NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

B.Tech. in

CIVIL ENGINEERING

SCHEME OF INSTRUCTION AND SYLLABI

for B.Tech. Program

(Effective from 2021-22)

DEPARTMENT OF CIVIL ENGINEERING

Vision and Mission of the Institute

National Institute of Technology Warangal

VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society

MISSION

- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.
- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.
- Fostering product-oriented research for establishing a self-sustaining and wealth creating centre to serve the societal needs.

Vision and Mission of the Department

Department of Civil Engineering

VISION

To be a knowledge nerve centre in civil engineering education, research, entrepreneurship and industry outreach services for creating sustainable infrastructure and enhancing quality of life.

MISSION

- Generate a specialized cadre of civil engineers by imparting quality education and training
- Attain international standards in teaching, research and consultancy with global linkages

Department of Civil Engineering:

Brief about the Department:

The Department of Civil Engineering was established in 1959, along with the setting up of the institute, that is, REC Warangal. The Department offers an undergraduate and eight post-graduate programs in addition to Ph.D. The Department has highly committed faculty who are well qualified and are members of several national and international policy making and advisory bodies including the BIS.

The Department is a recognized QIP center since 1978, to offer Ph.D programs to faculty of other institutes. The Department is known for its cutting-edge research and believes in disseminating the knowledge through publishing in highly reputed journals and patenting the research work.

The Department maintains very good industry-institute linkages. Most of the students are placed in reputed companies, Government organizations and Higher Educational Institutes in India and abroad. The alumni who are important stake holders of the Department, actively guide and provide valuable inputs. They constantly peer review the syllabus and curriculum to make students industry ready.

The Civil Engineering Department, apart from Teaching and R&D, also does enormous amount of consultancy, which adds up to the institutional internal revenue generation and involves faculty and students in challenging field problems. There are six centers of excellence in the Department and most of the laboratories have state of the art equipment.

The faculty of the Department are actively involved in sponsored projects and have prestigious projects like-SPARC, BRICS, IMPRINT, DST, SERB, DBT, ARDB to name a few. The Department takes pride in having conducted the highest number of GIAN and SPARC programs.

The Civil Engineering Department has MoUs with highly reputed organizations like NAAC, NCCBM, WALAMTARI, SCCL, INVENTA, PSI, among others and has collaborations with several foreign universities and companies such as – Texas A&M, NCAR-Colorado, PTV Group Germany, etc.

List of Programs offered by the Department:

Program	Title of the Program
B.Tech.	Civil Engineering
M.Tech.	Engineering Structures
	Water Resource Engineering
	Geotechnical Engineering
	Transportation Engineering
	Remote Sensing and Geographical Information Systems
	Environmental Engineering
	Construction Technology and Management
	Waste Management
Ph.D.	Civil Engineering

Note: Refer to the following weblink for Rules and Regulations of B.Tech. program:
https://www.nitw.ac.in/media/uploads/2021/08/27/btech_rules-and-regulations-2021-22.pdf

B.Tech. – Civil Engineering

Program Educational Objectives

PEO1	Apply principles of basic and engineering sciences in analysis, design and operation of civil engineering systems
PEO2	Assess societal needs and plan suitable infrastructure
PEO3	Analyze and design components of civil engineering projects
PEO4	Develop team spirit and inter personal dynamics for effective execution and management of projects
PEO5	Engage in lifelong learning and adapt to changing professional and societal needs

Program Articulation Matrix

PEO / Mission Statements	PEO1	PEO2	PEO3	PEO4	PEO-5
Generate a specialized cadre of civil engineers by imparting quality education and training	**3**	**3**	**3**	**2**	**1**
Attain international standards in teaching, research and consultancy with global linkages	**2**	**2**	**2**	**1**	**2**

1-Slightly; 2-Moderately; 3-Substantially

B.Tech. – Civil Engineering

Program Outcomes

PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and civil engineering to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/Development of solutions:** Design solutions for complex civil 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	**Conduct investigations of complex problems:** 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	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex civil engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** 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	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: 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	**Project management and Finance**: 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	**Life-long learning**: 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

PSO1	Survey, map, measure and analyze earth surface features and natural resources
PSO2	Characterize and evaluate materials for adoptability in civil engineering projects
PSO3	Analyze and design infrastructural facilities needed for the society and apply best management practices for construction and maintenance of these facilities
PSO4	Predict, forecast and take measures for mitigation of natural and man made hazards

SCHEME OF INSTRUCTION

B.Tech. Civil Engineering – Course Structure

I - Year, I – Semester

S. No.	Course Code	Name of the Course	L	T	P	Credits	Cat. Code
1	MA131	Matrix Theory and Calculus	3	0	0	3	BSC
2	PH131	Physics for Civil Engineers	3	0	2	4	BSC
3	CE101	Engineering Mechanics	3	0	0	3	ESC
4	CS131	Problem Solving and Computer Programming	3	0	2	4	ESC
5	ME132	Engineering Graphics	1	0	4	3	ESC
6	HS132	English for Technical Communication	2	0	2	3	HSC
7	IC001	Induction Program *				0	MNC
8	IC101	Extra Academic Activity-I *	0	0	2	0	MNC
		Total	**15**	**0**	**12**	**20**	

* MNC weblink: https://www.nitw.ac.in/media/uploads/2021/10/22/mnc_1st-year.pdf

I - Year, II – Semester

S. No.	Course Code	Name of the Course	L	T	P	Credits	Cat. Code
1	MA181	Differential Equations and Transforms	3	0	0	3	BSC
2	CY183	Chemistry for Civil Engineers	3	0	0	3	BSC
3	ME181	Basic Mechanical Engineering for Civil Engineers	2	0	0	2	ESC
4	CE151	Strength of Materials	3	0	0	3	PCC
5	CE152	Fluid Mechanics-I	3	0	0	3	PCC
6	CE153	Civil Engineering Materials	2	0	0	2	PCC
7	CY182	Chemistry Laboratory	0	0	2	1	BSC
8	ME184	Workshop Practice for Civil Engineers	0	0	2	1	ESC
9	IC151	Extra Academic Activity-II *	0	0	2	0	MNC
		Total	**16**	**0**	**6**	**18**	

* MNC weblink: https://www.nitw.ac.in/media/uploads/2021/10/22/mnc_1st-year.pdf

Note: BSC – Basic Science Courses
ESC – Engineering Science Courses
PCC – Professional Core Courses
PEC – Professional Elective Courses
OEC – Open Elective Courses
HSC – Humanities and Social Science Courses
MNC – Mandatory Non-credit Courses

SCHEME OF INSTRUCTION

B.Tech. Civil Engineering – Course Structure

II - Year, I – Semester

S. No.	Course Code	Name of the Course	L	T	P	Credits	Cat. Code
1	MA231	Numerical and Statistical Methods	3	0	0	3	BSC
2	CE201	Mechanics of Materials	3	0	2	4	PCC
3	CE202	Fluid Mechanics-II	3	0	2	4	PCC
4	CE203	Surveying	3	0	2	4	PCC
5	CE204	Concrete Technology	3	0	2	4	PCC
6	CE205	Design of Steel Structures	3	0	0	3	PCC
7		Mandatory Non-Credit Course *	1	0	0	0	MNC
		Total	**19**	**0**	**8**	**22**	

* MNC weblink: https://www.nitw.ac.in/media/uploads/2021/10/22/mnc_2nd-year.pdf

II - Year, II – Semester

S. No.	Course Code	Name of the Course	L	T	P	Credits	Cat. Code
1	CE251	Theory of Structures-1	3	0	0	3	PCC
2	CE252	Engineering Hydrology	3	0	0	3	PCC
3	CE253	Design of Concrete Structures	3	0	0	3	PCC
4	CE254	Geotechnical Engineering – 1	3	0	2	4	PCC
5	CE255	Environmental Engineering-1	3	0	0	3	PCC
6	CE256	Transportation Engineering - 1	3	0	2	4	PCC
7	CE257	Building Planning, Drawing and Construction	2	1	2	4	PCC
		Total	**20**	**1**	**6**	**24**	

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SCHEME OF INSTRUCTION

B.Tech. Civil Engineering – Course Structure

III - Year, I – Semester

S. No.	Course Code	Name of the Course	L	T	P	Credits	Cat. Code
1	CE301	Theory of Structures-2	3	0	0	3	PCC
2	CE302	Irrigation Engineering	2	0	0	2	PCC
3	CE303	Geotechnical Engineering - 2	3	0	0	3	PCC
4	CE304	Environmental Engineering - 2	3	0	2	4	PCC
5	CE305	Transportation Engineering - 2	3	0	0	3	PCC
6	CE306	Remote Sensing	2	0	0	2	ESC
7	CE307	Engineering Geology	2	0	2	3	PCC
8	SM331	Engineering Economics and Project Appraisal	3	0	0	3	HSC
		Total	**21**	**0**	**4**	**23**	

III - Year, II – Semester

S. No.	Course Code	Name of the Course	L	T	P	Credits	Cat. Code
1	CE351	Construction Technology and Project Management	3	0	0	3	PCC
2	CE352	Hydraulic Structures	3	0	0	3	PCC
3	CE353	Civil Engineering Software Lab	0	1	2	2	PCC
4	EE381	Electrical and Electronics for Civil Engineers	3	0	0	3	ESC
5	EC381	Civionics	3	0	0	3	ESC
6		Open Elective – 1 #	3	0	0	3	OEC
7		Department Elective -1	3	0	0	3	PEC
8		Department Elective -2	3	0	0	3	PEC
9		Mandatory Non-Credit Course *	1	0	0	0	MNC
		Total	**22**	**1**	**2**	**23**	

* MNC weblink: https://www.nitw.ac.in/media/uploads/2021/10/22/mnc_3rd-year.pdf

OEC weblink: https://www.nitw.ac.in/media/uploads/2021/10/22/open-elective-1_vi-sem.pdf

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SCHEME OF INSTRUCTION

B.Tech. Civil Engineering – Course Structure

IV - Year, I – Semester

S. No.	Course Code	Name of the Course	L	T	P	Credits	Cat. Code
1	CE401	Quantity Surveying and Public Works	2	0	2	3	PCC
2	SM431	Entrepreneurship for Engineers	3	0	0	3	HSC
3		Open Elective – 2 #	3	0	0	3	OEC
4		Department Elective -3	3	0	0	3	PEC
5		Department Elective -4	3	0	0	3	PEC
6		Department Elective -5	3	0	0	3	PEC
7	CE449	Summer Internship/ EPICS/Mini Project etc.				2	PCC
		Total	**17**	**0**	**2**	**20**	

OEC weblink: https://www.nitw.ac.in/media/uploads/2021/10/22/open-elective-2_vii-sem.pdf

IV - Year, II – Semester

S. No.	Course Code	Name of the Course	L	T	P	Credits	Cat. Code
1		Department Elective -6	3	0	0	3	PEC
2		Department Elective -7	2	0	0	2	PEC
3	CE498	Seminar	0	0	2	1	
4	CE499	Project Work @	0	0	8	4	
		Total	**5**	**0**	**10**	**10**	

@ **NOTE: Refer to the following link for the guidelines to prepare dissertation report:**
https://www.nitw.ac.in/media/uploads/2021/08/27/ug_project-report-format_55vW5pL.pdf

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Credits in Each Semester									
Cat. Code	**Sem-I**	**Sem-II**	**Sem-III**	**Sem-IV**	**Sem-V**	**Sem-VI**	**Sem-VII**	**Sem-VIII**	**Total**
BSC	7	7	3	-	-	-	-	-	**17**
ESC	10	3	-	-	2	6	-	-	**21**
PCC	-	8	19	24	18	8	5	-	**82**
PEC	-	-	-	-	-	6	9	5	**20**
OEC	-	-	-	-	-	3	3	-	**6**
HSC	3	-	-	-	3	-	3	-	**9**
MNC	-	-	-	-	-	-	-	-	**-**
Project	-	-	-	-	-	-	-	4	**4**
Seminar	-	-	-	-	-	-	-	1	**1**
Internship	-	-	-	-	-	-	-	-	**-**
Total	**20**	**18**	**22**	**24**	**23**	**23**	**20**	**10**	**160**

Program Elective Courses

Elective-1 & 2 (III Year, II Semester)		
S. No.	**Course Code**	**Name of the Course**
1	CE311	Systems Analysis in Civil Engineering
2	CE312	Prestressed Concrete
3	CE313	Advanced Surveying
4	CE314	Pavement Management System
5	CE315	Foundation Analysis and Design
6	CE316	Industrial Wastewater Treatment
7	CE317	Green Buildings
8	CE318	Advanced Reinforced Concrete Design
Elective-3,4 & 5 (IV Year, I Semester)		
S. No.	**Course Code**	**Name of the Course**
1	CE411	Applied Stress Analysis
2	CE412	Municipal Solid Waste Management
3	CE413	Groundwater Development
4	CE414	River Hydraulics
5	CE415	Design of Earthquake Resistant Structures
6	CE416	GIS Applications
7	CE417	Photogrammetry and UAV
8	CE418	Ground Improvement Techniques
9	CE419	Rock Engineering
10	CE420	Travel Demand Analysis
11	CE421	Traffic Engineering and Design
12	CE422	Building Information Modelling
13	CE423	Air Pollution
Note: Can choose any Three from the electives offered in the semester in the above list along with the courses from any of the M.Tech programs, offered in I Year I semester in the Department		
Elective-6 & 7 (IV Year, II Semester)		
S. No.	**Course Code**	**Name of the Course**
1	CE461	Environmental Impact Assessment
2	CE462	Geodesy and GNSS
3	CE463	Seismic Hazard Analysis
4	CE464	Watershed Management
5	CE465	Pedestrian and Bicycle Facility Design
6	CE466	Finite Element Methods
7	CE467	Hydropower Engineering

8	CE468	Noise Pollution
9	CE469	Construction Planning and Management Tools
10	CE470	Rehabilitation of Structures
11	CE471	Construction Geotechniques
12	CE472	Low Volume Roads
Note: Can choose any Two from the electives offered in the semester in the above list along with the courses from any of the M.Tech programs, offered in I Year II semester in the Department		

DETAILED SYLLABUS

B.Tech. – Civil Engineering

Course Code: MA131	MATRIX THEORY AND CALCULUS	Credits 3-0-0: 3

Pre-Requisites: None

Course Outcomes:

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

CO1	Apply orthogonal and congruent transformations to a quadratic form
CO2	Find the maxima and minima of multivariable functions
CO3	Evaluate multiple integrals in various coordinate systems
CO4	Apply the concepts of gradient, divergence and curl to formulate engineering problems
CO5	Convert line integrals into surface integrals and surface integrals into volume integrals

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Linear Algebra: Linear dependence and independence of vectors; Eigenvalues and eigenvectors of a matrix; Caley-Hamilton theorem and its applications; Reduction to diagonal form; Reduction of a quadratic form to canonical form - orthogonal transformation and congruent transformation

Differential Calculus: Taylor's theorem with remainders; Taylor's and Maclaurin's expansions; Functions of several variables - partial differentiation; total differentiation; Change of variables - Jacobians; maxima and minima of functions of several variables (2 and 3 variables) - Lagrange's method of multipliers.

Integral Calculus: Beta and Gamma integrals; Double and Triple integrals - computation of surface areas and volumes; change of variables in double and triple integrals.

Vector Calculus: Scalar and vector fields; vector differentiation; level surfaces; directional derivative; gradient of a scalar field; divergence and curl of a vector field; Laplacian; Line and Surface integrals; Green's theorem in a plane; Stoke's theorem; Gauss Divergence theorem.

Learning Resources:

Text Books:

1. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa Publishing House, 2016, 5th Edition
2. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley and Sons, 2015, 8th Edition
3. Calculus and Analytic Geometry, George B. Thomas and Ross L. Finney, Pearson, 2020, 9th Edition

Reference Books:

1. Advanced Engineering Mathematics, Dennis G. Zill, Jones & Bartlett Learning, 2018, 6th Edition
2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 2012, 42nd Edition

Online Resources:

1. https://nptel.ac.in/courses/111/108/111108157/
2. https://nptel.ac.in/courses/111/106/111106146/
3. https://nptel.ac.in/courses/111/104/111104144/

Course Code: PH131	PHYSICS FOR CIVIL ENGINEERS	Credits 3-0-2: 4

Pre-Requisites: None

Course Outcomes:

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

CO1	Apply the concepts of wave and particle nature of energy for solving problems radiant energy
CO2	Explain the applications of Interference, diffraction, optical fibers holography and lasers in civil engineering
CO3	Outline the principles behind the building acoustics
CO4	Summarize the functional materials and their applications in civil engineering.
CO5	Apply the concepts of interference, diffraction, and polarization in engineering measurements and determine acceptance angle and numerical aperture of an optical fiber
CO6	Demonstrate quantum nature of radiation using photoelectric effect

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-	-	-	1	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO6	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Waves, Oscillations and Building Acoustics:
Free vibrations-Equation of Motion -Energy Considerations-Damped Harmonic motion and measurement of Damping Factor-Forced Oscillations, Resonance
Ultrasonics-Production, Detection and NDT applications of Ultrasound.
Reverberation and Reverberation Time-Growth and Decay of Sound in an enclosure-Sabine's Formula-Measurement of Absorption Coefficient-Factors affecting architectural acoustics and Remedies.

Quantum Mechanics: Introduction-Wave Nature of Matter-de Broglie's Concept- Heisenberg's Uncertainty Principle -Schrodinger's wave equation for a moving particle-Wave Function-Potential Well Problems- Quantum mechanical tunneling

Wave and Quantum Optics :
Interference: Concept of Interference of Light-Division of Amplitude and Wave front with examples-Michelson and Fabry perot Interferometers- Applications of Interference of Light in Civil Engineering.
Diffraction: Fraunhofer's Class of Diffraction at Single, Double and Multiple Slits-Gratings and Applications
Polarization: Production and Detection of Polarised Light—Wave Plates- Optical Activity-Laurent's Half Shade Polarimeter- Photo elasticity-Polariscopes and Civil Engineering Applications.

Lasers: Interaction of Radiation with Matter-Spontaneous and Stimulated Emissions-Basic requirements for the construction of Lasers-Construction and working of He-Ne, CO2, Nd-YAG and Semiconductor Lasers, Holography and HNDT
Optical fibers: Structure, Classification and Propagation of Light in an Optical Fiber-Numerical Aperture- Fiber Gratings and Civil Engineering Applications of Optical Fibers.

New Engineering Materials: Introduction to Composites-Fiber Reinforced Plastics and Metals-High Temperature Materials-Metallic Glasses-Shape Memory Alloys- Ceramics-Methods of preparation, Properties and their Engineering Applications.
Nano Materials-Introduction-Preparation Methods-Properties and Engineering Applications

Measurement Techniques: Introduction-Basic Elements of a Generalised Measurement System-Static and Dynamic Characteristics of Measurement Systems-Measurement of Strain-Velocity-Flow-Vibrations and Climatological Variables.

Laboratory Syllabus:

1. Determination of Wavelength of Sodium light using Newton's Rings.
2. Determination of Wavelength of He-Ne laser - Metal Scale.
3. Measurement of Width of a narrow slit using He- Ne Laser.
4. Determination of Specific rotation of Cane sugar by Laurent Half-shade Polarimeter.
5. Determination of Numerical aperture, loss, Acceptance angle of optical fiber.
6. Determination of plank constant by photo electric effect.
7. Determination of I – V characteristics of photo diode.
8. Diffraction grating by normal incidence method.
9. Determination of resonating frequency and bandwidth by LCR circuit.

Learning Resources:

Text Books:

1. Fundamentals of Physics, Halliday, Resnik and Walker, John Wiley, 2011, 9th Edition.
2. Concepts of Modern Physics, Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, McGraw Hill Publications, 2009, 6th Edition.
3. Physics Laboratory Manual, Physics Department, NIT Warangal, 2021.

Reference Books:

1. Optics, Ajoy K. Ghatak,Tata McGraw Hill, 2017, 6th Edition.
2. Solid State Physics, S.O. Pillai, New Age Publishers, 2018, 8th Edition.
3. Understanding Lasers An Entry-Level Guide, by Jeff Hecht, Wiley Publications, 2018, 4th Edition
4. Practical Physics, G.L.Squire, Cambridge University press, 2001, 4th Edition,.

Online Resources:

1. https://nptel.ac.in/courses/122/107/122107035/
2. http://amrita.olabs.edu.in/

Course Code: CE101	ENGINEERING MECHANICS	Credits 3-0-0: 3

Pre-Requisites: None

Course Outcomes:

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

CO1	Determine the resultant force and moment for a given system of forces
CO2	Analyze planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction
CO3	Calculate the motion characteristics of a body subjected to a given force system
CO4	Determine the deformation of a shaft and understand the relationship between different material constants
CO5	Determine the centroid and second moment of area

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	-	-	1	-	-	-	-	-	-	-	-	3	-
CO2	3	3	2	-	-	1	-	-	-	-	-	-	-	-	3	-
CO3	3	3	2	-	-	1	-	-	-	-	-	-	-	-	3	-
CO4	3	3	2	-	-	1	-	-	-	-	-	-	-	1	2	-
CO5	3	3	2	-	-	1	-	-	-	-	-	-	-	1	2	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Specification of force vector, Formation of Force Vectors, Moment of Force – Cross product – Problems, Resultant of a general force system in space, Degrees of freedom - Equilibrium Equations, Kinematics – Kinetics – De' Alemberts principle, Degree of Constraints – Free body diagrams.

Spatial Force systems: Concurrent force systems - Equilibrium equations – Problems, Problems (Vector approach) – Tension Coefficient method, Problems (Tension Coefficient method), Parallel force systems - problems, Center of Parallel force system – Problems.

Coplanar Force Systems: Introduction – Equilibrium equations – All systems, Problems on Coplanar Concurrent force system, Coplanar Parallel force system, Coplanar General force system – Point of action, Method of joints, Method of sections, Method of sections, Method of members, Friction – Coulombs laws of dry friction – Limiting friction, Problems on Wedge friction, Belt Friction-problems.

Mechanics of Deformable Bodies: Stress & Strain at a point- Normal and shear stresses, Axial deformations – Problems on prismatic shaft, tapered shaft and deformation due to self-weight, Deformation of Stepped shaft due to axial loading, Poisson's Ratio – Bulk Modulus - Problems, change in dimensions and volume.

Centroid & Moment of Inertia: Centroid and M.I – Arial – Radius of Gyration, Parallel axis– Perpendicular axis theorem – Simple Problems.

Dynamics of Particles: Rectilinear Motion – Kinematics Problems, Kinetics – Problems, Work & Energy – Impulse Moment, Curvilinear Motion – Normal and tangential components.

Learning Resources:

Text Books:

1. Engineering Mechanics (In SI Units), S. Timoshenko, D.H. Young, J.V. Rao and Sukumar Pati, McGraw Hill Publishers, 2017, 5th Edition.
2. Vector Mechanics for Engineers - Statics and Dynamics, Ferdinand P. Beer, E. Russell Johnston Jr., et al., McGraw Hill Publishers, 2019, 12th Edition.
3. Mechanics of Materials, Gere and Timoshenko, CBS Publishers, 2011, 2nd Edition.

Reference Books:

1. Mechanics of Materials (SI Edition), R. C. Hibbeler, Pearson publication, 2018.
2. Engineering Mechanics: Statics, SI Version, J. L. Meriam, L. G. Kraige, et al., Wiley India Edition, 2017
3. Engineering Mechanics: Dynamics, SI Version, J.L. Meriam, L.G. Kraige, et al., Wiley India Edition, 2018
4. Engineering Mechanics, S S Bhavikatti, New Age International Private Limited, 2021, 8th Edition.
5. Engineering Mechanics, S Sengupta and Srinivas V Veeravalli P C Dumir, Universities Press (India) Private Limited, 2020

Online Resources:

1. https://nptel.ac.in/courses/122/104/122104015/
2. https://nptel.ac.in/courses/112/106/112106180/

Course Code: CS131	PROBLEM SOLVING AND COMPUTER PROGRAMMING	Credits 3-0-2: 4

Pre-Requisites: None

Course Outcomes:

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

CO1	Design and test programs to solve mathematical and scientific problems
CO2	Develop and test programs using control structures
CO3	Implement modular programs using functions
CO4	Develop programs using classes

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	-	3	-	3	-	-	-	-	-	-	-	-	-	-	-
CO2	-	2	3	-	3	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	3	-	3	-	-	-	-	-	-	-	-	-	-	-
CO6	1	-	3	-	3	-	-	-	-	-	-	-	1	1	1	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Fundamentals of Computers, Historical perspective, Early computers, Components of a computers, Problems, Flowcharts, Memory, Variables, Values, Instructions, Programs.

Problem solving techniques – Algorithmic approach, characteristics of algorithm, Problem solving strategies: Top-down approach, Bottom-up approach, Time and space complexities of algorithms.

Number systems and data representation, Basics of C++, Basic data types. Numbers, Digit separation, Reverse order, Writing in words, Development of Elementary School Arithmetic Testing System, Problems on Date and factorials, Solutions using flow of control constructs, Conditional statements - If-else, Switch-case constructs, Loops - while, do-while, for.

Functions – Modular approach for solving real time problems, user defined functions, library functions, parameter passing - call by value, call by reference, return values, Recursion, Introduction to pointers.

Sorting and searching algorithms, Large integer arithmetic, Single and Multi-Dimensional Arrays, passing arrays as parameters to functions

Magic square and matrix operations using Pointers and Dynamic Arrays, Multidimensional Dynamic Arrays String processing, File operations.

Structures and Classes - Declaration, member variables, member functions, access modifiers, function overloading, Problems on Complex numbers, Date, Time, Large Numbers.

Laboratory-Syllabus:

1. Programs on conditional control constructs.
2. Programs on loops (while, do-while, for).
3. Programs using user defined functions and library functions.
4. Programs on arrays, matrices (single and multi-dimensional arrays).
5. Programs using pointers (int pointers, char pointers).
6. Programs on structures.
7. Programs on classes and objects.

Learning Resources:

Text Books:

1. Problem Solving with C++, Walter Savitch, Ninth Edition, Pearson, 2014.
2. Timothy Budd, "Big C++, Cay Horstmann, Wiley, 2009, 2nd Edition.
3. How to solve it by Computer, R.G. Dromey, Pearson, 2008.

Reference Books:

1. Effective C++: 55 Specific Ways to Improve Your Programs and Designs, Meyers, Pearson, 2008
2. C++: The Complete Reference, Herbert Schildt, McGraw Hill Education, 2017, 4th edition
3. Object-Oriented Programming with C++, E Balagurusamy, McGraw Hill, 2020, 8th edition

Online Resources:

1. https://nptel.ac.in/courses/106/105/106105151/
2. https://onlinecourses.nptel.ac.in/noc21_cs38/preview

Course Code: ME132	ENGINEERING GRAPHICS	Credits 1-0-4: 3

Pre-Requisites: None

Course Outcomes:

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

CO1	Apply BIS standards and conventions while drawing Lines, printing Letters and showing Dimensions.
CO2	Classify the systems of projection with respect to the observer, object and the reference planes.
CO3	Construct orthographic views of an object when its position with respect to the reference planes is defined in CAD environment
CO4	Analyse the internal details of an object through sectional views in CAD environment.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1		-	-	-	1	-	-	2	-	3	-	-	1	-	1	-
CO2	2	-	-	-	1	-	-	-	-	1	-	-	3	-	1	-
CO3	1	-	2	-	3	-	-	-	-	1	-	-	2	-	1	-
CO4	2	-	2	-	3	-	-	-	-	-	-	-	-	-	1	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Drawing instruments and their uses, Types of lines, Lettering, General rules for dimensioning, Geometrical constructions using instruments. (Conventional)

Orthographic Projection: Methods of projection, Principles of Orthographic projection, First angle versus third angle of projection, Six views of an object, Conventions. (Conventional)

Projection of Points: Projections of points when they are situated in different quadrants. (Conventional)

Projections of Lines: Projections of a line parallel to one of the reference planes and inclined to the other, line inclined to both the reference planes, Traces. (Conventional)

Fundamentals of AutoCAD: Introduction to Auto-CAD, DRAW tools, MODIFY tools, TEXT, DIMENSION, PROPERTIES (AutoCAD)

Projections of Planes: Projections of a plane perpendicular to one of the reference planes and inclined to the other, Oblique planes. (AutoCAD)

Projections of Solids: Projections of solids whose axis is parallel to one of the reference planes and inclined to the other, axis inclined to both the planes. (AutoCAD)

Section of Solids: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section. (AutoCAD)

Learning Resources:

Text Books:

1. Engineering Graphics, N.D. Bhatt and V.M. Panchal, Charotar Publishers, 2016, 53rd Edition

2. Text Book of Engineering Drawing, P J Shah, S Chand and Company, 2013

Reference Books:

1. Engineering Drawing, Agarwal, B, McGraw Hill Education, 2015, 2nd Edition
2. Engineering Graphics, P I Varghese, McGraw Hill Education, 2012
3. AutoCAD 2017 for Engineers & Designers, Sham Tickoo, Dreamtech Press, 23rd Edition

Online Resources:

1. https://nptel.ac.in/courses/112/103/112103019/
2. https://nptel.ac.in/courses/112/104/112104172/

Course Code: HS132	ENGLISH FOR TECHNICAL COMMUNICATION	Credits 2-0-2: 3

Pre-Requisites: None

Course Outcomes:

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

CO1	Explain basic grammar principles
CO2	Write clear and coherent passages
CO3	Write effective letters for job application and complaints
CO4	Prepare technical reports and interpret graphs
CO5	Enhance reading comprehension
CO6	Comprehend English speech sounds, stress and intonation

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
CO3	-	1	-	-	2	-	-	-	-	3	-	-	-	-	-	-
CO4	-	-	-	-	2	-	-	-	-	3	-	-	-	-	-	-
CO5	-	-	-	-	-	2	-	-	-	3	-	-	-	-	-	-
CO6	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Grammar Principles (Correction of sentences, Concord) and Vocabulary Building (synonyms and antonyms): Idioms and Phrasal verbs--patterns of use and suggestions for effective employment in varied contexts.

Effective Sentence Construction: strategies for bringing variety and clarity in sentences- removing ambiguity - editing long sentences for brevity and clarity

Reported speech: contexts for use of reported speech - its impact on audiences and readers- active and passive voice- reasons for preference for passive voice in scientific English-

Paragraph-writing: Definition of paragraph and types- features of a good paragraph - unity of theme- coherence- linking devices- direction- patterns of development.

Note-making - definition- the need for note-making - its benefits - various note formats- like tree diagram, block or list notes, tables, etc.

Letter-Writing: Its importance in the context of other channels of communication- qualities of effective letters-types -personal, official, letters for various purposes- emphasis on letter of application for jobs - cover letter and resume types -examples and exercises

Reading techniques: Definition- Skills and sub-skills of reading- Skimming and Scanning - their uses and purposes- examples and exercises.

Reading Comprehension: reading silently and with understanding- process of comprehension- types of comprehension questions.

Features of Technical English: description of technical objects and process- Report-Writing- definition- purpose -types- structure- formal and informal reports- stages in developing report- proposal, progress and final reports-examples and exercises

Book Reviews: Oral and written review of a chosen novel/play/movie- focus on appropriate vocabulary and structure - language items like special vocabulary and idioms used

Language laboratory

English Sound System -vowels, consonants, Diphthongs, phonetic symbols- using dictionary to decode phonetic transcription-- Received Pronunciation, its value and relevance- transcription of exercises-

Stress and Intonation –word and sentence stress - their role and importance in spoken English- Intonation in spoken English -definition, patterns of intonation- –falling, rising, etc.- use of intonation in daily life-exercises

Introducing oneself in formal and social contexts- Role plays- their uses in developing fluency and communication in general.

Oral presentation - definition- occasions- structure- qualities of a good presentation with emphasis on body language and use of visual aids.

Listening Comprehension - Challenges in listening, good listening traits, some standard listening tests- practice and exercises.

NDebate/ Group Discussions-concepts, types, Do's and don'ts- intensive practice.

Learning Resources:

Text Books:

1. English for Engineers and Technologists (Combined edition, Vol. 1 and 2) Orient Blackswan 2010.
2. Ashraf, M Rizvi. Effective Technical Communication. Tata McGraw-Hill, 2006
3. Meenakshi Raman and Sangeetha Sharma. Technical Communication: Principles and Practice 2nd Edition, Oxford University Press, 2011

Reference Books:

1. English for Technical Communication Student's Book, Savitha Chilakamarri, Cambridge English, 2017
2. English Language and Communication Skills for Engineers: As per the latest AICTE syllabus, Oxford University Press, 2018, 1st edition

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc20_hs56/preview
2. https://nptel.ac.in/courses/109/106/109106094/
3. https://freevideolectures.com/course/3430/communication-skills
4. https://onlinecourses.swayam2.ac.in/cec21_lg13/preview

Software:

1. Clear Pronunciation – Part-1 Learn to Speak English.
2. Clear Pronunciation – Part-2 Speak Clearly with Confidence
3. Study Skills
4. English Pronunciation

Course Code: MA181	DIFFERENTIAL EQUATIONS AND TRANSFORMS	Credits 3-0-0: 3

Pre-Requisites: Matrix Theory and Calculus

Course Outcomes:

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

CO1	Solve arbitrary order linear differential equations with constant coefficients
CO2	Apply Laplace transforms to solve differential equations arising in engineering
CO3	Obtain the Fourier series for a given function
CO4	Find the Fourier transform of functions
CO5	Determine the solution of a PDE by variable separable method

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	1	-	-	-	-	-	-	-	1	-	-	1
CO2	3	3	-	1	1	-	-	-	-	-	-	-	1	-	-	1
CO3	3	3	-	-	1	-	-	-	-	-	-	-	1	-	-	-
CO4	3	3	-	-	1	-	-	-	-	-	-	-	1	-	-	-
CO5	3	3	1	1	1	-	-	-	-	-	-	-	1	-	-	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Ordinary Differential Equations: Geometric interpretation of solutions of first order ODE $y' = f(x, y)$; Exact differential equations; integrating factors; orthogonal trajectories; Higher order linear differential equations with constant coefficients - homogeneous and non-homogeneous; Euler and Cauchy's differential equations; Method of variation of parameters; System of linear differential equations; applications in physical problems - forced oscillations, electric circuits, etc.

Laplace Transforms: Laplace transforms; inverse Laplace transforms; Properties of Laplace transforms; Laplace transforms of unit step function, impulse function, periodic function; Convolution theorem; Applications of Laplace transforms - solving certain initial value problems, solving system of linear differential equations.

Fourier Series and Transforms: Expansion of a function in Fourier series for a given range - Half range sine and cosine expansions, Complex form of Fourier series - Fourier transformation and inverse transforms - sine, cosine transformations and inverse transforms - simple illustrations

Partial Differential Equations: PDE types, Solutions of Wave equation, Heat equation and Laplace's equation by the method of separation of variables and their use in problems of vibrating string, eigen value and boundary value problems, one dimensional unsteady flow through porous media and two-dimensional steady state potential flow

Learning Resources:

Text Books:

1. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa Publishing House, 2016, 5th Edition
2. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley and Sons, 2015, 8th Edition

Reference Books:

1. Advanced Engineering Mathematics, Dennis G. Zill, Jones & Bartlett Learning, 2018, 6th Edition
2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 2012, 42nd Edition

Online Resources:

1. https://nptel.ac.in/courses/111/105/111105123/
2. https://nptel.ac.in/courses/111/107/111107111/
3. https://nptel.ac.in/courses/111/103/111103021/

Course Code: CY181	CHEMISTRY FOR CIVIL ENGINEERS	Credits 3-0-0: 3

Pre-Requisites: None

Course Outcomes:

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

CO1	Apply the basic concept of physical chemistry in developing batteries
CO2	Synthesize and characterize nanomaterials for engineering applications
CO3	Summarize the concepts of spectroscopy and characterize the materials
CO4	Apply the knowledge to protect different metals from corrosion
CO5	Develop greener methods to replace non-eco-friendly processes for industrial production of materials.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	-	-	-	-	-	-	-	-	-		-	2	-	-
CO2	3	3	1	1	-	-	-	-	-	-	-	1	-	2	-	-
CO3	3	3	2	1	1	-	-	-	-	-	-	1	-	2	-	-
CO4	3	3	2	1	-	-	-	-	-	-	-	1	-	2	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	1	-	2	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Basic concepts of Physical Chemistry: Heat of Reaction, Types of Heats of Reaction, Kirchoff's Equation, Laws of Thermochemistry, Bond Energy and Bond Enthalpy., temperature dependence of equilibrium constant, membrane processes, principles of solvent extraction, electrochemistry, chemical kinetics, catalysis.

Corrosion: Introduction, Types of corrosion, Dry corrosion, Wet corrosion, causes of corrosion, Theories of corrosion, Factors influencing the rate of corrosion – Temperature, pH and Dissolved oxygen, Corrosion inhibitors, Corrosion prevention by chemical and electrochemical methods., Prevention of corrosion by chemical and electrochemical methods.

Lubricants, Protective Coating, Cement, Refractories, Ceramics
Lubricants: Classification, Properties- Viscosity, Viscosity index, Flash and Fire points, Cloud and Pour points, Aniline number, Mechanical stability, Carbon residue and Mechanism of lubrication. Protective Coating, Cement, Refractories,
Ceramics: Introduction, Metallic coatings, Electroplating, Methods of cleaning articles before electrodeposition, Electroplating methods, Electroless plating, Inorganic cementing materials, Gypsum plaster, cement, Manufacture of Portland cement, Chemical composition of cement, chemical constitution of Portland cement, setting and hardening of Portland cement, heat of hydration of cement, special cements, concrete and RCC, Decay of concrete, Glasses and ceramics

Nanomaterials and Engineering Applications
Introduction, classification, properties, introduction, Nanotechnology applications, Material self assembly, Molecular vs material self-assembly, synthesis - top down and bottom up, synthesis, properties & potential applications of carbon nanotubes, fullerenes and graphene, nanocatalysis

Polymer Chemistry and Spectroscopy Methods of Compound Analysis
Polymers: Introduction-classification, polymerization- Types, mechanism of addition polymerization, Preparation, Properties Spectroscopic Methods of Analysis:
Principle, Instrumentation and Applications of Absorption spectroscopy, Infrared spectroscopy, UV, NMR

Green Chemistry: Concepts of Green Chemistry, Principles of Green Chemistry. Green methods in synthesis. Degradation of Organic Pollutants by photocatalysis. Green technology & Green Building, Waste Materials, Recycling

Learning Resources:

Text Books:

1. A Text Book of Engineering Chemistry, Shashi Chawla, Danpathrao & Co. Publications, 6th India reprint edition, 2007
2. Text Book of Physical Chemistry, Puri and Sharma, ED-Tech Publications, 2018

Reference Books:

1. Inorganic Chemistry, Huheey, Pearson Publications India, 4th Edition 2006
2. Molecular Quantum Mechanics, Peter Atkins, Oxford University Press, 5th Edition, 2012
3. Advanced Organic Chemistry: Reaction Mechanism and Structure, Jerry March, John Wiley Publications, 4th Edition, 2003
4. Cement Chemistry and Physics for Civil Engineers by Wolfgang Czernin, Chemical Publishing Co Inc.,U.S.; 1St Edition (12 September 1962)
5. Textbook of Engineering Chemistry, Jaya Shree Anireddy, Wiley, 2018
6. Materials Selection in Mechanical Design, Michael Ashby, Butterworth-Heinemann, 2016, 5th Edition
7. An Introduction to Ceramics (Lecture Notes in Chemistry Book 86), Roman Pampuch, Springer, 2016, 1st Edition

Online Resources:

1. https://nptel.ac.in/courses/122/101/122101001/
2. https://nptel.ac.in/courses/122/106/122106028/
3. https://nptel.ac.in/courses/104/101/104101130/

Course Code: ME181	BASIC MECHANICAL ENGINEERING FOR CIVIL ENGINEERS	Credits 2-0-0: 2

Pre-Requisites: None

Course Outcomes:

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

CO1	Identify Materials for Engineering Applications
CO2	Describe the functions and operations of Conventional, NC, CNC and 3D Printing methods of manufacturing.
CO3	Select a power transmission system for a given application.
CO4	illustrate the concepts of thermodynamics and functions of components of a power plant.
CO5	Outline basics of heat transfer, refrigeration, internal combustion engines and automobile engineering.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	-	-	-	-	-	-	-	-	-	-	3	-	-
CO2	2	2	1	-	2	-	-	-	-	-	-	-	-	3	-	-
CO3	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Engineering Materials: Introduction to Engineering Materials, Classification and Properties

Manufacturing Processes: Castings - Patterns & Moulding, Hot Working and Cold Working,

Steel Industry- Raw Materials processing, Blast Furnace, Billets. Thermo Mechanical Treatment of Steel.

Metal Forming processes: Rolling mills , Extrusion, Drawing (Wire & Rod), Forging;

Welding - Arc Welding & Gas Welding, Soldering, Brazing.

Stone Crushing equipment- Jaw crusher, pounding machines- screens

Cement industry: Raw material processing, Rotary Kilins- different types, grinding mill- Ball mill etc.

Machine Tools: Lathe - Types - Operations, Problems on Machining Time Calculations, Drilling M/c - Types - Operations, Milling M/c - Types - Operations - Up & Down Milling, Shaping M/c -Operations-Quick Return Mechanism, Planer M/c.- Operations-Shaper Vs Planer, Grinding M/c-Operations. Introduction to NC/CNC Machines, 3D Printing

Power Transmission: Transmission of Power, Conveyor systems, Belt Drives, Gears and Gear Trains -Simple Problems.

Fasteners and Bearings: Fasteners - Types and Applications, Bearings - Types and Selection,

Thermal Power Plant: Layout of Thermal Power Plant; Components -Boilers - Steam Turbines -Cooling Towers, Fly ash ponds-precipitators

I.C. Engines: 2-Stroke & 4-Stroke Engines; S.I. Engine, C.I. Engine, Differences.

Refrigeration: Vapor Compression Refrigeration Cycle - Refrigerants, Desirable Properties of Refrigerants

Automobile Engineering: Layout of an Automobile, Transmission, Clutch, Differential, Internal Expanding Shoe Brake

Learning Resources:

Text Books:

1. Elements of Mechanical Engineering, M.L.Mathur, F.S.Mehta and R.P.Tiwari, Jain Brothers, New Delhi, 2009
2. Construction Planning, Equipment Methods, Peurifoy, Robert L., Tata Mc Graw Hill, 2004.
3. Construction Equipment and Its Management, S. C. Sharma; Khanna Publishers

Reference Books:

1. Engineering Heat Transfer-Gupta & Prakash, New chand Bros., New Delhi, 3rd Edition
2. Workshop Technology (vol. 1& 2)-B.S.Raghuvanshi, Dhanpath Rai & Sons, New Delhi
3. Elements of Mechanical Engineering, V K Manglik, PHI learning Private Limited, 2013

Online Resources:

1. https://nptel.ac.in/courses/112/105/112105123/
2. https://nptel.ac.in/courses/112/107/112107219/
3. https://nptel.ac.in/courses/112/106/112106293/
4. https://nptel.ac.in/courses/112/107/112107291/

Course Code: CE151	STRENGTH OF MATERIALS	Credits 3-0-0: 3

Pre-Requisites: Engineering Mechanics

Course Outcomes:

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

CO1	Analyse the statically determinate and indeterminate problems
CO2	Determine the stresses and strains in the members subjected to axial, bending and torsional loads
CO3	Evaluate the slope and deflection of beams subjected to loads
CO4	Analyse and design the thin cylinders and spherical shells

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	1	-	-	1	-	1	1	-	-	-	-	3	1	1
CO2	2	3	1	1	-	1	-	1	1	-	-	-	-	3	1	1
CO3	1	3	3	2	-	1	-	1	1	-	-	-	-	3	1	1
CO4	1	3	3	2	-	1	-	1	1	-	-	-	-	3	1	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Stress and Strain: Concept of Static Indeterminacy- Determinate andIndeterminate problems in Tension and Compression - Thermal Stresses.

Elastic Constants and Impact Loading: Stress-strain diagrams for brittle and ductile materials -working stress - Strain energy in tension and compression - Impact loading -pure shear - Modulus of rigidity and Bulk modulus - Relation between E, G and K.

Shear Force and Bending Moment: Types of supports - Types of determinate beams - Simply supported, Cantilever, Overhanging and compound beams with articulations -ShearForce and Bending Moment diagrams - Principles of Superposition.

Thin Cylinders & Thin spherical shells: Internal fluid pressure – Wire wound thin cylinders.

Theory of Simple Bending: Assumptions - Theory of Simple Bending - Bending stressesin beams - Discussion of efficiency of various shapes of cross sections - Flitched beams.

Deflection of Beams: Double Integration method, Macaulay's method, Moment areamethod, Conjugate Beam method - Calculation of Slope and deflections of staticallydeterminate beams.

Shear Stress Distribution: Flexural shear stress distribution in various shapes of crosssection of beams.

Torsion of Circular Shafts: Theory of Pure Torsion in Solid and Hollow circular shafts -Torsional Shear Stresses and angle of twist - transmission of Power.

Learning Resources:

Text Books:

1. Mechanics of Materials, Timoshenko and Gere, CBS Publishers, New Delhi, 2004, 2nd Edition.

2. Mechanics of Materials, Beer and Johnston, McGraw Hill India Pvt. Ltd., 2020, 8th Edition (SI Units).
3. Mechanics of Structures Vol 1 (Strength of Material), S. B. Junarkar and H. J. Shah, Charotar Publishing House Pvt. Ltd., 2012.

Reference Books:

1. Advanced Mechanics of Solids, L.S Srinath, McGraw Hill Education, 2017, 3rd Edition.
2. Engineering Mechanics of Solids, E.P.Popov, Pearson, 2015, 2nd Edition.
3. Strength of Materials - Fundamentals andApplications, T.D.Gunneswara Rao and Mudimby Andal, Cambridge University Press, 2018, 1st Edition
4. Strength of Materials - Pytel & Singer, Harper & Row Publishers, 2018, 4th Edition.

Online Resources:

1. https://nptel.ac.in/courses/105/105/105105108/

Course Code: CE152	FLUID MECHANICS-I	Credits 3-0-0: 3

Pre-Requisites: None

Course Outcomes:

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

CO1	Apply conservation laws to derive governing equations of fluid flows
CO2	Compute hydrostatic and hydrodynamic forces
CO3	Analyze and design simple pipe systems
CO4	Apply principles of dimensional analysis to design experiments

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1	-	-	-	-	-	-	-	1	-	-	3	-
CO2	3	3	2	1	-	-	-	-	-	-	-	1	-	-	3	-
CO3	3	3	3	2	-	-	-	-	-	-	-	1	-	-	3	-
CO4	3	3	3	3	2	-	-	-	-	-	-	1	-	-	3	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Purpose of study of fluid mechanics for design and operation of engineering systems in the fields of Mechanical Engineering, Aeronautical Engineering, Metallurgical Engineering, Civil Engineering, Biomedical Engineering, Chemical Engineering, Fundamental difference between a solid and a fluid, constituent relationships for solids and fluids, conservation principles applied in fluid mechanics.

Properties of fluids, concept of continuum, viscosity, compressibility, ideal and real fluids, surface tension, cavitation.

Stress at a point, pressure, Pascal's law, Variation of pressure with elevation in compressible and incompressible fluids, hydrostatic law, Pressure measurement, piezometers and manometers Hydrostatic forces exerted on submerged surfaces.

Description of fluid flow: with reference to translation, rotation and deformation, concept of continuum, control mass & control volume approach, Reynolds transport theorem. Steady flow and uniform flow.

Velocity field, one & two-dimensional flow analysis, circulation and vorticity, stream function and velocity potential function, potential flow, standard flow patterns, combination of flow patterns, flownet.

Forces exerted in a fluid flow, derivation of Continuity equation and Euler's equation. Bernoulli's equation and its applications. Momentum equation and its applications,.

Dimensional Analysis as a tool in design of experiments, identification of non-dimensional numbers and their significance, dimensional analysis methods.

Measurement of flow in pipes and open channels, orifice, mouthpiece, orificemeter and venturimeter, weirs and notches

Laminar flow and its characteristics, Navier-Stokes equations - exact solutions, Laminar flow between parallel plates, Laminar flow through pipes, Hazen-Poiseuille equation, Reynolds experiment, head loss in flow through pipes, Darcy Weisbach equation, losses in pipe

transitions, Turbulence, Reynolds turbulent stresses, Prandtl's mixing length theory, Velocity distribution in turbulent flow, pipe networks.

Learning Resources:

Text Books:

1. Fluid Mechanics, F M White, McGraw Hill Education India Private Limited, 2017, 8th Edition.
2. Introduction to Fluid Mechanics, Robert W. Fox, Philip J. Pritchard, Alan T. McDonald, Student Edition Seventh, Wiley India Edition, 2011.
3. Fluid Mechanics and Machinery, C. S. P. Ojha, P. N. Chandramouli, R. Berndtsson, Oxford University Press, 2010.

Reference Books:

1. Mechanics of Fluids, Shames, McGraw Hill Book Co., New Delhi, 1988.
2. Fluid Mechanics, Streeter V.L., Benjamin Wylie, McGraw Hill Book Co., New Delhi, 1999.
3. Introduction to Fluid Mechanics, Robert W. Fox, Alan T. McDonald, John W. Mitchell, Wiley, 2020.
4. Fluid Mechanics Through Problems, R. J. Garde, New Age International, 2006.
5. An Introduction to Fluid Mechanics, Chung Fang, Springer International Publishing, 2018.
6. IS 2065-1983(Reaffirmed 2001), Code of Practice for Water Supply in Buildings(Second Revision)

Online Resources

1. https://nptel.ac.in/courses/105/103/105103192/
2. https://nptel.ac.in/courses/105/101/105101082/
3. https://nptel.ac.in/courses/112/105/112105269/
4. https://nptel.ac.in/courses/112/105/112105171/

Course Code: CE153	CIVIL ENGINEERING MATERIALS	Credits 2-0-0: 2

Pre-Requisites: None

Course Outcomes:

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

CO1	Classify and characterize building stones
CO2	Comprehend the manufacturing process of bricks, lime and cement
CO3	Recognize the preservation methods of timber and metals
CO4	Identify the advanced Civil Engineering materials

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	-	-	-	-	2	-	1	2	2	3	2	3	2	1	-
CO2	2	2	2	-	-	2	2	2	2	2	2	2	-	3	1	-
CO3	1	2	1	2	1	2	2	2	2	2	2	3	2	2	1	-
CO4	2	3	2	2	3	3	2	1	2	2	3	3	-	3	1	-
CO5	1	-	-	-	-	2	-	1	2	2	3	2	3	2	1	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Building Stones: Classification of stones- Characteristics of good building stones, important types of building stones, their properties and stones and uses.

Brick and other Clay Products: Composition of brick-earth, manufacturing process of bricks, characteristics of good building bricks, classification and testing of bricks, special types of bricks and their uses. Types of tiles and their use in buildings. Terracotta, stoneware

Lime and Cement: IS classification of lime and uses, chemical composition of cement, IS specifications and tests on Portland cement, different types of cements and their uses.

Mortar and Concrete: Preparation of cement mortar and concrete for different types of works, factors affecting strength of concrete, types of concrete and their specific use.

Timber and Wood Based Products: Classification of timber trees, cross section of exogenous tree, hard wood and soft wood, seasoning of timber, ply wood and its uses.

Steel and Aluminium: Types of steel-mild steel, high carbon steel, high strength steel-properties and uses, light Guage steel, commercial forms of steel and aluminium and their uses.

Introduction to Advanced Materials: Ferro cement, FRP, FAL-G brick, fly ash, super plasticizers, plastics, paints, and geotextiles.

Learning Resources:

Text Books:

1. Building Materials, Duggal, S.K, New Age International (P) Limited Publishers., 2008, 3rd Edition
2. Civil Engineering Materials, Peter A. Claisse, Butterworth- Heinemann, 2016, 1st Edition.

Reference Books:

1. Essentials of Civil Engineering Materials. Kathryn E. Schulte Grahame, Steven W.

Cranford, Craig M. Shillaber, and Matthew J. Eckelman. Cognella Academic Publishing, San Diego, 2020, 1st Edition.
2. Building Materials in Civil Engineering, Haimei Zhang. Woodhead Publishing Limited and Science Press, 2011, 1st Edition.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc21_ar11/preview
2. https://nptel.ac.in/courses/105/102/105102088/
3. https://nptel.ac.in/courses/105/106/105106053/

Course Code: CY182	CHEMISTRY LABORATORY	Credits 0-0-2: 1

Pre-Requisites: None

Course Outcomes:

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

CO1	Select a suitable methodology for the estimation of metal content, iodine content, active chlorine or hardness of water
CO2	Analyse acids, bases, redox compounds, etc. using instrumental methods
CO3	Determine the corrosion inhibitor efficiency of selective compounds and processes
CO4	Verify the adsorption isotherms

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	-	3	-	-	-	-	-	2	-	-	-	2	-	-
CO2	3	3	-	3	3	-	-	-	-	2	-	-	-	2	-	-
CO3	3	3	-	3	-	-	-	-	-	2	-	-	-	2	-	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus :

1. Introduction of best practices of Chemistry Laboratory
2. Determination of Iron in Hematite.
3. Chemistry of Blue Printing.
4. Determination of Heat of Solution.
5. pH metric Titration of acid vs Base.
6. Conductometric titration of Acid vs Base.
7. Potentiometric Titration of an Acid vs Base.
8. Determination of Isoelectric point of an amino acid.
9. Determination of Hardness of Water or calcium in milk powder.
10. Determination of Rate of Corrosion of Mild Steel in Acidic Environment in the Absence and Presence of Inhibitor.
11. Synthesis of CdS nanomaterial.
12. Preparation of Phenol-formaldehyde resin.
13. Verification of Freundlich Adsorption Isotherm of acetic acid on charcoal.
14. Determination of Copper from Brass using colorimetry.

Learning Resources:

Reference Books:

1. Introductory Chemistry laboratory manual: Concepts and Critical Thinking, Charles Corwin, Pearson Education, 2012.
2. Investigating Chemistry: Laboratory Manual, David Collins, Freeman & Co., 2006.

Online Resources:

1. http://amrita.olabs.edu.in/

Course Code: ME184	WORKSHOP PRACTICE FOR CIVIL ENGINEERS	Credits 0-0-2: 1

Pre-Requisites: None

Course Outcomes:

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

CO1	Acquiring skills in basic engineering Practice: to identify the hand tools and instruments, to acquire measuring skills and to acquire practical skills in the trades.
CO2	Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding
CO3	Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping
CO4	Apply basic electrical engineering knowledge for House Wiring Practice

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	-	-	1	-	-	2	2	-	-	-	-	2	-
CO2	3	3	1	-	-	1	-	-	2	2	-	-	-	-	2	-
CO3	3	3	1	-	-	1	-	-	2	2	-	-	-	-	2	-
CO4	3	3	1	-	-	1	-	-	2	2	-	-	-	-	2	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus :

Demonstration of safety practices and precautions to be observed in workshop

Fitting Trade: Demonstration and practice of fitting tools, Preparation of T-Shape, Dovetail Joint, Dissembling and Reassembling of Tail Stock, Bench vice etc.

Carpentry:. Demonstration and practice of carpentry tools, Preparation of Cross Half lap joint / Mortise Tenon Joint.

Plumbing: Demonstration and practice of Plumbing tools, Preparation of Pipe joints with coupling for same diameter and with reducer for different diameters.

Machine shop: Demonstration and practice on Lathe Machine, Preparation of work pieces involving Facing, Plane Turning, step turning, Groove cutting, Chamfering, Taper turning, knurling and parting operations.

House Wiring: Demonstration and practice on Electrical tools, wiring and earthing, Exercises on Staircase Wiring & Godown wiring.

Power Tools: Demonstration and practice on Power tools and Safety Practices.

Foundry Trade: Demonstration and practice on Moulding tools and processes, Preparation of Green Sand Moulds for given Patterns.

Welding Shop: Demonstration and practice on Arc Welding and Gas welding. Preparation of Lap joint and Butt joint.

Learning Resources:

Text Books:

1. Basic Workshop Technology: Manufacturing Process, Felix W.; Independently Published, 2019.
2. Workshop Processes, Practices and Materials; Bruce J. Black, Routledge publishers, 5th Edn. 2015.
3. Engineering Practices Laboratory Manual, Ramesh Babu.V., VRB Publishers Private Limited, Chennai, Revised Edition, 2013 – 2014.
4. Wiring Estimating, Costing and Contracting; Soni P.M. & Upadhyay P.A.; Atul Prakashan, 2021-22.

Reference Books:

1. A Course in Workshop Technology Vol I. & II, B.S. Raghuwanshi, Dhanpath Rai & Co., 2015 & 2017.
2. Elements of Workshop Technology, Vol. I & Vol. II by S. K. Hajra Choudhury & Others, Media Promoters and Publishers, Mumbai. 2007, 14th Edition
3. Engineering Practices Lab Manual; T.Jeyapoovan, Vikas Pub, 4th Edn...2008.

Online Resources:

1. Different Trade E-Books (Fitting, Plumbing, Welding, Carpentry, Foundryman, Turner and House Wiring etc.) developed by National Instructional Media Institute, Chennai. Directorate General of Training, Ministry of Skill Development & Entrepreneurship, Govt. of India. (https://bharatskills.gov.in).

Course Code: MA231	NUMERICAL AND STATISTICAL METHODS	Credits 3-0-0: 3

Pre-Requisites: Differential Equations and Transforms

Course Outcomes:

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

CO1	Interpret experimental data using interpolation / curve fitting
CO2	Solve numerically algebraic/transcendental and ordinary differential equations
CO3	Explain the concepts of probability and statistics
CO4	Perform testing of hypothesis
CO5	Outline the use of complex variables in Conformal mapping

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	-	-	-	-	-	-	-	-	1	-	-	2
CO2	3	3	2	3	-	-	-	-	-	-	-	-	-	-	-	2
CO3	3	3	2	3	-	-	-	-	-	-	-	-	-	-	-	2
CO4	3	3	-	3	-	-	-	-	-	-	-	-	-	-	-	2
CO5	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Numerical Methods: Numerical solution of algebraic and transcendental equations by Regula-Falsi method, Newton-Rapson's method – Finite Differences - Newton's Forward, backward difference interpolation formulae - Lagrange interpolation - Numerical Integration with Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule - solving first order differential equations –Taylor's series method, Euler's method, Runge-Kutta method of 4th order

Probability and Statistics: Random variables, Discrete and continues distributions, mean and variance and skewness, Binomial, Poisson, Normal and exponential distributions, Testing of Hypothesis - Z-test for single mean and difference of means - t-test for single mean and difference of means, F-test for comparison of variances, Chi-square test for goodness of fit, Curve fitting by the method of least squares, Fitting of (i) Straight line (ii) Second degree parabola (iii) Exponential curves. coefficient of correlation, regression

Complex Variables: Analytic function - Cauchy Riemann equations, Conformal mapping

Learning Resources:

Text Books:

1. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa Publishing House, 2016, 5th Edition
2. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley and Sons, 2015, 8th Edition

Reference Books:

1. Miller & Freund's Probability and Statistics for Engineers, Richard A. Johnson, Pearson, 2018, 9th Edition
2. Complex Variables and Applications, James W. Brown and Ruel V. Churchill, McGraw-Hill, 2009, 8th Edition
3. Numerical Methods for Engineers, Steven Chapra and Raymond Canale, McGraw Hill Education India Private Limited, 8th Edition, 2021

Online Resources:

1. https://nptel.ac.in/courses/111/107/11110
2. https://nptel.ac.in/courses/111/105/111105077/ 7062/

Course Code: CE201	MECHANICS OF MATERIALS	Credits 3-0-2: 4

Pre-Requisites: Strength of Materials

Course Outcomes:

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

CO1	Determine the principal stresses and strains in structural members
CO2	Analyze columns and struts
CO3	Apply the concept of failure theories
CO4	Analyze and design springs and thick cylinders

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	-	1	-	1	1	-	-	-	-	3	1	1
CO2	2	3	3	2	-	1	-	1	1	-	-	-	-	3	1	1
CO3	1	3	1	1	-	1	-	1	1	-	1	-	-	3	1	1
CO4	2	3	2	3	-	1	-	1	1	-	1	-	-	3	1	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Strain Energy in Flexure and Castigliano's Theorem: Strain Energy of Beams in bending - Deflection of beams from Strain Energy. Castigliano's Theorem I - application to statically determinate beams for determining slopes and deflections.

Thick cylinders - Lame's theory - Shrink fit allowance - compound cylinders

Columns and Struts: Direct and Bending stresses - Kernel of a section - Euler's critical load for columns with ordinary end conditions - Slenderness ratio and effective length of a column - Rankine's Formula - IS Code formula - Critical load of eccentrically loadedcolumns.

Principal Stresses and Strains at a Point: Analysis of Biaxial state of stress at a point- Principal Planes - Principal stresses and strains - Mohr's Circle and its application to different cases - combined bending and torsion with or without end thrust - Equivalent Bending Moment and Equivalent Twisting Moment.

Failure Theories: (1) Maximum Principal Stress Theory (2) Maximum Principal Strain Theory (3) Maximum Shear Stress Theory (4) Strain Energy Theory (5) Distortion energy theory - Applications.

Springs: Types and classification of springs – Analysis of Close and Open coiled helical springs subjected to axial load and axial twist – Compound springs - Leaf springs.

Shear Centre: Concept of Shear Centre – Shear Centre of various cross sections – Shear flow – Shear lag.
Unsymmetrical bending of straight beams

Material Testing Laboratory

1. To study the stress -strain characteristics of (a) Mild Steel and (b) Tor steel by conducting tension test on U.T.M.
2. To find the Brinnell's and Vicker's hardness numbers of (a) Steel (b) Brass (c) Aluminium (d) Copper by conducting hardness test.

3. To determine the Modulus of rigidity by conducting Torsion test on (a) Solid shaft (b) Hollow shaft.
4. To find the Modulus of rigidity of the material of a spring by conducting Compression test.
5. To determine the Young's modulus of the material by conducting deflection test on a simply supported beam.
6. To determine the Modulus of elasticity of the material by conducting deflection test on a Propped Cantilever beam.
7. To determine the Modulus of elasticity of the material by conducting deflection test on a continuous beam.
8. To determine the impact resistance of mild steel and cast iron specimen by conducting Charpy Impact test.
9. Shear test on Mild Steel rods.

Learning Resources:

Text Books:

1. Mechanics of Materials, Timoshenko and Gere, CBS Publishers, New Delhi, 2004, 2nd Edition.
2. Mechanics of Structures Vol.II, H. J. Shah and S. B. Junarkar, Charotar Publishers, Anand, 2017.

Reference Books:

1. Strength of Materials, Pytel & Singer, Harper & Row Publishers, 2018, 4th Edition.
2. Mechanics of Materials (SI Edition), R. C. Hibbeler, Pearson Publications, 2018.
3. Advanced Mechanics of Solids, L.S Srinath, McGraw Hill Education, 2017, 3rd Edition.
4. Advanced Mechanics of Solids and Structures, N. Krishna Raju, McGraw Hill Education, 2018.

Online Resources:

1. https://nptel.ac.in/courses/105/106/105106172/

Course Code: CE202	FLUID MECHANICS-II	Credits 3-0-2: 4

Pre-Requisites: Fluid Mechanics-I

Course Outcomes:

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

CO1	Compute drag and lift coefficients
CO2	Design channels
CO3	Compute flow profiles in channel transitions and analyze hydraulic transients
CO4	Design the working proportions of hydraulic machines
CO5	Analyze compressible flows of liquids and gases
CO6	Calibrate flow measuring devices

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	-	-	-	-	-	-	-	1	-	-	3	-
CO2	3	3	3	1	-	-	-	-	-	-	-	1	-	-	3	-
CO3	3	3	2	2	2	-	-	-	-	-	-	1	-	-	3	-
CO4	3	3	3	3	2	-	-	-	-	-	-	1	-	-	3	-
CO5	3	3	2	2	-	-	-	-	-	-	-	1	-	-	3	-
CO6	1	2	1	3	-	1	-	-	1	-	-	1	2	-	2	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Boundary Layer Theory: Concepts of boundary layer flows, Laminar and turbulent boundary layers, Integral momentum equation for boundary layer flows, Boundary layer separation and control, Drag and lift.

Uniform Flow in Open Channels: Specific energy, Critical flow, Channel transitions, Uniform flow formulae, best hydraulic sections.

Steady Gradually Varied Flow: Non uniform flow in open channels, gradually varied flow equation, Type of GVF profiles, Computation of GVF profiles.

Steady Rapidly Varied Flow: Hydraulic jump in a horizontal rectangular channel, Specific force, Computation of energy loss.

Unsteady Flow: Celerity of a gravity wave, Monoclonal rising wave, Positive and negative surges, St. Venant's equations, Method of characteristics, Hydraulic routing.

Hydraulic Similitude: Review of dimensional analysis, Similarity laws, and Model studies.

Hydraulic Machinery: Classification of hydraulic machines, Euler's equation of turbo machines, one dimensional flow analysis and velocity triangles, Design of Pelton turbine, Design of Francis turbine, Design of centrifugal pump, Design of a Kaplan turbine/ axial flow pump, Selection of hydraulic machines.

Compressible Flows: Celerity of an elasticity wave, Area velocity relationships, Flow through nozzles, Constant area flow, Normal shocks, Water Hammer.

Laboratory Syllabus:

1. Calibration of Venturimeter, Orifice meter (discharge measuring device in pipes)
2. Calibration of Orifice and mouthpiece (discharge measuring device in Tanks).
3. Calibration of triangular notch and rectangular notch (discharge measuring device in Channels).
4. Measurement of viscosity by Hazen- Poiseuille method and Stokes method.
5. Determination of Darcy's friction factor, relative roughness for laminar and turbulent flows.
6. Application of momentum equation for determination of coefficient of impact of jets on flat and curved blades and Pelton bucket.
7. Determination of Manning's and Chezy's coefficients for smooth and rough channels
8. Determination of energy loss in hydraulic jump.
9. Determination Velocity distributions in open channels.
10. Computation of pressure drag coefficient for flow past a cylinder in a subsonic wind tunnel.
11. Performance Characteristics of single stage centrifugal pump, multi stage centrifugal pump, Submersible pumps, and varying speed centrifugal pump.
12. Performance Characteristics of Pelton turbine, and Francis turbine.

Learning Resources:

Text Books:

1. Flow in Open Channel, Subramnaya, K., Tata McGraw Hill Publications, New Delhi, 2008.
2. Fluid Mechanics, F M White, McGraw Hill Education India Private Limited, 2017, 8th Edition.
3. Introduction to Fluid Mechanics, Robert W. Fox, Alan T. McDonald, John W. Mitchell, Wiley, 2020.

Reference Books:

1. Open Channel Hydraulics, Chow V.T., Blackburn Press, 2009.
2. Introduction to Fluid Mechanics, Robert W. Fox Ogukuo H. Orutcgardm Alan T. Mc Donald, Student Edition 7th Wiley India Edition, 2011.
3. Fluid Mechanics and Machinery, C. S. P. Ojha, P. N. Chandramouli, R. Berndtsson, Oxford University Press, 2010.
4. Fluid Mechanics Through Problems, R. J. Garde, New Age International, 2006.
5. An Introduction to Fluid Mechanics, Chung Fang, Springer International Publishing, 2018.

Online resources

1. https://nptel.ac.in/courses/112/105/112105218/
2. https://nptel.ac.in/courses/112/105/112105287/

Course Code: CE203	SURVEYING	Credits 3-0-2: 4

Pre-Requisites: None

Course Outcomes:

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

CO1	Apply the basic principles of Surveying
CO2	Operate and use different instruments and techniques to determine the positions
CO3	Prepare maps/plans from the collected field data
CO4	Apply the techniques for setting out curves and other layouts etc
CO5	Demonstrate advanced equipment in preparing maps

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	1	3	3	3	3	1	1	1	1	-	3	-
CO2	3	2	3	3	2	2	2	1	1	2	3	2	1	-	1	-
CO3	3	1	2	1	1	3	1	1	2	3	2	2	2	2	-	2
CO4	3	3	2	2	3	2	3	2	3	2	3	2	2	-	2	-
CO5	3	2	2	3	3	3	3	3	3	2	3	2	3	-	2	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Surveying: Surveying objectives, plane surveying principles and classification, scales, Errors and Mistakes, Types of tapes and chains, offsets, Errors and Corrections

Compass Surveying: Measurement of directions and angles, types of compass, meridians and bearings, local attraction, magnetic declination, traversing, plotting of traverse, adjustment of closing error

Plane Table Surveying: Principle and instruments used in plane table surveying, working operations, methods of plane table surveying

Levelling and Contouring: Description of a point (position) on the earth's surface, instruments for leveling, principle and classification of leveling, bench marks, leveling staff, readings and booking of levels, field work, longitudinal section and cross section, plotting the profile, height (level) computations, contours, characteristics of contours, methods of contouring, interpolation, contour gradient, contour maps, calculation of areas of a closed traverse, measurements from cross sections, earth work calculations

Theodolite and Tacheometric Surveying: Principle of theodolite survey, Theodolite component parts, observations, Traversing, traverse computations, Trigonometrical Surveying, Tacheometry, principle of tacheometry, methods of tacheometry

Curve Settting: Types of curves, elements of a curve, setting out a simple curve, setting out a compound curve, checks on field work, reverse curve, transition curves, super elevation, deflection angles, transition curves, characteristics of transition curves, method of setting out a compound curve, types of vertical curves, setting out vertical curves

Advanced Surveying: Principle of EDM, Features and Functions of Total Station, GNSS – Segments, IRNSS, GAGAN

List of Practicals:

1. Measurement of a line using a chain taking offsets on both sides
2. Traversing using compass.
3. Measurement of horizontal angle using Theodolite by Repetition/ Reiteration method.
4. Differential Levelling.
5. Profile Levelling and Cross sectioning.
6. Grid Contouring
7. Plane table traversing
8. Direct contouring using plane tabling
9. Setting out simple curve using theodolite.
10. Introduction to Total Station.
11. Total station traversing.
12. Introduction to GPS

Learning Resources:

Text Books:

1. Surveying I & II, B.C. Punmia, Ashok Kumar Jain, Ashok Kr. Jain, Arun Kr. Jain., Laxmi Publications, 2015
2. Higher Surveying, Chandra A. M., New Age International Publishers, 2015

Reference Books:

1. Surveying Theory and Practice, James, M Anderson & Edward M., Tata Mc Graw Hill, 2012
2. Elementary Surveying, Charles D Ghilani, Paul R Wolf., Prentice Hall, 2012

Online Resources:

1. https://nptel.ac.in/courses/105/107/105107122/
2. https://nptel.ac.in/courses/105/104/105104101/
3. http://sl-iitr.vlabs.ac.in/sl-iitr/

Course Code: CE204	CONCRETE TECHNOLOGY	Credits 3-0-2: 4

Pre-Requisites: None

Course Outcomes:

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

CO1	Identify Quality Control tests on concrete making materials
CO2	Comprehend the behaviour of fresh and hardened concrete
CO3	Design concrete mixes as per IS and ACI codes
CO4	Determine the durability properties of concrete
CO5	Explore special concretes for construction

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	3	-	-	-	2	-	2	-	-	2	-	-	3	2	-
CO2	-	3	2	-	-	2	-	2	-	-	2	-	-	2	3	-
CO3	-	-	3	2	-	2	-	2	-	-	2	-	-	2	3	-
CO4	-	3	2	3	-	2	-	2	-	-	1	-	-	2	3	2
CO5	-	2	2	2	-	2	-	2	-	-	1	-	-	3	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Concrete Making Materials: Cement, Fine Aggregate, Coarse aggregate, Water, Chemical & Mineral admixtures.

Hydration of Cement: Bogue's compounds, Hydration, Gel formation, Types of cement,pore & capillary water.

Quality tests on cement: Different test on cement as per Indian standards

Aggregates: Tests on aggregates as per Indian standards, Bulking of sand, Sieve analysis – Grading.

Fresh concrete: Properties of fresh concrete- Workability – different tests of workability- Factors influencing workability compaction, finishing, curing.

Hardened concrete: Tests on hardened concrete as per IS codes – Relationship between different strengths – factors influencing strength, NDE Techniques.

Durability: Factors influencing durability – Chemical effects on concrete- Carbonation, Sulphate attack, Chloride attack.

Concrete Mix design: Different methods of mix design – factors affecting mix design – exercises.

Special concrete: Heavy density concrete, underwater concrete, self-compacting concrete, light weight concrete etc.

Concrete Laboratory

1. Determination of Fineness and Specific Gravity of cement.

2. Determination of consistency of Standard Cement Paste.
3. Determination of initial and Final Setting times of Cement.
4. Determination of Compressive Strength of Cement.
5. Determination of Fineness modulus of Coarse and Fine Aggregates.
6. Determination of percentage of voids, Bulk density, Specific Gravity of coarse and FineAggregates.
7. Workability Tests: Slump Cone Test, Compaction factor test, Vee-Bee Consistometer Test.
8. Determination of hardened properties of concrete – compressive strength split tensile strength and flexural strength.
9. Study of stress - strain characteristics of concrete and tests for tensile strength of concrete.
10. Experiments to demonstrate the use of non-destructive test equipment.

Learning Resources:

Text Books:

1. Properties of Concrete, AM Nevelli, Prentice Hall Publishers, 2012, 5th Edition.
2. Concrete Technology: Theory And Practice, M. S. Shetty and A. K. Jain, S Chand Co., Publishers, 2018.

Reference Books:

1. Concrete: Structure, Properties and Materials, P. K. Mehta and Paulo K. Monteiro, Prentice-hall international series in civil engineering and engineering mechanics, 1993.
2. Concrete Technology, J.J. Brooks and A. M. Neville, Pearson, 2019, 2nd Edition.
3. Concrete Technology, A.R. Santhakumar, Oxford Higher education, 2018
4. Concrete Technology: Theory and Practice, M.L. Gambhir, Tata Mc Graw Hill Publishers, 2017, 5th Edition.

Online Resources:

1. https://nptel.ac.in/courses/105/102/105102012/

Course Code: CE205	DESIGN OF STEEL STRUCTURES	Credits 3-0-0: 3

Pre-Requisites: Strength of Materials

Course Outcomes:

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

CO1	Design bolt and weld connections
CO2	Design tension and compression members
CO3	Design beams and beam columns
CO4	Design built up members and column base

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	-	1	-	-	-	-	-	-	-	-	-	2	-
CO2	3	3	3	-	1	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	3	-	1	-	-	-	-	-	-	-	-	-	2	-
CO4	3	3	3	-	1	-	-	-	-	-	-	-	-	-	2	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: General- Types of Steel – Mechanical behaviour of steel – Measures of Yielding – Measures of Ductility – Types of Structures – Structural Steel Sections.

Methods of Structural design: Introduction-Design Philosophies-Working Stress method-Ultimate Strength method-Load and Resistant factor- Limit State Method-Partial safety factor-Load-Load combinations-Classification of Cross sections- General aspects in the design.

Design of Steel fasteners: Types of fasteners – Riveted connections- Bolted connections-Assumptions- Failure of bolted joints – Strength of bolted joints – Design examples – Design of Welded connections – Butt weld- fillet weld – Design examples.

Design of Tension Members: General – Modes of Failure of Tension member- Analysis of Tension members- Example - Design steps – Design examples – Lug angles – Design.

Design of Compression Members: General – Strength of Compression members- Design Compressive strength- Example on analysis of Compression members – Design of Angle struts – Design Examples- Built up Columns- Design of Lacing – Design of Battens- DesignExamples-Design of Roof members.

Design of Beams: General- Lateral Stability of Beams- Bending Strength of Beams – Plastic Section Modulus - Design Examples.

Design of Beam Columns: Behaviour of members under combined loading – Modes of Failures – Design Examples.

Design of Column Splices and Column Base: Design of Column Splice-Design Examples-Design of Column Base- Slab Base- Gusseted Base- Design Examples.

Design of Eccentric Connections: Design of Brackets- Type-1 and Type 2 – Moment Resistant connections - Design Examples.

Design of Plate Girder: General- Components of Plate Girder- Optimum depth – Bending Strength – Shear Strength – Shear Buckling- Simple Post critical method- Tension Field method- Stiffeners-Bearing- Transverse stiffeners - Design Examples.

Introduction to Gantry Girders

Learning Resources:

Text Books:

1. Limit State Design of Steel Structures, S K Duggal, Tata Mc Graw Hill Publishers, 2019, 3rd Edition.
2. IS-800-2007, BIS Publication
3. Steel Structures: Design and Practice, N.Subramanian, Oxford Publishers, 2018.
4. Design of Steel Structures: By Limit State Method as per IS:800 – 2007, S.S. Bhavikatti, 2019, 5th Edition.

Reference Books:

1. Design And Analysis Of Steel Structures, V. N. Vazirani and M. M. Ratwani, Khanna Publishers, 1988.
2. Design of Steel Structures, P Dayaratnam, S. Chand Publishers, 2012
3. Design of Steel Structures, L S Negi, Tata Mc Graw Hill Publishers, 2017

Online Resources:

1 https://nptel.ac.in/courses/105/105/105105162/

Course Code: CE251	THEORY OF STRUCTURES-1	Credits 3-0-0: 3

Pre-Requisites: Mechanics of Materials

Course Outcomes:

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

CO1	Formulate Equilibrium and Compatibility equations for structural members
CO2	Analyze one dimensional indeterminate problems using classical methods
CO3	Analyze Indeterminate structures using energy methods
CO4	Analyze structures for gravity loads and moving loads

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	3	-	-	-	1	-	-	-	-	-	-	1	-
CO2	3	-	-	3	-	-	-	1	-	-	-	-	-	-	1	-
CO3	3	-	-	3	-	-	-	1	-	-	-	-	-	-	1	-
CO4	3	-	-	3	-	-	-	1	-	-	-	-	-	-	1	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Indeterminate beams: - Propped cantilever, Fixed and Continuous beams - Analysis for shear force and bending moment - Clapeyron's theorem of three moments - Slope and deflection - effect of sinking of supports.

Column Analogy Method: Application to fixed beams - Application to non-prismatic members - stiffness coefficients.

Slope - Deflection Method: Analysis and application to continuous beams - portal frames (single bay - Single storey).

Moment-Distribution Method: Analysis of continuous beams and portal frames (single storey - single bay).

Kani's method: Application to continuous beams and portal frames (Single bay two storey)

Approximate methods of analysis: Portal method - Cantilever method – Substitute frame method

Moving Loads: Maximum bending moment and shear force diagrams for simply supported spans traversed by single point load - two concentrated loads - Uniformly distributed load, shorter and longer than the span - enveloping parabola and equivalent uniformly distributed load, determination of maximum bending moment and shear force for a system of concentrated loads on simply supported girders - focal length of a girder - counter bracing.

Influence Lines: Influence lines for reaction bending moment and shear force diagrams for simply supported beams - stresses in members of statically determinate pin jointed plane frames due to moving loads.

Learning Resources:

Text Books:

1. Theory of Structures (Vol. 1), G. Pandit, S. Gupta, Rajesh Gupta, Tata McGraw Hill Pub., 2017.
2. Theory and Problems in Structural Analysis, L.S. Negi, Tata McGraw Hill Pub., 1997.
3. Mechanics of Structures Vol 1 & Vol.2, Junarkar. S. B and Shah H.J, Charotar Publishers, 2008, 32nd Edition.

Reference Books:

1. Intermediate Structural Analysis, Chu-Kia Wang, Tata McGraw Hill Publishers, 2017.
2. Structural Analysis, R C Hibbeler, Pearson, 2017.
3. Analysis Of Structures (Analysis, Design And Details of Structures) - Vol.1, V. N. Vazirani, M. M. Ratwani, S. K. Duggal, Khanna Publishers, 1999
4. Basic Structural Analysis, C S Reddy, Tata McGraw Hill Publishers, 2017

Online Resources:

1. https://nptel.ac.in/courses/105/105/105105166/

Course Code: CE252	ENGINEERING HYDROLOGY	Credits 3-0-0: 3

Pre-Requisites: None

Course Outcomes:

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

CO1	Analyse hydro-meteorological data
CO2	Estimate abstractions from precipitation
CO3	Compute yield from surface and subsurface resources
CO4	Develop rainfall-runoff models
CO5	Formulate and solve hydrologic flood routing models

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	3	2	-	-	-	-	-	-	1	3	-	1	2
CO2	2	3	1	2	2	-	-	-	-	-	-	1	3	-	1	-
CO3	3	3	3	2	2	-	-	-	-	-	-	1	2	-	3	-
CO4	3	3	2	2	3	-	-	-	-	-	-	1	2	-	2	3
CO5	3	3	2	2	3	-	-	-	-	-	-	1	1	-	2	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Description of Hydrologic Cycle, Overview of application of hydrology in engineering, Forms and types of precipitation, basic concepts of weather systems, characteristics of precipitation in India.

Precipitation: Measurement of precipitation, types of rain gauges, rain gauge network, collection and presentation of rainfall data, Test for consistency and continuity of data, analysis of rainfall data, average precipitation over an area, intensity-duration-frequency analysis and depth-area-duration analysis.

Abstractions from Precipitation: Evaporation and Evaporation Process, measurement, estimation and control of evaporation, Evapotranspiration, measurement and estimation of evapotranspiration, interception and depression storage, Infiltration process, measurement of infiltration, infiltration models and infiltration indices and effective rainfall.

Stream Flow Measurement: Methods of measurement of stream flow, stage-discharge relationship, Runoff characteristics, catchment characteristics effecting the runoff, yield from a catchment, flow duration curve and flow mass curve.

Hydrograph Theory: Components of hydrograph, base flow separation, direct runoff hydrograph, Unit hydrograph theory, derivation of unit hydrograph, S-hydrograph and instantaneous unit hydrograph, Derivation of unit hydrograph for ungauged catchments, conceptual models, synthetic unit hydrograph and its derivation.

Floods: Estimation of peak discharge, rational method, SCS method and unit hydrograph method, Design flood, return period, flood frequency analysis, probabilistic and statistical concepts. Gumbel's and log Pearson Type III methods.

Flood Routing: Concepts of flow routing, hydraulic and hydrologic routing, Reservoir routing, Channel routing, Muskingum and Muskingum-Cunge methods of channel routing and flood forecasting.

Groundwater: Occurrence of groundwater, types of aquifers, aquifer properties.

Learning Resources:

Text Books:

1. Applied Hydrology, Chow, V.T., Maidment, D., and Mays, L.W., Tata McGraw Hill Publications, 2010
2. Engineering Hydrology, Subramanya, K., Tata McGraw Hill Publications, 2008

Reference Books:

1. Water Resources Engineering, Mays, L.W., Wiley Publications, 2012
2. Introduction to Hydrology, Viessman, W., and Lewis, G.L., Prentice Hall of India, 2008

Online resources

1. https://nptel.ac.in/courses/105/105/105105110/

Course Code: CE253	DESIGN OF CONCRETE STRUCTURES	Credits 3-0-0: 3

Pre-requisites: Strength of materials and Concrete Technology

Course Outcomes:

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

CO1	Design Reinforced Concrete beams using limit state and working stress methods
CO2	Design Reinforced Concrete slabs
CO3	Design Reinforced Concrete columns and footings
CO4	Design structures for serviceability
CO5	Design stair cases, canopy, retaining wall and water tanks

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	-	1	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	3	-	1	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	3	-	1	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	3	-	1	-	-	-	-	-	-	-	-	-	3	-
CO5	3	3	3	-	1	-	-	-	-	-	-	-	-	-	3	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Review of Concrete making materials- Structural concrete- Grades- properties of Concrete- Modulus of elasticity-flexural strength-Characteristic and Design values-Partialsafety factor.

Methods of design: Aims of design- RCC- Limit State method- Assumptions- Stress-Strain behavior of Steel and Concrete- Stress block parameters- Working stress method- comparison of design process.

Analysis and Design of Singly Reinforced Beams: Analysis of Singly Reinforced RC Section- Neutral axis-Balanced-Under Reinforced-Over Reinforced Sections- Moment of Resistance- Design parameters- Design examples.

Analysis and Design of Doubly Reinforced Beams: Necessity of Doubly Reinforced sections- Analysis of Doubly Reinforced RC Section-Moment of Resistance- Design parameters- Design.

Shear and Bond design of RCC: Shear forces in RC-Shear Resistance of RC- Truss analogy- design of Vertical stirrups-Bent-up bars- Limitation- Bond failure in RC- Check for bond resistance-Development length-Design for shear and bond.

Analysis and Design of Flanged Beams: Analysis of flanged RC section- Singly and Doubly reinforced-Effective flange width- Moment of Resistance- design examples.

Design of RCC Slabs: Concept of yield line theory - Design of One and Two way slabs- Effect of edge conditions- Moment of resistance-Torsion reinforcement at corners- Design examples.

Design of Continuous Slab and Beams: Effect of continuity- analysis of continuous beam/slab- Moment and shear coefficients for continuous beam/slab- Critical sections.

Design of RC Columns: Design principles of RC columns- Assumptions- Rectangular and Circular columns- Helical reinforcement- Minimum eccentricity-Use of Interaction diagrams for Axial load and Moment.

Design of RC Footings: RC footings-Minimum depth of footing- Safe bearing capacity-Design for Bending-Shear in One way and Shear in Two way- Transfer of load at base of column.

Design for Serviceability: Concept of Serviceability- Deflection- Span to depth ratio- Short term-Long term deflection due to Shrinkage, Creep- Cracking-Crack width calculation.

Design of Miscellaneous RC Structures: Design of Stair case – Design of Canopy Slab and Beam – Design of cantilever Retaining walls- Design of RC Circular Water tank- Design of single story RC Building.

Learning Resources:

Text Books:

1. Limit State Design of Reinforced Concrete Structures, B.C.Punmia, Ashok.K.Jain and Arun.K.Jain, Laxmi Pub. Pvt Ltd, 2016.
2. IS-456-2000, BIS Publication
3. Design Of Reinforced Concrete Structures, IS:456-2000, N.Krishnaraju, CBS Publications, 2019, 4th Edition.

Reference Books:

1. Reinforced Concrete Design, Devdas Menon , S. Pillai, Tata McGraw Hill Pub., 2017, 3rd Edition.
2. Reinforced Cement Concrete Structures, R. Park and T. Paulay, MISL-WILEY Series, Wiley India Pvt. Ltd, 2009.
3. Design of Reinforced Concrete Structures, N.Subramanian, Oxford Pub Pvt Ltd, 2013.
4. Reinforced Concrete Design - Unnikrishnan & Pillai, McGraw Hill Pub, 2009.

Online Resources:

1. https://nptel.ac.in/courses/105/105/105105105/

Course Code: CE254	GEOTECHNICAL ENGINEERING – 1	Credits 3-0-2: 4

Pre-requisites: None

Course Outcomes:

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

CO1	Characterize and classify the soils.
CO2	Calculate the stress distribution and effective stress under various field conditions and estimate the consolidation settlements.
CO3	Select the suitable shear strength parameters for different field conditions and carryout the stability of slopes.
CO4	Determine the compaction parameters and exercise field compaction control. Understand the principles of compaction and its control.
CO5	Carryout the laboratory testing on soil samples to determine their index and engineering properties.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	-	3	-	-	-	1	-	-	-	-	1	3	-	-
CO2	3	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	1	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO5	1	-	-	2	-	-	-	-	2	2	-	-	1	3	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Soil formation- Development of soil mechanics- Importance of soil engineering- Major soil deposits of India.

Basic Definitions and Relationships: 3-phase soil system, Volumetric relationships and weight -volume relationships.

Determination of Index Properties: Water content, Specific gravity, Grain size distribution by sieve and hydrometer analysis, Relative density, Atterberg limits and indices.

Classification of Soils: Classification of soil systems – Particle size classification, Textural classification, AASHTO classification, Unified soil classification and Indian soil classification- Field identification of soils, Relative suitability of soils for engineering works based on soil classification.

Soil Water: Types of soil water, Capillarity in soils, Permeability of soils, Darcy's law, Determination of permeability of soils, Permeability of stratified soils, Field permeability determination, Seepage velocity, Absolute coefficient of permeability, Factors affecting permeability- Effective stress principle- Effective stress under different field conditions- Seepage pressure-Quick sand condition.

Compaction of Soils: Definition and importance of compaction – Standard Proctor compaction test, Modified compaction test- Factors affecting compaction- Influence of compaction on soil properties – Field compaction and its control, Relative compaction.

Stress distribution in Soils: Importance of estimation of stresses in soils – Boussinesq's and Westergaard's theories for point loads, uniformly loaded circular and rectangular areas,

pressure bulb, variation of vertical stress under point load along the vertical and horizontal planes – Newmark's influence chart, Contact pressure distribution in sands and clays.

Consolidation: Types of compressibility – Immediate settlement – Primary consolidation and secondary consolidation – Stress history of clay, Normally consolidated soil, Over consolidated soil and under consolidated soil- preconsolidation pressure and its determination- Consolidation test, Estimation of settlements -Terzaghi's 1-D consolidation theory – Coefficient of consolidation and its determination - Spring analogy.

Shear Strength: Definition and use of shear strength - Source of shear strength- Normal and Shear stresses on a plane – Mohr's stress circle- Mohr-Coulomb failure theory- Measurement of shear strength, Drainage conditions -Direct shear test, Triaxial shear test, Unconfined compression test and vane shear test – Factors affecting shear strength of granular soils and cohesive soils.

Stability of Soil Slopes: Types of slopes – Types of slope failures – Slip circle method, Determination of centre of most critical slip circle – Taylor's stability charts and their use. Stabilization of soil slopes.

Geotechnical Engineering Laboratory

1. Specific Gravity of soil particles.
2. Sieve Analysis.
3. Liquid Limit, Plastic Limit & Shrinkage Limit.
4. Proctor's Standard Compaction Test.
5. Determination of Field Density.
6. Constant Head Permeameter Test.
7. Variable Head Permeameter Test.
8. Unconfined Compression Test.
9. Triaxial Compression Test (U.U Test).
10. Consolidation Test.
11. Direct Shear Test

Learning Resources:

Text Books:

1. Basic and Applied Soil Mechanics, Gopal Ranjan and A.S.R. Rao, New Age Int. Publishers,2019, 3rd Edition.
2. Geotechnical Engineering, V.N.S. Murthy, CBS Publishers, 2018, First Edition.
3. Introduction to Geotechnical Engineering, Braja M. Das and N. Sivakugan, Cengage Learning, 2015, Second Edition.

Reference Books:

1. Essentials of Soil Mechanics and Foundations – Basic Geotechnics, David F.McCarthy, Pearson Education Ltd., 2014, 7th Edition.
2. Soil Mechanics and Foundations, Muni Budhu, Wiley Publishers, 2016, 3rd Edition.
3. Geotechnical Engineering Lab Manual, William A. Kitch, 2011.
4. SP 36(Part-1)-1987 "Compendium of Indian Standards on soil Engineering" Bureau of Indian Standards, New Delhi.

Online Resources:

1. https://nptel.ac.in/courses/105/101/105101201/
2. https://nptel.ac.in/courses/105/105/105105168/
3. https://nptel.ac.in/courses/105/101/105101160/

Course Code: CE255	ENVIRONMENTAL ENGINEERING-1	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Analyze characteristics of water, air and noise and interpret their importance
CO2	Assess water demand and design components of water distribution systems
CO3	Plan and design water treatment units
CO4	Assess sources and effects of air and noise pollution and identify appropriate control devices

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1	1	3	1	1	-	-	-	1	-	-	-	-
CO2	3	3	3	1	2	3	1	1	-	-	-	1	-	-	2	-
CO3	3	3	3	1	2	3	1	1	-	-	-	1	-	-	2	-
CO4	2	1	1	1	1	3	2	1	-	-	-	1	-	-	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Sources, Quality and Quantity Perspectives of Water: Surface sources, subsurface sources, physical, chemical and biological characteristics, Estimation of water demand, water consumption rate, fluctuations in rate of demand, design period, population forecasting methods.

Collection and Conveyance of Water: Intakes, types of Intakes, factors governing location of intakes, pumps, types of conduits, types of pipes, pipe appurtenances

Water Treatment: Working principles and design of water treatment units, screening, plain sedimentation, sedimentation aided with coagulation, filtration, disinfection, water softening, miscellaneous treatments.

Distribution System: Requirements of a good distribution system, methods of distribution, systems of supply of water, Distribution reservoirs, layout of distribution system, design of distribution system, analysis of pipe networks, appurtenances in distribution system, detection and prevention of wastage of water in distribution system.

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

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

Learning Resources:

Text Books:

1. Environmental Engineering, Peavy, H.S, Rowe, D.R., and G. Tchobanoglous, McGraw Hill Education, 2017 First Indian Edition
2. Environmental Engineering (Vol. I): Water supply Engineering, P.N. Modi, Standard Book House, 2018, 5th Edition

3. Environmental Engineering (Vol.II): Sewage Disposal and Air Pollution Engineering, S.K. Garg, Khanna Publishers, 1999, 40th Edition

Reference Books:

1. Environmental Engineering (Vol. I): Water supply Engineering, S.K. Garg, Khanna Publishers, 2017, 34th Edition
2. MWH's Water Treatment: Principles and Design John C. Crittenden, R. Rhodes Trussell, David W. Hand, Kerry J. Howe, George Tchobanoglous, John Wiley & Sons, Inc., 2012, 3rd Edition
3. Water and Wastewater Engineering: Design Principles and Practice, Mackenzie L. Davis, McGraw Hill Education, 2017,1st Edition
4. Water Supply and Sewerage, Terence Mcghee, McGraw-Hill Education, 1991, 6th edition
5. Introduction to Environmental Engineering and Science, Masters, G.M., Ela W.P., Prentice Hall of India, 1994, 3rd Edition

Online Resources:

1. http://cpheeo.gov.in/cms/manual-on-water-supply-and-treatment.php
2. http://cpheeo.gov.in/cms/manual-on-operation--and-maintenance-of-water-supply-system-2005.php
3. http://cpheeo.gov.in/cms/manual-on-storm-water-drainage-systems---2019.php
4. https://nptel.ac.in/courses/105/105/105105201/
5. https://nptel.ac.in/courses/105/106/105106119/
6. https://nptel.ac.in/courses/105/104/105104102/

Course Code: CE256	TRANSPORTATION ENGINEERING - 1	Credits 3-0-2: 4

Pre-requisites: None

Course Outcomes:

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

CO1	Plan highway networks.
CO2	Design highway geometrics.
CO3	Determine the characteristics of traffic flow.
CO4	Characterize the pavement materials and design a bituminous mix.
CO5	Analyze and design flexible pavements and rigid pavements.
CO6	Select appropriate pavement construction techniques and maintenance options.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	3	3	2	-	-	-	-	-	-	2	2	3	1
CO2	3	2	2	3	1	1	-	-	-	-	-	-	2	1	2	-
CO3	2	2	2	3	2	1	-	-	-	-	-	-	2	-	3	2
CO4	3	2	2	2	2	2	-	-	-	-	-	-	2	1	2	-
CO5	3	3	3	2	2	2	-	-	-	-	-	-	2	1	-	-
CO6	3	3	2	1	1	2	-	-	-	-	-	-	3	1	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Highway Network Planning: Different modes of transportation, the role of highway transportation, classification, network patterns, planning surveys, preparation of plans, final report, master plan, evaluation by saturation system, 20-year road development plans, salient features, determination of road lengths, introduction to highway economics.

Highway Alignment and Geometric Design: Principles of highway alignment, requirements, controlling factors, engineering surveys, the importance of geometric design, design controls and criteria, cross-section elements, pavement surface characteristics, camber, carriageway, Krebs, road margins, formation, right of way, typical cross-sections, sight distance, stopping sight distance, overtaking sight distance, sight distance at intersections, design of horizontal alignment, super elevation, transition curves, design of vertical alignment, gradients, vertical curves.

Traffic Engineering Principles: Traffic characteristics; components of traffic stream: flow-speed-Density, measurement and analysis, q-k-v relationships, hourly design volume, the concept of EPCU, capacity, level of service, parking studies and road safety, types of intersections, and designs.

Pavement Materials and Mix Design: Types of pavement structures, functions of pavement component layers, materials used in pavements, basic soil properties relevant to pavement applications, properties of aggregate, blending of aggregates, tests on bitumen, grading of bitumen, bituminous mix design using Marshall method.

Design of Pavements: Stresses in flexible pavements: layered system concepts, stress solution for one, two, and three-layered systems, fundamental design concepts; variables considered in pavement design: axle types, standard and legal axle loads, ESWL, EWLF,

vehicle damage factor, ADT, AADT, growth factor, lane distribution factor, directional distribution factor, tire pressure, contact pressure, design life; design of flexible pavement using IRC method; stresses in rigid pavements: Westergaard's theory and assumptions, stresses due to curling, stresses and deflections due to loading, frictional stresses, design of joints; design of rigid pavement using IRC method.

Pavement Construction and Maintenance: Construction of subgrade, subbase, base layers, bituminous courses and MoRTH specifications, routine maintenance, periodic maintenance, special repairs, responsive maintenance program, reconstruction, and treatment strategies.

Laboratory Experiments

A. Tests on Soil and Aggregate:
   a. Atterberg limits, Proctor Tests, and California Bearing Ratio Test.
   b. Aggregate Gradation, Shape Tests, Specific Gravity Test, and Water Absorption Test, Aggregate Impact Test, Aggregate Crushing Value Test, and Los Angeles Abrasion Test and
   c. Introduction to Advanced types of equipment.

B. **Field Tests:**
   a. Roughness using MERLIN and Pavement Layer Density using Sand Replacement Method.

C. **Tests on Bitumen and Mixtures:**
   a. Penetration Test, Viscosity Test, Flash and Fire Point Tests, Ductility Test, Softening Point Test, Bituminous Mix Design using Marshall Stability Test, and Stripping Value of Aggregates.

D. Traffic Studies:
   a. Traffic Volume Studies, Spot Speed Studies, Headway Studies and Parking Surveys.

Learning Resources:

Textbooks:

1. Traffic Engineering and Transport Planning, Kadiyali, L.R., Khanna Publishers, 2018, Ninth Edition.
2. Highway Engineering, Khanna, S.K., Justo C.E.G., and Veeraragavan A., Nem Chand and Bros., Roorkee, India, 2017, Tenth Edition.
3. Highway Materials and Pavement Testing, Khanna, S.K., Justo, C.E.G. and A. Veeraragavan, Nem Chand and Bros, Roorkee, India, 2013, Fifth Edition.

References:

1. Principles of Transportation Engineering, Chakroborty, P. and Animesh Das., Prentice Hall of India Pvt. Ltd, New Delhi, India, 2017, Second Edition.
2. Transportation Engineering: An Introduction, Jotin Khisty C., and B. Kent Lall., Prentice Hall of India Pvt. Ltd, New Delhi, India, 2002, Third Edition.
3. Bituminous Road Construction in India, Kandhal P.S., PHI Learning Pvt. Ltd., New Delhi, India, 2016.
4. Principles of Pavement Design, Yoder E.J. and M.W. Witczak., Second Edition, John Wiley and Sons, New York, USA, 2012.

Online Resources:

1. https://nptel.ac.in/courses/105/101/105101087/
2. https://www.youtube.com/watch?v=5zKC_aq4ypM

Course Code: CE257	BUILDING PLANNING, DRAWING AND CONSTRUCTION	Credits 2-1-2: 4

Pre-requisites: None

Course Outcomes:

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

CO1	Comprehend multiple factors to be considered in planning and construction of buildings
CO2	Identify various components of the building, their functionality, and construction techniques
CO3	Plan various service and safety requirements of the building, their functionality, and construction techniques
CO4	Create and draw the plan of different buildings in different views using computer aided graphic tools

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	2	-	-	3	3	2	-	2	2	2	2	-	1	2
CO2	1	1	2	-	-	3	2	-	-	2	1	1	1	1	1	1
CO3	1	1	2	-	-	3	2	-	-	2	2	2	1	1	2	2
CO4	1	1	2	-	2	3	2	2	2	2	2	2	2	-	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Functional planning of Buildings: Types of Buildings, Aspects and Principles of Building Planning, Building By-laws and Regulations, Site Selection criteria, Orientation of Building and its relation to surrounding environment, Sustainability and Green Buildings.

Components of Buildings: Foundation and its requirements, Soil characteristics, Construction of Foundation; Masonry construction and Materials used; Construction of Floors and Roofs; Functional requirements and planning of a stair case

Service and Safety requirements of Buildings: Damping causes, its effects, and Proofing techniques; Fire hazards, protection, and grading rules; Methods of thermal insulation and materials used.

Building Drawing Lab:

Planning a building according to the rules and requirements
Drawing the plan of the building
Draw elevation and sectional views of the building
Drawing various components of the building
Bar bending schedule for steel and RCC
Notations used in various civil engineering drawings

Learning Resources:

Text Books:

1. Building Construction, Punmia B. C., Jain A.J., and Jain A.J., Laxmi Publication, 2016, Eleventh Edition.
2. The Text book for Building Construction, Arora S. P., and Bindra S. P., Dhanpat Rai Pubications, 2010

Reference Books:

1. Building Construction, Varghese P.C., PHI Learning Pvt. Ltd., 2017, 2nd Edition.
2. National Building Code of India, Bureau of Indian Standards, 2016.
3. AutoCAD Manual. (https://knowledge.autodesk.com/)

Online Resources:

1. https://nptel.ac.in/courses/105/106/105106197/
2. https://nptel.ac.in/courses/105/102/105102175/

Course Code: CE301	THEORY OF STRUCTURES-2	Credits 3-0-0: 3

Pre-requisites: Strength of materials

Course Outcomes:

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

CO1	Formulate Equilibrium and compatibility equations for structural members
CO2	Analyze one dimensional and two dimensional structures using matrix methods of structural analysis
CO3	Analyze structures up to three degrees of indeterminacy
CO4	Analyze cables and suspension bridges
CO5	Determine dynamic parameters for single degree of freedom vibration problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	3	2	2	-	1	-	1	-	-	1	-	-	-	3	3
CO2	1	3	2	2	-	1	-	1	-	-	1	-	-	-	3	3
CO3	2	3	2	2	-	1	-	1	-	-	1	-	-	-	3	3
CO4	2	3	2	2	-	1	-	1	-	-	1	-	-	1	3	3
CO5	3	3	-	2	-	1	-	1	-	-	1	-	-	1	3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Matrix Methods: flexibility and stiffness influence coefficients, Order of Indeterminacy – Flexibility and stiffness Matrix- inversion- MAT Lab applications

Flexibility Method: Basic principles - choice of redundants - released structure - application of fixed beams, continuous beams and frames (jointed) upto two degree static indeterminacy, portal frames higher degree static indeterminacy- verification by computer aided analysis

Stiffness Method: Concept of stiffness method - restrained structure - applications to continuous beams and portal frames up to two degree of kinematic indeterminacy portalframes higher degree static indeterminacy- verification by computer aided analysis

Three Hinged Arches: Action of an arch - eddy's theorem - Three hinged, parabolic and segmental arches - determination of horizontal thrust, bending moment, normal thrust and radial shear, Influence lines for three hinged arches.

Two Hinged Arches: Determinations of horizontal thrust, bending moment, normal thrust and radial shear for parabolic and segmental shapes, Influence lines for two hinged arches - effect of rib shortening - temperature effects - tied arches.

Suspension Bridges: Force in loaded cable and hanging cables - length of cables fordifferent support conditions - simple suspension bridges with three hinged and two hinged stiffening girders - bending moments and shear force diagrams, influence lines - temperature effects on cables and stiffening girders.

Introduction to Structural Dynamics: Single degree of freedom system without and with damping.

Learning Resources:

Text Books:

1. Indeterminate Structures, R L Jindal, S.Chand & Co. , New Delhi,
2. Basic Structural Analysis, C S Reddy, Tata McGraw Hill Publishers, 2017
3. Structural Dynamics: Theory and Computation, Mario Paz and Young Hoon Kim, Springer Publisher, 2018, 6th Edition.

Reference Books:

1. Intermediate Structural Analysis, Chu-Kia Wang, Tata McGraw Hill Publishers, 2017.
2. Computational Structural Mechanics, Rajasekaran & Sankara Subramanian, PHI, 2003.
3. Theory of Structures (Vol. II), G. Pandit, S. Gupta, Rajesh Gupta, Tata McGraw Hill Publishers 2017.
4. Analysis Of Structures (Theory, Design & Details Of Structures) - Vol.2, V. N. Vazirani, M. M. Ratwani, S. K. Duggal, 1994.

Online Resources:

1. https://nptel.ac.in/courses/105/105/105105109/

Course Code: CE302	IRRIGATION ENGINEERING	Credits 2-0-0: 2

Pre-requisites: None

Course Outcomes:

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

CO1	Plan an Irrigation System
CO2	Estimate the Irrigation Requirements of Crops
CO3	Plan and design a Canal System
CO4	Design a Land Drainage System

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	3	1	2	-	-	-	-	1	2	-	3	2
CO2	2	3	1	2	2	-	-	-	-	-	-	1	3	-	1	-
CO3	3	3	3	1	2	1	1	-	-	-	-	1	2	-	3	-
CO4	3	2	3	2	2	1	2	-	-	-	-	1	1	-	3	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Irrigation Systems: Need for irrigation, Types of irrigation systems, Gravity irrigation, Lift irrigation, Well irrigation.

Soil-Water-Plant Relationship: Soil classification, Soil moisture, Field capacity, Permanent and temporary wilting point, Available moisture, Measurement of soil moisture, Soil moisture tension.

Water Requirement of Crops: Consumptive use of water, Evapotranspiration, Factors affecting evapotranspiration, Potential evapotranspiration and Reference crop evapotranspiration, Methods of estimating evapotranspiration, Penman-Monteith method, Irrigation water requirement, Duty and Delta, Frequency of irrigation, Irrigation efficiencies, Irrigation water quality, Cropping pattern.

Methods of Irrigation: Surface irrigation – controlled flooding methods, contour farming, Sub-surface irrigation – drip irrigation, Sprinkler irrigation.

Canal Systems: Types of canals, Principles of design of stable irrigation canals, Silt theories – Kennedy's and Lacey's theory, Tractive force theory, Design of lined canal, Design of longitudinal section.

Water Logging and Drainage Systems: Causes and effects of water logging, Anti water logging measures, Land drainage, Types of drainage systems, Design criteria of open and closed surface drains, Design of tile drains.

Learning Resources:

Text Books:

1. Irrigation Water Resources and Hydropower Engineering, Modi, P. M., Standard Book Publishing Company, 2014,9th Edition
2. Irrigation, Water Power and Hydropower Engineering, Arora K. R., Standard Book Publishing, 2018, 5th Edition

Reference Books:

1. Irrigation and Water Resources Engineering, Asawa G.L., New Age International Publishers, 2006
2. Water Resources Engineering – Principles and Practice, Murthy, C.S.N., New Age International Publishers, 2020, 2nd Edition

Online Resources:

1. https://nptel.ac.in/courses/105/105/105105110/
2. https://nptel.ac.in/courses/126/105/126105010/
3. https://nptel.ac.in/courses/126/105/126105019/
4. https://nptel.ac.in/courses/105/102/105102159/

Course Code: CE303	GEOTECHNICAL ENGINEERING - 2	Credits 3-0-0: 3

Pre-requisites: Geotechnical Engineering -1

Course Outcomes:

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

CO1	Determine the earth pressures on foundations and retaining structures
CO2	Analyze shallow and deep foundations
CO3	Calculate the bearing capacity of soils and foundation settlements
CO4	Conduct soil exploration for engineering works

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	-	1	-	-	-	-	-	-	-	-	-	-	-	2
CO2	2	1	-	3	-	-	-	2	-	-	-	2	-	2	2	2
CO3	3	3	-	1	-	-	-	-	-	1	-	-	-	-	2	2
CO4	2	2	-	3	-	-	-	2	2	2	-	2	-	3	-	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Lateral Earth Pressures: Lateral earth pressure theory, Different types of earth pressures, Rankine's active and passive earth pressures, Pressure distribution diagram for lateral earth pressures against retaining walls for different conditions in cohesionless and cohesive soils, Coulomb's active and passive earth pressure theory, Culmann's graphical construction, Stability check, Problems.

Bearing Capacity of Foundation: Bearing capacity – Basic Definitions, Factors affecting bearing capacity, Estimation of Bearing capacity by different methods, Analytical measures – Terzaghi's and Meyerhof methods and calculations, Field measures – SPT, CPT and Plate load tests.

Settlement of Foundation: Settlement analysis – Types of foundation settlement, Components of settlements - their estimation, Allowable settlement values, Effects, Causes and remedial measures of total and differential settlements.

Shallow Foundations: Types of shallow foundations and choice, Basic requirements, Significance of these foundations.

Pile Foundations: Classification and uses, Load carrying capacity calculations by different methods - static methods, dynamic methods, in-situ penetration tests, piles load test, Negative skin friction, Under reamed pile foundations, Pile groups - necessity, efficiency, Group capacity and settlements.

Well Foundations: Types of caissons and their construction, Different shapes of wells, component parts and forces, Estimation of bearing capacity, Sinking of wells and remedial measures for tilts and shifts.

Soil Exploration: Introduction, Different methods - direct methods, semi-direct and indirect methods, Sampling in soils and rocks, Subsurface exploration program - Preparation of bore logs and preparation of exploration report.

Learning Resources:

Text Books:

1. Basic and Applied Soil Mechanics, Gopal Ranjan, ASR Rao, New Age International Pvt Ltd, 2016.
2. Textbook of Soil Mechanics and Foundation Engineering Geotechnical Engineering Series, V.N.S. Murthy, CBS, 2018.
3. Principles of Foundation Engineering, Braja.M. Das, Cengage Learning India Private Limited, 2011, Seventh Edition

Reference Books:

1. Textbook of Geotechnical Engineering, Iqbal H. Khan, PHI Learning, 2020.
2. Soil Mechanics and Foundation Engineering, K. R. Arora, Standard Publisher Dist., 2020.
3. Foundation Analysis and Design, Bowles,J.E, Mc.Graw Hill Company limited, England, 1988

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc21_ce39/preview
2. https://nptel.ac.in/courses/105/105/105105168/

Course Code: CE304	ENVIRONMENTAL ENGINEERING - 2	Credits 3-0-2: 4

Pre-requisites: Environmental Engineering-1

Course Outcomes:

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

CO1	Assess characteristics of wastewater and solid waste and interpret their importance
CO2	Design conveyance elements of wastewater collection systems
CO3	Plan and design components of wastewater treatment systems
CO4	Design sludge treatment and disposal systems
CO5	Plan suitable engineering systems for treatment and disposal
CO6	Assess the quality of water and wastewater

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	1	3	1	1	-	-	-	1	2	-	3	2
CO2	3	3	3	3	2	3	1	1	-	-	-	1	2	-	2	2
CO3	3	3	3	3	2	3	3	2	-	-	-	1	1	-	2	1
CO4	3	3	3	3	2	3	2	2	-	-	-	1	1	-	2	1
CO5	3	3	3	3	1	3	2	2	-	-	-	1	1	-	2	1
CO6	2	2	2	2	2	1	-	-	-	-	-	1	2	-	2	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Quality and Quantity Perspectives of wastewater: Physical, chemical and biological characteristics of wastewater, analysis of wastewater, Importance of BOD and COD, Effluent standards, impacts of disposal

Sewers and sewer appurtenances: Wastewater Collection, Estimation of dry weather flow and storm water flow, Hydraulic design of sewers, Limiting velocities, effect of variation in flow of sewage on velocity of flow in sewers, types of sewers, design of storm water drains. Construction of sewers: factors affecting the selection of material for sewer construction, materials for sewers, joints in sewers, shapes of sewers, maintenance, cleaning & ventilation of sewers. Sewer appurtenances.

Primary Treatment of wastewater: Preliminary & primary treatment of wastewater: screening, grit removal basins, removal of oil and grease, sedimentation, sedimentation aided with coagulation.

Secondary Treatment of wastewater: Secondary treatment of Wastewater: Principles and classification of secondary treatment, activated sludge process, trickling filters, miscellaneous methods such as oxidation ditch, oxidation ponds, aerated lagoons, rotating biological contractors. Disposal of wastewater, self-purification of streams, sewage irrigation, Treatment and disposal of sludge, On-site disposal methods

Tertiary Treatment of wastewater: Tertiary wastewater treatment, necessity and principles, Industrial wastewaters and effluent treatment plants including institutional and industrial waste management.

Municipal Solid Wastes: Characteristics of MSW, Elements of solid waste management, engineered systems for solid waste management, Disposal of MSW, Hazardous waste,

Biomedical and e-waste disposal.

Laboratory Syllabus

1. Determination of pH, Conductivity, Acidity, Alkalinity, Chlorides, Hardness, Fluorides of water;
2. Determination of Available Chlorine in bleaching powder;
3. Conducting Break Point Chlorination Test;
4. Determination of Residual Chlorine;
5. Determination of Dissolved Oxygen, Chemical Oxygen Demand, Biochemical Oxygen Demand;
6. Conducting Jar test for determining optimum dosage of coagulant;
7. Determination of Total Solids, Total Dissolved Solids & Settleable Solids

Learning Resources:

Text Books:

1. Environmental Engineering, Peavy, H.S, Rowe, D.R., and G. Tchobanoglous, McGraw Hill Education, 2017 First Indian Edition
2. Theory and Practice of Water and Wastewater Treatment, Ronald Droste and Ronald Gehr, Wiley, 2019, 2nd Edition
3. Chemistry for Environmental Engineering and Science, Sawyer, C. N., McCarty, P. L., and Perkin, G.F., McGraw-Hill Inc., 2002, 5th Edition

Reference Books:

1. Introduction to Environmental Engineering and Science, G.B. Masters, Pearson, 2013, 3rd Edition
2. Water and Wastewater Engineering: Design Principles and Practice, Mackenzie L. Davis, McGraw Hill Education, 2017,1st Edition
3. Environmental Engineering (Vol. II): Sewage Waste Disposal and Air Pollution Engineering, S.K. Garg (1999), Khanna Publishers, 2018, 40th Edition
4. Waste water Engineering Treatment and Reuse, Metcalf & Eddy, McGraw Hill Education, 2017, 4th Edition
5. Integrated Solid Waste Management, Engineering Principles and Management Issues, Tchobanoglous G, Theisen H and Vigil SA, McGraw Hill Education, 2014, Indian Edition
6. Handbook of Water and Wastewater Treatment Technologies, Nicholas P. Cheremisinoff, Butterworth- Heineman, 2001, 1st Edition.
7. Industrial Wastewater Management, Treatment and Disposal, WEF Manual of practice No. FD-3, WEF Press and McGrawHill, 2008, 3rd Edition
8. Standard methods for the examination of water and wastewater, Washington: APHA, 2012, 21st Edition
9. Environmental Engineering Laboratory Manual, Kotaiah, B., and Kumara Swamy, N., Charotar Publishing House Pvt. Ltd., 2007, 1st Edition
10. CPCB, Guide Manual: Water and Wastewater Analysis

Online Resources:

1. http://cpheeo.gov.in/cms/manual-on-storm-water-drainage-systems---2019.php
2. http://cpheeo.gov.in/cms/manual-on-sewerage-and-sewage-treatment.php
3. https://nptel.ac.in/courses/105/105/105105048/
4. https://nptel.ac.in/courses/105/105/105105178/
5. https://nptel.ac.in/courses/105/107/105107207/
6. https://nptel.ac.in/courses/105/103/105103205/
7. https://www.vlab.co.in/

Course Code: CE305	TRANSPORTATION ENGINEERING - 2	Credits 3-0-0: 3

Pre-requisites: Transportation Engineering - 1

Course Outcomes:

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

CO1	Determine the factors governing design of railway infrastructure.
CO2	Design the railway track system and identify a suitable signal system.
CO3	Analyze the effects of atmospheric variables on aircraft performance and determine the orientation of runways.
CO4	Design the geometric and structural elements of airfield infrastructure.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	1	1	-	1	1	-	-	-	-	1	1	2	3	1
CO2	3	3	1	2	-	1	1	-	-	-	-	1	2	1	3	-
CO3	3	3	3	2	3	1	1	-	-	-	-	1	2	-	3	2
CO4	3	3	3	3	2	2	2	-	-	-	-	1	-	1	3	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Railway Track Geometric Design and Rolling Stock: Overview of Indian Railways; permanent way; coning of wheels; tilting of rails; rails, sleepers, ballast, formation; track fittings and fastenings; gradients, horizontal curves, super elevation, vertical curves; points and crossings, design of turnouts; track junctions; locomotives, coaching stock, goods wagons, train resistance and tractive power.

Railway Station and Yards: Railway station site selection, classification, platforms; types of yards; catch and slip sidings; equipment at railway stations; railway signalling; signs and symbols; interlocking, track circuits, axle counter, types of interlocking, automatic warning system.

Aircraft and Airfield Components: Aircraft components; landing gear configurations; aircraft weight; engine types; atmospheric conditions affecting aircraft performance; air traffic separation rules; navigational aids; airport classification and planning; passenger terminal system and its components; aircraft parking type, apron layout; airport lighting, marking, airfield signage.

Geometric and Structural Design of the Airfield Infrastructure: Runway configurations, runway orientation, wind rose, estimating runway length; exit taxiway geometry, location of exit taxiways, design of taxiway curves and intersections, end-around taxiways; Aprons; flexible and rigid pavement design using FAARFIELD.

Learning Resources:

Text Books:

1. Railway Engineering, Chandra, S., and Agarwal, M.M., Oxford University Press, Noida, India, 2013, Second Edition.
2. Planning and Design of Airports, Horonjeff, R., McKelvey, F.X., Sproule, W.J., and Young, S.B., McGraw-Hill, New York, USA, 2010, Fifth Edition.

Reference Books:

1. Railway Track Engineering, Mundrey, J.S., Tata McGraw-Hill Education Private Limited, New Delhi, India, 2017, Fifth Edition.
2. Railway Engineering; Rangwala, S.C.; Charotar Publishing House Pvt. Ltd., Anand, India, 2017.
3. Airport Planning and Design, Khanna, S.K., Arora, M.G., and Jain, S.S.; Nem Chand and Bros, Roorkee, India, 2012, Sixth Edition.
4. Air Transportation Planning and Design; Kumar, V., and Chandra, S.; Galgotia Publications Pvt. Ltd., New Delhi, India, 2012.

Online Resources:

1. https://rdso.indianrailways.gov.in
2. https://www.iricen.gov.in
3. https://www.icao.int
4. https://www.faa.gov/

Course Code: CE306	REMOTE SENSING	Credits 2-0-0: 2

Pre-requisites: None

Course Outcomes:

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

CO1	Identify the earth surface features
CO2	Analyze the energy interaction with atmosphere and earth surface features
CO3	Select the type of remote sensing technique / data for required application
CO4	Apply the remote sensing principles in civil engineering practice

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-	2	-	-	-	2	-	-	2	3	2	3	2
CO2	2	1	1	3	2	2	2	1	1	3	2	2	2	2	2	1
CO3	-	1	1	2	2	-	2	2	2	2	2	2	2	-	3	2
CO4	-	2	3	3	2	3	3	3	2	3	3	2	2	2	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Physics of Remote Sensing: Sources of Energy, Active and Passive Radiation, Stages of Remote Sensing, Advantages of Remote Sensing over conventional surveying methods.

Electromagnetic Spectrum: wavelength regions important to remote sensing, Reflectance, Transmission, Absorption, Thermal Emissions, Interaction with Atmosphere, Atmospheric windows, Spectral reflectance of Earth's surface features, Multi concept of Remote Sensing.

Platforms and Sensors: Types of platforms, orbit types, Sun-synchronous and Geosynchronous, Passive and Active sensors, resolution concept

Earth resources and meteorological satellites: Characteristics - LANDSAT, SPOT, IRS, IKONOS, QUICK BIRD, CARTOSAT, INSAT and other Satellites.

Image interpretation: Data Products and Their Characteristics, Basic Elements of Visual Interpretation (Image and Terrain), Equipment for Visual Interpretation, Ground Truth, Ground Truth Equipment.

Image Processing: Digital Image Processing – Pre-processing – image enhancement techniques – multispectral image classification – Supervised and unsupervised.

Applications: Geosciences, Water Resources, Land use – Land cover, Transportation Engineering

Learning Resources:

Text Books:

1. Remote sensing and image Interpretation, Lillisand T.M and Kiefer R.W., John Wiley & Sons, 2015
2. Introduction to Remote Sensing, James B. Campbell, Randolph H. Wynne., The Guilford Press, 2011.

Reference Books:

1. Remote Sensing: Principles and interpretation, Floyd F.Sabins, W.H. Freeman and Company, 2007
2. Remote Sensing and GIS, Basudeb Bhatta, Oxford, 2021, 3rd Edition

Online Resources:

1. https://nptel.ac.in/courses/105/108/105108077/

Course Code: CE307	ENGINEERING GEOLOGY	Credits 2-0-2: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Classify weathering processes and mass movement
CO2	Identify geological formations and structures for rock mass quality assessment
CO3	Identify subsurface information and groundwater potential sites through geophysical investigations
CO4	Apply geological principles for mitigation of natural hazards and select sites for dams and tunnels

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	-	-	-	-	-	-	-	2	2	2	2	2	2	2	2
CO2	1	2	-	2	-	-	2	-	2	2	2	2	3	3	2	2
CO3	2	2	3	3	3	2	2	2	2	2	3	3	2	2	3	3
CO4	2	2	2	2	3	2	2	1	3	2	3	2	2	2	2	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

General Geology: Branches and scope of geology, Importance of geology in Civil engineering. Earth-surface features and internal structure, weathering of rocks.

Minerology: Minerals, physical properties, identification of important rock forming and economic minerals.

Petrology: Formation and classification of rocks – Igneous, Sedimentary and metamorphic rocks, their textures and structures. Drilling Techniques, Core Recovery, RQD, Engineering Properties of Rocks

Structural Geology: Geological Map, outcrop, attitude of beds, types and classifications of folds, faults, joints, unconformities.

Ground Water: Subsurface distribution of ground water, water table, aquifers, occurrence of ground water in different geological formations, springs, ground water exploration.

Earthquakes And Landslides: Causes and effects of earthquakes and landslides, Remedial measures to prevent damage for engineering structures.

Subsurface Investigations: Soil Profile, Geophysical methods – Electrical Resistivity and Seismic refraction methods.

Dams: Types of dams, Requirements of dam sites, preliminary and detailed geological investigations for a dam site. Factors affecting the seepage and leakage of reservoir and the remedial measures.

Tunnels: Purpose of tunneling, geological considerations for tunneling, geothermal step, over break, stand up time, and logging of tunnels.

List of Practicals:

1. Introduction to Crystallography – Identification of Crystals.
2. Introduction of minerals and the study of Physical properties, Identification of Quartz and feldspars.
3. Identification of pyroxenes and Amphiboles and other silicates.
4. Identification of important economic minerals.
5. Identification of important ore deposits.
6. Identification of Igneous rocks
7. Identification of Sedimentary rocks
8. Identification of metamorphic rocks
9. Structural geology- strike and dip, three and 3-point problems point problems.
10. Structural geology – Completion of out crops maps, order of superposition.

Learning Resources:

Text Books:

1. Text Book of Engineering Geology by N. Chenna Kesavulu, Mac Millan Ltd., New Delhi. 2018
2. Engineering Geology, D Venkat Reddy, Viskas Publishing House Pvt. Ltd., 2017

Reference Books:

1. Engineering and General Geology – Parbin singh, Katson Publishers. 2013
2. Principles of Engineering Geology – K.V.G.K. Gokhale, BS Publications, Hyderabad, 2006.
3. Engineering Geology – F.G. Bell, Elsevier Publications, 2007
4. Principles of Engineering Geology and Geotechnics – D.P. Krynine, W.R. Judd, 2018

Online Resources:

1. https://nptel.ac.in/courses/105/105/105105106/

Course Code: SM331	ENGINEERING ECONOMICS AND PROJECT APPRAISAL	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Estimate project cost
CO2	Perform economic analysis of an engineering project
CO3	Evaluate alternate project proposals
CO4	Carryout life-cycle cost analysis of projects
CO5	Analyze the macro economic performance of the Nation
CO6	Sensitized to Macro economic environment

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	1	1	-	-	-	-	-	1	-	-	-	2	-
CO2	-	-	-	1	1	-	-	-	-	-	2	-	-	-	2	-
CO3	-	-	-	1	1	-	-	-	-	-	2	-	-	-	2	-
CO4	-	-	-	1	1	-	-	-	-	-	3	-	-	-	2	-
CO5	-	-	-	-	1	-	-	-	-	-	3	-	-	-	1	-
CO6	-	-	-	-	1	-	-	-	-	-	3	-	-	-	1	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Engineering Economics: Review of engineering economics, elements of engineering economics, valuation of time, goals and objectives, principles of economic analysis, Discounted cash flows: analysis of costs and benefits, methods of economic analysis; suitability, analysis for null alternative, mechanisms to deal with risks.

Micro Economics: Microeconomics, welfare theory. Consumer equilibrium, Consumer surplus and producer surplus, latent demand

Macro Economics and Economic Policy: Introduction to Macro Economic performance indicators (National Income, Inflation, BOP, Exchange rates) – Meaning, limitations, Economic Policy 1991, Liberalization, Privatization and Globalization.

System selection and evaluation: Framework of evaluation, Feasibility and evaluation, cost, impacts and performance levels project evaluation methods, achievement matrices, factor profiles, plan ranking, introduction to mathematical programming, case studies.

Project appraisal: Types of Projects – BOT, BOOT, PPP; Evaluation of alternatives, analysis techniques, cost benefit analysis, social and financial benefits, Internal Rate of return method for economic and financial viability, prioritization of projects, multi-criteria decision assessment, Life Cycle Cost Analysis, TQM Concepts and Principles.

Learning Resources:

Text Books:

1. Fundamentals of Engineering Economics, Chan S. Park, Pearson Education Inc, 2004
2. Engineering Economic Analysis, Donald G. Newnan, Ted G. Eschenbach and Jerome P. Lavelle, Oxford University Press, 2012, ,11th Edition

Reference Books:

1. Engineering Economy and Management, Pravin Kumar, Wiley.
2. Engineering Economy, Zahid A Khan, Brajesh Kumar, Pearson, 2012.
3. Principles of Engineering Economics with applications, Zahid A Khan, Cambridge, 2018, 2nd Edition.

Online Resources:

1. https://nptel.ac.in/courses/112/107/112107209/

Course Code: CE351	CONSTRUCTION TECHNOLOGY AND PROJECT MANAGEMENT	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Comprehend the roles and responsibilities of a project manager
CO2	Prepare schedule of activities in a construction project
CO3	Prepare tender and contract document for a construction project
CO4	Demonstrate the safety practices in construction industry
CO5	Identify the equipment used in construction

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	2	-	-	3	2	2	3	-	-	-	-	-	-	-	-
CO2	-	-	-	-	3	2	2	3	-	-	-	-	-	-	-	-
CO3	-	-	-	-	3	-	-	3	-	-	-	-	-	-	-	-
CO4	-	-	-	-	3	3	-	3	-	-	-	-	-	-	-	-
CO5	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Importance of Project Management, Role of Project manager, Stakeholders in construction project, Different types of projects, similarities & dissimilarities in projects., Time, Scope & Money, Knowledge areas & Processes involved in construction projects, WBS of a major work, with examples, Planning, monitoring & executing, Planning, sequencing, scheduling, Bar Charts, Networks, CPM, PERT, Upgrading, Cash flow diagram, resource levelling & resource allocation, Crashing of project, Earned Value Analysis

Safety in construction - Cost of Accidents - Safety norms - Safety aids

Estimation, Tenders & Contracts - EOI- Prequalification - Types of Contract - Terminology used.

Equipment for construction - Earthwork - Concreting - Bitumen – Hoisting etc.,

Construction Finances – decision making,

Advanced Construction: Construction of piles, Construction of Tunnels, Construction of cofferdams

Formwork in construction: Requirements of formwork, types of formwork, timber, steel, modular shuttering, slip forms, scaffolding

Learning Resources:

Text Books:

1. Construction Project Management, Kumar Neeraj Jha , Pearson Publication , 2015, Second edition
2. Project Management, Choudhary S, Tata McGraw Hill Publishing Company Limited, New

Delhi, 2017.
3. Project Planning and Control with PERT and CPM, Punmia and Khandelwal K.K., Laxmi Publications Delhi, 2016

Reference Books:

1. Construction project Management, K K Chitkara, Tata McGraw Hill Publishing Company Limited, New Delhi, 2019, Fourth Edition
2. Construction Planning Equipment & methods, Puerifoy R.L, 2010

Online Resources:

1. https://nptel.ac.in/courses/105/106/105106149/
2. https://nptel.ac.in/courses/105/103/105103093/

Course Code: CE352	HYDRAULIC STRUCTURES	Credits 3-0-0: 3

Pre-requisites: Irrigation Engineering

Course Outcomes:

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

CO1	Plan and Design Diversion Head Works
CO2	Design Canal Regulators, Canal Falls and Cross Drainage Works
CO3	Analyse Gravity Dams
CO4	Analyse Earth Dams
CO5	Design Spillways and Energy Dissipation Systems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3	1	1	-	-	-	-	1	2	-	3	-
CO2	3	3	3	2	3	1	1	-	-	-	-	1	2	-	3	-
CO3	3	3	3	1	3	1	1	-	-	-	-	1	1	-	3	3
CO4	3	3	3	1	3	1	1	-	-	-	-	1	1	-	3	3
CO5	3	3	3	1	3	1	1	-	-	-	-	1	1	-	3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Types of hydraulic structures, Diversion and Storage headworks

Surface and Subsurface Flow Analysis in Hydraulic Structures: Hydraulic structures on permeable foundation, Seepage theories, Principles of design of hydraulic structures on permeable foundation, Principles of energy dissipation.

Design of diversion head works: Types of hydraulic structures, Layout of a diversion head work, Design of vertical drop weir, Design of sloping glacis weir, Silt control in head works.

Design of Canal Structures: Canal regulators, Types of canal falls, Design of Sarda type fall, Design of straight glacis fall, Types of cross drainage works, Design of canal fluming, Design of aqueduct/ syphon aqueduct.

Gravity Dams: Types of storage head works, Forces acting on gravity dams, Analysis of gravity dams, Profile of a gravity dam.

Earth dams: Types of earth dams, Causes of failure of earth dams, Seepage analysis, Seepage control, Stability analysis.

Spillways and energy dissipation systems: Types of spillways, Design of Ogee spillway, Design of stilling basins.

Learning Resources:

Text Books:

1. Irrigation Water Resources and Hydropower Engineering, Modi, P. M., Standard Book Publishing Company, 2014, 9th Edition
2. Irrigation, Water Power and Hydropower Engineering, Arora K. R., Standard Book

Publishing, 2018, 5th Edition

Reference Books:

1. Irrigation and Water Resources Engineering, Asawa G.L., New Age International Publishers, 2006
2. Water Resources Engineering – Principles and Practice, Murthy, C.S.N., New Age International Publishers, 2020, 2nd Edition

Online Resources:

1. https://nptel.ac.in/courses/105/105/105105110/
2. https://nptel.ac.in/courses/105/103/105103096/
3. https://nptel.ac.in/courses/105/103/105103097/

Course Code: CE353	CIVIL ENGINEERING SOFTWARE LAB	Credits 0-1-2: 2

Pre-requisites: None

Course Outcomes:

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

CO1	Identify software tools in analysis and design of Civil Engineering Systems
CO2	Apply the available open source software tools used for analyzing specific problems in Civil Engineering
CO3	Develop Civil Engineering drawings using CAD software
CO4	Apply latest software tools for Advanced Modelling and Design of Civil Engineering Systems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	3	-	-	-	2	3	2	-	-	-	2	3
CO2	-	-	2	-	2	-	-	-	1	2	1	-	-	1	2	2
CO3	1	-	-	-	2	-	-	-	1	-	-	-	-	-	1	-
CO4	-	-	2	2	3	-	-	-	2	1	2	-	-	2	2	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

1. MATLAB - Applications
2. SAP 2000: Structural analysis and Design
3. ETABS: Integrated Analysis, Design and Drafting of Building Systems.
4. Plaxis: Geotechnical modelling software
5. Civil 3D: Computer aided Drafting, used for all Civil Engineering Drawings
6. MxRoad Suite: Modelling software for Road & Highway design, Rehabilitation and Renewal
7. MIKE-SHE: Hydrologic and Hydraulic modelling
8. HEC-HMS: Hydrologic Modelling system
9. SWMM: Storm Water Management Model
10. SWAT: Soil and water Assessment Tool
11. EPANET: Hydraulic and water quality behavior of water distribution system
12. OPEN FOAM: Fluid flow Simulation and Analysis

Learning Resources:

1. Software manuals

Course Code: EE381	ELECTRICAL AND ELECTRONICS FOR CIVIL ENGINEERS	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Plan the specifications for electrical equipment.
CO2	Identify the type of electrical machines for a given application
CO3	Apply electronic circuits for the measurement of strain, pressure, flow, velocity, acceleration & vibration.
CO4	Apply Electrical and Electronics to civil engineering structures

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	1	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO4	3	3	3	2	2	-	1	-	-	-	-	1	-	-	2	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

AC Circuits: Introduction to single phase & three phase circuits, Complex representation of Impedance, Phasor diagrams, Power & Power Factor, Introduction to house wiring.

Electrical Machines (Qualitative treatment only): Principle of Operation of a Single-Phase Transformer, Regulation & Efficiency of a Transformer. Introduction to 3-pahse induction and synchronous machines.

Electronic Devices & Circuits: P-type and N-Type semiconductors, P-N junction diode and its I-V characteristics, Single-phase Half-wave and Full wave rectifiers. Bipolar Junction Transistor-operation and Integrated Circuits.

Introduction to Operational Amplifiers: Ideal characteristics, concept of virtual ground, inverting and non-inverting amplifiers, differential amplifier.

Illumination: Laws of illumination and luminance (qualitative).

Transducers: Applications of LVDT, strain gauge, Wheatstone bridge, piezoelectric, measurement of pressure, flow, velocity, acceleration and vibrations.

IoT for smart buildings & structures.

Learning Resources:

Text Books:

1. Electrical & Electronic Technology, Edward Hughes, Pearson, 2016, 12th Edition
2. Op-Amps and Linear Integrated Circuits, Gayakwad Ramakant A, Pearson Education India, 2015, 4th Edition
3. Measurement Systems, Applications and Design, Doebelin, Tata McGraw Hill, 2008.

Reference Books:

1. Electrical Engineering Fundamentals, Vincent Del Toro, Pearson, 2015, 2nd Edition
2. Principals of Electrical & Electronics Engineering, V. K Mehtha, S. Chand Publications, New Delhi, 2010, 3rd Edition.
3. A course in Electrical Measurements Electronic Measurements Instrumentation, A.K. Sawhaney, Dhanpat Rai and Co, 2008,17th Edition.
4. Integrated Electronics, Millman & Halkias, Tata McGraw-Hill Education, 2001.
5. Experimental Stress Analysis, J Dally and W Riley, McGraw-Hill Inc., 2nd Revised edition

Online Resources:

1. https://nptel.ac.in/courses/108/108/108108076/
2. https://nptel.ac.in/courses/108/105/108105053/

Course Code: EC381	CIVIONICS	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Comprehend the measurement systems
CO2	Identify basic electrical measurements and sensing devices
CO3	Select instrumentation for civil engineering applications
CO4	Apply data acquisition and processing methods
CO5	Describe advanced measurement techniques

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	3	3	2	1	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	2	1	-	-	-	-	-	-	-	-	-	1	-
CO4	3	3	3	3	2	-	-	-	-	-	-	-	-	-	1	-
CO5	3	3	3	3	-	-	-	-	-	-	-	1	-	-	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Functional elements of an instrument, static characteristics, dynamic characteristics, loading effects under dynamic conditions. Sensitivity, Resolution, Accuracy and Precision, Absolute and Relative types of errors, Statistical analysis, Probability of Limiting errors, Linearity, over view of the system development.

Sensors and Transducers: R, L, C parameter sensors, strain gauge sensor, stresses or minuscule movements, fiber bragg grating, force transducers, accelerometer, tensometer, piezo-electric Sensors. Flow and velocity measurements, Pressure measurement, Measurement of angles & distances, temperature measurement and Level measurements.

Signal Conditioning Circuits: Need for pre-processing, identification of signal conditioning blocks and their characteristics. BRIDGE CIRCUITS: Analysis of DC and AC bridges with applications. Op-Amps: Operational Amplifiers, differentiator circuits, charge amplifiers and impedance converters, active filters. Introduction to Data Acquisition Systems (DAS): Block Diagram, Specifications and various, components of DAS, applications of DAS in various fields.

Controllers and Interfacing: Arduino, Raspberry, DSP 32 Processor, Damage assessment using self-powered wireless sensors, Energy harvesting, Application of signal processing: Low pass filtering technique etc., Categories of multiprocessors, bus protocols, I2C bus and CAN bus, multiprocessor system -on-chip (MPSoC), accelerators, wireless sensor networks, embedded systems, IoT systems, Image processing, remote sensing.

Internet of Things and Applications – Definitions & Characteristics of IoT, physical design of IOT, Logical design of IoT, IoT Enabling Technologies, IoT Levels & Deployment Templets, Various types of IoT Applications. Difference between IoT and M2M, Introduction, IoT design methodology, case study on IoT system, Basic building blocks of an IoT device.

Learning Resources:

Text Books:

1. Measurement systems - Application and Design, DOEBELIN, E.O., McGraw Hill, 4th Ed.1990
2. Electronic Instrumentation & Measurement techniques, W.D.Cooper & Felbrick, PHI.
3. A Course in Electrical and Electronic Measurements and Instrumentation by A K Sawhney, 4th Edition, Dhanpat Rai & Co. (P) Limited
4. Internet of Things: A Hands-On Approach, Arsheep Bahga & Vijay Madisetti, Universities Press.

Reference Books:

1. Electronic Measurements and Instrumentation, by Oliver and Cage, McGraw Hill.
2. Transducers and Instrumentation, Murthy, D.V.S.,PHI, New Delhi

Online Resources:

1. https://nptel.ac.in/courses/108/105/108105064/
2. https://nptel.ac.in/courses/108/105/108105062/

Course Code: CE401	QUANTITY SURVEYING AND PUBLIC WORKS	Credits 2-0-2: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Prepare quantity estimates for Civil Engineering works
CO2	Calculate the quantity of materials required for civil works as per specifications
CO3	Evaluate contracts and tenders in construction practices
CO4	Prepare cost estimates

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	3	-	-	-	-	3	1	3	3	3	-	2	-
CO2	-	2	-	-	3	-	-	-	3	1	3	3	-	-	3	-
CO3	-	3	-	-	-	-	-	-	2	2	2	1	-	2	2	2
CO4	-	3	-	-	3	-	-	-	2	2	2	3	-	2	2	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Estimates: Purpose of estimating, Different types of estimates - their function and preparation.

Building Estimates: Methods, Estimation of different building components, Schedule of rates, Units of measurements, Units of works.

Earthwork: Different methods, Earthwork for roads, rails and canals, Earthwork for hill roads.

Analysis of Rates: Preparation for analysis of rates, Quantity of materials per unit rate of work, Labour estimate.

Specifications: Necessity, Types of specifications, Specifications for different civil engineering materials.

Contracts: Essentials of contracts, Types of engineering contracts, Advantages and disadvantages.

Tenders: Tender forms, Tender documents & notices time limits, Necessity.

Valuation: Purpose, Difference between value and cost, Qualifications and functions of a valuer, Scrap & salvage value, Sinking fund, Capitalised value.

Learning Resources:

Text Books:

1. Estimating Costing Specification & Valuation in Civil Engineering, M Chakraborti, National Halftone Co. Calcutta, 2006.
2. Estimating and Costing in Civil Engineering, B. N. Dutta, CBS Publishers & Distributors Private Limited, 2020.

Reference Books:

1. A Text Book of Estimating and Costing for Civil Engineering, G.S. Birdie, Dhanpat Rai

Publishing Company Private Limited, 2014.
2. A Textbook of Estimating and Costing (Civil), D. D. Kohli, R. C. Kohli, S Chand Publishing, 2013.
3. Estimating, Costing and Valuation, Rangwala, Charotar Publishing House Pvt. Ltd., 2017.

Online Resources:

1. https://www.udemy.com/course/estimating-and-costing/

Course Code: SM431	ENTREPRENEURSHIP FOR ENGINEERS	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Study the culture of entrepreneurship
CO2	Discuss the characteristics and behaviour associated with possessing an entrepreneurial mindset
CO3	Design strategies for pursuing, exploiting and further developing new opportunities
CO4	Comprehend business planning concept as a whole
CO5	Explore entrepreneurial leadership and management style

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
CO3	1	-	-	2	2	-	-	-	-	-	2	-	-	-	2	-
CO4	1	-	1	1	-	-	-	-	2	2	3	2	-	-	1	-
CO5	-	-	-	-	-	-	-	-	3	2	-	3	-	-	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Entrepreneurship, The entrepreneurial process and its importance, The entrepreneurial mindset

Creating opportunities: creativity and Innovation, Generating new ideas, From idea generation to opportunity recognition, Screening opportunities

Evaluating opportunities: Building business models, Entrepreneurial planning, Revenue models

Resourcing opportunities: financing, Team building, Marketing and Pitching, Developing networks, Legal aspects

Challenges and Case learning: Learning from failure, Challenges in entrepreneurship, Social entrepreneurship, Family business, Case histories of entrepreneurs and leaders

Learning Resources:

Text Books:

1. Entrepreneurship, Hirish, D. Robert and P. Peters Michael, McGraw Hill, 2020 and 11th Edition
2. Entrepreneurship: Theory, Process, Practice, Donald F. Kuratko, Cengage Learning Publishing, 2019 and 11th Edition

Reference Books:

1. Innovation and Entrepreneurship, Peter F. Drucker, HarperCollins Publishers, 2006
2. Competitive Advantage: Creating and Sustaining Superior Performance, Michael E. Porter, Free Press, New York, NY, 1985

Online Resources:

1. https://www.forbes.com/entrepreneurs
2. https://www.entrepreneur.com

Course Code: CE311	SYSTEMS ANALYSIS IN CIVIL ENGINEERING	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Formulate and solve deterministic optimization models
CO2	Apply deterministic optimization techniques for resource allocation, scheduling, inventory control, capacity expansion and transportation problems
CO3	Apply decision theory and stochastic optimization techniques for decision making under uncertainty
CO4	Formulate and solve optimization models for planning and design of civil engineering systems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3	1	-	1	-	-	-	1	1	1	-	2	-
CO2	3	3	3	3	2	-	1	-	-	-	1	1	1	-	3	-
CO3	3	3	3	3	2	-	1	-	-	-	1	1	1	-	3	2
CO4	3	3	3	3	3	-	1	-	-	-	1	1	1	-	3	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Modeling Techniques: Concepts of Systems Engineering, Types of mathematical models, Formulation of a prescriptive model, Overview of optimization techniques.

Linear Programming, Graphical method, Simplex method, Sensitivity analysis, Dual LP, Transportation problem, Assignment problem, Integer Linear Programming.

Dynamic Programming: Concepts of dynamic programming, Formulation of recursive equation, Resource allocation using DP, Capacity expansion, Inventory control.
Nonlinear Optimization, Classical optimization techniques, Lagrange methods, Kuhn-Tucker conditions, steepest gradient technique and other gradient based search techniques, Overview of genetic algorithm.

Decision Theory: Decision analysis, Decision making under risk and uncertainty, Markovian decision process, stochastic inventory control.

Simulation: Types of simulation models, Monte-Carlo simulation, Applications of simulation. Overview of Multi Objective Optimization Techniques.

Learning Resources

Text Books:

1. Civil and Environmental Systems Engineering, Charles S. Revelle, E. Earl Whitlatch and Jeff R. Wright., Pearson Education Inc., New Jersey, 2004
2. Operations Research – A Systems Engineering Approach, P D Dahe, CENGAGE India, 2019

Reference Books:

1. Introduction to Operations Research, Fredrick S Hillier and Gerald J Lieberman, McGraw Hill Education, 2017

2. Operations Research – An Introduction, Hamdy A Taha, Pearson Education, 2019

Online Resources:

1. https://nptel.ac.in/courses/105/108/105108081/

Course Code: CE312	PRESTRESSED CONCRETE	Credits 3-0-0: 3

Pre-requisites: Design of Concrete Structures

Course Outcomes:

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

CO1	Apply the concepts of pre-stressing in concrete structures and identify the materials for pre-stressing
CO2	Analyse pre-stressed concrete sections
CO3	Estimate losses of pre-stressing
CO4	Design pre-tensioned and post tensioned girders for flexure and shear
CO5	Design continuous pre-tensioned and post tensioned beams

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	-	-	-	1	-	1	-	-	1	-	-	2	1	-
CO2	-	3	1	-	-	1	-	1	-	-	1	-	-	-	3	1
CO3	1	2	3	-	-	1	-	1	-	-	1	-	-	-	2	-
CO4	-	1	3	2	-	1	-	1	-	-	1	-	-	-	3	-
CO5	-	-	2	3	-	1	-	1	-	-	1	-	-	-	3	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Fundamentals of prestressing - Classification and types of prestressing- Concrete Strength and strain characteristics - Steel mechanical properties - Auxiliary Materials like duct formers.

Prestressing Systems: Principles of pre-tensioning and post tensioning - study of common systems of prestressing for wires strands and bars.

Losses of Prestress: Losses of prestress in pre tensioned and post tensioned members - I.S. code provisions.

Analysis of Sections: In flexure, simple sections in flexure, kern distance - cable profile - limiting zones - composite sections cracking moment of rectangular sections.

Design of Simply Supported Beams: Allowable stress as per I.S. 1343 - elastic design of rectangular and I-sections.

Shear and Bond: Shear and bond is prestressed concrete beams - conventional design of shear reinforcement - Ultimate shear strength of a section - Prestress transfer in pretensioned beams-Principles of end block design.

Learning Resources:

Text Books:

1. Prestressed Concrete, Krishna Raju. N, Tata Mc Graw Hill, 2018, 6th Edition.
2. Design of Prestressed concrete, Lin.T.Y and Ned H. Burns, Mc Graw Hill Pub. Co., 2010
3. Prestressed concrete, Rajagopalan, Narosa Publishing House, 2010.

Reference Books:

1. Prestressed Concrete: A Fundamental Approach, Edward G. Nawy P.E., 1999
2. Prestressed Concrete Structures, P. Dayaratnam, P Sarah, 2017, 6th Edition
3. Reinforced and Prestressed Concrete, F. K. Kong , R. H. Evans, 1987.
4. Prestressed concrete analysis and design, J.P. Annie, P. Easwary and Y.R.M. Rao, 2018.

Online Resources:

1. https://nptel.ac.in/courses/105/106/105106117/

Course Code: CE313	ADVANCED SURVEYING	Credits 3-0-0: 3

Pre-requisites: Surveying

Course Outcomes:

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

CO1	Familiarize with modern surveying principles, methods and instruments
CO2	Identify and correct errors in field measurements
CO3	Apply procedures of triangulation
CO4	Conduct geodetic surveys
CO5	Classify topographical sheets based on grid pattern

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	1	1	2	1	3	1	2	3	1	1	3	2
CO2	2	3	2	2	2	2	1	3	2	2	1	2	1	1	1	1
CO3	2	3	2	2	1	1	1	2	2	2	1	2	3	3	1	1
CO4	2	3	2	2	1	1	1	2	2	2	1	2	3	3	2	2
CO5	2	2	3	2	2	1	3	2	2	2	1	2	3	3	3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Control Surveys and Geodetic Reductions: Horizontal and Vertical Control Surveys. Triangulation, Trigonometrical Levelling, Boundary Surveys, Construction surveys

Earthworks: Calculation of areas of a closed traverse, measurements from cross sections, Partition of land, Cross sections, Dip and Strike, Volumes, Mass-haul diagrams

Surveying Errors and Correction methods: Errors in measurements, Mistakes, Sources of errors, Error propagation, Method of Weights, Least Square solutions

Survey of India Topographical maps, Map numbering System, Grid patterns

EDM and GPS: Basic principles, classifications, applications, comparison with conventional surveying. Electromagnetic wave theory - electromagnetic distance measuring system - principle of working and EDM instruments, Components of GPS – space segment, control segment and user segment, reference systems, satellite orbits, GPS observations

Learning Resources:

Text Books:

1. Advanced Surveying: Total Station, GIS and Remote Sensing, Gopi, Pearson Education India, 2017.
2. Higher Surveying, Chandra, A. M., New Age International (P) Limited, 2015

Reference Books:

1. Higher Surveying, Punmia B. C, Ashok K. Jain, Arun K. Jain, Laxmi Publications, 2016.
2. Advanced Surveying: Total Station, GPS, GIS & Remote Sensing, Gopi Satheesh, R.Sathikumar, N Madhu, Pearson Education, 2017, 2nd Edition

Online Resources:

1. https://nptel.ac.in/courses/105/104/105104100/

Course Code: CE314	PAVEMENT MANAGEMENT SYSTEM	Credits 3-0-0: 3

Pre-requisites: Transportation Engineering-1 and II

Course Outcomes:

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

CO1	Identify and select suitable database strategies for a given pavement.
CO2	Determine the pavement condition using functional and structural methods.
CO3	Decide the type and timing of maintenance required for given pavement.
CO4	Estimate the life cycle cost of pavements and implementation strategies.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	1	-	2	2	2	2	-	-	2	2	3	1
CO2	3	3	1	-	-	2	-	-	2	2	-	-	2	2	2	-
CO3	3	3	3	3	-	-	2	2	2	2	-	-	2	-	3	2
CO4	3	3	3	2	-	-	2	2	2	2	-	-	2	1	2	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to PMS: Historical perspectives of PMS, Evolution of PMS concepts, basic components of PMS, Network and Project levels of PMS, data needs, GIS applications, database design, inventory and monitoring databases, planning pavement investments process and benefits of pavement management.

Pavement Performance Models: General concepts, pavement evaluation with respect to user cost, pavement evaluation technologies, techniques for developing prediction models deterministic, probabilistic, expert system of PMS models; remaining service life, AASHO, CRRI, and HDM models, deterioration concepts and modeling, priority programming methods.

Design Alternatives: Design alternatives, evaluation, and selection, a framework for pavement design, design objectives and constraints, generating alternative pavement design strategies, economic evaluation methods, economic evaluation of alternative pavement design strategies, and selecting optimal design strategies.

Pavement Prioritization Techniques: General concepts, ranking methods and procedures, prioritization based on benefit-cost ratio, mathematical optimization for prioritization of M, R&R Work Programs, Markov and heuristic approaches and ANN techniques for Prioritization of M, R&R Work programs, pavement life cycle cost analysis, implementation of PMS, operational issues, system complexity, feedback, other institutional issues, and PMS case studies.

Learning Resources:

Textbooks:

1. Pavement Management for Airports, Roads and Parking Lots, Shahin, M.Y., Chapman & Hall, New York, 1994.
2. Modern Pavement Management, Haas, R., W. R., Hudson, and J. P. Zaniewski. Modern Pavement Management. Krieger Publishing Company. Malabar, Florida, 1994.

References Books:

1. Infrastructure Management: Integrating Design, Construction, Maintenance, Rehabilitation, and Renovation. Hudson, W. R., R. Haas, and W. Uddin., McGraw Hill. New York, 1997.
2. Southeast Michigan Council of Governments. Pavement Management System, SEMCOG, 1997.
3. Transportation Association of Canada. Pavement Design and Management Guide. Transportation Association of Canada, Ottawa, 1997.
4. Structural Design of Asphalt Pavements NCHRP, TRR, and TRB Special Reports.

Online Resources:

1. https://www.youtube.com/watch?v=lDv67Eppaos
2. https://ocw.mit.edu/courses/civil-and-environmental-engineering/
3. http://www.trb.org/Publications/PubsNCHRPProjectReportsAll.aspx

Course Code: CE315	FOUNDATION ANALYSIS AND DESIGN	Credits 3-0-0: 3

Pre-requisites: Geotechnical Engineering - 1 & 2

Course Outcomes:

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

CO1	Identify the behaviour of problematic soils
CO2	Design various types of foundations
CO3	Estimate the compressive, uplift and lateral capacities of piles
CO4	Analyze the lateral stability of well foundations
CO5	Evaluate design parameters for dynamic loading

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2	-	2	2	1	-	2	2	3	2	3	-	3
CO2	1	2	2	3	-	2	2	2	-	2	2	3	2	-	2	2
CO3	1	2	2	2	2	2	-	1	-	2	2	2	-	-	2	-
CO4	1	2	2	3	2	1	-	1	-	2	2	2	-	-	1	-
CO5	1	2	-	2	2	2	-	1	2	2	3	2	2	1	1	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Problematic soils: Different types of problematic soils – Soft Clays, Loose Sands, Expansive soils, Erodible soils and Collapsible soils, Identification, categorization and problems associated with these soils, Geotechnical remedies for rectification of damage potential of these soils.

Expansive soils: Identification and characteristics of Expansive soils, Free swell index and swell potential, Swell pressure – Factors –Test, Effect of swelling on building foundations, Fundamental design in expansive soil – CNS layer, Under reamed pile and other concepts, Problems.

Shallow foundations: Individual footings, Combined Footings and Mat/Raft foundations - Computation of loads – Design steps – Proportioning of footings, Bearing capacity and settlements of foundations, Types of rafts – Conventional methods of design (Rigid beam analysis), Beams on Elastic foundations, Problems.

Pile foundations: Pile behavior under axial loads (piles under compression) – Review uplift capacity / resistance of piles (piles under tension), Lateral load capacity/ Resistance of piles, Winkler's hypothesis – Differential equations, Brom's solution for laterally loaded vertical piles in sand and clay, IS Code method, Problems.

Caissons and Well foundations: Introduction – types and shapes of Caissons – Grip length, Estimation of bearing capacity and settlement of well foundation, Design of various elements/ components of well foundation, Forces acting on well foundation, Lateral stability of well foundations by IRC method, Problems.

Soil Dynamics and Machine foundations: Introduction, Fundamentals of vibration and soil dynamics, Types of Machines and Foundations, General requirements, Foundations of Reciprocating and Impact Machines, Vibration isolation and screening - Introduction, force isolation, motion isolation, screening of vibrations by use of open trenches, passive screening by use of pile barriers, problems.

Learning Resources:

Text Books:

1. Advanced Soil Mechanics, Das, B.M, CRC Press, London & NewYork, 5th Edition, 2020
2. Principles of Foundation Engineering, Braja.M. Das, Cengage Learning India Private Limited, 2011, Seventh Edition
3. Soil Mechanics and Foundation Engineering, Murthy V.N.S - CBS publications, New Delhi, 2018.
4. Handbook of Machine Foundations, Srinivasulu, P. And Vaidyanathan, C. V, Tata McGraw-Hill, New Delhi, 2017

Reference Books:

1. Basic and applied soil mechanics, Gopal Ranjan and Rao ASR, New age Publications, Delhi, 3rd Edition, 2016.
2. Foundations for Machines, Analysis and Design" Prakash Shamsher and Puri Vijay K,John Wiley and Sons, USA,1988.
3. Foundation Engineering – Geotechnical Principles & Practical applications, Richard L Handy, Mc Graw Hill, New York, 2020

Online Resources:

1. https://nptel.ac.in/courses/105/104/105104162/

Course Code: CE316	INDUSTRIAL WASTEWATER TREATMENT	Credits 3-0-0: 3

Pre-requisites: Environmental Engineering – 1 & 2

Course Outcomes:

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

CO1	Identify the characteristics of industrial wastewaters
CO2	Describe pollution effects of disposal of industrial effluent
CO3	Identify and design treatment options for industrial wastewater
CO4	Design system or process for various industries to meet desired standards

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	1	1	3	-	-	1	-	-	-	-	-	1
CO3	3	3	3	3	-	-	3	2	1	-	2	-	-	1	3	-
CO4	3	3	3	-	-	-	3	2	1	-	2	-	-	1	3	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Composition of an industrial effluent, Difference between Domestic and Industrial Wastewater, Measurement of Polluting parameters and their effects on water bodies, Current legislation. General standards for discharge of environmental pollutants, industry-based wastewater generation standards.

Pre and Primary treatment for industrial wastewater: Treatment – Equalization, Proportioning, Neutralization, Oil Separation by Floatation – Waste Reduction – Volume Reduction - Strength Reduction

Control and removal of specific pollutants in industrial wastewaters: Unit processes and operations to remove oil and grease, cyanide, fluoride, toxic organics, heavy metals, radioactivity substances, some advanced technologies for removal of toxic contaminants from industrial wastewater.

Treatment of specific Industrial wastewater: Dairy, Pulp and Paper, Tanneries, Textiles, and Pharmaceuticals.

Learning Resources:

Text Books:

1. Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, McGraw Hill Education, 2017, 4th Edition
2. Industrial Waste Water Pollution Control by W' Wesley Eckenfelder – McGraw-Hill'
3. Wastewater Treatment, Rao, M.N., and Dutta, A.K., IBH Publ., 1995

Reference Books:

1. Industrial Wastewater Management, Treatment and Disposal, WEF Manual of practice No. FD-3, 3rd Ed., WEF Press and McGraw Hill, 2008
2. Industrial Waste Water Treatment, Patwardhan, A.D., PHI Learning, 2009
3. Industrial Wastewater Treatment, Recycling and Reuse, Vivek Ranade Vinay Bhandari, Elsevier Publications, 2014.

Online Resources:

1. https://nptel.ac.in/courses/105/106/105106119/
2. http://nptelvideos.com/video.php?id=1118
3. https://www.youtube.com/watch?v=in3GSRuooRs

Course Code: CE317	GREEN BUILDINGS	Credits 3-0-0: 3

Pre-Requisites: None

Course Outcomes:

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

CO1	Assimilate environmental impact of buildings
CO2	Quantify the environmental impact of buildings in terms of energy consumption.
CO3	Integrate design strategies in the construction of green buildings as well as existing buildings.
CO4	Comprehend the procedure involved in green building certification.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	2	-	-	1	3	-	-	-	-	2	2	-	3	-
CO2	-	-	3	2	-	3	3	-	-	-	-	2	1	2	3	-
CO3	-	2	3	3	-	2	3	-	-	-	-	2	3	2	3	1
CO4	-	-	3	-	-	3	3	-	-	-	-	2	1	2	3	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Green Buildings: History of Green Building Movement; Environmental Impact and Resource Consumption; Introduction to concept of green buildings; Benefits of Green Building and its Productivity.

Indoor Built Environment: Problem of Existing Buildings and Built Environment; Energy use in buildings; Greenhouse Gas Emissions and Indoor Air pollution; Building Water Use; Land use and consumption; Construction Materials; Construction, Operation and Demolition Waste.

Green Building Design: Passive Design Strategies: Optimum Design, Performing Insulation Solution, Ventilation; Active Strategies: Equipment, Renewable Energy; Retrofitting; Net Zero Building Design; Embodied Energy Estimation; Life Cycle Assessment Analysis.

Green Building Assessment: Green Building Organizations, Green Building Rating Tools, Green building certification procedure

Learning Resources:

Text Books:

1. Green Building Technology Guide: Volume 1 - Residential, Fred Andreas, Academic Press Inc., 2020, First Edition.
2. The Idea Of Green Building, A. K. Jain, Khanna Publishers, 2014, First Edition.
3. Green Building Guidance: The Ultimate Guide for IGBC Accredited Professional Examination, Karthik Karuppu, Notion Press, 2019, First Edition.

Reference Books

1. Sustainable Construction: Green Building Design and Delivery, Charles Kibert, John Wiley & Sons, 2005.
2. Energetics Perspective on the Environmental and Human Impact of Buildings, Teodora Melania Soimosan and Ligia Mihaela Moga, Business Science Reference, 2020.
3. Alternative Energy Systems in Building Design, Peter Gevorkian, McGraw-Hill Education, 2009, First Edition.

Online Resources:

1. https://beeindia.gov.in/sites/default/files/BEE_ECBC%202017.pdf
2. https://law.resource.org/pub/in/bis/S03/is.sp.41.1987.pdf
3. https://www.grihaindia.org/griha-ah

Course Code: CE318	ADVANCED REINFORCED CONCRETE DESIGN	Credits 3-0-0: 3

Pre-requisites: Design of Concrete Structures

Course Outcomes:

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

CO1	Design cantilever and counterfort retaining walls
CO2	Design underground and elevated water tanks
CO3	Design bunkers and silos
CO4	Design reinforced concrete chimneys

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	-	2	-	-	1	1	-	-	1	-	-	-	2	-
CO2	2	2	-	2	-	-	1	1	-	-	1	-	-	-	2	-
CO3	1	2	1	2	-	-	-	1	-	-	1	-	-	-	2	-
CO4	-	2	1	-	-	-	1	1	-	-	1	-	-	-	2	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

1. Principles of Cantilever and Counterfort type retaining walls,
2. Detailed design of cantilever type of retaining walls,
3. Detailed Design of Grid Floors, Analysis and Design of Flat Slabs,
4. Design principles of underground and elevated water tanks,
5. Detailed design of rectangular and circular elevated water tanks as per IS 3370,
6. Detailed Design of Intz Tanks,
7. R.C. Bunkers and Chimneys.

Learning Resources:

Text Books:

1. Advanced Reinforced Concrete Design, N. Krishna Raju, CBS Publishers,2016, 3rd Edition.
2. RCC Designs (Reinforced Concrete Design), Punmia B.C. Ashok Kumar Jain and Arun K. Jain, Lakshmi Publishers, 2006, 10th Edition.

Reference Books:

1. Advanced Reinforced Concrete Design, Varghese, PHI pub., 2005, 2nd Edition.
2. Advanced R.C.C Design (R C C Vol. 2), S.S. Bhavikatti, New Age International Pub., 2016, 3rd Edition.
3. Reinforced Cement Concrete Structures, R. Park and T. Paulay, MISL-WILEY Series, Wiley India Pvt. Ltd, 2009.
4. Reinforced Concrete Design - Unnikrishnan & Pillai, McGraw Hill Pub, 2009.

Online Resources:

https://www.youtube.com/watch?v=BNZp9121cms

Course Code: CE411	APPLIED STRESS ANALYSIS	Credits 3-0-0: 3

Pre-requisites: Strength of Materials and Mechanics of Materials

Course Outcomes:

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

CO1	Comprehend the basic concepts of elastic theory to determine stresses and strains
CO2	Model and analyse homogenous and isotropic plane elastic problems
CO3	Formulate the stress analysis problems using elasticity theory
CO4	Apply experimental techniques to solve field problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	-	-	2	-	-	-	1	-	2	-	1	-	2	1	-
CO2	2	-	-	2	-	-	-	1	-	2	-	2	-	2	1	-
CO3	2	2	-	2	-	-	-	1	1	1	-	1	-	2	1	1
CO4	2	3	-	1	-	-	-	1	2	2	-	2	-	1	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Continuum Mechanics: Assumptions made in elasticity theory, Necessary and sufficient conditions for analyzing a structure, Specification of stress at a point, Specification of stress at a point-Determination of normal thrust and shear stress

Concept of Orthogonal Transformation of axes: Determination of Stress invariants, Determination of principal stresses and planes, Determination of maximum shear stresses and their corresponding planes, Tresca's criteria.

Derivation of Equilibrium conditions in three dimensions: Concept of Strain at a point, Determination of Normal and Shear Strain, Generalized Hooke's Law, Interrelationship between stresses and Strains in three dimensions, Formulation of a plane stress problem.

Derivation of Airy's Stress function: Boundary conditions, equilibrium equations, compatibility conditions, solution to stress analysis problems based on direct, inverse and semi-inverse methods

Introduction to Experimental stress analysis: Strain measurement- Types of strain gauges, Characteristics of ideal strain gauges, gauge factor, Strain gauge Rosettes, Introduction to two dimensional photo elasticity, Stress-Optic law.

Learning Resources:

Text Books:

1. Theory of Elasticity, S. Timoshenko and J N Goodier, McGraw Hill Education; 2017, 3rd Edition.
2. Advanced Mechanics of Solids, L.S. Srinath, McGraw Hill, Delhi 2009, 3rd Edition.
3. Theory of Elasticity, T.G.Sitharam, L.Govinda Raju, Springer, 2021.

Reference Books:

1. A Treatise on the Mathematic Theory of Elasticity, A.E.H.Love, , Cambridge University Press, 2013.

2. Applied Elasticity, Matrix and Tensor Analysis of Elastic Continuum, Horwood Publishing Limited, 2005.
3. Advanced Mechanics of Solids and Structures, N.Krishna Raju, Mc Graw Hill Education(India) Pvt Ltd, 2018.
4. Experimental Stress Analysis, J.W. Dally and W.F.Riley, Mc Graw Hill 1991, 3rd Edition.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc21_ce45/

Course Code: CE412	MUNICIPAL SOLID WASTE MANAGEMENT	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Identify various types of solid wastes and their sources
CO2	Examine the physical and chemical composition of wastes
CO3	Analyze the activities associated with the management of solid waste
CO4	Evaluate the techniques and methods used in recovery of materials and energy from solid wastes
CO5	Design a sanitary landfill for disposal of solid waste

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	1	1	1	-	-	-	-	-	-	1	-	1	-	-
CO2	2	1	1	3	1	1	2	1	-	-	-	1	-	2	1	-
CO3	3	2	2	2	3	2	2	1	-	-	-	1	-	2	3	-
CO4	3	3	3	2	2	2	2	1	-	-	-	1	-	2	1	-
CO5	3	3	3	2	3	2	3	1	-	-	-	1	-	-	3	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Solid Waste: Definitions, Characteristics, and Perspectives; Types of solid wastes, sources of solid wastes, properties of solid wastes, solid waste management: an overview.

Engineering Systems for Solid Waste Management: Solid waste generation; on-site handling, storage and processing; collection of solid wastes; transfer and transport; processing techniques; ultimate disposal.

Engineering Systems for Resource and Energy Recovery: Processing techniques; materials-recovery systems; recovery of biological conversion products; recovery of thermal conversion products; recovery of energy from conversion products; materials and energy recovery systems.

Learning Resources:

Text Books:

1. Integrated Solid Waste Management, Engineering Principles and Management Issues, Tchobanoglous G, Theisen H and Vigil SA, McGraw Hill Education, 2014, Indian Edition
2. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel, CRC Press, 2014, 2nd Edition
3. Solid Waste Engineering, Vesilind PA, Worrell W and Reinhart D, Brooks/Cole Thomson Learning Inc., 2010, 2nd Edition

Reference Books:

1. Environmental Engineering, Peavy, H.S., Rowe, D.R., and Tchobanoglous G., McGraw Hill Education, 2017 First Indian Edition
2. Handbook of Solid Waste Management, Tchobanoglous G and Kreith F, McGraw-Hill Education, 2002, 2nd Edition
3. Geotechnical Aspects of Landfill Design and Construction, Qian X, Koerner R M and Gray D H, Prentice Hall, 2002, 1st Edition

Online Resources:

1. http://cpheeo.gov.in/cms/manual-on-municipal-solid-waste-management-2016.php
2. https://nptel.ac.in/courses/105/103/105103205/
3. https://nptel.ac.in/courses/120/108/120108005/
4. https://nptel.ac.in/courses/105/106/105106056/

Course Code: CE413	GROUNDWATER DEVELOPMENT	Credits 3-0-0: 3

Pre-requisites: Fluid Mechanics – I & II

Course Outcomes:

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

CO1	Evaluate groundwater resources using geophysical methods
CO2	Estimate aquifer parameters
CO3	Model regional groundwater flow
CO4	Design water wells
CO5	Identify sites for artificial recharge of groundwater

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	3	2	1	1	-	-	-	-	1	3	-	1	1
CO2	3	2	1	3	2	1	1	-	-	-	-	1	3	-	1	1
CO3	3	3	3	3	2	1	1	-	-	-	-	1	1	-	3	2
CO4	3	2	3	2	2	1	1	-	-	-	-	1	1	-	3	
CO5	2	2	2	3	2	1	2	-	-	-	-	1	1	-	2	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction, Groundwater resources of India, Regional Groundwater balance, Distribution of subsurface water, Occurrence of groundwater in hydrogeological formations.

Rock properties affecting groundwater, Aquifers, Geologic formations of Aquifers, Types of aquifers, estimation of aquifer parameters by different methods, Porosity and representative volume, specific surface, storage coefficient.

Geophysical exploration studies, electrical resistivity method, seismic refraction method, Gravity and Magnetic methods, Test Drilling, Determination of Aquifer thickness.

Groundwater movement, Darcy's law, Permeability, Conductivity and Transmissivity, Determination of in-situ hydraulic conductivity, Anisotropic Aquifers, Groundwater flow rates and directions, General flow equations, Unsaturated flow.

Steady State well hydraulics, Steady unidirectional flow, Steady radial flow to a well, Yield from a well under steady state conditions.

Unsteady flow in confined and unconfined aquifers, well losses and specific capacity, Pumping tests.

Water well design, Well construction and maintenance procedures, Testing wells for yield, Characteristics of well losses.

Artificial recharge- Concept, Artificial recharge methods.

Learning Resources:

Text Books:

1. Groundwater hydrology, Todd, D.K., and Mays, L.W., John Wiley & sons, 2011 3rd Edition
2. Numerical Groundwater Hydrology, Rastogi, A.K., Penram International Publishing Pvt. Ltd., 2012
3. Groundwater, Raghunath H.M., New Age International Publications, 2002.

Reference Books:

1. Groundwater Hydrology: engineering, planning, and management, Karamouz, M., Ahmedi, A., Akhbari, M., CRC Press, 2011 2nd edition
2. Groundwater Hydrology, Agarwal, V.C., Prentice Hall Publications, 2012

Online Resources:

1. https://nptel.ac.in/courses/105/103/105103026/

Course Code: CE414	RIVER HYDRAULICS	Credits 3-0-0: 3

Pre-requisites: Fluid Mechanics – I & II, Engineering Hydrology

Course Outcomes:

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

CO1	Determine the characteristics of Rivers and Sediments
CO2	Comprehend the concept of incipient motion and bed load
CO3	Compute sediment load
CO4	Design river training works

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	3	1	1	1	-	-	-	-	1	2	-	1	
CO2	2	2	1	2	1	1	1	-	-	-	-	1	3	-	1	1
CO3	3	2	2	3	1	1	1	-	-	-	-	1	1	-	3	2
CO4	3	3	2	2	2	1	1	-	-	-	-	1	1	-	3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Behaviour of Rivers: Introduction, River Channel patterns, Straight river channels, causes, characteristics and shapes of meanders and control, Braided Rivers, Bed forms, Instability of rivers.

Incipient Motion: Properties of sediment, Incipient motion and quantitative approach to incipient motion.

Bed forms and resistance to flow: Sediment transport and budgets, Bed forms and resistance to flow. Channel degradation and armouring.

Modes of sediment transportation: Various approaches for bed load transport, suspended load profile and suspended load equations, total load transport including total load transport equations. Comparison and evaluation of sediment transport equations. Sediment sampling.

Bed level variation: Bed level variations, local scour, degradation, aggradation and reservoir sedimentation.

Design of stable channel: Stable channel design with and without suspended sediment and sediment control. River Training and Protection Works: Introduction, Classification of River Training, Types of training works, Protection for Bridges with reduced waterway, Design of Guide Band, embankment and spurs/dampners and other river/ flood protection works.

Learning Resources:

Text Books:

1. Mechanics of Sediment Transportation and Alluvial Stream Problems, Garde, R. J. and Ranga Raju, K. G., New Age Publishers.
2. Principals of River Engineering, Jansen, P. P. H., VSSD Publications.
3. River Morphology. Garde, R. J., New Age Publishers.

Reference Books:

1. River Mechanics, Pierre Y. Julien, Cambridge University Press,2002.

2. River Engineering, Margaret S Peterson, Prentice Hall,1986.
3. Fluvial Hydraulics, Dey, S., Springer, 2014.
4. Aronne Armanini, Principles of River Hydraulics, Springer International Publishing, 2018.
5. Artur Radecki-Pawlik, Jan Hradecky, Stefano Pagliara, Open Channel Hydraulics, River Hydraulic Structures and Fluvial Geomorphology, CRC Press, 2017.
6. U. S. Army Corps of Engineers, River Hydraulics, University Press of the Pacific, 2004.

Online Resources:

1. https://www.routledge.com/IAHR-Design-Manual/book-series/TFIAHRHSDM

Course Code: CE415	DESIGN OF EARTHQUAKE RESISTANT STRUCTURES	Credits 3-0-0: 3

Pre-requisites: Theory of Structures – 2

Course Outcomes:

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

CO1	Apply seismic coefficient and response spectrum methods for analysis of multi storied buildings
CO2	Apply concepts of ductility in the design of multi-storeyed structures
CO3	Analyze water tank structures based on latest earthquake code
CO4	Apply the concepts of base isolation

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	2	3	-	-	1	-	1	-	-	1	-	-	-	2	3
CO2	-	-	3	2	-	1	-	1	-	-	1	-	-	-	3	1
CO3	-	2	3	1	-	1	-	1	-	-	1	-	-	-	3	1
CO4	-	-	2	3	-	1	-	1	-	-	1	-	-	-	2	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Elements of Earthquake Engineering: Earthquake magnitude and intensity, Focus and Epicentre, Causes and Effects of Earthquakes, Characteristics of Earthquake, Seismic zone mapping.

Structural Systems for Seismic Resistance: Structural systems – building configuration, frames, walls, dual systems – response in elevation – plan – influence of structural classification- Concepts of seismic design.

Analysis for Earth Quake Loads: IS: 1893-2002- Seismic Coefficient method- modal analysis- Applications to multi-storied building frames – water tanks – chimneys.

Ductile Detailing: Ductility of R.C structures- Confinement- detailing as per IS-13920-1993- moment redistribution – principles of design of beams, columns – beam column joints – soft story concept.

Base Isolation: Isolation systems – Effectiveness of base isolation and applications.

Learning Resources:

Text Books:

1. Dynamics of structures, A.K. Chopra, Prentice Hall, 2020.
2. I.S. 1893 - 2002, Criteria for Earthquake Resistance design of Structures.
3. Earthquake resistant design of structures, Pankaj Agarwal and Manish Shrikhande, 2017.

Reference Books:

1. Dynamics Of Structures, Clough R.W, 2015, 2nd Edition.
2. Structural Dynamics: Theory and Computation, Mario Paz and Young Hoon Kim, Springer Publisher, 2018, 6th Edition.

3. Earthquake Resistant Design of Structures, Shashikant K. Duggal, Oxford, 2013, 2nd Edition.
4. Mechanical Vibrations, Singiresu S. Rao, Pearson, 2018, 6th Edition.

Online Resources:

1. https://nptel.ac.in/courses/105/107/105107204/

Course Code: CE416	GIS APPLICATIONS	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Prepare geospatial layers
CO2	Analyze geospatial data for solving problems of natural and anthropogenic systems
CO3	Create GIS and cartographic outputs
CO4	Apply geospatial skills in Civil Engineering projects

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	3	2	2	-	1	1	1	1	3	-	3	2
CO2	3	3	-	-	2	2	2	-	1	1	-	1	3	-	-	3
CO3	2	1	3	2	3	2	2	-	2	3	2	2	2	-	2	1
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	2	3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: GIS definition, development, application areas

Map Concept: Map-Definition, Elements of Maps, Types of maps, Advantages and disadvantages of analog/digital maps, Coordinate Systems- Geometric models of earth, Global/Local coordinate system, Projection Systems- Classification, Cylindrical projection, Conical projection, Selection of a particular projection

Fundamental concepts of GIS: Modeling Real World Features- Raster data model, vector data model, Data Formats- Spatial and Non-Spatial data

Database preparation and editing: Data collection and Input, Data conversion, Hardware & software Requirements, Topology – Editing and Error Rectification, Types of topology, Topological Relationships.

Spatial Analysis: Buffer Analysis-Variations in Buffering, Applications of buffering, Overlay Analysis-Feature type and overlay, Vector Overlay methods, Network Analysis-Impedance, Shortest path analysis, closest facility, Concepts of Proximity analysis, Neighborhood operations, DEM and TIN.

GIS Project Planning: Steps in GIS project, Problem Identification and Implementation of a GIS project.

GIS Applications: Transportation, Water Resources, Environment, Geology, Emergency Management, Agriculture, Urban planning, climate change, Business.

Advances in GIS: Concepts and application of open source Mobile and Web GIS.

Learning Resources:

Text Books:

1. Concepts and Techniques of Geographic Information Systems, C.P. Lo, Albert K. W.

Yeung, Prentice Hall India Pvt. Ltd, New Delhi, 2009
2. Introduction to Geographic Information Systems, Kang-Tsung Chang, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2015

Reference Books:

1. Principles of Geographical Information Systems, Peter A. Burrough and Rachael A. McDonnell,Oxford University Press, 2016
2. Advanced Surveying: Total Station, GPS, GIS & Remote Sensing, Gopi Satheesh, R.Sathikumar, N Madhu, Pearson Education, 2017, 2nd Edition

Online Resources:

1. https://nptel.ac.in/courses/105/102/105102015/

Course Code: CE417	PHOTOGRAMMETRY AND UAV	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Classify the photogrammetry methods and their applications
CO2	Determine the scale, ground coordinates and the aerial extent of aerial photographs
CO3	Explain various methods of photogrammetric techniques
CO4	Apply the photogrammetric skills to extract the earth surface features

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	3	2	2	-	1	1	1	1	3	-	1	1
CO2	3	3	-	-	2	2	2	-	1	1	-	1	3	-	1	-
CO3	2	1	3	2	3	2	2	-	2	3	2	2	2	-	2	1
CO4	3	2	3	2	3	3	3	3	3	3	3	3	2	2	3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to photogrammetry: Photogrammetric terms, applications, advantages, limitations and a brief history, types of camera: metric vs. non-metric, types of photogrammetry

Aerial photogrammetry: Geometry of vertical/near-vertical aerial photographs: Orthographic vs. perspective projection, Map vs. photograph, scale of photograph, estimate the scale, relief displacement and its determination, parallax in photographs and measurement, stereoscopy.

UAV: History of unmanned air vehicle (UAV) development. Classifications and components of UAVs – Design standards and Regulatory aspects – Environment, Budget & Time, Airframe Design & Payload, Flight planning, Mosaicing, Ground control, Feature detection and mapping, Point cloud, 3D Models, DEM generation, Orthophoto generation, UAV Applications.

Laser Scanning: Principles, methods of scanning, scanning of terrestrial structures, monuments, LiDAR characteristics and types of systems

Integrated systems (UAV, Car, Aircraft etc.): Applications and some case studies: Mining, exploration, SLAM.

Learning Resources:

Text Books:

1. Elements of Photogrammetry, Wolf, Paul, R.. Fourth Ed., McGraw-Hill, 2014
2. Introduction to UAV Systems, Paul Gerin Fahlstrom & Thomas James Gleason., Wiley Publications, 2012
3. Introduction to Modern Photogrammetry, Mikhail, E., M., Bethel, J. S. and McGlone, J. C., John Wiley & Sons, 2001

Reference Books:

1. Topographic laser ranging and scanning Principles and Processing, Toth, C., K., Shan, J. CRC Press
2. Close Range Photogrammetry and 3D Imaging., Thomas Luhmann, Stuart Robson,

Stephen Kyle & Jan Boehm., Walter de Gruyter GmhH, 2nd Edition, 2014

Online Resources:

1. https://nptel.ac.in/courses/105/104/105104100/

Course Code: CE418	GROUND IMPROVEMENT TECHNIQUES	Credits 3-0-0: 3

Pre-requisites: Geotechnical Engineering – 1& 2

Course Outcomes:

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

CO1	Identify ground conditions and suggest methods of improvement
CO2	Design and assess the level of improvement
CO3	Apply principles of soil reinforcement and confinement in engineering constructions
CO4	Design reinforced soil structures

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	2	1	1	-	-	1	1	-	1	3	1	1	2
CO2	3	2	3	1	-	1	1	-	-	-	-	-	-	1	3	1
CO3	2	2	-	-	2	-	1	-	-	-	-	-	-	3	-	-
CO4	3	2	3	1	-	1	1	-	-	-	1	-	-	2	3	--

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Need and objectives of Ground Improvement, Classification of Ground Modification Techniques – suitability and feasibility.

Mechanical Modification: Principles of Mechanical Modifications - Methods of compaction, Shallow compaction, Deep compaction techniques – Vibro-floatation, Blasting, Dynamic consolidation, pre-compression and compaction piles.

Hydraulic Modification: Methods of dewatering – open sumps and ditches, Well-point system, Electro-osmosis, Vacuum dewatering wells; pre-loading with sand drains - strip drains, Design of vertical drains.

Physical and chemical modification: Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen. Grouting – materials and methods.

Reinforced Earth Technology: Concept of soil reinforcement, Reinforcing materials, Backfill criteria, Design of reinforcement for internal stability, Applications of Reinforced earth structures.

Ground Anchors and Soil Nailing: Types of ground anchors and their suitability, Uplift capacity of anchors; Soil nailing and Applications.

Soil Confinement Systems: Concept of confinement, Gabion walls, Crib walls, Sand bags, Evergreen systems and fabric form work.

Geotextiles: Overview on Geosynthetics – Geotextiles, Functions and Applications

Learning Resources:

Text Books:

1. Engineering principles of ground modification, Manfred, R. Haussmann –– McGraw Hill, August 2013
2. Ground Improvement Techniques, Huat BBK, Taylor & Francis Ltd, February 2020.

3. Ground Improvement Techniques" Purushothama Raj, P Laxmi Publications (P) Limited, Laxmi Publications; Second edition (1 January 2016).

Reference Books:

1. Principles and Practice of Ground Improvement" Jie Han. John Wiley & Sons, Inc. (2007).
2. Geotechnical Investigations and Improvement of Ground Conditions Anjan Patel. (Woodhead Publishing Series in Civil and Structural Engineering) 1st Edition. (2006).
3. Ground Improvement Techniques, Bikash Chandra Chattopadhyay, Joyanta Maity, PHI Learning; Eastern Economy Edition (30 July 2017.

Online Resources:

1. https://nptel.ac.in/courses/105/108/105108075/

Course Code: CE419	ROCK ENGINEERING	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Comprehend the importance of rock mechanics in engineering practice.
CO2	Determine rock properties and classify the rock mass
CO3	Assess the stability of rock slopes and suggest slope slide preventive methods
CO4	Evaluate the rock bearing capacity and calculate the load capacity for deep foundations in rock.
CO5	Identify the different methods of tunnel drilling and support/stabilization methods.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1	-	-	-	-	-	2	1	3	1	3	3	-
CO2	3	1	2	3	-	-	-	-	1	2	-	1	1	3	1	-
CO3	-	2	3	2	2	2	-	2	-	2	-	1	1	-	3	3
CO4	-	-	3	1	-	-	-	-	-	2	-	2	-	-	3	-
CO5	-	1	3	-	-	-	1	-	2	2	-	1	-	-	3	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Development of Rock Mechanics and its Engineering Importance.

Laboratory and in-Situ Testing: Rock sampling, Determination of density, Porosity and Water absorption, Uniaxial Compressive strength, Determination of elastic parameters, Tensile strength, Shear Strength, Flexural strength, Swelling and slake durability, permeability, point load strength, Factors affecting strength of rocks.

Engineering classification of Intact rock and rock mass: Classification by Rock Quality Designation (RQD), Rock structure Rating (RSR), Rock Mass Rating (RMR), Geomechanics and Norwegian Geotechnical Classification (Q-system). Strength and modulus from classifications, Classification based on strength & modulus and strength.

Stability of Rock Slopes and Foundations on Rocks: Types, mode of slope failure, causes of slope failure, stability analysis, Hoeks stability charts, prevention and control of rock slope failures, stabilization methods, prevention methods and warning methods.

Rock Foundations: Types of Foundations, Shallow foundation- failure mechanisms, different situations with shallow foundations, sliding instability, foundation over sinkholes, foundation on faulty, foundation on swelling rocks.

Tunnelling in rocks: Applications of tunnelling, investigation and planning, tunnel drilling methods, tunnel support systems and stabilization methods, construction control and tunnel maintenance

Learning Resources:

Text Books:

1. Introduction to Rock mechanics, Goodman, Willey International (2007).
2. Engineering in Rocks for slopes, foundations and tunnels, Ramamurthy T. Prenice Hall of India. Learning Pvt. Ltd., (2015).

3. Fundamentals of Rock Mechanics, Jaeger J. C., Cook N. G. W., and Zimmerman R. W, Wiley Blackwell, 2007.
4. Underground Excavation in Rock, Hoek, E. and Brown, E. T., Institution of Mining and Metallurgy, 1982.

Reference Books:

1. Rock Mechanics an Introduction, Nagaratnam Sivakugan, Sanjay Kumar Shukla, Braja M. Das, CRC Press, 2019.
2. Rock Mechanics for Underground, Brady B.H.G. and Brown E.T. zining, Kluwer Academic Publishers, 2005.
3. Rock Mechanics Principles in Engineering Practice, Hudson, J.A. CIRIA, Butterworth & Co, London, (1989).
4. Engineering Rock Mass Classification, R Goel, Bhawani Singh, Elsevier, 2011

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc21_ce34/preview

Course Code: CE420	TRAVEL DEMAND ANALYSIS	Credits 3-0-0: 3

Pre-requisites: Transportation Engineering - 1

Course Outcomes:

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

CO1	Identify the urban transportation issues.
CO2	Assess the data required for travel demand estimation.
CO3	Analyse and estimate urban travel demand.
CO4	Design regional transportation network.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	-	-	-	-	-	-	-	-	1	1	-	1	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	-	-	1	-
CO3	3	3	2	2	1	-	1	-	-	-	-	1	-	-	2	1
CO4	3	3	3	1	-	-	-	-	-	-	-	1	-	-	1	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Transportation Issues: Population, urbanization and migration, findings of commission on urbanization; transportation problems and issues in urban areas; travel characteristics; issues related to regional transportation planning, methods of delineation regions; policies for urban and regional transportation

Travel Demand: Trends, overall planning process, long term versus short term planning; demand function; independent variables, travel attributes; assumptions in demand estimation; sequential and simultaneous approaches; aggregate and disaggregate techniques.

Data Collection and Inventories: Collection of data-organization of surveys and analysis; study area, zoning, screen lines; types and sources of data - roadside interviews; home interview surveys; commercial vehicle surveys, sampling techniques, expansion factors; accuracy checks, use of secondary sources; economic data: income, population, employment, vehicle ownership.

Urban Travel Demand Estimation: Trip Generation Analysis: Zonal models, category analysis, household models, trip attraction models, commercial trip rates.
Trip Distribution: Growth factor methods, gravity models, opportunity models, time function iteration models.
Mode Choice Analysis: Mode choice behavior, competing modes, mode split curves, models, and probabilistic approaches.
Traffic Assignment: Basic elements of transport networks, coding, route properties, path building criteria, skimming tree, All-or-Nothing assignment, capacity restraint techniques, reallocation of assigned volumes, Equilibrium Assignment.

Regional Travel Demand Estimation: Factors affecting goods and passenger flows, use of aggregate direct demand model to estimate freight and passenger demand, IVF models..

Learning Resources:

Text Books:

1. Fundamentals of Transportation Engineering, Papakostas. C.S., Pearson Education India, 2015, Third Edition.
2. Traffic Engineering and Transport Planning, Kadiyali, L.R., Khanna Publishers, 2018, Ninth Edition.
3. Transportation Engineering, Khisty, C.J., and Lall, B.K., Pearson, 2017, Third Edition.

Reference Books:

1. Transportation Planning: Principles, Practices and Policies, Sarkar, P.K., Maitri, V., Joshi, G.J., PHI Learning, 2017, Second Edition.
2. Urban Transport: Planning and Management, Jain A.K., APH Publishing Corporation, 2008.
3. Urban Transportation Planning Lecture Notes, Chari, R., 1990.

Online Resources:

1. https://nptel.ac.in/courses/105/107/105107067/
2. https://dspace.mit.edu/bitstream/handle/1721.1/107706/11-540j-fall-2006/contents/lecture-notes/index.htm

Course Code: CE421	TRAFFIC ENGINEERING AND DESIGN	Credits 3-0-0: 3

Pre-Requisites: Transportation Engineering - 1

Course Outcomes:

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

CO1	Conduct traffic flow studies and determine basic characteristics of the traffic stream.
CO2	Collect and analyze traffic flow data and formulate the problem.
CO3	Design geometric elements of traffic flow facility.
CO4	Analyze and design unsignalized and signalized intersections.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	---	--	2	-	1	-	-	-	-	1	-	-	1	1
CO2	3	3	-	2	2	1	1	-	-	-	-	1	1	-	3	1
CO3	3	3	3	2	3	1	1	-	-	-	-	1	-	-	3	-
CO4	3	3	3	3	2	2	2	-	-	-	-	1	1	-	3	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Characteristics of Traffic System: Human-vehicle-environment system, Fundamental parameters of traffic and relationships; Microscopic and macroscopic characteristics.

Traffic Data Collection studies: Traffic study components, types of data; Volume studies; Speed studies; Travel time and delay studies; Intersection studies, Pedestrian studies; Parking studies, Vehicle detection methods; Advanced methods: GPS, Instrumented Vehicles, Image Processing, Bluetooth, Infrared methods.

Highway Capacity Analysis: Capacity and level of service concepts; Factors affecting capacity and LOS; Freeway and multi-lane analysis; Capacity of Urban arterials; Signalised intersections; Un-signalised intersections; US Highway Capacity Manual (HCM) and IRC standards, Indo-HCM standards

Design of unsignalized intersections: At grade intersection types and their suitability, factors affecting design, data requirement, parameters selection, intersection controls, estimation of conflict points, uncontrolled intercession analysis, sight distance requirements, roundabouts, and design methodologies, the capacity of roundabouts, mini-roundabouts.

Design of signalized intersections: Warrants for signalization, saturation flow rate and capacity, estimation of amber time, design of all aspects of signal timings, LOS studies, estimation of queue length and control delay, signal coordination, channelization and its objectives, channelizing devices, design considerations, typical channelizing examples.

Design of Interchanges: Necessities of interchanges, classification and types of common interchanges, layouts of interchange, interchange warrants, interchange design elements, spacing and design speed, design of ramps, ramp configurations, weaving at an interchange, design examples.

Design of parking facilities: Parking and influencing factors, type of parking system, parking angles and aisle width, on-street parking design, design parameters, parking surveys and

demand estimation, various parking layouts and vehicle circulation, design of off-street parking facilities, types and layouts, design examples.

Learning Resources:

Text Books:

1. Traffic Engineering and Transport Planning, Kadiyali, L.R., Khanna Publishers, 2018, Ninth Edition.
2. Traffic Engineering, Roger P. Roess, Elena S. Prassas and William R. McShane, Prentice Hall, 2010, Fourth Edition.

Reference Books:

1. Traffic Engineering Design: Principles and Practice, Mike Slinn, Paul Matthews, Peter Guest, Butterworth-Heinemann, 2005, Second Edition.
2. Nicholas J. Garber, Lester A. Hoel, Principles of Traffic and Highway Engineering, Cengage Learning India, 2010, Second Edition.
3. Principles of Transportation Engineering, Chakroborty Partha, Das Animesh, PHI Learning Pvt. Ltd., 2016.
4. Principles of Highway Engineering and Traffic Analysis, Fred L. Mannering, Scott S. Washburn, Kilareski Walter P., Wiley India Pvt Ltd., 2011, Fourth Edition.
5. Traffic Engineering: Theory and Practice, Louis J. Pignataro and Edmund J. Cantilli, Prentice hall, Inc., 1973.
6. Highway Capacity Manual, TRB, Transportation Research Board, Washington, D.C., 2010.

Online Resources:

1. https://nptel.ac.in/courses/105/101/105101008/

Course Code: CE422	BUILDING INFORMATION MODELLING	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Study the background of BIM and its role in construction management
CO2	Apply BIM in construction design, planning and construction phases.
CO3	Comprehend the role of BIM approach in design coordination to aid in decision making
CO4	Apply BIM for case studies

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	1		-	-	2		-	2	-	-	-
CO2	2	2	3	3	3	-	2	-	-	2	2	-	1	-	-	2
CO3	-	2	2	2	2	-	2	2	1	-	2	-	-	3	2	2
CO4	2	1	-	2	2	2	-	-	2		2	2	-	2	2	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Building Information Modelling (BIM): Background of Building Information Modelling (BIM); Components of BIM, BIM Focus, Users of BIM information and Project Delivery Methods using BIM.

BIM in Pre-Construction Phase: Conceptual Design in Terms Shape, Orientation, Site in Terms of Green Strategy, Architectural BIM, Architectural Drafting, Architecture 3D Rendering. Structural BIM Design: Systems and Materials, Structural Rebar Detailing, Green Design Decisions. BIM Analysis: Daylighting, Energy Analysis and Energy Cost; Documentation.

BIM in Planning and Construction Phase: BIM In Fabrication, BIM In Construction Gatekeeping, 4D BIM – Construction Scheduling, 5D – Construction Cost Estimation, Quantity Take off, Clash Detection and Construction Logistics.

Case studies on BIM: Architectural BIM in Residential Buildings and 3D Rendering Services; Structural BIM Modelling for Multi Storey– Residential Building and BIM Implementation during New Construction.

Learning Resources:

Text Books:

1. Building Information Modelling (BIM) in Design, Construction and Operations De Wilde, P., Mahdjoubi, L., & Garrigós, A. G., WIT Press, 2019, Volume 192.
2. Building Information Modeling: Planning and Managing Construction Projects with 4D CAD and Simulations, Kymmell, W., McGraw-Hill Education, 2008, First Edition.

Reference Books:

1. Integrated Practice in Architecture: Mastering Design-Build, Fast-Track, And Building Information Modelling, Elvin, G., John Wiley & Sons, 2007, First Edition.

2. Organization and digitization of information about buildings and civil engineering works, including building information modelling -- Information management using building information modelling: Concepts and principles, BS EN ISO 19650-1, The British Standards Institution, 2018.
3. Organization and digitization of information about buildings and civil engineering works, including building information modelling -- Information management using building information modelling: Delivery phase of the assets. BS EN ISO 19650-2, The British Standards Institution, 2018.

Online Resources:

1. https://youtu.be/iRMA2TauyvM
2. https://youtu.be/mVsy_ycUD1Q

Course Code: CE423	AIR POLLUTION	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Identify sampling and analysis techniques for air quality assessment
CO2	Describe the plume behaviour for atmospheric stability conditions
CO3	Apply plume dispersion modelling and assess the concentrations
CO4	Design air pollution controlling devices

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	1	2	1	1	1	1	1	1	1	1	1	1
CO2	3	1	2	2	2	2	1	1	2	1	2	3	1	2	1	2
CO3	3	1	2	1	2	1	2	1	1	2	2	1	1	2	1	1
CO4	3	2	1	1	1	1	2	2	1	1	1	2	3	3	2	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Air Pollution: Definition - Sources & Classification of Air Pollutants - Effects of air pollution on humans, plants and materials- Global effects - Air Quality and NAAQS - National Clean air Programme- Sampling of Pollutants in ambient air - Stack sampling

Meteorology and Air Pollution: Factors influencing air pollution, Wind rose, Mixing Depths, Lapse rates and dispersion - Atmospheric stability, Plume rise and dispersion, Prediction of air quality, Box model - Gaussian model - Dispersion coefficient - Application of tall chimney for Pollutant dispersion.

Control of Particulate Pollutants: Properties of particulate pollution - Particle size distribution - Control mechanism - Dust removal equipment - Design and operation of settling chambers, cyclones, wet dust scrubbers, fabric filters & ESP.

Control of Gaseous Pollutants: Process and equipment for the removal by chemical methods - Design and operation of absorption and adsorption equipment - Combustion and condensation equipment.

Learning Resources:

Text Books:

1. Air Pollution Control Engineering, Noel, D. N., Tata McGraw Hill Publishers, 1999.
2. Fundamentals of Air Pollution, Stern, A.C., Academic Press, 1984.

Reference Books:

1. Air Pollution: Measurement, Modeling and Mitigation, Colls, J., CRC Press, 2009.
2. Fundamentals of air pollution, Boubel, R.W., Fox, D.L., Turner, D.B. and Stern, A.C., Academic Press, New York, 1994, 3rd Edition

OnlineResources:

1. https://indair-neeri.res.in/

Course Code: CE461	ENVIRONMENTAL IMPACT ASSESSMENT	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Identify environmental attributes to be considered for the EIA study
CO2	Formulate objectives of the EIA studies
CO3	Identify the methodology to prepare rapid EIA
CO4	Prepare EIA reports and environmental management plans

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	2	2	2	2	1	2	2	-	-	1	-	-	-
CO2	1	2	2	1	2	2	2	2	2	1	-	-	-	-	2	-
CO3	1	2	2	1	2	1	2	2	1	-	-	1	-	-	1	1
CO4	1	2	2	2	3	2	3	1	3	1	2	1	-	-	1	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: The Need for EIA, Indian Policies Requiring EIA , The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process, List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements.

Identifying the Key Issues: Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input Requirements, Wastes and Emissions, Air Emissions, Liquid Effluents, Solid Wastes, Risks to Environment and Human, Health, Socio-Economic Impacts, Ecological Impacts, Global Environmental Issues.

EIA Methodologies: Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods, Environmental index using factor analysis, Cost/benefit analysis, Predictive or Simulation methods. Rapid assessment of Pollution sources method, predictive models for impact assessment, Applications for RS and GIS.

Reviewing the EIA Report: Scope, Baseline Conditions, Site and Process alternatives, Public hearing. Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of Environmental Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Impact, Impact on Transport System, Integrated Impact Assessment.

Case Studies: Preparation of EIA for major developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, Highways, Construction industry, Pharmaceutical industry, thermal power plant, Nuclear fuel complex, Sewage treatment plants, Municipal Solid waste processing plants, Tannery industry.

Learning Resources:

Text books:

1. Environmental Impact Assessment Methodologies, Anjaneyulu.Y., and Manickam. V., B.S. Publications, Hyderabad, 2007.
2. Environmental Impact Analysis, Jain, R.K., Urban, L.V., Stracy, G.S., Van Nostrand Reinhold Co., New York, 1991.

Reference Books:

1. Environmental Impact Assessment, Barthwal, R. R., New Age International Publishers, 2002
2. Environmental Impact Assessment, Rau, J.G. and Wooten, D.C., McGraw Hill Pub. Co., New York, 1996.
3. Environmental Impact Assessment-Theory and Practice, Wathern.P., Routledge Publishers, London, 2004.

Online Resources:

1. MEVE-001: Environmental Impact Assessment for Environmental Health - Course (swayam2.ac.in)
2. 120108004.pdf (nptel.ac.in)
3. environmentclearance.nic.in/writereaddata/Form-1A/HomeLinks/ommodel2.html
4. environmentclearance.nic.in/writereaddata/Form-1A/HomeLinks/ommodel3.html

Course Code: CE462	GEODESY AND GLOBAL NAVIGATION SATELLITE SYSTEMS	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Comprehend principles of Geodesy
CO2	Outline different navigation systems and constellations
CO3	Identify and apply error sources in GNSS observations
CO4	Establish geodetic control and map geospatial features

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	2	2	3	2	2	3	2	3	1	2	1	2	2
CO2	2	2	3	1	3	2	2	3	2	2	2	1	2	1	1	1
CO3	1	3	2	3	2	1	1	2	2	2	1	2	1	1	1	1
CO4	2	2	1	2	1	1	2	1	1	1	2	2	1	1	2	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Reference Systems and Coordinate systems: Definition and scope of Geodesy, Earth Indian Geodetic System and Everest Spheroid, WGS 84, Geodetic coordinate systems Datum transformations, Height systems, Time systems

Introduction: History of Global Navigation Satellite Systems (GNSS); Various positioning systems, Global and regional systems

GLONASS system: Services and Segments

Galileo System: Services and Segments

Regional Navigation Satellite Systems: IRNSS, GAGAN

Surveying with GNSS: Planning a GNSS Survey, Positioning methods – point positioning, relative positioning, Static, Differential, RTK

Accuracy measures, software modules, GIS and GNSS data integration, Applications of GNSS

Learning Resources:

Text Books:

1. GNSS Remote Sensing: Theory, Methods and Applications, Shuanggen Jin, Estel Cardellach & Feiqin Xie., Springer, London, 2014
2. GPS Satellite Surveying, Alfred Leick, 4th ed. John Wiley and Sons Inc., 2015

Reference Books:

1. The Global Positioning System & GIS: An Introduction, Kennedy M, Taylor & Francis, 2010
2. Satellite Geodesy Foundations - Methods and Applications, Gunter Seeber., De Gruyter, 2008

Online Resources:

1. https://nptel.ac.in/courses/105/107/105107194/

Course Code: CE463	SEISMIC HAZARD ANALYSIS	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Comprehend the mechanism involved in earthquakes
CO2	Evaluate the effect of earthquake motion on soil properties
CO3	Determine the Probabilistic and Deterministic Seismic Hazard Analysis
CO4	Design of structures and foundations under seismic loading

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	-	-	1	2	1	-	-	-	-	-	-	-	-	3
CO2	2	1	-	-	1	2	1	-	-	-	-	-	-	-	-	3
CO3	1	3	-	-	-	1	-	-	-	-	-	-	-	-	-	3
CO4	1	3	2	1	-	-	-	-	-	-	-	-	-	-	-	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Seismic microzonation; Basic steps; Site characterization and quantification; Seismic zonation map of India; factors affecting seismic microzonation, seismic microzonation of mega cities

Seismotectonic Sources and Seismicity Data: Geological and seismological criteria used for source identification and source geometry; Characteristics and Delineation of Seismic Sources for Seismic Hazard Analysis; Modeling of fault segments in hazard analysis; Completeness in size and time; Estimation of maximum probable magnitude.

Earthquake Occurrence Models and Ground Motion Prediction Equations: Gutenberg Richter frequency magnitude distribution, return period; log normal distribution, Strong motion attenuation relationships, PGA and spectral accelerations

Deterministic and Probabilistic Seismic Hazard Analysis: Deterministic and probabilistic seismic hazard methods; Types of earthquake sources-point, line and areal sources, Epistemic and aleatory uncertainty estimation, deaggregation, logic tree, hazard estimation at the bedrock level, design specifications for structures and foundations under seismic loading

Seismic Microzonation Deliverables: Amplification maps, fundamental frequency map, probability of exceedance of strong ground motion; Liquefaction potential maps; Landslide hazard zonation maps

Learning Resources:

Text Books:

1. Geotechnical Earthquake Engineering, Kramer, S. L., Pearson Education, 2004.
2. Earthquake Hazard Analysis, Issues and Insights, Reiter, L., Columbia University Press, 2001.
3. Geotechnical Earthquake Engineering, Ikuo Towhata, Springer, 2008

Reference Books:

1. Earthquake Microzoning, Antoni Roca and Carlos Oliveria, Birkhauser Verlag, Berlin, 2002.
2. Geotechnical Earthquake Engineering Handbook, Day Robert W., McGraw-Hill, New York, 2001.
3. Recent Advances in Earthquake Geotechnical Engineering and Microzonation, Ansal, Atilla, Springer, 2004.

Online Resources:

1. https://nptel.ac.in/courses/105/108/105108074/#

Course Code: CE464	WATERSHED MANAGEMENT	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Identify the causes of soil erosion
CO2	Plan and design soil conservation measures in a watershed
CO3	Plan and design water harvesting and groundwater recharging structures.
CO4	Plan measures for reclamation of saline soils

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	1	1	1	1	-	-	-	-	1	2	-	3	-
CO2	3	2	3	1	1	1	1	-	-	-	-	1	2	-	3	-
CO3	3	2	3	1	1	1	2	-	-	-	-	1	2	-	3	2
CO4	3	2	3	1	1	1	2	-	-	-	-	1	1	-	3	2

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction, concept of watershed, need for watershed management, concept of sustainable development, Hydrology of small watersheds.

Principles of soil erosion, causes of soil erosion, types of soil erosion, estimation of soil erosion from small watersheds, Control of soil erosion, methods of soil conservation – structural and non-structural measures.

Principles of water harvesting, methods of rainwater harvesting, design of rainwater harvesting structures.

Artificial recharge of groundwater in small watersheds, methods of artificial recharge.

Reclamation of saline soils, Micro farming, biomass management on the farm.

Learning Resources:

Text Books:

1. Watershed Management, Murthy, J.V.S., New Age International Publishers, 2017 2nd Edition
2. Land and Water Management, Murthy, V.V.N., and Jha , M.K., Kalyani Publishers, 2013 6th Edition

References:

1. Soil and Water Conservation Engineering, Suresh, R., Standard Publishers, 1998
2. Water Resources Conservation and Management, Chatterjee, S.N., Atlantic Publishers, 2008
3. Common Guidelines for Watershed Development Projects, Government of India, 2008

Online resources:

1. https://nptel.ac.in/courses/105/101/105101010/
2. http://ecoursesonline.iasri.res.in/course/view.php?id=542

Course Code: CE465	PEDESTRIAN AND BICYCLE FACILITY DESIGN	Credits 3-0-0: 3

Pre-Requisites: Transportation Engineering - 1

Course Outcomes:

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

CO1	Quantify the benefits of creating walkable and bikeable environments.
CO2	Analyse the characteristics of pedestrians and bicyclists.
CO3	Design and Implement pedestrian and bicycle facilities.
CO4	Assess bicycle and pedestrian safety and existing facilities.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1	-	-	-	-	-	-	-	1	1	-	1	-
CO2	3	3	1	-	-	-	1	-	-	-	-	-	-	-	3	-
CO3	3	2	3	-	-	1	1	-	-	-	-	-	-	-	2	1
CO4	3	1	1	1	1	1	2	-	-	-	-	1	-	-	1	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Pedestrian and Bicycle Facilities: Need for pedestrian and bicycle facilities; sustainable transport modes; measuring current non-motorized travel; predicting potential non-motorized travel; evaluating existing conditions and prioritize improvements.

Pedestrian and Bicycle Data Analysis: Characteristics of pedestrian and bicycle; surveys; crash data; barrier effect; cycling condition evaluation techniques; pedestrian condition evaluation techniques; prioritizing improvements and selecting preferred options; demand estimation and analysis.

Planning and Design of Pedestrian Facility: Pedestrian facilities and planning; pedestrian standards and improvements; design of pedestrian facilities sidewalks, crosswalks, Foot over bridges; level of service.

Planning and Design of Bicycle Facility: Bicycle network planning; Integrating cycling into roadway planning; accommodating cyclists on rural roads; design of bicycle boulevards/bike paths; bicycle parking/storage facilities; roadway maintenance for cyclists.

Pedestrian and Bicycle Operation, Safety: Trends in walking and bicycle safety; safety at school zones; pedestrian safety action plans; pedestrian signs and markings; bicycle-specific traffic signs; first and last-mile connectivity with public bikes haring.

Learning Resources:

Text Books:

1. Transportation Engineering, Khisty, C.J., and Lall, B.K., Pearson, 2017, Third Edition.
2. Sustainable Transport: Planning for walking and cycling in urban environments, Tolley, R., CRC Press; 2003, First Edition.

Reference Books:

1. Bicycle Transportation: A Handbook for Cycling Transportation Engineers, Forester, J., MIT Press, 1994.

2. Design and Safety of Pedestrian Facilities: A Recommended Practice of the Institute of Transportation Engineers, Zegeer, C.C.V., TENC-5A-5 Engineering Council Committee Traffic, The Institute of Transportation Engineers, 2016.
3. Pedestrian- and Transit-Oriented Design, Ewing, R., and Bartholomew, K., Urban Land Institute Publishing House, 2013.
4. Pedestrian Planning and Design, Fruin, McGraw Hill Publication, 1987.
5. Planning and Management of Bikes haring for Sustainable Urban Transport, Cihan, E., LAP Lambert Academic Publishing, 2014.
6. The Bicycle Planning, Hudson, M., Open Books, 1982.

Online Resources:

1. CREATING WALKABLE + BIKEABLE COMMUNITIES: A user guide to developing pedestrian and bicycle master plans (OTREC) http://www.pdx.edu/ibpi/sites/www.pdx.edu.ibpi/files/IBPI%20Master%20Plan%20Handbook%20FINAL%20(7.27.12).pdf
2. https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/strategic_agenda/,
3. Federal Highway Administration. (2015). Separated Bike Lane Planning and Design Guide https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/separated_bikelane_pdg/page00.cfm
4. https://dusp.mit.edu/cdd/news/cycling-infrastructure-first-mile-solution-mass-transit-access

Course Code: CE466	FINITE ELEMENT METHODS	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

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

CO1	Develop shape functions and stiffness matrices different finite elements
CO2	Develop global stiffness matrices and global load vectors
CO3	Apply natural and arial coordinate systems to constant strain triangle and linear strain
CO4	Analyze planar structural systems using finite element modeling

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	1	3	-	-	-	-	1	-	-	-	-	-	-	2	-
CO2	-	-	2	3	-	-	-	1	-	-	-	-	-	-	2	-
CO3	-	-	2	3	-	-	-	1	-	-	-	-	-	-	2	-
CO4	-	-	3	2	-	-	-	1	-	-	-	-	-	-	3	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Matrix Methods of Structural Analysis: Review of concepts – Actions and displacements – compatibility – indeterminacy – Member and joint loads – Flexibility Matrix formulation - Stiffness Matrix formulation.

Introduction to Finite Element Method: Background and general description of the method – summary of the analysis procedure.

Theory of Finite Element method: Discretisation concept- Concept of element – various elements shapes – displacement models – Convergence- shape functions – condensation of internal degrees of freedom-Summary of analysis procedure.

Finite Element Analysis: Development of shape functions for different elements-Spring- Truss-Beam-Plane elements- Plane stress and plane strain-Assemblage of elements construction of stiffness matrix and loads – boundary conditions –patch test-solution of overall problem.

Isoparametric Formulation: Concept of Isoparametric element – One and Two dimensional elements-Natural coordinates- Development of Higher order elements- Lagrange – Serendipity –Interpolation-formulation of element stiffness and loads.

Application to Solid Mechanics problems: Analysis of Trusses – Beams – Frames and 3D space elements.

Learning Resources:

Text Books:

1. Finite Element Analysis: Theory and Programming, C Krishnamoorthy, McGraw Hill Pub., 2017, 2nd Edition.
2. Introduction to Finite elements in Engineering, Tirupathi chandra Patla and Belugundu, Pearson, 2015, 4th Edition,.
3. The Finite element Method in Engineering, S. S. Rao, Elsevier Publication, 2020, 6th Edition

Reference Books:

1. Finite Element Method: Its Basic and Fundamentals, O.C. Zeinkiewicz, Butterworth Heinemann, 2007, 6th Edition.

2. Textbook of Finite Element Analysis, P. Seshu, PHI Pub., 2003
3. Introduction To Finite Element Method, J. N. Reddy, McGraw Hill Pub., 2020, 4th Edition
4. Fundamentals of finite element analysis, David Hutton, McGraw Hill Pub., 2017.
5. Numerical Methods in Finite Element Analysis, Bathe K J, Prentice-Hall civil engineering and engineering mechanics series, 2016.

Online Resources:

1. https://nptel.ac.in/courses/105/105/105105041/

Course Code: CE467	HYDROPOWER ENGINEERING	Credits 2-0-0: 2

Pre-requisites: None

Course Outcomes:

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

CO1	Estimate hydropower potential
CO2	Identify types of hydropower plants
CO3	Design penstocks and surge shaft
CO4	Plan the layout of a hydropower plant

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	3	1	2	-	-	-	-	1	1	-	3	2
CO2	3	3	3	2	3	1	1	-	-	-	-	1	2	-	3	
CO3	3	3	3	2	3	1	1	-	-	-	-	1	1	-	3	2
CO4	3	3	3	1	3	1	1	-	-	-	-	1	1	-	3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Stream flow analysis, Hydrograph, Mass curve, Runoff estimation methods, estimation of hydropower potential, flow duration curves, power duration curves, pondage and storage.

Electrical load on hydro turbines, load curves, load duration curves, Performance factors.

Types of hydropower plants, Storage power plant, Runoff River plant, Pumped storage plant, two units and three unit arrangements, Reversible pump turbines, types of turbines, hydraulics of turbines, cavitation in turbine, efficiency of pumped storage plants.

Intakes, losses in intakes, air entrainment at intake, inlet aeration, Water conveyance systems, fore bay, canals, Tunnels and Penstocks, classification of penstocks, design criteria of penstock, economical diameter of penstock, Anchor blocks, Conduit valves, types of valves, bends and manifolds.

Water hammer, resonance in penstocks, channel surges, Gates, Surge tanks, Power house layout, lighting and ventilation, variations in design of power house, underground power house, structural design of power house.

Learning Resources:

Text Books:

1. Irrigation Water Resources and Hydropower Engineering, Modi P.M., Standard Publishing Company, New Delhi, 2000.
2. Water Power Engineering, Vikas Publishing Company, Dandekar, M.M., and Sharma, K.N., New Delhi, 2003

Reference Books:

1. Hydroelectric and Pumped Storage Plants, Jog, M.G., Wiley Eatern Ltd., New York, 1989.
2. Hydro Power Structures, Varshney, R.S., Nem Chand & Bros. 2001.
3. Hydropower Engineering, Warnick, C.C., Prentice-Hall. 1984.

Online Resources:

1. https://nptel.ac.in/courses/105/105/105105110/
2. https://nptel.ac.in/courses/105/104/105104103/
3. https://nptel.ac.in/content/storage2/courses/105105110/pdf/m5l01.pdf

Course Code: CE468	NOISE POLLUTION	Credits 2-0-0: 2

Pre-requisites: None

Course Outcomes:

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

CO1	Classify the type of noise pollution
CO2	Identify the sources of noise pollution
CO3	Evaluate the adverse impacts of noise pollution
CO4	Design noise pollution control devices

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1
CO2	2	2	3	2	1	1	1	1	2	1	2	3	1	2	1	2
CO3	3	1	2	1	2	2	2	1	1	2	2	1	1	2	1	1
CO4	1	2	3	1	1	2	2	2	1	1	1	2	3	3	2	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Basics of acoustics and specification of sound; sound power, sound intensity and sound pressure levels; Sources and Effects of Noise; Sources and typical range of noise levels, types of noise pollution.

Characteristics of noise, Industrial noise, Transportation noise, Urban noise, Specific noise sources, Effects of noise on the human health environment, Reactions to noise, Psychological effects.

Measurement of noise, Assessment and Evaluation Basic definitions and terminology, Frequency sensitivity and equal loudness characteristics, Vibration and vibration Measurement, Measuring Noise at workplace and community levels,

Noise control and abatement measures, Noise control at the source, Source-Path-Receiver Concept, Control of Noise Source by Design, Control of Noise Source by Redress, Noise control in the transmission path, Acoustical Separation, Physical Barriers, Isolators and Silencers, Protecting the receiver, Work Schedules, Equipment and Shelters

Learning Resources:

Text Books:

1. Environmental Noise Pollution: Noise Mapping, Public Health, and Policy Book by Enda Murphy and Eoin King, Elsevier, 2014.
2. Environmental Pollution Control Engineering by C. S. Rao, 2018

Reference Books:

1. Advanced Air and Noise Pollution Control: Volume 2 (Handbook of Environmental Engineering) Lawrence K. Wang, Norman C. Pereira, Yung-Tse Hung, 2004.
2. Industrial Noise Control and Acoustics Randall F. Barron,2002
3. Noise Control in Industry A Practical Guide Nicholas P. Cheremisinoff,, 1997.
4. Downloaded Integrated Pollution Prevention and Control Chris Backes, Gerrit Betlem, 1999.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc19_me72/preview
2. https://www.iberdrola.com/environment/what-is-noise-pollution-causes-effects-solutions
3. https://www.environmental-expert.com/health-safety/noise-pollution/training

Course Code: CE469	CONSTRUCTION PLANNING AND MANAGEMENT TOOLS	Credits 2-0-0: 2

Pre-requisites: None

Course Outcomes:

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

CO1	Prepare organizational, Enterprise and work breakdown structure for a construction Project
CO2	Develop project Schedule for a construction Project
CO3	Determine task dependencies and allocate resources
CO4	Prepare project reports

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	1	1	-	3	-	-	-	1	-	1	-	-	-	-	-
CO2	-	2	2	-	3	-	-	-	2	-	2	1	-	-	-	-
CO3	-	2	2	-	3	-	-	-	3	-	2	-	-	-	-	-
CO4	-	-	1	-	3	-	-	-	1	2	1	-	-	-	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Microsoft Project tool: Setting up of project, Calendars, Configuration of Time units, currency, Work and duration calculation units, Creating a Work Break down Structure, Determining the task dependencies, define and allocate resources, Develop baseline schedule and Tracking the baseline, Communicating the project through reports.

Primavera Tool: Creating a Project, Duration types, Percent Completion types, developing an Organizational Breakdown Structure (OBS), Enterprise Project Structure (EPS), and Work Breakdown Structure (WBS), Define and allocate resources, Develop Baseline schedule and tracking the baseline, communicating the project through reports.

Learning Resources:

Text Books:

1. Project planning & scheduling using primavera, Paul Harris, Eastwood Harris Private Limited, 2012
2. Manual for MS Project 2019 Step by Step, Lewis, C., Chatfield, C., & Johnson, T., Microsoft Press, 2019, First Edition.

Reference Books:

1. The Project Managers Guide to Microsoft Project 2019, Cicala, G., Apress, Berkeley, CA 2020.
2. Project Planning and Control with PERT and CPM, Punmia and Khandelwal K.K., Laxmi Publications Delhi, 2016

Online Resources:

1. https://www.youtube.com/watch?v=OuOZVoTwqm8
2. https://www.youtube.com/watch?v=0qAqID1NVq0

Course Code: CE470	REHABILITATION OF STRUCTURES	Credits 2-0-0: 2

Pre-requisites: Concrete Technology

Course Outcomes:

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

CO1	Identify the reasons for distress and deterioration of structures.
CO2	Apply NDE for condition assessment of structures in distress
CO3	Select a suitable repair material for various field applications
CO4	Select suitable repair and rehabilitation methods for Civil Infrastructure

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO31	PSO4
CO1	3	3	2	2	1	-	1	-	2	2	-	1	-	2	-	-
CO2	2	2	1	3	3	-	-	-	2	-	-	2	-	-	2	-
CO3	2	1	1	-	-	-	2	1	1	-	1	1	-	3	2	-
CO4	3	1	2	1	1	-	-	1	1	1	1	2	-	1	2	-
CO5	3	3	2	2	1	-	1	-	2	2	-	1	-	2	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction: Causes of distress in concrete structures- Permeability of concrete, aggressive chemical agents, durability aspects, Holistic models for deterioration of concrete

Condition Survey: Preliminary inspection, planning stage, visual inspection, field laboratory testing stage, consideration for repair strategy

Non-Destructive Evaluation tests: Estimation of Strength, Chemical and other durability tests, estimation of corrosion potential

Selection of repair materials for concrete: Ideal characteristics for selection of repair materials, premixed cement concrete and mortars, polymer modified mortars and concrete, epoxy and epoxy systems

Repair /Rehabilitation methods: Shortcreting and Guniting. Repair and strengthening of columns and beams using ferrocement jacketing, fiber wrap technique, Foundation Rehabilitation methods

Learning Resources:

Text Books:

1. Concrete Structures-Repair, Rehabilitation and Retrofitting, B.Bhattacharjee, CRS Publishers and Distributors, 2017.
2. Concrete Structures-Protection, Repair and Rehabilitation, R.Dodge Woodson, Elsevier, 2009.
3. Concrete Technology, Santhakumar A.R, Oxford University Press, New Delhi, 2007

Reference Books:

1. CPWD Handbook on Repair and Rehabilitation of RCC buildings, Govt of India Press, New Delhi, 2014.
2. ACI 546R-14, Guide to Concrete Repair, American Concrete Institute, 2014

Online Resources:

1. https://nptel.ac.in/courses/105/106/105106202/
2. https://www.concrete.org/store/productdetail.aspx?ItemID=W1506&Format=ONLINE_LEARNING&Language=English&Units=US_Units
3. https://www.classcentral.com/course/swayam-maintenance-and-repair-of-concrete-structures-17678
4. https://www.classcentral.com/course/swayam-maintenance-and-repair-of-concrete-structures-17678

Course Code: CE471	CONSTRUCTION GEOTECHNIQUES	Credits 2-0-0: 2

Pre-requisites: Geotechnical Engineering - 1 & 2

Course Outcomes:

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

CO1	Comprehend the advanced construction methods in geotechnical engineering.
CO2	Apply the current piling methods / techniques for specific works
CO3	Apply different construction techniques in deep excavation for Engineering works
CO4	Comprehend the application of diaphragm walls for Engineering works
CO5	Comprehend and apply suitable tunnel driving /excavation method for specific ground conditions

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	3	-	3	-	-	-	3	3	-	2	-	-	3	-
CO2	-	-	3	-	3	-	-	-	3	3	-	2	-	-	3	-
CO3	-	-	3	-	3	-	-	-	2	3	-	2	-	-	3	-
CO4	-	-	3	-	3	-	-	-	2	3	-	2	-	-	3	-
CO5	-	-	3	-	3	-	-	-	3	3	-	2	-	-	3	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Deep Excavation Techniques: Need for deep excavations, susceptibilities of deep excavations-oozing of water, caving of sides; supporting techniques- bracing and sheet pile walls, piling, secant piling, nailing, coffer dams.

Special Piling Techniques: Special piling applications, construction techniques for Special cased concrete piles and uncased concrete piles, screw piles, micro-piles.

Drilled Piers: Applications of drilled piers, Construction techniques of drilled piers: Chicago method, Gow method, dry method, casing method and slurry method, potential construction problems.

Diaphragm walls: Applications of diaphragm walls, Construction of deep diaphragm walls of rigid and flexible type, secant pile walls.

Shafts and Tunnels: Applications of shafts and tunnels, types, excavation techniques in soils-cut and cover method, bored tunnel method, clay kicking method, shaft method, pipe jacking method, box jacking method; Under water tunnels; excavation methods in rock- full face method, top heading and benching method, pilot tunnel method, spiral drilling and blasting method and TBM.

Learning Resources:

Text Books:

1. Introduction to Modern Techniques in Geotechnical Engineering, Nainan P. Kurian, 2019, Alpha Science, 1st Edition.
2. Construction and Geotechnical Methods in Foundation Engineering, R.M. Koerner, 1984, 1st Edition.

Reference Books:

1. Basic and Applied Soil Mechanics, Gopal Ranjan and A.S.R. Rao, New Age Int. Publishers, 2019, 3rd Edition.
2. Geotechnical Engineering, V.N.S. Murthy, CBS Publishers, 2018, 1st Edition.

Online Resources:

1. https://nptel.ac.in/courses/105/103/105103206/

Course Code: CE472	LOW VOLUME ROADS	Credits 2-0-0: 2

Pre-requisites: None

Course Outcomes:

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

CO1	Plan low-volume road network.
CO2	Design low volume road geometrics
CO3	Identify appropriate marginal materials for cost-effective construction of LVRs.
CO4	Select an appropriate pavement construction technique and perform quality control tests

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	1	1	1	-	1	2	-	1	3	-	-	-
CO2	2	3	3	3	2	2	1	-	-	-	-	-	1	2	3	-
CO3	2	2	3	3	2	2	2	1	-	1	-	1	-	-	3	2
CO4	3	2	2	3	2	2	-	1	-	1	-	-	-	2	2	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Low Volume Road Network Planning: Significance, definition, characteristics of LVRs and terminology, PMGSY, development of LVRs in India, Master plan and core network concepts, network planning and models, detailed project report preparation, and GIS-based rural road network planning.

Geometric Design of LVRs: Topography and physical features, traffic, geometric design standards for LVRs with special reference to PMGSY, Hill Road standards, design concepts and criteria, cross-sectional elements, CD works, horizontal alignment, vertical alignment, and traffic engineering requirements.

Waste and Marginal Materials: Waste materials, marginal materials, guidelines, dealing with poor subgrades, framework for appropriate use of marginal materials, Geosynthetic applications and functions.

Construction and Specifications of LVRs: Conventional construction methods, specifications, new technologies, construction methods and benefits, low-cost construction techniques, quality control and assurance mechanism and MoRD specifications.

Learning Resources:

Textbooks:

1. Low Volume Road Engineering: Design, Construction and Maintenance, Robert A., Douglas Ninth Edition, CRC Publishers, January 2016
2. Low-Volume Roads Engineering: Best Management Practices Field Guide, Gordon Keller & James Sherar, USDA Forest Service / USAID, 2003.

References Books:

1. Ethiopian Roads Authority, Design Manual for Low Volume Roads, Parts A-G.
2. Introduction to Transportation Planning, Bruton, M. J., UCL Press, London, UK, 1992.
3. IRC SP 20: Rural Road manual, Indian road congress, New Delhi, 2002.

4. Principles of Pavement Design, Yoder E.J. and M.W. Witczak., John Wiley and Sons, New York, USA, 2012, Second Edition.
5. Specifications for Rural Roads, Ministry of Rural Development, Indian Road Congress, New Delhi, 2014, Fifth revision.

Online Resources:

1. https://www.fs.fed.us/t-d/programs/forest_mgmt/projects/lowvolroads/
2. https://pdf.usaid.gov/pdf_docs/PNADB595.pdf
3. http://www.trb.org/LowVolumeRoadsConference/LVR10Literature.aspx
4. https://pmgsy.nic.in/publications