasing, and summarizing; Materials and Methods—Mathematical Materials:

Methodology, methods, tools, and techniques; Quantitative, qualitative, experimental, and mixed methods; Numbers and numerals, engineering and scientific notations of numbers, mathematical operators, equations, flowcharts, algorithms, SI units, significant digits and order of magnitude, figures, tables, and photographs; Experimental apparatus, materials, specifications, measuring instruments, procedure, data analysis; Concluding Materials—Conclusions, implications, generalization, limitations, scope for further work, and contributions of the work.

End Matters: References, Appendixes, and Supplementary materials.

Structure of Selected Technical Documents
PowerPoint presentation, Abstract of a paper, Laboratory reports, Progress report, Project proposal, Minutes of a meeting, Brochure, and News items.

Reference Books

1. Lecture notes on Scientific and Technical Writing.
2. Alred, G. J., C. T. Brusaw, and W. E. Oliu (2008), *Handbook of Technical Writing*, St. Martin's Press, New York, 9th Edition.
3. Angelika H. Hofmann (2014), Scientific Writing and Communication, Papers, Proposals, and Presentations, Oxford: Oxford University Press.
4. Duke Graduate School Scientific Writing Resource (https://sites.duke.edu/scientificwriting/).
5. Gerald. J. Alred, Charles. T. Brusaw, and Walter. E. Oliu (2008), *Handbook of Technical Writing*, St. Martin's Press, New York, Ninth Edition.
6. OWL, The Purdue Online Writing Laboratory, https://owl.english.purdue.edu/owl/.
7. Perelman, L. C., J. Paradis, and E. Barrett (1998), The Mayfield Handbook of Technical and Scientific Writing, Mayfield Publishing (ed.), Available free at http://www.mhhe.com/mayfieldpub/tsw/toc.htm, Mayfield Publishing Company, Inc., 1280 Villa Street, Mountain View, CA 94041, 415.960.3222, <http://www.mayfieldpub.com>, <mailto:hypertext@mayfieldpub.com>.
8. Rubens, P. (2001), Science and Technical Writing: A Manual of Style, 2nd Edition, Routledge, New York.

RESEARCH METHODS AND ETHICS

Course Code: **EX40001**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to introduce to the undergraduate students the various elements and methods of ethically conducting a piece of scientific research.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Select research topics and formulate research questions,
CO 2: Conduct a literature search and make a review of literature,

CO 3: Get acquainted with a range of qualitative, quantitative, experimental, and theoretical methods of research,
CO 4: Become familiar with the techniques of data collection, analysis, and interpretation,
CO 5: Understand the importance of research ethics and the implications of the broader impact of research, and
CO 6: Conduct research with honesty and integrity.

COURSE DETAILS

Introduction to research
Structure of research: Scientific method and Engineering design cycle, Defining and scoping Research problems, Formulating research objectives and research questions.

Literature Review
Searching for literature; Narrative and systematic literature review; Summarizing, paraphrasing, and quoting; and Referencing styles.

Design of Experiments
Basic Principles of randomization, replication, and Blocking; Factors and Responses; Analysis of variance, Experiments with blocking factors, and Factorial designs.

Data Analytics
Data pre-processing; Data visualization; Tests of hypothesis; Decision trees; and Artificial neural networks.

Theoretical Models
Typology of models; Optimization models, forecasting models, and control models; Monte Carlo simulation; Genetic Algorithm; Model verification and validation; and Measurement and uncertainty analysis.

Drawing Inferences
Drawing inferences, Generalizing, Finding potential applications, Imagining future scope, and Highlighting novelty of research.

Research Ethics
Ethics and morality; Utilitarian and deontological theories of ethics; Fabrication, falsification, plagiarism, and questionable research practices; Issues related to privacy and confidentiality; and Ethical issues related to publications.

Reference Books

1. Dunn, P. K. (2021), Scientific Research and Methodology: Tutorials, An Introduction to Quantitative Research and Statistics in Science, Engineering, and Health: Tutorials, Available free at https://bookdown.org/pkaldunn/SRM-tutorials/.
2. Dunn, P. K. (2021), Scientific Research and Methodology: Software, An Introduction to Quantitative Research and Statistics in Science, Engineering, and Health: Using Software, Available free at https://bookdown.org/pkaldunn/SRM-software/. (Uses Jamovi and SPSS Software, Jamovi is a freely downable software)
3. Lectures note on Research Methods and Ethics provided by Concerned faculty members.

ENGINEERING PROFESSIONAL PRACTICE

Course Code: EX40003
Credit: 2
L-T-P: 2-0-0

Prerequisite: Nil

COURSE OBJECTIVE

Engineers are expected to perform their tasks responsibly and ethically, following professional standards and guidelines. This course allows the students to understand the roles and responsibilities of engineers in society, learn professional standards, codes of ethics, issues concerning employment contracts and other legal matters, and skills of working in teams, and to effectively communicate.

COURSE OUTCOMES

At the end of the course, the student will be able to

CO 1: Know (a) the features of engineering as a profession, (b) the roles and responsibilities of engineers in society, and (c) the skills for working in teams,
CO 2: Realize the use of professional standards, codes of ethics, legal provisions surrounding engineering functions,
CO 3: Apply the above-stated standards, codes, legal provisions, and group communication skills in their decision-making situations,
CO 4: Break down a complex problem into smaller manageable tasks,
CO 5: Compare among alternatives in situations of uncertainty, risk, and ambiguity, and
CO 6: Design engineering solutions to industrial environmental and social problems.

COURSE DETAILS

Engineering and Engineer
Engineering as a discipline and a profession; Attributes and functions of a practicing engineer; and Engineer as a problem solver, designer, and change agent.

Selected Functions of Engineering
Designing for safety and reliability; Quality and productivity management; Dealing with problem complexity, uncertainty, risk, and ambiguity; Project management; and Managerial functions such as planning, organizing, motivating, and controlling; Costing and accounting.

Professional Aspects of Engineering
Accreditation, certification, and licensing; Ethical issues: Ethics and morality, ethical dilemmas, codes of ethics, professional conduct, nature and role of professional societies, engineering standards; Legal issues—Legal forms of business organizations, employment contracts, trademarks, patents, copyrights, trade secrets, professional liability, contractual agreements, environment and information technology laws, and international legal framework such as WTO.

Group Dynamics
Individual cognition; Dynamics of working in teams/groups; Interacting with stakeholders; Dealing with multicultural environments; Team and group communication; and Negotiation and conflict resolution.

Textbook

1. Shrestha, R. K. and Shrestha, S. K., Textbook of Engineering Professional Practice, 3rd Edition, Heritage Publishers and Distributors Pvt. Ltd, 2020.

Reference Books

1. Habash, R. Professional Practice in Engineering and Computing: Preparing for Future Careers, 1st Edition, Boca Raton: CRC Press, 2019.
2. Walesh, S.G., Engineering Your Future: The Professional Practice of Engineering, 3rd Edition, Wiley, 2012.
3. Subramaniam, R., Professional Ethics, 2nd Edition, Oxford University Press, 2017.
4. Lectures note on Engineering Professional Practice provide by Concerned faculty members.

ENGLISH

Course Code: HS10001
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The objective of the course is to develop and improve, in the students, the skills of active listening, speaking, reading, and writing in English, through lecture classes and practice sessions, and improve their professional communication abilities. The course will help the students to enhance their critical thinking and situational communicative skills through the study of contemporary social issues depicted in literature.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Apply verbal and non-verbal modes of communication effectively in practical situations,
CO 2: Retain a grammatically correct and logical flow while drafting reports and other technical pieces of writing,
CO 3: Develop competence in reading and comprehension,
CO 4: Implement active listening responses in professional practice,
CO 5: Utilize neutral accent in English pronunciation successfully, and
CO 6: Understand situational and conversational English used for different purposes and contents.

COURSE DETAILS

Professional Communication
Process of Communication: Definition, Explanation & Diagram, Difference Between General and Technical Communication; Methods of Communication (Verbal & Non-Verbal); Non-Verbal Communication (Kinesics, Proxemics, Chronemics, Oculesics, Olfactics, Gustorics, Haptics, and Iconics); Paralanguage; Flow of Communication (Formal & Informal); Levels of Communication; and Barriers of Communication (Intrapersonal, Interpersonal, and Organizational).

Basics of Grammar and Writing Skills
Error Detection in Sentences: Articles, Prepositions, Tense, Subject-Verb Agreement, Active and Passive Voice; Use of Punctuation: Full Stop, Comma, Colon, Semi-colon, Single & Double Inverted Commas, Exclamation & Interrogation Marks, Hyphens and Dashes, and Ampersand.
Paragraph Writing – Components; Writing Bias-free English; Business Letters: Enquiry, Claim/Complaint, and Order; Technical Reports: Formats, Style & Referencing; and Reading Techniques: Skimming, Scanning, Intensive & Extensive Reading.

Basic Sounds of English

Hearing & Listening: Types of Listening – Appreciative, Empathetic, Critical, Comprehensive, Superficial, Differences between Listening & Hearing; Introduction to Basic Sounds of IPA: Symbols of IPA, Types of Vowels & Consonants; and Problem Sounds & Mother Tongue Influence: Concept of MTI with Examples.

English Literature
Short Story – O. Henry: 'Gift of the Magi;'Short Story – Ismat Chughtai: 'Sacred Duty;'; Poem – Robert Frost: 'Stopping by Woods on a Snowy Evening; Poem – Tennessee Williams: 'We Have Not Long to Love' and Drama: William Shakespeare: Merchant of Venice.

Textbook

1. M. Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill Education Publication, 2005.

Reference Books

1. Sidney Greenbaum. The Oxford Grammar (English). Oxford University Press, 1st Edition. 2005.
2. S. Verma, Technical Communication for Engineers, Vikas Publishing House,2015.
3. R Dove,The Penguin Anthology of 20th Century American Poetry,Penguin Books. 2013.
4. The Merchant of Venice (The New Cambridge Shakespeare). Mahood & Lockwood eds. CUP. 2018.

SHADES OF ECONOMICS

Course Code: HS10121
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course will provide technical students with knowledge in concepts of environmental economics, resource economics, and circular economy, allowing prosperity for present and future generations. The course will equip future engineers with skill to handle resources efficiently and effectively. Acquaint them with the contemporary trends in business settings and thereby innovate novel solutions to existing problems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the economic drivers that shape the future of India,
CO 2: Understand sustainability issues related to usage of factor endowment,
CO 3: Create linkage between Economics, Science and Technology,
CO 4: Apply knowledge, reasons and the need for regulating circular economy,
CO 5: Assess and analyses scope for global market opportunities, and
CO 6: Explore yet to be unearthed employment opportunities.

COURSE DETAILS

Purple Economy: Economics of Glocalization
Introduction to colours and world of economics (including White, Blue, Black, Green, Purple, Grey, Red, Pink, Silver); Concept and definition of purple economy; Cultural footprint; Local and global cultural economy;

Culture and well being; Rethinking employment and training in the purple economy; Vocal for Local; Make in India.

Grey Economy: Economics of Informal Sector
Concept and definition of grey economy; Introduction to formal and informal Sector; Formal and informal sector linkage; Labour absorption and dualism in economy; Theoretical and policy issues; Migration in informal sector.

Green Economy: Economics of Reduce, Reuse, and Recycle
Concept and definition of green economy; Green investment and green bond; Green technology and renewable resources; Carbon footprint; Waste management.

Blue Economy: Economics of Ocean Resources
Concept and definition of blue economy; The marine environment; Fisheries and aquaculture; Tourism; Ocean-based renewable sources of energy; Transportation and the blue economy; ; Pollution of water resources; Water resource management.

Black Economy: Economics of Unsanctioned Sector
Concept and definition of black money; Causes and consequences of black economy; Global black income generation; Extent of black money in India. Government measures to curb black money.

Textbook

1. S.K Mishra and V. K. Puri, Indian Economy. Himalaya Publishing House,2022, ISBN: 978-93-5596-423-6

Reference Books

1. Uma Kapila. Indian Economy: Economic Development and Policy. Academic Foundation ISBN-10: 9332705550 and ISBN-13: 978-9332705555,2022.
2. Taneja and Myer: Economics of development and Planning, Vishal Publishing Co. ISBN-13: 978-9382956068.
3. Datt Gaurav & Mahajan Ashwani , Indian Economy, S Chand & Company Limited. 2017.
4. Adrian C. Newton, Elena Cantarello, An Introduction to the Green Economy. Science, Systems and Sustainability,2014
5. Shalini Goyal Bhalla. Circular Economy- (Re) Emerging Movement, 2020.
6. Somnath Hazra & Anindya Bhukta, The Blue Economy. An Asian Perspective.
7. The Informal Economy: an Employer's Approach. The Informal Economy: an Employer's Approach. 2021.
8. The Purple Economy: An Objective, An Opportunity, 2013.
9. Tom Tietenberg, Lynne Lewis, Environmental and Natural Resource Economics. 2018.

INDIAN ECONOMY POST LIBERALISATION

Course Code: HS10123
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Study of this course provides an extensive understanding of changing structure of Indian economy over time. This course targets to put emphasis on inclusive growth, reducing poverty, inequality and creating decent employment in the economy. This course will give an understanding about the issues faced by an economy in achieving sustainable development.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Interpret the changing structure of Indian economy,
CO 2: Perceive the issues and challenges faced by Indian economy,
CO 3: Evaluate the policies and programmes required to achieve inclusive growth,
CO 4: Realise the importance of human capital in triggering economic development,
CO 5: Comprehend the state and role of external sector in strengthening Indian economy, and
CO 6: Help in achieving sustainable development for the economy.

Introduction and features
Changing structure of the Indian economy Changing paradigms of Development Strategies and Economic Reforms.

Poverty, Inequality and Employment
Various concepts and estimates of poverty; Income inequality; Problem of unemployment; Interface among growth, poverty and employment; Inclusive growth and Human Development; Sustainable Development Goals—Targets for reduction in Poverty, Inequality and Decent Employment.

Demographic Issues
Demographic trends, size and structure of population; Health and Education; Skill challenges and demographic dividends; Sustainable Development Goals—Targets for Greater Wellbeing and Better Human Capital.

Perspectives in Agriculture, Industry and Services
Agricultural growth performance and food security; Growth, trends and changing pattern of Indian industries, industrial reforms and policies; Services in India's growth process; Sustainable Development Goals—Targets for Inclusive and Sustainable Growth.

External Sector and Issues in Indian Public Finance
Foreign trade and trade policy; fiscal devolution, Indian Union Budget and Tax System

Textbook

1. Uma Kapila, Indian Economy Performance and Policies, academic foundation, 2020, ISBN:978-933270545.

Reference Books

1. S.K. Mishra, and V.K. Puri, Indian Economy, Himalaya Publishing House,2022, ISBN: 978-93-5596-423-6.
2. Gaurav Datt and Ashwani Mahajan, Indian Economy, GENERIC. Classic Edition, 2022, ISBN-10: 9352531299, ISBN-13: 978-9352531295.

ESSENTIALS OF MANAGEMENT

Course Code: HS10221
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course explores the basic concepts and processes of management. Students will learn the importance of management in their professional life from the stories on the evolution and practices of management. Students will examine the fundamental roles and processes of planning, organizing, staffing, directing and controlling that comprise the managers' role. This course also examines the fundamentals of marketing and financial management for the success of the organization. This course will make an attempt to introduce students to the business environment and strategic management process to understand the nuances of business. Students will develop skills related to the manager's function as required in today's competitive environment.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn different approaches, theories and stories of various practitioners of management and know how such knowledge could be applied to achieve goals of Organizations within the changing environment,
CO 2: Understand the core functions of management in order to facilitate efficient and effective decision making both at individual and organizational level,
CO 3: Identify the human resource requirement of the organization for achieving its objective effectively,
CO 4: Synthesize various marketing and financial skills and techniques in order to be successful in corporate world,
CO 5: Assess the business environment and understand the importance of various types of business environment for better decision making, and
CO 6: Acquire the lesson learnt in strategic management process for strategic decision making by leveraging the core competencies of the organization.

COURSE DETAILS

Evolution of Management Thoughts
Concept, Scope and Significance of Management; Classical Approach; Scientific, Bureaucratic & Administrative theory of Management; Neo-classical and Modern Approach; Contribution of Management Practitioners.

Functions of Management (Part I)
Nature, scope and significance of Planning; Types of Planning; Process of Planning; Barriers to effective planning; Decision making: concept, types and process; Organizing: concept and significance; Delegation of authority; Authority vs. Responsibility; Structure of Organization: departmentalization, Centralization vs. Decentralization.

Functions of Management (Part II)
Concept of Staffing, Manpower planning and Job design; Recruitment and selection; Training and development; Performance Appraisal; Directing: Concept, Direction and Supervision; Controlling: Concept, Importance and levels; Process and types of controlling.

Marketing and Financial Management

Marketing Mix (Product, place, price, Promotion); Market Segmentation; Introduction, scope, importance and functions of Financial management; Introduction to Financial statements: Profit and loss account; balance sheet.

Business Environment and Strategic Management
Business environment: concept, importance, elements; Types of business environment; Strategic Management: Concept, Importance and levels of strategy; Process of Strategic Management.

Textbooks

1. S.A. Sherlekar & V.S. Sherlekar, Modern Business Organization & Management (Systems Approach) by Himalya Publishing House, 2018.
2. Harold Koontz and Heinz Weihrich, Essentials of Management: an International Perspective, McGraw Hills, 2020.

Reference Books

1. K. Ashwathappa, Essentials of Business Environment, Himalaya Publishing House, 2017.
2. Joseph L. Massie, Essentials of Management, Pearson Education India, 4th Edition, 2015.
3. Azhar Kazmi and Adela Kazmi, Strategic Management, Mc-GrawHill, 5th Edition 2020.

SOCIETY, SCIENCE AND TECHNOLOGY

Course Code: HS10321
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

There is a circular relationship between society, science, and technology. Society creates a need and an ambience to develop science and technology, and science and technology create means to meet societal needs and new opportunities to make human life better. Studying this relationship is the objective of this course. The course will expose, before the students, the past developments of science and technology and the social forces that played a dominant role in making these developments possible and the way these were used in the society. The course will also present the ethical principles that underlie the development and use of science and technology in the society**.**

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the forces that shape the development of science and technology,
CO 2: Understand the major milestones of scientific discoveries have impacted human thought processes,
CO 3: Understand the effect of technological developments in societal transformation,
CO 4: Analyse the contribution of Science and Technology in solving societal and Environmental problems,
CO 5: Evaluate the ethical issues related to abuse of science and technology, and
CO 6: Apply the skills learned to suggest solutions to global problems linked to science and technology.

COURSE DETAILS

Introduction

Human Curiosity to Know the Truth of Nature, Need to Improve Quality of Life, Emergence of Science and Technology, Characteristics of Society, Science, and Technology, and Impact of Science and Technology on the Society.

Scientific Discoveries
Milestone Scientific Discoveries of the Past and the Ways They Impacted Human Thought Process and Culture; Scientific Method, Developing a Theory, and Making of a Discovery; Discoveries in the Physical, Biological, and Mathematical Sciences; Normal Science, Paradigms, Anomalies, Crisis and Emergence of Scientific Theories, and Scientific Revolutions.

Technological Developments
Milestone Developments of Technologies and the Ways They Transformed the Society. Stories of Technological Developments such as Steam Engines, Electricity, Semiconductors, and IoT.

Science and Technology in the Service of the Society
Contributions of Science and Technology to Solving Societal, Environmental, and Global Problems.
Successes and Limitations, and Abuses and Control of Science and Technology; Ethical Considerations.

Textbook

1. Bucchi, M., Science in Society: An Introduction to Social Studies of Science, Routledge Publication, 1st Edition, 2004.

Reference Books

1. Collins, H. and T. Pinch, The Golem: What You Should Know about Science, 2nd Edition, New York: Cambridge University Press,1998.
2. Collins, H. and T. Pinch,The Golem: What You Should Know about Technology, 2nd Edition. New York: Cambridge University Press, 2014.
3. Kuhn, T. S.,The Structure of Scientific Revolutions, 4th Edition, Chicago University Press, 2012.
4. Hatton, J. and P. B. Plouffe, Eds., Science and Its Ways of Knowing, New Jersey: Prentice Hall,1997.
5. Moskovites, M., Ed., Science and Society, Ontario: House of Anansi Press Limited,1997
6. Sismondo, S. An Introduction to Science and Technology Studies, 2nd Edition. Maldon, MA: Blackwell Publishing, 2009.
7. Sarukkai, S. What Is Science?, New Delhi: National Book Trust, India, 2012.

COMMUNICATION LABORATORY

Course Code: **HS18001**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course is designed to enrich the basic knowledge of engineering students in the field of communication and to support the engineering and research programs.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Use English grammar correctly and unambiguously in technical writing,
CO 2: Apply verbal and non-verbal modes of communication effectively in practical situations,
CO 3: Have a basic understanding of the communication process and to know the practical implementations in the workplace,
CO 4: Retain a logical flow while drafting reports and other technical pieces of writing,
CO 5: Develop competence in reading and comprehension, and
CO 6: Be familiar with English pronunciation and use neutral accent successfully.

COURSE DETAILS

Reading Comprehension
Understanding meaning and sequence of ideas in written language.
Activity based on matching, multiple choice questions, open close, appropriate headings.

Time & Tense + Subject-Verb Agreement
Applying correct grammar in everyday writings.

Vocabulary Building (Mind Mapping/Phrasal Verbs)
Developing vocabulary through associating key ideas, and learning idioms and phrases.
Listening Comprehension
Interpreting meaning and syntax in spoken language.

E-mail Writing
Formulating appropriate e-mails with relevant salutation, language &conclusion.

Resume Writing/ Video Resume
Creating suitable, job-orientedresume.

Thematic Speaking
Practising and implementing theme-based individual speaking skills.

PowerPoint Presentation
Developing skills to design and deliver engaging, informative and impactful presentations.

Class Participation

ECONOMICS OF DEVELOPMENT

Course Code: HS20120
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The objective of this course is to provide students with the essential tools and concepts of development economics, to prepare them to understand what makes underdevelopment persist and what helps development succeed.Students will explore diverse dimension and measures of development, as well as the application of microeconomic analysis to issues of development in poor countries, including the study of household decisions and the analysis of institutions and norms influencing development.And To enhance students understanding of the SDGs to create a better- informed citizenry, which will lead to a more sustainable action by all and for all.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand key factors and issues in the process of economic development,
CO 2: Enhance their ability in applying economic models to study development problems,
CO 3: Learning the role of the three basic components of ecosystems and environment and underlying causes of their degradation,
CO 4: Understand the policy scenario and the existing environmental conventions/regulations/ laws,
CO 5: Development of sustainable planning for sustainable development of environment, economy and firms, and
CO 6: Select and apply appropriate economic techniques to solve environmental problems and measure the value of environmental goods.

COURSE DETAILS

Economic Growth and Development
Meaning of development and Economic growth, Characteristics of less developed countries. Factors in Economic development, Measuring development and development gap — per capita income, inequality of income and wealth, Gini coefficient, Human Development Index, Physical Quality of Life Index, and other indices of development.

Theories of Economic Growth and Development
Theories of Economic Development: Classical (Smith, Ricardo, Malthus), Marxian – Theory of Social change, immutable laws, Crisis in capitalism, Schumpeter and capitalist development, Rostow's stages of growth. Partial theories of growth and development: Vicious circle of Poverty, Big push, balanced growth, unbalanced growth.

International aspects of Economic Development
International trade as an engine of growth; Static and dynamic gains from trade; Prebisch, Singer and Myrdal theses vs. free trade; Export-led growth; Tariffs and effective protection; WTO and developing countries. External resources; FDI; Aid vs. trade.

Development and Environment
Economy linkage; Environment as a necessity and luxury; Population environment linkage. Allocation problem; Market failure for environmental goods; environment as a public good.

Sustainable Development
Concept and indicators of sustainable development. Common Property Resources, Property right approach to environmental problem-property rights approach, property rights and environmental problems, Externalities and Pigovian tax, Coase theorem, Coase theorem and transaction cost. Prevention, control, and abatement of pollution.

Textbooks

1. S. Ghatak, An Introduction to Development Economics, Allen and Unwin, London, 2003.
2. Kindleberger, C. P. Economic Development, McGraw Hill, New York, 1958.
3. Todaro, M. P. Economic Development, Longman, London.

References Books

1. Thirwal, A. P. Growth and Development, Macmillan, UK, 2017.
2. Adelman, I. Theories of Economic Growth and Development. Stanford University Press, Stanford, 1966.

3. Chenery, H. and T.N. Srinivasan (Eds) Handbook of Development Economics, Vols 1, 2, Elsevier, Amsterdam, 2002.
4. Myint, H. Economic Theory and Underdeveloped Countries, Oxford University Press, New York, 1971.

INTERNATIONAL ECONOMIC COOPERATION

Course Code: **HS20122**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This objective of this course is to equip students with knowledge of both the theoretical concepts and the actual procedures involved in international trade. The specific purpose is to increase the knowledge of importing and exporting essentials and to offer the with the skills for understanding the international trading process.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn theories of international trade,
CO 2: Understand free trade, protection, and BOP,
CO 3: Analyse the role of international organisations,
CO 4: Understand the working of foreign exchange,
CO 5: Study the EXIM policies, and
CO 6: Analyse secondary data relating to international trade.

COURSE DETAILS

Theories of International Trade
Classical Theories of International Trade- Mercantilism, Absolute Advantage, Comparative advantage Theory, Gains from international trade; Terms of trade; Theory of Reciprocal Demand; Modern Theories of International Trade-Heckscher-Ohlin theory.

Free Trade, Protection and Balance of Payment
Free trade and protection in developing countries; Forms, methods and effects of protection; Introduction of BoP, Structure of BoP, Disequilibrium in BoP, Measures to overcome disequilibrium in BoP, Tariff, Trade creation vs Trade diversion.

International Organizations
International Monetary Fund; World Trade Organization; Regional Trade Agreements; Trade Blocs.

Foreign Exchange
Foreign Exchange Market; Theories of foreign exchange; Factors affecting exchange rate; Fixed and flexible exchange rate; FERA and FEMA.

EXIM Policies
Recent budgetary policies and programs relating to inequality; Analysis of Economic Survey data.

Textbooks

1. R.R. Paul, Money Banking and International Trade, Kalyani Publishers, 12th Edition,2015, ISBN-10:932725774X, ISBN-13: 978-932725774.
2. Bo Södersten and Geoffrey Reed, Palgrave Macmillan, International Economics. 1994, ISBN-10: 0333612167, ISBN-13: 978-0333612163.

Reference Books

1. Dominick Salvatore, International Economics: Trade and Finance, Wiley; 11th Edition, 2017, ISBN-10: 8126552344 ISBN-13: 978-8126552344.
2. Paul R. Krugman, Maurice Obstfeld, Marc Melitz, International Trade: Theory and Policy, 2017, ISBN-10: 9789332585768, ISBN-13: 978-9332585768.

ORGANIZATIONAL BEHAVIOUR

Course Code: HS20220
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course shall guide the students to learn the basic concepts of Organizational Behaviour and its applications in contemporary organizations. Further, it helps them to describe how people behave under different conditions and understand why people behave as they do. The students would be in a position to synthesize related information and evaluate options for the most logical and optimal solution such that they would be able to predict and control human behaviour and improve results. Lastly, this course would help the students to understand how individual, groups and structure have impacts on the organizational effectiveness and efficiency.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Know about organization, organizational behaviour, it's nature, scope and significance,
CO 2: Develop their personality as per industry requirement,
CO 3: Apply motivational techniques to make the employees work with confidence and satisfaction,
CO 4: Develop different leadership styles to adjust themselves in different organizational situations,
CO 5: Improve the knowledge of group behaviour and techniques of group decision making, and
CO 6: Apply the concepts for managing changes in organization as well as the development of an organization's human resources.

COURSE DETAILS

Introduction to Organizational Behaviour
Organizational Behaviour- nature and scope; Need for studying OB; contributing disciplines to OB; evolution of OB; OB approaches and models; OB opportunities and disruptions.

Individual Perspective

Introduction to Individual behaviour; Personality- concept, determinants, types and theories/models; Personality and OB; Perception- meaning, perceptual process, factors affecting perception; perception and its application in OB; Attitude- nature, components, formation and types; Values- concepts, types and formation; attitude, values and behaviour.

Individual Perspective
Learning- meaning, determinants, theories and principles; learning and behaviour; Motivation- nature, importance, process and theories; managerial implication of motivation- job design, quality of work life and employee engagement; organizational citizenship behaviour- meaning, theoretical perspective, determinants and predictors.

Group Perspective
Foundation of group behaviour; meaning and characteristics of group; why do people form and join groups; types and groups; stages of group development; group decision making; Team building- meaning and types of team; team building process; Meaning, sources and types of conflict; conflict management and negotiation strategies; Leadership- meaning and importance; differentiating between leader and manager; leadership styles; leadership theories.

Organizational Perspective
Organizational structure- meaning and elements; Organizational culture- meaning, types and functions of culture; creating, sustaining and changing a culture; Organizational change- meaning and need; managing resistance to change; Organizational development- meaning, objectives, models and interventions.

Textbooks

1. S.S. Khanka, Organizational behaviour texts and cases Sultan Chand, OB text and cases S.S. Khanka, S. Chand, 2022.
2. Stephen P. Robbins, Timothy A. Judg, Neharika Vohra Organizational Behaviour, Pearson, 18th Edition, 2018.

Reference Books

1. Fiona M. Wilson, Organizational Behaviour and Work, Oxford University Press, 2014.
2. K. Aswathappa, Organizational Behaviour, Himalaya Publishing House, 2013.

ENGINEERING ECONOMICS

Course Code: **HS30101**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of Engineering Economics is to aid in decision-making by focusing on the economic implications of technical analysis. It is committed to making operational level decisions and solving problems.

COURSE OUTCOME

At the end of the Course the student will be able to

CO 1: Comprehend the significance of different components of Engineering Economics,
CO 2: Analyze the basic economic concepts required for engineers and managers,
CO 3: Develop the problem solving aptitude in the students through practical and case problems,
CO 4: Decide the feasibility of a particular project by the application of different project evaluation Techniques,
CO 5: Use the economic tools in the decision making process, and
CO 6: Survey the current macroeconomic situations in the economy.

COURSE DETAILS

Introduction to Economics and Engineering Economics
Basic concepts of Engineering Economics: Demand Analysis, Supply Analysis, Market Equilibrium. Revenue Analysis. Demand Forecasting- Quantitative Methods, Consumer's Equilibrium.

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

Time Value of Money
Interest Formulae and their applications with cash flow diagram. Evaluation of Investment Proposals - Present Worth, Future worth and Annual Equivalent Method of comparison.

Economic Appraisal Techniques
Net Present Value (NPV), Internal Rate of Return (IRR), Cost Benefit analysis. Depreciation calculation; Meaning and Definition, Methods.

Macroeconomic policies
Functions of commercial banks and central bank, Fundamentals of Business cycle, Macroeconomic policies for stabilization.

Textbooks

1. Dominick Salvatore, Siddartha K. Rastogi, Managerial Economics: Principles and Worldwide Applications, Oxford University Press, ISBN: 9780199467068, 9th Edition, 2020.
2. D N Dwivedi, H L Bhatia, & S N Maheswari, Engineering Economics, Vikas Publishing House, Noida, ISBN:978-93-5674-625-1, 2nd Edition 2023.
3. James Riggs, David D. Bedworth and Sabah U. Randhawa, Engineering Economics, 4th Edition, McGraw Hill Education (India) Private Limited, New Delhi, 2016.

Reference Books

1. William A. McEachern and Simrit Kaur Micro ECON-A South-Asian Perspective-, Cengage Learning, 2013.

2. Yogesh Maheshwari, Managerial Economics- 3rd Edition, PHI Learning Private Limited,2014.
3. A. Khan, Arshad Noor Siddiquee, Brajesh Kumar, Engineering Economy-Zahid Pearson Publication, 2012.
4. R. Panneerselvam Engineering Economics, Pub: PHI Learning Private Limited, New Delhi, 9thEdition, 2008.
5. G.S Gupta Managerial Economics, Tata McGraw Hill Education Private Limited, 2nd Edition, 2011.
6. D.M. Mithani, Managerial Economics – Theory and Applications –Himalaya Publication, New Delhi, 6th Edition, 2009.
7. S.B. Gupta, R7. Monetary Economics-Institutions, Theory and Policy, S. Chand, 1995.
8. R.D. Gupta R8. Macro – Economics, Publication: Kalyani Publication, 1994.

MARKET STRUCTURE AND PRICING POLICIES

Course Code: HS30125
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Develop the ability for getting conceptual clarity about the various types of markets along with their functions and understand the pricing policy operations in the different markets.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Comprehend the significance of different components of market,
CO 2: Analyze the basic economic concepts required for various types of market and their policies,
CO 3: Develop the problem-solving aptitude through practical and case study problems faced by the economy,
CO 4: Use the economic tools in the decision-making process of fixing prices and quantities in different Market,
CO 5: Differentiate between different markets and the policy measures to regulate it, and
CO 6: Survey and map the impact of the current micro and macro-economic situations in the economy.

COURSE DETAILS

Cost and Revenue Analysis
Concepts of cost (economic cost, production cost, real cost, opportunity cost, private & social cost), cost function, Output maximisation and cost minimisation, Derivation of cost function, traditional and modern theories of costs. Concepts of revenue (total, average, marginal revenue), relationship between TR, AR and MR.

Market Structures and Perfect Competition
Meaning of market, characteristics of market, and types of market. Perfectly competitive market and features, equilibrium of the firm and industry under perfect competition (short run and long run).

Monopoly Market
Meaning, concepts and characteristics of monopoly market. Equilibrium price and output determination under monopoly market in short and long run. Monopoly price discrimination. Degree of monopoly power and its measure. Control and regulation of monopoly power.

Duopoly and Oligopoly Market
Non-collusive oligopoly: Cournot's duopoly and Kinked-Demand Model. Collusive oligopoly: Cartel; Cartels aiming at joint profit maximization and market sharing cartels. Price leadership; low-cost price leadership, dominant firm price leadership and barometric price leadership.

Monopolistic Competition
Meaning, price determination of a firm under monopolistic competition; Chamberlin's group equilibrium; theory of excess capacity; selling costs; difference between perfect competition and monopolistic competition; difference between monopoly and monopolistic competition.

Textbooks

1. Koutsoyiannis, Modern Microeconomics, St. Martin's Press, New York,2nd Edition 1979, ISBN 978-0-333-25349-6.
2. G. S. Maddala, Ellen M. Miller, Microeconomics: Theory and Applications, McGraw-Hill Inc., US-Publisher, 1989, 0070394156-ISBN.
3. H.L. Ahuja, Modern Microeconomics: Theory & Applications, S. Chand Publishing, 2022, ISBN: 9789355011015.

Reference Books

1. Robert Pindyck, Daniel Rubinfeld, Microeconomics, 8th Edition, 2017, 9789332585096-ISBN, Pearson Education Publication.
2. G. Fransico Stigler, Theory of Price, Prentice Hall of India, New Delhi, 4th Edition, 1996.
3. H. Gravelle and R. Rees, Microeconomics, Person Education U.K. 3rd Edition 2007, 2007ISBN: 9788131716557, 8131716554.
4. H.R. Varian, Micro Economic Analysis, W.W. Norton & Company; New York, 3rd edition 2019, ISBN-13: 978-8130908632.

PRAGMATIC INQUIRY

Course Code: HS30127
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

As a foundation for lifelong inquiry, this course introduces students to research techniques and how they are used in both liberal arts, technical and professional courses.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the meaning and importance of research in behavioral science,
CO 2: Describe in detail different types of research methodologies,
CO 3: Identify the strengths and weaknesses of the different study designs,
CO 4: Assess whether research studies are using the most appropriate study design,

CO 5: Discuss why various approaches may be appropriate/ inappropriate for their work-based research question, and
CO 6: Apply the concepts in research related activity.

COURSE DETAILS

Pragmatic Inquiry
Meaning, characteristics, need, type, and approaches.

Research Problem
Meaning, definition, selection, and framing of problem statement.

Research Design
Meaning, characteristics, need, type, approaches, and problems of research design.

Sampling Design
Meaning, characteristics, need, type, approaches, and problems.

Data Collection Method and Analysis
Types of data, Source of data, Methods of data collection, data analysis.

Textbook

1. Deepak Chawla & Neena Sodhi, Research Methodology: Concepts and Cases, Vikas Publishing House,2018, ISBN-10: 9325982390, ISBN-13: 978-9325982390.

Reference Books

1. C.R. Kothari and Gaurav Garg, Research Methodology, New Age International Publishers,2019, ISBN-10 9386649225, ISBN-13- 978-9386649225.
2. S.K. Mangal, Research Methodology in Behavioural Sciences, Prentice Hall India Learning Private Limited, 2013, ISBN-10: 9788120348080, ISBN-13: 978-8120348080.
3. Sameer S. Phanse, Research Methodology-Logic, Methods, and Cases, OUP, Sameer S. Phanse,2016 ISBN: 9780199453788.

ECONOMIC ANALYSIS OF DECISION RULES

Course Code: HS30129
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Analyze and understand investment decisions under the conditions of risk and uncertainty. Particular economic models are not the ends, but the means for illustrating the method of applying mathematical techniques to economic theory in general.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Analyze and understand investment decisions under the conditions of risk and uncertainty,
CO 2: Explain how game theory brings out the strategy used by the oligopoly firms to determine the best possible action to maximize profit-maximizing objective,
CO 3: Understand functional formulation of the problem and application of linear programming,
CO 4: Describes different concepts used in analysing the national income and the different methods applied to measure the national income,
CO 5: Describe and explain the main channels of the monetary transmission mechanism through monetary and fiscal policy, and
CO 6: Describe managerial decisions through the application of some economic concepts, theories and principles.

COURSE DETAILS

Investment Decisions under Risk and Uncertainty
Concepts of Risk and Uncertainty; Investment Decisions under Risk: The Pay-Off Matrix Method, Risk-Adjusted Discount Rate Method, Certainty-Equivalent Approach, Probability Theory Approach, Decision Tree Method, Simulation, Sensitivity Analysis.

Game Theory and Strategic behaviour of Firms
Basics of Game Theory, Prisoners' Dilemma: The Problem of Oligopoly Firms; Application of Game Theory to Oligopolistic Strategy; Nash Equilibrium: Pure and Mixed Strategy.

Optimization: Constrained & Extrema
Free and constrained optimization, extrema of a function of two variables: graphical analysis, Lagrange method. Utility maximization & Cost minimization.

Linear and Non-Linear Programming for Business Decisions
Conditions for Application of Linear Programming; Concept of Feasible Solution; Assumptions of Linear Programming Application of Linear Programming Technique: Profit Maximization Problem, Formulation of Profit Maximization Problem in Linear Programming Mode; Graphical Method of Solving Linear Programming Problems; Simplex Method: Algebraic Solution, Simplex Tableau Method. Introduction to Non-Linear Programming.

Input-Output Analysis
Input-output model, its structure and its derivation. The use of input output model in Economics.

Textbook

1. D.N. Dwivedi, H.L. Bhatia, S.N. Maheshwari, Vikas Publishing Pvt. Ltd., 2022.

Reference Books

1. C. Chiang and K. Wainwright, Fundamental Methods of Mathematical Economics, McGraw Hill International Edition, 2017.
2. K. Sydsaeter and P. J. Hammond, Mathematics for Economic Analysis, Pearson Educational Asia, 2002.

ECONOMICS OF HEALTH AND EDUCATION

Course Code: HS30131
Credit: 3

L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The United Nations member states' adoption of the Millennium Development Goals, which include among other objectives achieving universal primary education, reducing child mortality, enhancing maternal health, and combating diseases, reflects the significance of education and health in enhancing wellbeing. This course offers a microeconomic framework to examine, among other things, individual preference in the demand for health and education, governmental involvement, and elements of inequality and discrimination in both sectors. An outline of India's health and education system is also provided.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understanding role of health and education in human development,
CO 2: Analysing microeconomic foundations of health economics,
CO 3: Assessing the growth of health sector in India,
CO 4: Appraising the benefits of investment in human capital,
CO 5: Assessing the growth of education health sector in India, and
CO 6: Examining the underling discrepancies in both sectors.

COURSE DETAILS

Role of Health and Education in Human Development
Importance of health and education outcomes and their relationship with macroeconomic performance.

Health Economics Market
Demand for health; uncertainty and health insurance market; alternative insurance mechanisms; market failure and rationale for public intervention; equity and inequality.

Education: Investment in Human Capital
Rate of return to education: private and social; quality of education; signaling or human capital; theories of discrimination; gender and caste discrimination in India.

Health and Education Sectors in India: An Overview
Health outcomes; health systems; health financing. Cost effectiveness and cost-benefit analysis; burden of disease. Literacy rates, school participation, school quality measures.

Trend in Health and Education Sector in India
Secondary data analysis pertaining to health and education sector. Trend analysis and forecasting using time series data. Simple growth rate calculations.

Textbook

1. S.K. Mishra, and V.K. Puri, *Indian Economy*, Himalaya Publishing House,2022, ISBN: 978-93-5596-423-6.

Reference Books

1. William, Jack, Principles of Health Economics for Developing Countries, World Bank Institute Development Studies, 1999.

2. World Development Report, Investing in Health, The World Bank, 1993.
3. G. Ronald, Ehrenberg and S. Robert, Smith, Modern Labor Economics: Theory and Public Policy, Addison Wesley, 2005.

BUSINESS ETHICS AND CORPORATE GOVERNANCE

Course Code: **HS30223**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

This course focuses upon the fundamental principles and standards that should govern the business organizations. The objective of this paper is to make the students aware about the importance of ethics, corporate governance and role of CSR & sustainable development goals in the business to encourage moral practices and sensitivity towards the ethical dimension of managerial problems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Familiarize the learners with the concept and relevance of Business Ethics in the modern era,
CO 2: Understand the value of business ethics which will guide them in maintaining firm moral values while taking managerial decision,
CO 3: Make moral judgments in dilemmatic situations across the work domains,
CO 4: Analyse the application of management practices by adhering to corporate law and ethics,
CO 5: Evaluate the scope, opportunity and complexity of Corporate Social responsibility in the global and Indian context, and
CO 6: Create an opportunity to understand the sustainable development goals in maintaining a balance between the economic, environmental and social needs.

COURSE DETAILS

Business Ethics: Concept, Principles & Theories
Meaning, objective and types of Ethics; Business ethics- concept, need, scope, objectives and importance; factors influencing business ethics; Principles of Business ethics; Relationship between ethics and business ethics; theories of business ethics; Ethical dilemma and ethical decision making.

Ethics in Practice across the domain
Ethics in marketing- introduction, ethical dilemma in marketing, unethical marketing practices, measures to stop unethical practices in marketing; Ethics in Finance- introduction, code of ethics in finance, unethical practices in finance or frauds, measures to stop unethical practices in finance; Ethics in HRM- introduction, ethical issues in HRM (job discrimination, sexual harassment, employee privacy, whistle blowing, affirmative action); importance of workplace ethics and employee code of conduct.

Corporate Governance
Corporate Governance- concept, objective and need. Role of law in corporate governance; important issues in corporate governance; Corporate governance in India-past, present and Future; Importance and principles of Corporate Governance.

Introduction to Corporate Social Responsibility
CSR- Concept, evolution and development; Why CSR; Apprehensions against CSR; Forms and dimensions of CSR; making business corporations socially responsible; CSR in India.

Sustainable Development
Introduction, meaning, history, features, objectives of sustainable development; The pillars and principles of sustainable development; SDG and its relevance in business.

Textbooks

1. K. Nirmala, Dr. B.A. Karunakara Reddy & N. Aruna Rani, Business Ethics and Corporate Governance, Himalaya Publication House
2. C.S.V. Murthy, Business Ethics and Corporate Governance, Himalaya Publishing, 2022.

Reference Books

1. Prabhakaran Paleri, Corporate Social Responsibility (concept, cases and trends Cengage Learning India Pvt. Limited, 2020.
2. S.S. Khanka, Business Ethics and Corporate Governance, Sultan Chand, 2019.
3. C.U. Saraf, Corporate Social Responsibility (CSR), Corporate Governance, Sustainable Development and Corporate Ethics/Business Ethics Himalaya Publishing House 2017.

LEADERSHIP AND TEAM EFFECTIVENESS

Course Code: HS30225
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

An effective leader understands the team dynamics, stimulates the morale of the followers and always aims at creating a participative workforce by enhancing team work. This course mainly focuses on individual, group and organization factors associated with leadership. There is a strong connection between emotional intelligence and leadership because the technical skills and knowledge will definitely help the students to fulfil the entry level requirements. Similarly, understanding employee empowerment would assist the students in acquiring the desirable professional skills.

COURSE OUTCOMES

At the end the course, student will able to

CO 1: Learn the characteristics and need of an effective leader,
CO 2: Understand the effectiveness of different leadership styles in different contexts from an instrumental, political, and ethical perspective,
CO 3: Apply leadership theories to the real business scenario,
CO 4: Analyse group dynamics and importance of team work,
CO 5: Evaluate the ways to handle emotions and stress and manage work-life flexibility, and
CO 6: Create organizational environment that is psychologically safe and make the employees feel empowered.

COURSE DETAILS

Leadership: concepts and practices
Meaning, Definition and understanding of leadership; the role and functions of a leader; Differentiation between leadership and management; what makes a leader effective; characteristics of an effective leader; leadership in Indian organization.

Leadership Perspectives
Trait perspective of leadership (Great man theory and trait theory); Behavioural perspective of leadership (mangerial grid and likert system - four management); Studies on leadership (Hawthorne, IOWA, Michigan and Ohio); Contingency perspective of leadership (fiedler's contingency theory, path goal, hersey blanchard situational theory); contemporary perspective to leadership (transformational, transactional, charismatic, servant and Nurturant-task leadership style).

Team effectiveness and Leadership
Characteristics and types of teams; types and functions of group; Group vs team; understanding an effective team; who is a team leader; tuckman's team development stages; team development and team building; team meetings and leadership; team effectiveness leadership model; high-performance teams and leadership; team cohesiveness; common threats to groups.

Emotional Intelligence and Leadership
What are emotions; Meaning, type and source of emotions; Concept and competencies of emotional intelligence; Elements of emotional intelligence; importance of EI; EI at workplace; Emotional intelligence and leadership; Significance of EI for leaders; strategies to enhance EQ in our jobs; EQ vs. IQ; developing EQ; obstacles to the development of EQ.

Leadership and empowerment
Employee empowerment- concept, need and importance; approaches to empowerment; advantages and disadvantages of empowerment; empowerment skills of a leader; Empowering vs. Dis-empowering; leader as a coach (coaching skill); delegation (advantages and levels of delegation, steps and principles of effective delegation); empowering interpersonal skills.

Textbook

1. Ranjana Mittal, Leadership Personal effectiveness and Team Building, Vikas Publishing House Pvt Ltd, 2015.

Reference Book

1. S. Bhargava and Gourav Bhargava, Team Building and Leadership, Neelam Himalaya Publishing House, 2015.

UNIVERSAL HUMAN VALUES

Course Code: HS30401
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The objective of the course is to develop a holistic perspective based on self-exploration, understand the harmony in the human being, strengthen self-reflection, and develop commitment and courage to act.

COURSE OUTCOME

After successfully completing the course, the students will be able to

CO 1: Understand the concept of value education and its need,
CO 2: Apply their knowledge on value education for apt self-assessment,
CO 3: Comprehend human-human relationship,
CO 4: Build holistic perception of harmony at all levels of existence,
CO 5: Develop the sense of natural acceptance of human values, and
CO 6: Create people friendly and eco-friendly environment.

COURSE DETAILS

Need, Basic Guidelines, Content and Process for Value Education
Purpose and motivation for the course, recapitulation from Universal Human Values-I. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. Continuous Happiness and Prosperity- A look at basic Human Aspirations. Right understanding, Relationship and Physical Facility- the basic requirements for fulfillment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfil the above human aspirations: understanding and living in harmony at various levels. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

Understanding Harmony in the Human Being - Harmony in Myself!
Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Health. Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

Understanding Harmony in the Family and Society- Harmony in Human Relationship
Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and competence. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all pervasive space. Holistic perception of harmony at all levels of existence. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Implications of the above Holistic Understanding of Harmony on Professional Ethics
Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics: a) Ability to utilize the professional competence for augmenting universal human order b) Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c) Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human Order: a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers b) At the level of society: as mutually enriching institutions and organizations . Sum up. Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

Textbook

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. A.N. Tripathi, Human Values, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. Mohandas Karamchand Gandhi, The Story of My Experiments with Truth.
5. E. F Schumacher, Small is Beautiful.
6. Cecile Andrews, Slow is Beautiful.
7. J.C. Kumarappa, Economy of Permanence.
8. Pandit Sunderlal, Bharat Mein Angreji Raj.
9. Dharampal, Rediscovering India.
10. Mohandas K. Gandhi, Hind Swaraj or Indian Home Rule.
11. Maulana Abdul Kalam Azad, India Wins Freedom.
12. Romain Rolland (English), Vivekananda.
13. Romain Rolland (English), Gandhi.
14.

GENDER STUDIES

Course Code: HS30421
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The objective of this course is to make student understand the concepts of masculinity and femininity as analytical categories via analysing the role of communalism, patriarchy, violence as major hurdles to women's rights globally. Further, this course will enhance their understanding over the current health and education status of women to analyze impact of government health policy on women. Additionally, it will bring greater

understanding over the integration of gender concerns and perspectives in policies and programmes for sustenance of environment at international, national, regional levels.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Familiarise the students with the concepts of sex, gender and sexuality commonly used in gender studies,
CO 2: Identifying major human rights violations faced by women worldwide,
CO 3: Learn about women's health movements and government health policies,
CO 4: Develop an insight into policy perspective issues, and concerns of girl's education in India,
CO 5: Delineate the characteristics and the issues of environment and the involvement of women in balancing ecosystem, and
CO 6: Understand sustainable development, millennium development goal, and other global level development initiatives taken for uplifting women status in society.

COURSE DETAILS

Understanding Basic Concepts in Gender Studies
Concepts: Sex, Gender, Sexuality, Femininities, Masculinities and other sexualities, Patriarchy; WID: Women in Development; WAD: Women and Development; GAD: Gender and Development

Gender and Human Rights Discourse
Women's Rights as Human Rights (FGM, FF, Rape, Honour Killing, IVP, Witch Hunting, Virginity Test, Communalism, Trafficking, Immigration); National Commission for Women and other State Commissions, Ministry and Department of Women and Child.

Gender and Health
Sexual and reproductive health (ICPD, B.P.A. Family planning and Abortion); Impact of violence on women's health; Women's health movement: National and International; National health and population policy; National Family Health Survey (NFHS)

Gender and Education
Women's Education in Free India: Gender Disparity in Enrolment; Constraints of Women's Education: Social, Economic, Cultural, Geographical, other Factors; Important Committees and Commissions on Women's Education: Radhakrishnan Commission (1948), Mudaliar commission (1952), Kothari Commission (1964-1966), Ramamurthy Commission (1991).

Gender and Environment
Role of women in environment conservation; Role of Women in Waste Management; Women's Resistance to Environmental Destruction: Joint Forest Management – CHIPKO Movement – Narmada Bachao Aandolan.

Reading Materials

1. Gerda Lerner, Creation of Patriarchy, Oxford University Press,1985
2. Menon, Nivedita. ed. 2007. Sexualities. Women Unlimited. New Delhi.
3. Gnew, Sneja, A Reader in Feminist Knowledge, Routledge, New York,1991
4. Marjorie Agosin (ed.), Women, Gender and Human Rights: A Global Perspective, Rawat Publications, 2000
5. Monica Chawla, Gender Justice: women and law in India, Deep and Deep pub., New Delhi, 2006, 2013
6. P D Kaushik, Women's rights; access to justice, Bookwell Publications, New Delhi, 2007
7. Paola Monzini, Sex Traffic, Prostitution, Crime and Exploitation, Zed Pub., 2005

8. Chloe E. Bird, Patricia P. Rieker, Gender and Health, Cambridge University Press, 2008.
9. Jasmine Gideon, Ed., Handbook on Gender and Health (International Handbooks on Gender series), Development Studies, Birkbeck, University of London, UK, 2016.
10. Nelson E, Zimmerman C. Household survey on domestic violence in Cambodia. Ministry of Women's Affairs, Project Against Domestic Violence, Cambodia,1996.
11. Parker B, McFarlane J, Soeken K. Abuse during pregnancy: effects on maternal complications and birth weight in adult and teenage women. Obstetrics and gynaecology, 1994, 84(3):323-328.
12. Madeleine Arnot and Mairtin Mac, An Ghaill, (2006) "Gender and Education" Routledge, New York
13. Aruna Goel, (2004) "Education and Socio-Economic Perspective of Women Development and Empowerment" Deep and Deep Publications, New Delhi
14. Eileen M. Byrne, (1978) "Women and Education" Tevi Stock Publications, Michigan
15. Payal Mago and Isha Gunwal, (2019). Role of Women in Environment Conservation.
16. M.S Swaminathan. (1998). "Gender Dimensions in Biodiversity management". Konark Publisher's Pvt. Ltd, New Delhi.
17. P.K.Rao. (2000). "Sustainable Development – Economics and Policy". Blackwell, New Delhi.
18. Swarup, Hemlata and Rajput, Pam. (2000). "Gender Dimensions of Environmental and Development Debate: The Indian Experience" in Stuart S. Nagel, (ed.) "India's Development and Public Policy". Ashgate, Burlington.

TRIBAL RESOURCE MANAGEMENT

Course Code: HS30423
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The course intends to impart a comprehensive knowledge about the reality, pertaining to economic alleviation of the poor and downtrodden. It is inter-disciplinary and based on utilization of natural resources employing traditional means of approach, conducive for societal growth and development. This shall hone socioeconomic environmental development for uplifting the condition of tribal population for igniting new ideas in the new economy.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Identify the concept of sustainable natural resource management,
CO 2: Recognize agribusiness management, its opportunities and risks,
CO 3: Discuss adequate skills to prepare and implement integrated development plan & projects for the optimal use of tribal renewable resources for the sustainable development of the environment,
CO 4: Illustrate the nuances of environmental policies and Laws in India and understand the core competencies required for resource mobilization and policy formulation based on the research insight,
CO 5: Prioritize the role of health and education for the development of tribal community, considering tribal people as resources, and
CO 6: Develop trainees or volunteers as competent change agent in the field of tribal resource management.

COURSE DETAILS

Natural Resource Management

Introduction to Natural Resources and their management: Natural Resource Management (NRM): Concept, Issue and Approaches; Need for developing extension strategies for NRM; Issues in management of NRM; Problems encountered while advocating strategies for NRM; Monitoring and auditing in Natural Resource Management (NRM); Triple Bottom Line (TBL) and concept of Sustainable Natural Resource Management; NRM of Water, land and forests: Water resources and their management, Overview of irrigation management, Integrated Watershed management and rainwater harvesting, River Basin management; Scope of market mechanism in NRM

Agribusiness Management

Agricultural value chains and their relevance; Managerial Insights: Identifying agribusiness opportunities; Assessing feasibility – technical, commercial and financial and thereby identify feasible opportunities for projects; Analyzing influences of external environment factors and associated risks; Discussions on illustrative agribusiness projects; select models and opportunities of agribusiness opportunities and ventures.

Environmental Resource Management of Tribals

Environment and Development-Theories of optimal use of exhaustible and renewable resources; Sustainable Development - The concept of sustainable development; strong and weak sustainability; Mechanism for environment regulation in India; environmental laws and their implementation; Environmental Policy in India-Policy instruments for controlling water and air pollution and forestry policy; Institution for forest Management-The institutions of joint forest management , social foresty-rationale and benefits

Tribal Health and Education Management

Role of Health and Education in Tribal Development: Importance in poverty alleviation; health and education outcomes and their relationship with macroeconomic performance; Tribal Health in India: An Overview Health outcomes; health systems; health; Evaluation of Health Programs for tribals: Costing, cost-effectiveness and cost benefit analysis; burden of disease; Tribal Education in India: An Overview Literacy rates, school participation, school quality measures

Agro forestry Management

Multiplicity of Agroforestry products and services- ecological and economic and cultural considerations- gender equality- preservation of indigenous knowledge. Socioeconomic benefits of agroforestry; Smallholder livelihood and the role of agroforestry- Food and nutritional security Fulfillment of food, fodder, fuelwood and shelter based needs- income generation vs. subsistence production; Adoption of AF- Determinants of adoption: feasibility, profitability, and acceptability; . Self-efficacy in farmer decision-making - policy aspects.

Textbooks

1. Madhusudan Bandi, Tribals and Community Forest Management, Rawat Publication, 2013
2. Jumyir Basar, Indigenous Knowledge and Resource Management Shipra Publications, 2014
3. Laishram Herojit, Rethinking Resource Management: Sustainability and Indigenous Peoples, A.K. Publications, 2012.

Reference Book

1. G.K. Bera, Tribal India's Traditional Wisdom and Indigenous Resource Management by, Abhjeet Publishers.

Course Code: HS30425
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The objective of the course is to promote interdisciplinary study on all aspects of the Indian Knowledge System (IKS), preserve and disseminate IKS for further study and societal applications. It will actively help students to engage in spreading the rich heritage of our country and traditional knowledge in the field of Liberal Arts, Literature, Basic Sciences, Engineering and Technology, Economics, mental and physical well being etc.

COURSE OUTCOMES

At successfully completing the course, the students will be able to

CO 1: Understand the concept of Indian traditional knowledge and its importance,
CO 2: Know the need and importance of protecting traditional knowledge,
CO 3: Develop an appreciation among the students for ancient scriptures,
CO 4: Contrast and compare characteristics and important kinds of traditional knowledge,
CO 5: Evaluate social change on traditional knowledge, and
CO 6: Create innovative ways of bringing forward ancient knowledge to the forefront.

COURSE DETAILS

Meaning of Traditional Knowledge System

Overview of the Vedas, the Upanishads, the Puranas, and the Itihasas. Main Schools of Darshana/ Philosophy: Astika (Vedanta, Nyaya, Vaisheshika, Sankhya, Mimamsa, Yoga) and Nastika (Buddhist, Jainist, Lokayata). Types of Shastra (Vyakarana, Kavya, Alamkara, Shilpa, Vastu, Natya and Sangita). Types of Kavya (Drishya, Shravya, Chitra). Theory of Rasa: Natyashastra by Bharata (Chapter 6). Applied Traditional Knowledge: Myths, Rituals, Taboos and Superstitions, Folktales, Proverbs. Fundamental Concept of Dharma and Its Role in Various Streams of Indian Knowledge System

Yoga and Spiritualism
Definition and Origin of Yoga. Significance of spirituality in Yoga, Historical development of Yoga; Yogic philosophy: The eight limbs of yoga according to Patanjali, Mind, body & spirit connection in yoga; Relevance of Asana, Pranayama & Dhyana in Yoga: Physical posture for physical, mental and spiritual development, Breathing techniques for energy restoration & consciousness, Meditation for inner stillness and mindfulness, Meditation for spiritual growth & self-discovery; Ethics & Moral Values in Yoga: Exploring the ethical principles Yama and Niyama, Application of yogic principles to daily life for spiritual growth; Yoga & Spirituality in modern life.

Fun with mathematics without calculator
Arithmetic- Quick calculation with 11 and 12, Multiplication with 99999 in seconds, multiplication with numbers near the bases, vertical and cross multiplication, Magic squares and square roots, cubes, fractions, divisions, HCF and LMC in ancient style. Algebra- Factorising quadratic expressions, One variable linear equation, Simultaneous linear equations. Implementation of Vedic mathematics tools during competitive examinations.

Ancient Indian Science and Technology
Technological development in India: Agriculture (Origin and development, ancient crops, Traditional practices), Water management (Overview, Harappan water management, other case studies, Medieval Water structures),

Pottery (Overview, Technical aspects), Silpasastra (Architecture and Construction· An introduction to Silpasastra, Construction Technology), Metallurgy (Copper/Bronze/Zinc, Iron and Steel Technology in India).

Trade and Commerce in Ancient India

Internal, External, Trade routes Indo-Roman contacts and Maritime Trade of South India; Silk and Cotton Textiles, the Principal Maritime Trade Commodities of Ancient India; Trade routes in Ancient India: Silk Route and Spice Route.

Reading Materials

1. Dasgupta, Surendranath. A History of Sanskrit Literature, Motilal Banarsidass
2. Banerji, Suresh Chandra. A Companion to Sanskrit Literature, Motilal Banrasidass
3. Chatterjee, Satischandra. An Introduction to Indian Philosophy, Motilal Banarsidass
4. Sharma, Chandradhar. A Critical Survey of Indian Philosophy, Motilal Banarsidass
5. A Textbook on Yoga and Health by Dr. Sajib Kumar Bhowmik, Sports Publication, 2020.
6. Light on the Yoga Sutras of Patanjali, B.K.S Iyengar, Element, 2005.
7. The Complete Book of Yoga: Karma Yoga, Bhakti Yoga, Raja Yoga, Jnana Yoga by Swami Vivekananda, Fingerprint Publishing, 2019.
8. Singhal, Aditi. How to Become A Human Calculator. ISBN : 9789352836543. S Chand Publishing
9. M. Tyra and K Kundan. Magical Book on Quicker Maths . ASIN : B07X93W2FC. BSC Publishing Co Pvt Ltd.
10. Singh, Balram. Science and Technology in Ancient texts. DK Print World ltd, 2012. ISSN 9788124606322.
11. Chandra Moti, Trade and Trade Routes in Ancient India. New Delhi: Abhinav Publications, 1977
12. Textiles in Ancient India: From Indus Valley Civilization to Maurya Period. Vishwavidyalaya Prakashan, 1994.
13. Duraiswamy, D. Silk and Cotton Textiles, the Principal Maritime Trade Commodities of Ancient India. ACTA VIA SERICA, Vol. 6, No. 2, Dec. 2021: 91-116, 6(2), 91–116.

SCIENCE OF LIVING SYSTEMS

Course Code: **LS10001**
Credit: **2**
L-T-P: **2-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of the course is to enrich the basic knowledge of students in the field of biology and use that knowledge to support the engineering and research programs. Besides, the course also helps to learn methodology to establish models for various biological phenomena and apply the aforementioned models to predict/analyse the functionality of various systems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to
CO 1: Learn the typical characteristics that distinguish life forms and analyze life process at cellular level,
CO 2: Apply concepts on structure and function of simple biomolecules in life processes
CO 3: Understand different process involved in life and analyse their effects,
CO 4: Analyse different biological phenomena and relate them to engineering applications,

CO 5: Comprehend different physiological functions and relate them to computer-based techniques, and
CO 6: Implement concepts of biology and their relevance to engineering and technology.

COURSE DETAILS

Cellular Organization of a Living Organism
Biology in engineering, The Living World: Biodiversity of living world, Microorganisms, Cell as the basic unit of life, Cell theory, Structure and function of Prokaryotic and Eukaryotic cells, Cell growth and reproduction, Homeostasis, Concept of gene, Basic structure and function of chromosomes.

Molecular and Biochemical Basis of an Organism
Chemical Context of Life: Water, Carbon, Structure and Function, Types of bonding, Bio- macromolecules (Carbohydrates, Proteins, Amino acids, Lipids and Nucleic acids), Protein synthesis, Cell differentiation, Stem cells and their applications.

Enzymes, Photosynthesis, Metabolism and Bioenergetics
Enzymes: Introduction, structure, properties, Classification, Mechanism of enzyme actions, Factors affecting enzyme action, Strategies utilized by enzymes to affect catalysis. Photosynthesis: Introduction, pigments, process of photosynthesis, Mechanism of photosynthesis (light reaction and dark reaction). Metabolism and Bioenergetics: Anabolism and catabolism.

Nervous system, Immune system and Cell Signaling
Nervous system: Introduction, History of neuroscience, Types of glial cells, Nerve cells - Neurons, Organization of the nervous system, Action potential, Diseases of the nervous system, Computer-based Neural Networks. Immune system: Introduction, Innate Immunity, Adaptive or acquired immunity, Diseases of the immune system, Immune engineering. Cell signaling: General principles of cell signaling.

Molecular Machines, Biosensor and Bioremediation
Molecular Machines: Introduction, Molecular motors and Machines, F0F1-ATP synthase motors, Cytoskeleton associated motors. Biosensors: Concept of biosensor, Working principle, Types of biosensors, Glucose biosensors, Bio-detectors: DNA detection biosensor, Detection of pollutants, Biosensor in food industry. Bioremediation: Introduction, Role of microorganisms, Factors determining bioremediation, Types – *in situ/ex situ*, Advantages and disadvantages, Biofuel.

Textbook

1. S. Thyagarajan, N. Selvamurugan, M.P Rajesh, R.A Nazeer, Richard W. Thilagarajan, S. Bharathi and M.K. Jaganathan, Biology for Engineers, McGraw Hill Education (India),7th Edition, 2022.

Reference Books

1. P.H. Raven and G.B. Johnson. Biology (Indian Edition), Tata McGraw Hill Education Publication,13th Edition, 2023.
2. E.D. Enger, Feederick C, Ross and David B. Bailey. Concepts of Biology, Tata McGraw-Hill Publication, 14th Edition, 2011.
3. Neil A. Campbell and Jane B. Recee, Biology, Pearson Education, 8th Edition, December 2007.
4. Cecie Starr, Biology Concepts and Application, Thomson Books, 6th Edition, January 2006.

MOLECULAR DIAGNOSTICS

Course Code: **LS10003**
Credit: **2**
L-T-P: **2-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of the course is to understand methods and techniques that are used to study biological processes in living beings. They include experimental and methodological approaches, protocols and tools for biological research.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn the basics of Genes, Chromosomes, DNA, RNA and proteins along with their Aberrations,
CO 2: Understand the principles and working mechanisms of various instruments used in the study of biological processes in living things,
CO 3: Apply the knowledge of different diagnostics methods for quantitative estimation of xenobiotics (drugs and their metabolites) and biotics (proteins, DNA, metabolites) in biological systems,
CO 4: Analyze the recent developed techniques which are required for gene editing and their Applications,
CO 5: Evaluate the role of various bio-analytical techniques in environmental studies, biomedical sciences, life sciences, molecular biology, and biotechnological research, and
CO 6: Implement the knowledge of diagnostics in designing point-of-care instruments for different diseases.

COURSE DETAILS

Biomolecules
Overview of DNA, RNA, and Proteins, Chromosomal structure & mutations, DNA polymorphisms; and Gene and Genetic errors.

Molecular Basis of Diseases
Infectious, non-infectious; Diagnosis- traditional, modern tools, Concepts of molecular diagnostics.

Molecular Diagnosis and Techniques
DNA fingerprinting, Auto-antibody fingerprinting, Southern blotting, PCR, Real-time PCR and variations; Nucleic acid sequencing: New generations of automated sequencers, CRISPR technology and its use in diagnostics and gene editing.

Protein Diagnostics Techniques
Antigen-antibody reactions, ELISA, variations of ELISA; Western blotting.

Point-of-Care Devices
Biosensors and nano-biosensors for disease and metabolites detection.

Textbook

1. M K. Campbell, S O. Farrell, O M. McDougal, AE Biochemistry, Cengage Publisher, 9th Edition, 2017, ISBN-13: 9789814846448.

Reference Books

1. N. Rifai, Andrea Rita Horvath and Carl T. Wittwer, Principles and Applications of Molecular Diagnostics, 2018, Elsevier Publisher, 1st Edition, 2018.
2. K.G. Ramawat & Shaily Goyal, Molecular Biology and Biotechnology, Publisher S. Chand & Co., 2nd Edition, 2010, ISBN: 9788121935128.
3. H. Lodish, Arnold Ber, Molecular Cell Biology, WH Freeman Publisher, 8th Edition, 2016, ISBN-10 9781464187445.

OPTIMIZATION TECHNIQUES

Course Code: MA10003
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

To familiarize the students with a few rudimentary and popular optimization techniques to enable them to solve resource-constrained real-world problems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to
CO 1: Know the concept of Linear programming problem (LPP) and will able to formulate linear programming problem,
CO 2: Understand the basic terminology and concepts of solving LPP,
CO 3: Solve LPP by simplex method,
CO 4: Know the concept of duality in Optimization technique,
CO 5: Apply optimization technique to solve transportation problem, and
CO 6: Solve assignment problem.

COURSE DETAILS

Linear Programming
Mathematical foundations and basic definitions, Linear optimization: Formulation and graphical solution of linear programming problems, Simplex method, Duality.

Transportation
General structure of a transportation problem, Finding initial basic feasible solution by North-West corner rule, Least-Cost method and Vogel's Approximation Method, and Testing for optimality.

Assignment Problem
Hungarian assignment method, Unbalanced assignment problems, Restrictions in assignment, Travelling Salesman model.

Textbook

1. H.A. Taha, Operation Research, An Introduction, Pearson Education, 10th Edition.

Reference Books

1. K. Gupta, Kanti Swarup, and Man Mohan, Operations Research, P.S. Chand & Co, 2004.
2. N.S. Kambo, Mathematical Programming Techniques, East West Press, 1997.
3. R. Fletcher, Practical Methods of Optimization, 2nd Edition, John Wiley, 1987.
4. Hanif D, Sherali, M. S. Bazarra & J.J. Jarvis, Linear Programming and Network Flows, Wiley Publication, 2nd Edition.

DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA

Course Code: MA11001
Credit: 4
L-T-P: 3-1-0
Prerequisite: Nil

COURSE OBJECTIVE

The objective of this course is to familiarize the prospective engineers with techniques in ordinary differential equations and linear algebra. It aims to equip the students to tackle advanced level of mathematics and applications that they would find useful in their disciplines.

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COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the concept of modelling and formulation of Differential equation of physical problems,
CO 2: Apply different methods to solve ODE problems involving growth-decay, cooling effects and electrical circuits etc,
CO 3: Solve 2nd and higher order ODEs,
CO 4: Apply the knowledge of special function in engineering problems,
CO 5: Use the essential tool of matrices and linear algebra in a comprehensive manner, and
CO 6: Apply the knowledge of Eigen value and Eigen vector in the field of engineering and also get the concept of complex matrices.

COURSE DETAILS

Ordinary Differential Equations of First Order
Introduction and formation of differential equations, Overview: Variable separable, homogeneous, equations reducible to homogeneous form. Exact differential equations, equations reducible to exact form, linear differential equations, equations reducible to linear form (Bernoulli's equation). Applications of differential equations: Growth-Decay Problem, Newton's Law of Cooling, Mixing problem, Orthogonal trajectories.

Linear Differential Equations of second order
Second order linear homogeneous equations with constant coefficients; differential operators; solutions of homogeneous equations; Euler-Cauchy equation; linear dependence and independence; Wronskian; Solutions of non-homogeneous equations: general solution, complementary function, particular integral; solution by variation of parameters; undetermined coefficients. Applications of 2nd order differential equations in Electric circuit.

Special Functions
Improper Integrals for one variable, some test for convergence of improper integrals, Gamma function, Properties, Beta function, Relation between Gamma and Beta functions. Radius of convergence of power series, Legendre equation. Legendre polynomial. Recurrence relations and Orthogonality property of Legendre polynomial. Bessel's equation, Bessel's function, Recurrence relation.

System of Linear Equations and Vector Space
Linear system of equations; rank of matrix; consistency of linear systems; Solution of system of linear equations: Gauss elimination, inverse of a matrix by Gauss Jordan method, Vector Space, Sub-space, Basis and dimension, linear dependence and independence, Linear transformation.

Matrix-Eigen value problems
Eigen values, Eigen vectors, Eigen basis, quadratic form; Hermitian, Skew-Hermitian forms; similar matrices; Diagonalization of matrices.

Textbook

1. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley INC, 10th Edition, 2011.

Reference Books

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition.
2. H.K. Das, Introduction to Engineering Mathematics, S. Chand & Co Ltd, 11th Edition.
3. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill Publications 2007.
4. J. Sinha Roy and S. Padhy, A course on ordinary & partial differential Equation, Kalyani Publication, 3rd Edition.

TRANSFORM CALCULUS AND NUMERICAL ANALYSIS

Course Code: MA11002
Credit: 4
L-T-P: 3-1-0
Prerequisite: Nil
COURSE OBJECTIVE

The objective of this course is to familiarize the students with the methods of Laplace and Fourier transformation and various numerical techniques to solve engineering problems.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Apply Laplace Transform to problems in the field of science and engineering,
CO 2: Use Fourier series and Transform as a tool to solve differential equations,
CO 3: Estimate the error in the results obtained in the numerical methods,
CO 4: Solve nonlinear equations that arise in engineering problems and interpolation,
CO 5: Know various numerical methods of differentiation and integration, and
CO 6: Apply numerical solution of differential equations and systems of linear equations.

COURSE DETAILS

Laplace Transforms
Laplace Transform, Inverse Laplace Transform, Linearity, Transform of derivatives and integrals, Unit Step function, Dirac delta function, Second shifting theorem, Differentiation and integration of transforms, Convolution, Solution of ODEs and integral equation by Laplace transform.

Fourier Series and Transform
Fourier series, Arbitrary periods, Even and odd functions, Half range expansions, Fourier integral, Cosine and sine transforms, Fourier Transform, Inverse Fourier Transform, Linearity, Fourier Transform of derivative, Convolution.

Approximations & Errors
Approximation of numbers by truncation and rounding-off, Types of errors.
Numerical solution of Nonlinear equations: Solutions by Bisection Method, Fixed Point Iteration Method, Newton-Raphson Method, Regula-Falsi and Secant Method, Rate of Convergence of Secant & Newton-Raphson Method.

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

Numerical Differentiation & Integration
Numerical differentiation of first- and second-order equations using difference table. Trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rules, Gauss-Legendre's two-point and three -point formulae. Error in Numerical Integration.

Numerical Solution to ODE
Taylor's series Method, Euler's Method, Modified Euler's Method, Runge-Kutta Methods of order 2 and 4, Reduction of second-order ODE to system of first-order ODEs and its solution by R-K method of order four. Solution of System of Linear Equations, Solutions by Gauss-Seidel and Gauss-Jacobi methods.

Textbooks
1. E Kreyszig, Advanced Engineering Mathematics by Wiley Inc, 10^{th} Edition.
2. Jain, Iyenger and Jain, Numerical Methods for Scientific and Engineering Computation, New age International (P) Ltd., 6^{th} Edition.

Reference Books
1. B.S. Grewal, Khanna, Higher Engineering Mathematics, Publishers, 44^{th} Edition.
2. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill Publications, 2007.
3. A, Thangapandi and Somasundaram, Numerical Methods, Scitech Publishers, 2^{nd} Edition.

PROBABILITY AND STATISTICS

Course Code: **MA21001**
Credit: **4**
L-T-P: **3-1-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to familiarize the students with the foundation of probability and statistics and to use it in solving the problems arises in engineering and real-life applications.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand basic probability and its applications,
CO 2: Study probability distributions and can use it in real life data analysis,
CO 3: Have a knowledge on univariate and bivariate distributions and their properties,
CO 4: Measure the central tendency and dispersion of a data set to draw conclusion from the data and interpret the data with the appropriate pictorial representation,
CO 5: Have good understanding of the Central Limit Theorem and its applications, and
CO 6: Analyze the statistical inference.

COURSE DETAILS

Probability and random variables
Basic concepts of sample space, events (with example), Axiom of Probability, Conditional Probability, Bayes' Theorem and its applications. Discrete random variable, probability mass function, cumulative distribution function and Moment Generating function for discrete random variable, some special distributions like Uniform distribution, Geometric distribution, Binomial distribution, Negative Binomial distribution, Poisson distribution, Hypergeometric distribution, mean and variance. Continuous random variable, density function, cumulative distribution function and Moment Generating function. Uniform distribution, normal distribution, mean, variance, percentile and critical value of normal distribution, normal approximation of the binomial distribution and exponential distribution.

Joint probability and distributions
Joint probability mass function and marginal probability mass function, joint probability density function and marginal probability density function, concept of independent random variable (joint probability), conditional probability mass function and conditional probability density function. Expected value, covariance and correlation for jointly distributed random variable (both continuous and discrete).

Descriptive Statistics
Frequency distribution, pictorial and tabular representation of data, stem and leaf display, dot plots, histogram, box plots and comparative box plots. Basic concepts on mean, median and mode, Skewness, Kurtosis, Correlation, Coefficient of Correlation, rank correlation, Regression Analysis: Least square method.

Inferential Statistics
Population, sample, random sample, sampling distribution, distribution of sample mean, central limit theorem, point estimator, point estimation of parameter using method of maximum likelihood estimation, confidence interval, confidence interval for the mean of a normal population with known and unknown variance, confidence interval for the variance of a normal population, hypothesis testing, one sided and two sided alternatives, Tests for mean of the normal distribution with known variance, Tests for mean of the normal distribution with unknown variance, tests for variance of the normal distribution.

Textbooks

1. J. L. Devore, Probability and Statistics for Engineers and Sciences, CENGAGE Learning, 9th Edition
2. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley Inc., 10th Edition.

Reference Books

1. S.M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier/AP, 6th Edition.
2. J.S. Milton & J.C. Arnold, Introduction to Probability and Statistics, Mc Graw Hill, 4th Edition.

VECTORS, PDES AND COMPLEX ANALYSIS

Course code: **MA21004**
Credit: **4**
L-T-P: **3-1-0**
Prerequisite: **Differential Equations and Linear Algebra (MA11001), Transform Calculus and Numerical Analysis (MA11002)**

COURSE OBJECTIVE

The objective of this course is to empower the students to design and solve branch prospective problems by the use of Vector calculus, Complex variables, partial differential equations and its numerical solutions.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the physical significance of the concepts like divergence, curl and gradient,

CO 2: Apply vector integration theorems like Gauss divergence, Stokes and Greens theorem in different engineering applications like work done by force, evaluation of flux etc.,

CO 3: Know the basic analytical techniques for solving the classical wave, heat and Laplace equation,

CO 4: Find the numerical solution of wave, heat and Laplace equation using finite difference method,

CO 5: Understand the fundamental concepts of complex variable and skill of contour integration to evaluate complicated real integrals via residue calculus, and

CO 6: Apply the techniques of vector integration and complex integration to diverse situations in engineering and other mathematical contexts.

COURSE DETAILS

Vector Calculus

Brief concepts of vectors, gradient of a scalar field, directional derivatives, divergence and curl of a vector field. Vector line integral, surface integral, Green's theorem, Gauss divergence theorem, Stoke's theorem, engineering applications of above integral theorems like work done by force, flux integration, independence of path etc.

Partial Differential Equations (PDE)

Basic concepts of PDE like order, degree, linear, nonlinear, homogeneous and non-homogeneous PDE. Solution of PDE by Variable Separable method. Classification of PDE and their reduction to normal form. One dimensional Wave equation, D'Alembert and Fourier series solution of 1-D wave equation. Solution of 1-D heat conduction equation by Fourier series method. Solution of 2-D Laplace equation and 2-D heat conduction equations (steady state) with boundary conditions using Fourier series. Laplace equation in polar co-ordinates and its application to find the electrostatic potential/steady state temperature in a disk with appropriate boundary conditions. Solution of PDE by Laplace Transform.

Numerical Solution of PDE

Basics of finite difference approximation, forward, backward and central difference approximation of derivatives. Brief concepts of discretization for time and space derivatives. Numerical solution of 1-D wave

equation (hyperbolic) using explicit and Crank-Nicholson scheme, 1-D heat equation (parabolic) explicit and Crank-Nicholson method and 2-D Laplace equation (elliptic) using the Liebmanns method and ADI method .

Complex Analysis

Basic concepts of complex number. Complex functions, derivatives, analytic function, Cauchy Riemann equations, harmonic functions, harmonic conjugate, elementary functions like exponential, trigonometric, hyperbolic, logarithmic functions and general powers. Curves in complex plane and their parametric representation. Line integrals, Cauchy integral theorem, Cauchy integral formula, Derivatives of analytic function. Power series, Taylor's series, Maclaurin's series, Laurent's series, singularities, Residues, Residue Integration, Real Integrals and Cauchy's Principal Value integrals.

Textbooks

1. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley Inc., 10th Edition.
2. Jain, Iyenger and Jain, Numerical Methods for Scientific and Engineering Computation, New age International (P) Ltd., 6th Edition.

Reference books

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition.
2. B.V. Ramana, Higher Engineering Mathematics, TMH, 2017 Edition.
3. H.K. Dass, Advanced Engineering Mathematics, S. Chand, 2007 Edition.

ADVANCED NUMERICAL TECHNIQUES

Course Code: **MA30002**
Credit: **3**
L-T-P: **3-0-0**
Prerequisite: **Differential Equations and Linear Algebra (MA11001), Transform Calculus and Numerical Analysis (MA11002)**

COURSE OBJECTIVE

The objective of this course is to equip the students with the advanced level ofnumerical computations to tackle the different mathematical models.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the error propagation in numerical computations,
CO 2: Know the concept of numerical techniques to find the root of non- linear equations and simultaneous equations,
CO 3: Find the interpolating polynomials and inverse interpolation,
CO 4: Apply the numerical techniques to approximate the definite single and double integrals,
CO 5: Know the concept of numerical solution of boundary value problems, and
CO 6: Use the finite difference method to solve partial differential equations.

COURSE DETAILS

Errors
Definition and sources of errors, Propagation of errors, Errors in summation.

Root finding for nonlinear equations and systems of equations
Muller's Method, Chebyshev Method, Solution of the system of non-linear equations using the Newton Raphson method.

Interpolation
Gauss forward and backward interpolation, Hermit's interpolation, Bivariate Interpolation and Inverse interpolation.

Numerical Integration
Rombergh Integration, Gauss-Legendre, Gauss-Chebyshev, Gauss-Laguerre, and Gauss-Hermite Integration Methods. Double Integration by Trapezoidal and Simpsonsmethods.

Numerical Solution of ODEs and PDEs
Milne' method, Shooting Method and Finite difference methods to solve parabolicand elliptic equations.

Textbook

1. Singresu S Rao, The Finite Element method in Engineering, Elsevier, ButterworthHeinemann, 5th Edition.
2. M.K. Jain, S.R.K. Iyenger and R. K. Jain Numerical, Methods for Scientific and engineering computation by, New Age International Publisher, 6th Edition.

Reference Books

1 S. Rajasekharan, Finite Element Analysis in Engineering Design, S. Chand, 2nd Edition.
2 S.S Bhavikatti, Finite Element Analysis, New Age International Edn., 8th Edition.
3. P. Seshu, Textbook of Finite Element Analysis, PHI.

ENGINEERING MECHANICS

Course Code: ME10001
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Engineering Mechanics is a specialized need-based extension of Applied Physics and uses the principles of Statics and Dynamics. The objective of this course is to build the foundational knowledge of the students which is required for the design of mechanical systems. In particular, the course will cover aspects of analysis of rigid body, frame and machine under the action of force system, and analysis of free body diagram of a system whether at rest or in motion

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Draw complete and correct free-body diagrams and write the appropriate equations from the free-body diagram,
CO 2: Use scalar analytical techniques for analyzing forces and moments in mechanical systems,
CO 3: Analyze forces in statically determinate structures such as trusses, frames and problems related to friction,
CO 4: Determine the centroid and second moment of area,
CO 5: Apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple and practical problems, and
CO 6: Solve real life problems by using mathematics, physical laws and theorems.

COURSE DETAILS

Concurrent Forces in a Plane
Introduction to Engineering Mechanics, Free-body diagrams, Composition and resolution of forces, Methods of moments. Friction: Concept of friction, Wedge friction.

Force Analysis of Plane Trusses
Methods of joints, Method of Sections, Centroid: Parallel forces in a plane, Centroid of plane figures, Theorem of Pappus, and Centroid of composite plane figures.

Moment of Inertia
Moment of Inertia of plane figures, Parallel axis theorem, Perpendicular axis theorem, and Moment of Inertia of composite figures.

Principle of Virtual Work
Equilibrium of Ideal Systems, Virtual work.

Dynamics of Particles
Differential equations of rectilinear motion, Free vibration, D'Alembert's Principle, Momentum and Impulse, Work & Energy, Conservation of energy, Impact.

Curvilinear Motion
Normal and tangential acceleration, Motion of a projectile, Work and Energy in curvilinear motion.

Rotation of a Rigid Body
Kinematics of rotation, Rotation under the action of a constant moment.

Textbook

1. S. Timoshenko, D.H. Young and J.V. Rao, Engineering Mechanics, Tata McGraw-Hill Publication 5th Edition, 2017.

Reference Books

1. I.H. Shames, Engineering Mechanics (Statics and Dynamics), Prentice Hall, 4th Edition, 2005.
2. S.S. Bhavikatti, Engineering Mechanics –New Age International, 8th Edition, 2021.
3. S. Rajasekaran and G. Sankarasubramanian, Engineering Mechanics (Statics and Dynamics), Vikas publishing House, 3rd Edition, 2017.

BASIC MECHANICAL ENGINEERING

Course Code: **ME10003**
Credit: **2**
L-T-P: **2-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course is designed to give an overview of the fundamental aspects of mechanical engineering so that a student pursuing any branch of engineering will realize the possibilities that the branch of mechanical engineering offers.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: understand the basic principles of thermodynamics,
CO 2: develop an understanding of fluid machines like turbine and pump,
CO 3: determine stress and strains in a component subject to a load,
CO 4: understand the working and design aspect of power drives,
CO 5: recognize appropriate material for a particular engineering application, and
CO 6: understand the fundamentals of manufacturing processes.

COURSE DETAILS

Concepts of Thermodynamics
Systems, properties, state, and cycle, Thermodynamic equilibrium and quasi-static process, First law of thermodynamics for closed system, First law of thermodynamics for open/flow systems, Second law of thermodynamics, Kelvin Plank statement, Clausius statement, and Basic concept of entropy.

Fluid Mechanics and Hydraulic Machines
Introduction to fluids, Properties of fluids, Pressure variation with depth, Bernoulli's equation and its applications, and Introduction to hydraulic turbines and pumps.

Mechanics of Materials
Stress, Strain, Stress-Strain diagrams for ductile and brittle materials, Elastic constants, Hooks Law, Factor of Safety, One-dimensional loading of members of varying cross sections.

Power Transmission
Gear, Belt, and Chain Drives, Shaft under varying loading conditions, Introduction to robots, Applications of robotics, Basic robot motions, Sensors and Actuators.

Manufacturing Processes
Introduction to engineering materials, Types and classification of materials, Properties of materials, Introduction to casting, forming, forging, rolling, extrusion and welding, Introduction to machine tools, NC, CNC, and 3-D Printing.

Textbook

1. P. Kumar, Basic mechanical Engineering, Pearson Education, 2nd Edition, 2018.

Reference Books

1. J.K. Kittur and G.D. Gokak, Elements of Mechanical Engineering, Willey, 1st Edition, 2015.
2. B. Agrawal, C.M. Agrawal, Basic Mechanical Engineering, Willey, 1st Edition, 2011.

WORKSHOP

Course Code: **ME18001**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

This workshop 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 cover 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 machine tools and 3D printing.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Practice different operations related to fitting shop,
CO 2: Use different welding tools to prepare a given type of joint,
CO 3: Demonstrate various turning operations including taper turning and knurling using a conventional lathe machine,
CO 4: Design a tray and prepare it using sheet metal equipment involving soldering,
CO 5: Appraise different operations using a CNC machines, and
CO 6: Interpret different advanced machines such as 3D printing/additive manufacturing.

COURSE DETAILS

- Turning operations
- Sheet metal operations
- Fitting
- Welding

ADDITIVE MANUFACTURING (3D PRINTING)

Course Code: **ME28011**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

Additive Manufacturing (AM) is a modern manufacturing technology also known as 3D printing process, will provide a clear understanding about the process, acceptability and usability in various field. AM technologies classified on the basis material types will be focused with its real life applications with advantages and disadvantages. Different types of errors associated with AM and CAD technology will be discussed with suitable error minimization processes. Various reverse engineering process will be discussed and practically implemented with its real life applications.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the concept of additive manufacturing, its benefits and applications in various fields,
CO 2: Know the various liquid, powder and solid material based technologies in Rapid Prototyping and Rapid Tooling process,
CO 3: Know the application of AM process in the field of Biomedical,
CO 4: Design solid models and converting it to 3D printing readable file format required for part fabrication,
CO 5: Focus on the various types of errors in the RP parts and errors during CAD file conversion, and
CO 6*:* Apply reverse engineering process to generate data for fabrication of RP part.

COURSE DETAILS

Introduction to Additive Manufacturing Technologies
Need & Development of AM systems, AM process chain, Impact of AM and Tooling on Product Development, Benefits, Applications, Digital prototyping, Virtual prototyping.
Model Preparation using Solid Modelling Software.

Classification of Additive Manufacturing Technologies
Classification of AM technologies on the basis of Materials types. Discussion on various AM processes based solid, liquid and semi solid type of materials along with its application, advantages and disadvantages.
Hands on practice for model creation and saving on particular file format.

Data Processing for AM Technologies

Process planning for AM, CAD model preparation, data requirements & geometric modelling techniques: Wire frame, surface and solid modelling data formats.
Hands on practice for the fabrication of Single components and Assembly components.

Rapid Tooling
Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect, Fabrication processes, Applications, Rapid tooling techniques such as laminated metallic tooling, direct metal laser sintering, vacuum casting.
Hands on practice for the fabrication of pattern and mould preparation.

Reverse Engineering Processes
Introduction to reverse engineering, Integration of reverse engineering with AM technology.
Hands on practice to generate model data in revere engineering process integrated with AM process

Reference Books

1. Rafiq I Noorani, Rapid Prototyping: Principle and Applications, Wiley & Sons, 2006.
2. Chua C.K., Leong K.F., and Lim C.S., Rapid prototyping: Principles and applications, Yes Dee Publishing Pvt. Ltd, Third Edition, 2010.
3. Frank W. Liou, Rapid Prototyping and Engineering Applications, CRC Press, Special Indian Edition, 2007.
4. R.B. Choudhary, Additive manufacturing, Khanna Publication, 2022.

DIE DEVELOPMENT BY CNC MILLING

Course Code: **ME28013**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Workshop (ME18001)**

COURSE OBJECTIVE

The objective of the course is to provide basic knowledge on various tools and precision instruments used during CNC milling operation. It helps in understanding the usage of various machining cycles to reduce the manufacturing lead time. Moreover, it explains the usage of various standards and programming methods to be followed during CNC machining operation. Finally, the students can develop/generate the programs used to produce the geometries with complex contours using CNC milling machine.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the usage of different tools and precautions to be followed during machining,
CO 2: Know the principle and operation of precision instruments,
CO 3: Understand the technological advancements in NC and aimed to achieve JH pillar,
CO 4: Understanding the programming methods and programming in simulators,
CO 5: Planning for optimized CNC programming by estimating suitable process parameters, and
CO 6: Programming of die contours and executing on CNC milling machine.

COURSE DETAILS

Tools and Safety
List of tools used on Milling Machine to perform various operations.
Safety: Introduction to safety equipment and their uses.

Measuring instruments
Vernier caliper, Micrometer, Bevel protractor, Coordinate measuring machine (CMM): Construction, principle graduation and reading, least count.

Introduction to CNC
Introduction to CNC technology, Conventional Vs. CNC machine tool, CNC clamping system. Implementation of JH for CNC.

CNC programming

Introduction to CNC programming, Introduction and demonstration of line programs milling machine using ISO codes into the CNC simulator. Part programming methods, Cutting process parameter selection, Process planning issues and path planning, G & M Codes, Interpolations, Tool compensations.

CNC Programming-Milling
Calculations of parameters like speed feed, depth of cut etc. and set a references for the various operations. Prepare & set CNC Milling operations and dry run on the machine. Execute program and inspect simple geometrical forms / standard parts.

Reference Books

1. Yoram Koren, Computer Control of Manufacturing Systems, Mc Graw Hill Publication.
2. Mikell P. Groover, CAD/CAM.
3. P.C. Sharma, A textbook of Manufacturing Technology-II.
4. R.K. Jain, Engineering Metrology, Khanna Publishers.

CONCEPT CAR MANUFACTURING

Course Code: **ME28015**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

Objective of the course is to give the students hands on experience on building a racing car. Students find it very interesting to develop important parts of a racing car and then assemble and take part in various national and international events. In this process they meet the requirement set by the authorities. Therefore the students learn here how to propose a new car body and prove the feasibility by computational analysis of the body and other important parts.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Remember the fundamentals of concept car characteristics,
CO 2: Understand the aerodynamic requirements in racing vehicles,
CO 3: Use the concepts of chassis behaviour of concept car,
CO 4: Illustrate the suspension characteristics of the concept car,
CO 5: Understand the problems faced in drives and braking systems in motor sports, and
CO 6: Build a concept car body.

COURSE DETAILS

Car Development
Constraints And Specifications – Performance, Handling, Structure; Driver Accommodation and Safety.

Tyres
Adjustable Features, Preliminary Design and Analysis; Driver-Vehicle Relationship. Desirable Vehicle Characteristics, Fundamentals of Track and Lap.

Racing Car Aerodynamics
Aerodynamic Force and Moment, Race Car Drag; Spoilers, Dams, Wings - Effectiveness Of Wings In Steady State Cornering.

Chassis Design
Conditions For Traversing a 90° Corner, Effects Of High Speed Braking, Cornering, Combined Braking Cornering; Steady State Cornering, Throttle Behaviour, Steering Wheel Force And Kick Back; Moving CG Position, Roll Centre Position Changing.

Suspension System
Front Suspension- General Design Issues, Camber Effects; SLA Suspension, McPherson Struts; Independent Rear Suspension- Trailing Arm Types, Instant Axis Concept; Suspension Springs- Torsion Springs, Coil Springs.

Textbook

1. Advanced Race Car Chassis Technology HP1562: Winning Chassis Design and Setup for Circle Track and Road Race Cars Bob Bolles, HP Books; Revised, Updated Edition, 2010.

Reference Books

1. William F. Milliken and Douglas L. Milliken, Race car vehicle dynamics, 11th Edition, SAE, 1995.
2. Peter Wright, Formula 1Technology, Sae Intl; 1st Edition, 2001.

DEVELOPMENT OF AUTONOMOUS WHEELED ROBOTS

Course Code: **ME28017**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Basic Electronics (EC10001)**

COURSE OBJECTIVE

Nowadays, robotics is playing a vital role in industry 4.0, and autonomous wheeled robots are being applied to minimize human efforts and to improve the production rate. This course gives fundamental knowledge about wheeled robotics and its different hardware and software components. Moreover, the subject discusses kinematics equations, which will be implemented to control the motion of wheeled robots through the actuators. Further, the present course also describes the integration of various sensors and their programming, which will be used to make an autonomous control system for a robot.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the fundamentals of wheeled robotics and its different components,
CO 2: Apply locomotion constraint features to travel the wheeled robots in different surface conditions,
CO 3: Apply various sensors integration on wheeled robots for autonomous navigation,
CO 4: Analyze the kinematics of wheeled robots,
CO 5: Create a robot programming to make an autonomous sensor-actuator control system, and
CO 6: Design of automation solutions using wheeled robots.

COURSE DETAILS

About Locomotion for Wheeled Robot
Key issues for locomotion, wheeled mobile robot's locomotion, Legged wheeled robots.

Wheeled Robots Kinematics
Kinematic models and constraints, Representing robot position, Forward kinematic models, Wheel kinematic constraints, Degree of freedom.

Sensors for Autonomous Wheeled Robots
Various sensors for wheeled robots, Sensor classification, Ultrasonic sensor, Infrared sensor, Vision sensor, Inertial measurement unit (IMU).

Actuators for Autonomous Wheeled Robots
Various actuators for wheeled robots, DC motor, Servo motor, Stepper motor, Motor controller.

Wheeled Robots Programming
Robot programming language features, Computer control and robot software (monitor mode, run mode and editor mode), Arduino microcontroller programming, Raspberry Pi programming, Complete design of an autonomous wheeled robot.

Reference Books

1. R. Siegwart, I.R. Nourbakhsh, D. Scaramuzza, Introduction to Autonomous Mobile Robots, MIT Press, 2011.
2. S.G. Tzafestas, Introduction to Mobile Robot Control, Elsevier Science, 2013.
3. G. Dudek, M. Jenkin, Computational Principles of Mobile Robotics, Cambridge University Press, 2010.
4. T. Bräunl, Embedded Robotics Mobile Robot Design and Applications with Embedded Systems, Springer Berlin Heidelberg, 2013.
5. U. Nehmzow, Mobile Robotics: A Practical Introduction, Springer, London, 2012.

MODELLING OF MICRO-WIND TURBINE BY 3D CAD DESIGN

Course Code: **ME28019**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Differential Equations and Linear Algebra (MA11001)**

COURSE OBJECTIVE

Introduce computer-based solid, parametric, and assembly modeling as a tool for engineering design; enhance critical thinking and design skills. This course introduces the technology and economics of converting wind energy to electricity and other kinds of energy. Both utility scale horizontal axis wind turbines and small-scale horizontal are addressed, as well as the economical and environmental issues associated with wind energy.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn about the basic concepts of wind energy conversion system,
CO 2: Understand the engineering design process and the implementation of different design phases,
CO 3: Create a 3D solid model with high degree of confidence,

CO 4: Develop the ability to extract 2D orthographic views from the 3D model for fabrication,
CO 5: Learn the basics of assembly and associative constraints, and
CO 6: Understand the importance of standalone, grid-connected, and hybrid operation in renewable energy systems.

COURSE DETAILS

Introduction to Wind Energy, Wind Power, State of the art technology
Introduction to renewable sources, Wind energy, Types of wind turbines, State of the art technology in wind energy.

Design and development of small wind turbines
Small wind technology, blade element momentum theory, design of tail fin, Wind turbine tower structure design stiffness and strength consideration, Aerodynamics of wind turbine rotor blade design, angle of attack, profile.

3D modelling of wind turbine using CAD tools (SOLIDOWRKS)
Introduction to 3D modeling, Parametric modeling, feature-based modeling, Design Intent; Solid modeling commands: Sketching, Extrusion, Revolve, fillet, pattern.; Solid Modeling: reference geometry, Sweeps and Lofts;

Assembling of the 3D model of the Wind turbine
Assembly modeling; Top-down and bottom-up, Mates in assembly, exploded view,

Creation of 2D drawings for production/manufacturing processes
Extract 2D orthographic views from the 3D model for fabrication by specifying the proper dimensions, according to industry standards, for parts to be fabricated and to extract section and auxiliary views, Dimensioning standards and conventions. 3D assembly drawing of the wind turbine, exploded view of the tower, 3D drawings of all 3D printed parts.

Simulation of wind turbine using SOLIDWORKS using CAD tools (SOLIDOWRKS and ANSYS)
Engineering analysis with SolidWorks, Stress and deflection of the wind turbine tower, Simulation of wind turbine using SolidWorks

Reference Books

1. James F. Manwell, Jon G. McGowan, and Anthony L. Rogers, Wind Energy Explained: Theory, Design, and Application, Wiley, 2010.
2. Gasch, Robert, Twele, Jochen (Eds.), Wind Power Plants: Fundamentals, Design, Construction and Operation, Springer-Verlag Berlin Heidelberg; 2nd Edition, 2012.
3. Open source SOLIDWORKS Tutorial: https://my.solidworks.com/training/video/40d7a678-3293-4d7b-ba18-2113ff114b2a.

SCIENCE OF PUBLIC HEALTH

Course Code: **PE10002**
Credit: **2**
L-T-P: **2-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The objective of this course is to orient the students to core scientific disciplines in public health practice.

COURSE OUTCOMES

At the end of the course, students should be able to

CO 1: Understand and enlist the scientific approaches in public health,
CO 2: Understand and apply the epidemiologic and biostatistical science in evidence synthesis,
CO 3: Understand and apply the environmental health science in public health practice,
CO 4: Understand and apply the social and behavioral science in public health practice,
CO 5: Understand and apply the health economic and health management principles in setting priority for resource allocation, and
CO 6: Understand and apply the health economic and health management principles in health system optimization.

COURSE DETAILS

Scientific Approaches to Public Health
Health and public health concepts, Science and practice of applied public health: Scientific disciplines as part of interdisciplinary public health, Examples of use of behavioral model in changing the community perception of public health interventions.

Social and Behavioral Sciences in Public Health
Social and behavioral determinants of health and disease, WHO and CDC models of social determinants of health, Disease and social status, Disease and poverty, Social interventions for good health.
Health behavior change models for public health interventions, Health Belief Model, Transtheoretical Model. The theory of planned behavior, Health communication to improve the outcome of public health interventions.

Environment Health Sciences in Public Health
Environment & climate change, Ecosystem, Lifestyle and dietary effects on health, food safety and sanitation, Environmental pollution, waste disposal and treatment.

Epidemiology and Data Science in Public Health
Epidemiology and achievements in public health, Measurements in Epidemiology—Incidence and prevalence, Causation and association, and Measures of association.
Outline of study designs (including cross-sectional study design, case-control study design, cohort study design and randomized control trials); Introduction to confounding and bias; Screening tests- validity and reliability methods.

Management and Economic Sciences in Public Health
Systems approach (input, process and outcome) in public health. Health management information system, Horizontal and vertical integration of public health interventions, Public-Private mix.
Understanding community, Community health related needs assessment, Community orientation and Community mobilization, Introduction to digital health.

Textbooks

1. R Detal, Oxford Textbook of Global Public Health, Oxford, 7th Edition, 2021.
2. K Parks, Textbook of Preventive and Social Medicine, M/S Banarsidas Bhanot Publishers, . 26th Edition, 2021.

Reference Books

1. Robert H. Friis, Essentials of Environmental Health, Jones & Bartlett Publishers, 2018

2. Warrier S., Information and Communication Technologies in Public Health A Sociological Study, CBS Publishers, 2020.
3. Baker JJ. Baker RW, Dworkin NR, Health Care Finance: Basic Tools for Non-financial Managers, Jones and Bartlett Publishers, Inc, 5th Edition, 2017.
4. Ross TK, Practical Budgeting for Health Care: A Concise Guide, Jones and Bartlett Publishers, Inc, 2020.

PHYSICS

Course Code: PH10001
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course is designed to enrich the basic knowledge of engineering students in the field of physics and to support the engineering and research programs. The course will also help the students to develop mathematical models to understand the behavior of physical systems and phenomena.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn the basic concepts of oscillation, waves, wave function and fields,
CO 2: Understand the principles of wave phenomena in light and matter, and the quantum mechanics,
CO 3: Apply the principles of oscillation, superposition of waves, electromagnetic theory, and quantum mechanics in different fields,
CO 4: Analyze different types of particle motion in different media,
CO 5: Evaluate the problem-solving skills for the topics learnt, and
CO 6: Develop critical thinking ability supported by the learned concepts of Physics.

COURSE DETAILS

Oscillation
Damped Harmonic Oscillation (underdamped, overdamped and critically damped), Energy decay, Relaxation time, Quality factor, Forced oscillation, Resonance, Coupled oscillations, Applications.

Waves and Interference
Wave equation, Superposition of waves, Interference of light, Types of interference: Division of wavefront and division of amplitude.

Interference in thin films
Wedge shaped thin film, Newton's rings and their applications, Michelson interferometer, Applications.

Diffraction
Diffraction and its applications, Types of diffraction, Fraunhofer diffraction by a single slit, Plane diffraction grating (condition of maxima, minima), Maximum order of observable spectra, Absent spectra, and Dispersive power, Applications.

Quantum Mechanics
Dual nature of radiation and matter, de Broglie hypothesis for matter waves, Phase velocity and Group velocity, Heisenberg's uncertainty principle and applications, Wave function and its interpretation, Concepts of operators,

Schrodinger's time-dependent and time-independent equations, Postulates of Quantum mechanics, Particle in one-dimensional box and applications, Quantum tunnelling and applications.

Electromagnetic Theory
Vector calculus: scalar and vector field, Gradient, divergence and curl, Line, surface and volume integrals, Gauss divergence and Stoke's theorem, Maxwell's equations in differential and integral form with necessary derivations. Electromagnetic wave equations, Transverse nature of electromagnetic waves.

Laser and Fiber Optics
LASER: Properties and applications, Spontaneous and stimulated emission, Meta-stable state, Population inversion, Pumping, Three and four-level Laser, Ruby Laser.

Optical fiber
Principle, Construction, Types of optical fiber, Acceptance angle, Numerical aperture, Applications.

Textbook

1. B.K. Pandey and S. Chaturvedi, Engineering Physics, Cengage Publication, New Delhi, 2nd Edition 2022, ISBN-13: 978-81-953536-7-5.

Reference Books

1. D. J. Griffiths, Introduction to Electrodynamics, Pearson Education, 4th Edition, 2015.
2. L.I. Schiff and J. Bandhyopadhyay, Quantum Mechanics, Tata McGraw-Hill Publications, 4th Edition, 2014, ISBN- 9781259062865.
3. A.K. Ghatak, Optics, Tata McGraw-Hill Publications, 4th Edition, 2008, ISBN: 9780070262157.
4. A. Beiser, Concepts of Modern Physics, Tata McGraw-Hill Publications, 6th Edition, 2002, ISBN 10: 0071234608.
5. R K Gaur and S. L. Gupta, Engineering Physics, Dhanpat Rai Publications, New Delhi, 2nd Edition, 2012, ISBN-10: 8189928228.

SMART MATERIALS

Course Code: PH10003
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

This course is designed with the objective of enabling engineering students to get a flavour of advances in materials science. The knowledge of smart materials learnt by the students in the course will let them to realize the usefulness of various new-age materials for technological advances and allow them to explore further in their higher semesters. This course will help them bridge the gap between traditional Textbook science put into physics, chemistry, etc. and the state-of-the-art science of materials.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Learn about smart materials, their properties and applications,
CO 2: Understand types of smart material based on their electrical and magnetic properties,
CO 3: Characterize piezoelectric, ferroelectric and multiferroic materials,

CO 4: Identify novel functions of smart materials,
CO 5: Apply the acquired knowledge of smart materials in different applications, and
CO 6: Evaluate the importance of smart materials in day-to-day life.

COURSE DETAILS

Introduction to Smart Materials
common smart materials and associated stimulus-response, Classification: active and passive, Piezoelectric, Shape-memory alloys, Photo-responsive polymers, Electroactive polymers, Magnetostriction and Electro-striction, Thermo-responsive polymers, Dielectric elastomers, Halochromic, Thermoelectric materials; Application areas of smart materials: Space, health care and biomedical sectors.

Piezoelectric Materials: Piezoelectric Effect
Direct and Converse, Piezoelectric coefficients, Piezoceramics, Piezopolymers, Piezoelectric Materials as Sensors, Actuators etc.

Shape-memory Alloys
Shape memory alloys (SMAs) and properties, Phase change in SMAs, Shape memory effect: One-way and two-way, binary, and ternary alloy systems, Applications.

Chromic Materials
Photochromic, Thermochromic, Electrochromic, Magneto-chromic and Piezo-chromic Materials.

Multiferroic Materials
Multiferroics definitions, Ferroic phases, Magnetoelectric coupling; Type-I and Type-II multiferroics, Mechanism: Charge ordering, lone pair, geometric effect, and spin driven mechanism; Multiferroic materials, Applications.

Textbook

1. B. K. Pandey and S. Chaturvedi, Engineering Physics, Cengage Publication, New Delhi, 2nd Edition 2022, ISBN-13: 978-81-953536-7-5.

Reference Books

1. Mohsen Shahinpoor, Fundamentals of Smart Materials, 2020, Royal Society of Chemistry, ISBN: 9781782626459.
2. M. Schwartz, Smart Materials, 1st Edition, 2008, CRC Press, ISBN 9781420043723.

PHYSICS LABORATORY

Course Code: PH19001
Credit: 1
L-T-P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE

This lab course covers different measurement techniques of various parameters using the instruments i.e., interferometer, spectrometer, spherometer, screw gauge, vernier calliper, microscope, 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

After successfully completing the course, the students will be able to

CO 1: Understand the wave nature of light through experiments based on interference and diffraction phenomena,
CO 2: Apply the laws of quantum physics to understand the photoelectric emission using the particle nature of light,
CO 3: Characterize photovoltaic cells to find out efficiency in terms of power output,
CO 4: Evaluate mechanical properties of materials using their elastic properties,
CO 5: Apply the principles of optics such as refraction, total internal reflection to calculate refractive index and related parameters, and
CO 6: Use the principles of oscillation to understand phenomena such as damping, resonance and to determine the factors (such as gravity, elasticity etc) affecting the time period of various oscillators.

COURSE DETAILS

- Measurement by vernier callipers, screw gauge, spherometer: A review.
- Determination of wavelength (λ) of a monochromatic light by Newton's ring experiment.
- Determination of wavelength (λ) and difference (dλ) between wavelengths of sodium D-lines by Michelson's interferometer.
- Determination of grating element (e+d) of a plane diffraction grating.
- Determination of Planck's constant using photocell.
- Study of the characteristics of a photo cell.
- Study of the characteristics of a solar cell.
- Determination of Young's modulus (Y) of a material by bending of beam method.
- Determination of Poisson's ratio (σ) of rubber.
- Determination of rigidity modulus (η) of a material by dynamic method.
- Determination of refractive index (μ) of a transparent liquid by Boy's method.
- Determination of numerical aperture of optical fibre.
- Determination of acceleration due to gravity (g) by bar pendulum.
- Determination of damping coefficient, relaxation time and quality factor of damped harmonic oscillation by simple pendulum.
- Measurement of velocity of sound in air using resonance column method.
- Studies on dielectric/multi-ferroic materials (Open ended).
- Diffraction studies using Laser sources (Open ended).

Reference Books

1. Physics laboratory instruction manual, School of Applied Sciences, Department of Physics, KIIT Deemed to be University, Bhubaneswar.
2. S.L. Gupta and V. Kumar, 2018, Practical Physics, Pragati Prakashan, 33rd Edition, ISBN: 978-93-87151-58-1.

QUANTUM COMPUTING

Course Code: PH40001
Credit: 3
L-T-P: 3-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The objective of this course is to open up and introduce quantum computation as well as its supremacy over classical computation to the students and technically trained professionals from the field of engineering and general science.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand and apply the mathematical background and principles of basic quantum mechanics needed for quantum computation,
CO 2: Understand and apply the principle of measurement in quantum theory on pure and composite systems,
CO 3: Know the architecture of quantum computers and apply them in handling quantum circuits,
CO 4: Understand some fast quantum search algorithms and evaluate certain simple problems,
CO 5: Understand quantum cryptography and know simple cryptography protocols, and
CO 6: Understand principles and working of practical quantum systems for physical realization of quantum computers.

COURSE DETAILS

Background mathematics and Framework of Quantum mechanics
Operators, Projectionra and Ket Vectors, Orthonormal Bases, Two Dimensional Hilbert Space, Qubit and Quantum States, Linear Operators, Matrix Representations of Vectors and Linear Operators, Inner and Outer Products, Eigen Values and Eigen Vectors, Gram–Schmidt Procedure of Constructing an Orthonormal Basis Set, Completeness Relation, Hermitian Operators, Projection Operator, Unitary Operator, Normal operator, The Commutator and Anti-commutator, Change of Basis, Spectral Decomposition, Pauli Matrices, Tensor Products, The Postulates of Quantum Mechanics, Collapsing of Wave Function, Uncertainty Principle, State Space, Time Evolution of Quantum State, Stern-Gerlach Experiment, Spin as a Degree of Freedom, Representing Spin States using Spin Vectors. Bloch Sphere, Representation of Qubit on Bloch Sphere.

Density operator and Quantum Measurement theory
Density Operator for Pure and Composite Systems and its Key Properties, Partial Trace and Reduce Density Operator, Density Operator and Bloch Vector. Projective Measurements, Measurements on Composite Systems, Positive Operator Valued Measures (POVM).

Basic Quantum Logic Operations and Gates
Classical Irreversible and Reversible Gates, Reversible Computation.
Single Qubit Gates and Their Matrix Representations, Identity Gate, Pauli Gates, Square Root of NOT Gate, Phase Shift Gates, Hadamard Gate, Rotation Operator Gates. Limitations with These Gates.
Multiple Qubit Gates and their Matrix Representations: Controlled NOT (CNOT) Gate and its Matrix Representations, CNOT Basis Transformations, Entangled States and Their Visualization.
Universal quantum gates**:** Two-level Unitary Gates as Universal Gates, Single Qubit and CNOT Gates as Universal Gates, A Discrete Set of Gates for Universal Quantum Computation.

Quantum Algorithms
Matrix representation of serial and parallel Operations, Quantum Interference, Quantum Parallelism, Deutsch's-Jozsa Algorithm, Quantum Fourier Transform, Phase Estimation, Shor Factorization, Grover Search.

Quantum Cryptography
Classical Cryptography, Quantum Key Exchange: BB84 Protocol, B92 Protocol, EPR Protocol, Teleportation.

Quantum hardware
Goals and Challenges, Implementing Quantum Computers, Guiding Principles, Ion Traps, Linear Optics, Nuclear Magnetic Resonance (NMR) and Superconductors.

Textbook

1. Nielsen and Chuang, Quantum Information and Quantum Computation, Cambridge University Press, 2002.

Reference Books

1. David McMahon- Quantum Computing Explained, John Wiley & Sons, Inc. (2008)
2. G Benenti, G Casati, G Strini - Principles of quantum computation and information. Volume 1-World Scientific (2004).

THINKING PERSPECTIVES

Course Code: PS10043
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

Cognition plays a significant role in accumulation and processing of information. This course provides an in-depth understanding of some of the cognitive processes in terms of current theories, models and applications. It helps learners to understand the importance of these cognitive processes and the rationale behind cognition, problem solving, critical thinking, and scientific thinking. It facilitates students to identify and analyze the key conceptual and theoretical frameworks underpinning cognitive process.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the definition and scope of cognition, problem solving, and creativity,
CO 2: Understand the theories related to cognition, decision making, and critical thinking,
CO 3: Understand the classic and current experimental research in cognitive processes,
CO 4: Develop skills essential in designing and conducting experiments in cognition, reasoning, and problem solving,
CO 5: Understand various aspects of critical thinking, scientific thinking, and design thinking process, and
CO 6: Apply the knowledge of cognitive processes to one's own personal life and to real life issues.

COURSE DETAILS

Basics of Cognition

A Brief History, Emergence of Modern Cognitive Approach, Thinking, Basic Elements of Thought: Forming Concepts, Propositions, Images.

Reasoning, some Basics sources of error, Information-processing approach, connectionist approach, evolutionary approach, ecological approach.

Memory Processes and Critical Thinking

Organization of Long Term Memory, Forgetting, Retrieval and Metamemory; Proactive and Retroactive inference; Amnesia and Retrieval, Flashbulb Memory, Eyewitness Memory, Traumatic Memory, False Memories.

Phases of Critical Thinking: Intellectualization, Suggestion, Hypothesis, Reasoning, and Testing, Critical Thinking Abilities: Thinking, Observational, and Questioning and Dispositions, Critical Thinking Skills: Analysis, Communication, Creativity, Problem-solving Skills, and Open-mindedness.

Systems Thinking and Scientific Thinking

System Definition and Characteristics, Approaches to System Modelling, Causal-Loop Diagramming, System Archetypes, Micro world and Learning Laboratory, The Learning Organization and the Fifth Discipline, Systems Thinking Study, Examples.

Characteristics of Science: Systematic observation and experimentation, Inductive and deductive reasoning, Lessons from Scientific Thinking: Empirical Evidence, Logical Reasoning.

Creativity and Designing Thinking

Creative Thinking, Stages in Creative Thinking, Nature of Creative Thinking, Features of Creativity—Novelty, Originality and Usefulness, Guilford's Measure of Creativity—Fluency, Flexibility, and Originality, Barriers to Creativity, Enhancing Individual and Organizational Creativity.

Designing Thinking as a Process of Problem Solving: Defining Problems, Challenging Assumptions, Developing Concepts, identifying Alternative Strategies and Solutions, Prototyping, and Experimenting Problem Solving through Innovative Solutions, Stages of Design Thinking—Empathize, Define, Ideate, Prototype and Test.

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Textbooks

1. Solso, R.L., Cognitive Psychology, Pearson Education, 6th Edition. 2004.
2. Baron, R.A., Psychology,Pearson Education, 5th Edition, 2002.
3. Rathus, S.A. Introductory Psychology Wadsworth Cengage, 5th Edition, 2016.
4. Ciccarelli, S. & White, N.J, Psychology 5th Edition, Pearson Education., 2017.
5. The Fifth Discipline: The Art & Practice of the Learning Organization, Cengage Publication, 2nd Edition, 2006.
6. Cross, N., Design Thinking: Understanding How Designers Think and Work, Berg Publishers.

Reference Books

1. Baddley, A., Human memory: Theory and practice. New York Psychology Press, 1997.
2. Treror, A., The psychology of language: From data to theory. Taylor Francis, 2002
3. Smith, E.E. & Kosslyn, Cognitive psychology: Mind and brain. Prentice Hall, 2007.
4. Tripathi, A.N. &Babu, Nandita (2008). Cognitive processes. In Misra, G. Psychology in India: Advances in Research, Vol. 1, Pearson Education.
5. Vaid, J., & Gupta, Ashum, Exploring word recognition in a semi-alphabetic script: the case of Devanagari. Brain and Language, 81, 679-690.

CREATIVITY, INNOVATION AND ENTREPRENEURSHIP

Course Code: **PS10045**
Credit: **2**
L-T-P: **2-0-0**
Prerequisite: **Nil**

COURSE OBJECTIVE

The course is designed for students who want to enhance their creative and innovative skills and apply them to prepare business plans to form entrepreneurial enterprises. More specifically, the course is designed to help students to stimulate creativity in themselves and learn the impact of innovation on growth creation and design thinking in real-world business situations. In this course, the concepts of entrepreneurship and the environment in which the entrepreneurs act will be developed along with business plans and business models for start-ups.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand the key elements of creativity and innovation,
CO 2: Visualize the impact of innovation on growth creation,
CO 3: Apply creative and design thinking to real-world business situations,
CO 4: Create a foundation of entrepreneurship development and its theories,
CO 5: Develop business plans and business models to start entrepreneurial enterprises, and
CO 6: Analyze the business plan and implement it in real field.

COURSE DETAILS

Introduction
Definitions, Importance, and Relationships among Creativity, Innovation, and Entrepreneurship; Examples.

Creativity
Definitions, Importance, and Relationships among Creativity, Innovation, and Entrepreneurship; Examples, Creative Thinking and Stages of Creative Thinking, Barriers to Creativity, Enhancing Individual Creativity, Guilford's Usual Unusual Test, Psychometric Approaches to Tests of Creativity, Structured tools of Creativity (Developing Creative Focus, Exercising Mind, Setting Directions, Suspending Rules, Thinking Differently, Establishing Formatted Work Space, Stimulating Mechanisms, Utilizing Experiences.

Innovation
Innovation, Benefits, Keys to Successful Innovations, Types of Innovation, Barriers to Innovation, Methods of Generating Ideas, Design Thinking. Creative Problem Solving, and Measures of Innovation.

Entrepreneurship
Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneur, Intrapreneur, Social Entrepreneur, Case Study on the Entrepreneurial Excellence of N. R. Narayan Murthy, Introduction to Agricultural, Rural, Tourism, Social and Digital Entrepreneurship, Entrepreneurial Motivational Behavior (Creativity, Self-Efficacy, Locus of Control, Risk Taking, Leadership, Communication),
Converting Ideas into Products/Services with Differentiating Features, Niche Market, Design of the Products/Services, Bootstrap Marketing, Formulation of Business Plan, Business Model, Financial Planning, and Sources of Finance.

Practical classes will be devoted to organizing practicing sessions on creativity, case study discussion sessions and market analysis sessions on generating novel ideas, and developing and presenting business plans. Students, in groups, will design a new product/service, do a bootstrap market study, develop a business plan, and make an elevator pitch.

Textbooks

1. Khanka, S.S., Creativity, Innovation, and Entrepreneurship, S. Chand.
2. Praveen Gupta, Business Innovation, S. Chand, 2007.

Reference Books

1. Barringer B.R. and R. Duane, Entrepreneurship: Successfully Launching New Ventures: Pearson Prentice Hall, Ireland, 3rd Edition 2009.
2. Duening, T.N., R.D. Hisrich, and M.A. Lechter, Technology Entrepreneurship: Taking Innovation to the Marketplace, Elsevier, Amsterdam, 2nd Edition 2015.
3. Harrington, H.J., Creativity, Innovation, and Entrepreneurship: The Only Way to Renew Your Organization, Routledge, 2019.

K-XPLORE
(Practice Oriented Open Elective – I)

The B. Tech. curriculum provides for a 1-Credit practice-oriented Open Elective K-Xplore in Semester V to make our undergraduate engineering programme holistic, multidisciplinary, skill-based, and balanced. This course allows the students to explore the opportunity that the KIIT University offers to them to sharpen their skills in areas which excite them the most.

Offered in a self-learning mode, this course allows the students to hone their skills in areas they are passionate about which they select from a wide spectrum of courses in art, literature, technology, community engagement and service, health, and environment and sustainability. In addition, the students develop soft skills that are important for them in their professional life. This course, thus, allows students to explore and grow in areas outside of core academics and provides a channel for complementing the lessons learned in the classroom, offering them the opportunity to apply academic skills in a real-world context and providing a truly well-rounded education.

This course is designed on the basis of the guiding philosophy of student-centered learning where the students define problems, evaluate alternatives, design solutions, and self-learn by performing certain assigned activities with limited guidance from faculty facilitators.

Each student selects an area of his (or her) choice from a specified list of areas. All the students with choice in a particular area are assigned to one or more faculty facilitators. Faculty facilitators assign the activities and tasks necessary for the course to the students and decide the desired mode of skills training. They may decide to make small groups of students of varying group sizes to carry out the assigned activities and tasks. They also make the required facilities available to the students to enable them to carry out the assigned activities and tasks.

The timetable will earmark specific hours for the course. But the students are expected to use their spare time (including holidays and after-lecture hours on working days) to learn the required skills and use these skills to accomplish the assigned activities and tasks. The students, however, have to meet the faculty supervisors on the specified hours every week to appraise them of their progress, clear their doubts, if any, and chart their future plan.

The Head of KIIT Student Activity Centre (KSAC) will coordinate offering of the course.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Develop the needed technical skills in their chosen fields of interest,
CO 2: Develop higher levels of self-confidence and soft skills such as communication, writing, discussion and debate, time-management, and leadership skills,
CO 3: Apply the learned skills to give shape to their passionate ideas,
CO 4: Develop Innovation and entrepreneurial mindset,
CO 5: Analyze and judge a problem situation for deploying the learnt knowledge and skills and develop problem solving strategies, and
CO 6: Build new products and services using the learned knowledge and skills.

ROBOTICS

Course Code: SA38001
Credit: 1
L-T-P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE

To assist students, develop the knowledge of robotics and circuitry, build circuits, bots and robots, and participate in different Robotics events such as Robo Wars.

WEB DESIGNING

Course Code: SA38003
Credit: 1
L-T-P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE

To help a student learn and develop front-end and back-end web development skills and create websites.

CIVIL-TECH

Course Code: SA38005
Credit: 1
L-T-P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE

To make a student ready to plan and design selected aspects of real-life construction projects with relation to environment, transport & connectivity, water resource engineering & soil exploration and gain pre-, present-, and post- construction experience.

CIRCUIT DESIGN & CONTROL

Course Code: **SA38007**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

To let the students, learn the required skills to design and develop electrical circuits and implement controllers for use in robotics, automation, voice recognition, gesture recognition, etc.

INDIAN CLASSICAL, FOLK & BOLLYWOOD DANCE

Course Code: **SA38009**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

To encourage and boost the confidence of the students to choreograph and perform in classical, semi classical / folk and bollywood dance forms.

INDIAN CLASSICAL & WESTERN MUSIC

Course Code: **SA38011**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

To give confidence to the students to participate and perform as a vocalist and/or instrumentalist in different forms of Indian classical and western music.

GRAPHIC DESIGNING & EDITING

Course Code: **SA38013**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

To nurture the students' skills in creative designing, photo and video editing activities, and digital sketching and painting, using Designing & Editing software such as Photoshop, Illustrator and video editing software.

ART & CRAFT

Course Code: **SA38015**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

To endow the students with the skills to do various types of painting such as portrait painting, landscape painting, abstract painting, pencil sketching, and doodling and craft, using various Painting and Sketching tools.

THEATRE & STREET PLAY

Course Code: **SA38017**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

To give students the confidence to perform in Theatres, Nukkad, Mono Acts and skits based on written scripts.

FILM MAKING

Course Code: **SA38019**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

To impart skills for film making in areas such as cinematography, script writing, audio recording, and editing.

DEBATING, PUBLIC SPEAKING & ANCHORING

Course Code: **SA38021**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

To develop the students' skills for performing oratory activities such as extempore speech, debate, poetry reading, open topic speech, public speaking, interviewing, open dialogue, anchoring, and presentation.

CREATIVE WRITING

Course Code: **SA38023**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

To develop the students' skills in creative writing, content writing, article writing, and poem composition.

PHOTOGRAPHY & VIDEOGRAPHY

Course Code: **SA38025**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

To provide the technical knowledge required to create photos and videos that tell a story or capture a real-world occurrence.

FASHION STYLING

Course Code: **SA38027**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

To impart the basic skills of costume design, styling, grooming, and presentation relevant to a specified theme.

CULINARY ARTS

Course Code: **SA38029**
Credit: **1**
L-T-P: **0-0-2**
Prerequisite: **Nil**

COURSE OBJECTIVE

To help the students learn the skills of cooking, knowing ingredients, and preparing cuisines of Pan India and 65 countries.

QUIZ ACTIVITY

Course Code: SA38031
Credit: 1
L-T-P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE

To give the students the confidence to participate in, and conduct, various forms of quiz, such as Technical Quiz and Business Quiz.

SOCIAL OUTREACH

Course Code: SA38033
Credit: 1
L-T-P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE

To sensitize the students on the social issues and giving them an opportunity to connect with the community and the environment through outreach activities, community projects, and volunteering.

HEALTH & EMERGENCY CARE

Course Code: SA38035
Credit: 1
L-T-P: 0-0-2
Prerequisite: Nil

COURSE OBJECTIVE

To let the students, learn about health issues, basic Life-saving skills and participate in health awareness and sensitization programs.

SOCIO-POLITICAL ENVIRONMENT

Course Code: SO10043
Credit: 2
L-T-P: 2-0-0
Prerequisite: Nil

COURSE OBJECTIVE

The objective of this paper includes providing basic knowledge on socio-political environment of India and to equip the students with an understanding of their roles, duties, and responsibilities in a democratic set up.

COURSE OUTCOMES

After successfully completing the course, the students will be able to

CO 1: Understand contemporary Indian social problems,

CO 2: Understand the roles and functions of the three political institutions in our democratic setup,
CO 3: Familiarize the students with the Rights and Duties enlisted in the Indian Constitution,
CO 4: Grasp the interrelationships among political, social and economic issue,
CO 5: Visualize contemporary changes in Political Institutions, and
CO 6: Realize the importance of equity, equality, and dignity in a democratic system.

COURSE DETAILS

Social Problem in India

Meaning and Definition of Social Problems, Characteristics, Causes and Consequences, Problems of Poverty, Unemployment, Population growth, Problems of Women and Aged, Corruption and Nepotism, Illiteracy, Substance Abuse, and Terrorism.

Social Stratification

Equity and Equality, Caste, Religion, Class, Gender Discrimination, UrbanSlums.

Political Institutions

Meaning and Basic Concepts of Political Institutions: Legislative, Executive and Judiciary Systems of the Indian Constitution.

Fundamental Rights and Duties

Fundamental Rights and Duties in Indian Constitution, Directive Principles of State Policy.

Contemporary Changes in Political Institutions

Changing Role of the Government in Contemporary India, Role of Government in the Formation of National and International Policies and Their Impact on Business and Trade.

Textbooks

1. C. N. Shankar Rao, S. Chand., Indian Social Problems, S. Chand Publication, 2017.
2. M. Laxmikanth, Constitution of India, Cengage Learning, 2020.
3. Himanshu Roy & M.P Singh Indian Political System, Pearson publisher, 4th Edition, 2018.
4. Ram Ahuja, Social Problems in India, Rawat publisher, 4th Edition, 2014.

Reference Books

1. Subhash C Kashyap, Our Parliament, NBT, 2021.
2. Social Stratification, Dipankar Gupta (Ed), Oxford India Publication, 1997.
3. Yogendra Singh, Modernization of Indian Tradition, Rawat Publication, 1986.

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