DEPARTMENT OF CIVIL ENGINEERING

Course Book for

B. Tech. in Civil Engineering

For

Academic Year
2025 - 2026

National Institute of Technology Goa

Program Outcomes for B. Tech. in

Civil Engineering

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review 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 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 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.

Scheme of Instructions for B. Tech. in Civil Engineering

Sl. No.	Course Code	Course Title	Type	L-T-P	Credits
3rd Semester					
1	MA200	Advanced Differential Equations and Complex Analysis	BS	2-1-0	3
2	CV200	Mechanics of Solids	DC	3-0-0	3
3	CV201	Mechanics of Fluids	DC	3-0-0	3
4	CV202	Surveying	DC	3-0-0	3
5	CV203	Engineering Geology	DC	2-1-0	3
6	CV204	Building and Construction Materials	DC	3-0-0	3
7	CV205	Material Testing Laboratory	DC	0-0-3	2
8	CC206	Fluid Mechanics Laboratory	DC	0-0-3	2
9	CV207	Surveying Laboratory	DC	0-0-3	2
4th Semester					
1	XX250	Innovation and Entrepreneurship	HU/HM	1-0-0	1
2	CV250	Computational Methods in Civil Engineering	DC	2-0-2	3
3	CV251	Structural Analysis	DC	3-1-0	4
4	CV252	Geotechnical Engineering	DC	3-0-0	3
5	CV253	Environmental Engineering	DC	3-0-0	3
6	CV254	Highway Engineering	DC	3-0-0	3
7	CV255	Concrete Technology Laboratory	DC	0-0-3	2
8	CV256	Building Design and Drafting Studio	DC	0-0-3	2
5th semester					
1	ES300	Environmental Studies	HU/HM	1-0-0	1
2	CV301	Design of Reinforced Concrete Structures	DC	3-1-0	4
3	CV302	Advanced Structural Analysis	DC	3-1-0	4
4	CV5XX	Elective-I	DE/OE	3-0-0	3
5	CV303	Foundation Engineering	DC	3-0-0	3
6	CV304	Waste Water Engineering	DC	3-0-0	3
7	CV300	Seminar	DC	0-0-2	1
8	CV305	Transportation Engineering Laboratory	DC	0-0-3	2
9	CV306	Geotechnical Engineering Laboratory	DC	0-0-3	2
6th semester					
1	HU300	Human Values and Professional Ethics	HU/HM	1-0-0	1
2	CV350	Estimation, Costing and Specification	DC	3-1-0	4
3	CV351	Design of Steel Structures	DC	3-1-0	4
4	CV352	Engineering Hydrology and Irrigation Systems	DC	3-1-0	4
5	CV5XX	Elective-II*	DE	3-0-0	3
6	CV353	Structural Design Studio	DC	0-0-3	2
7	CV354	Environmental Engineering Laboratory	DC	0-0-3	2
8	IKXXX	OE-IKS	OE-IKS	3-0-0	3
7th semester					
1	HS300	Industrial Economics	HU/HM	3-0-0	3
2	CV401	Summer Project/Industrial Training	DC	0-0-2	1
3	CV402	Major Project-1	DC	0-0-3	2
4	CV400	Comprehensive Examination	DC	0-0-0	1
5	CV5XX	Elective-III	DE/OE	3-0-0	3
6	CV5XX	Elective-IV	DE/OE	3-0-0	3
7	CV5XX	Elective-V	DE/OE	3-0-0	3
8	CV5XX	Elective-VI	DE/OE	3-0-0	3
8th semester					
1	CV550	Major project-II	DC	0-0-6	3

2	CV5XX	Elective-VII	DE/OE	3-0-0	3
3	CV5XX	Elective-VIII	DE/OE	3-0-0	3
4	CV5XX	Elective-IX	DE/OE	3-0-0	3
5	CV5XX	Elective-II[#]	DE/OE	3-0-0	3

* offered only for students who have not opted for minor course.
[#] offered only for students who have opted for minor course

Note: A student can register only one open elective (OE) per semester and a maximum of two OE in the B.Tech tenure. This is excluding the Indian Knowledge Systems (IKS) course offered in the VIth semester. Since IKS is a mandatory OE, students are not allowed to register for an OE in that semester.

List of Electives

Sl. No.	Course Code	Course Title	Type	L-T-P	Credits
1.	CV501	Railway, Airport and Harbour Engineering	DE	3-0-0	3
2.	CV502	Advanced Surveying	DE	3-0-0	3
3.	CV503	Irrigation and Hydraulic Structures	DE	3-0-0	3
4.	CV504	Prestressed concrete Structures	DE	3-0-0	3
5.	CV505	Road Safety and Management	DE	3-0-0	3
6.	CV506	Earth retaining structures	DE	3-0-0	3
7.	CV507	Construction Planning and Management	DE	3-0-0	3
8.	CV508	Concrete Composite Materials	DE	3-0-0	3
9.	CV509	Solid waste management	DE	3-0-0	3
10.	CV510	Groundwater hydrology	DE	3-0-0	3
11.	CV511	Hazardous waste management	DE	3-0-0	3
12.	CV512	Advanced Highway Engineering	DE	3-0-0	3
13.	CV513	Geotechnical Investigation of Construction Projects	DE	3-0-0	3
14.	CV514	Advanced RCC structures	DE	3-0-0	3
15.	CV515	Engineering optimization	DE	3-0-0	3
16.	CV516	Ocean Engineering	DE	3-0-0	3
17.	CV517	Structural Stability	DE	3-0-0	3
18.	CV518	Remote Sensing and GIS	DE	3-0-0	3
19.	CV519	Non Destructive Testing and Evaluation	DE	3-0-0	3
20.	CV520	Finite Element Method	DE	3-0-0	3
21.	CV521	Pavement Design	DE	3-0-0	3
22.	CV522	Advanced Foundation Engineering	DE	3-0-0	3
23.	CV523	Environmental pollution and Control	DE	3-0-0	3
24.	CV524	Quality and Safety in Construction	DE	3-0-0	3
25.	CV525	Structural Dynamics	DE	3-0-0	3
26.	CV526	River Engineering	DE	3-0-0	3
27.	CV527	Design of Concrete Bridges	DE	3-0-0	3
28.	CV528	Geo-environmental Engineering	DE	3-0-0	3
29.	CV529	Occupational health and Safety Act	DE	3-0-0	3
30.	CV530	Non-Conventional and Renewable Energy	DE	3-0-0	3
31.	CV531	Water Distribution Systems	DE	3-0-0	3
32.	CV532	Smart Materials and Structures	DE	3-0-0	3
33.	CV533	City and Urban Planning	DE	3-0-0	3
34.	CV534	Pavement Evaluation and Management	DE	3-0-0	3

35.	CV535	Irrigation Structures and Hydropower Engineering	DE	3-0-0	3
36.	CV536	Industrial Waste Treatment	DE	3-0-0	3
37.	CV537	Ground Improvement Techniques	DE	3-0-0	3
38.	CV538	Repair and Rehabilitation of Structures	DE	3-0-0	3
39.	CV539	Computational Fluid Dynamics	DE	3-0-0	3
40.	CV540	Soil Dynamics and Design of Machine Foundations	DE	3-0-0	3
41.	CV541	Advanced Steel Structures	DE	3-0-0	3
42.	CV542	Structural Health Monitoring	DE	3-0-0	3
43.	CV543	Reinforced Earth and Geosynthetics	DE	3-0-0	3
44.	CV544	Urban Stormwater Management	DE	3-0-0	3
45.	CV545	Traffic Engineering	DE	3-0-0	3
46.	CV546	Disaster management and Mitigation	DE	3-0-0	3
47.	CV547	Environmental Impact Assessment of Civil Engineering Projects	DE	3-0-0	3
48.	CV548	Air and noise pollution control	DE	3-0-0	3
49.	CV549	Earthquake resistant structures	DE	3-0-0	3
50.	CV550	Rapid Transport Systems and Smart Cities	DE	3-0-0	3
51.	CV551	Rock Mechanics and Engineering	DE	3-0-0	3
52.	CV552	Forensic Structural Engineering	DE	3-0-0	3
53.	CV553	Wind Resistant Designs	DE	3-0-0	3
54.	CV554	Tunnel and Underground Structures	DE	3-0-0	3
55.	CV555	Offshore structures	DE	3-0-0	3
56.	CV556	Numerical Modelling in Geotechnical Engineering	DE	3-0-0	3
57.	CV557	Hydro climatology	DE	3-0-0	3
58.	CV558	Green Building Design	DE	3-0-0	3

Semester-wise courses of Second year B. Tech. Programme

III Semester

Sl.No.	Course Code	Course Name	Type	L-T-P	Credits
1	MA200	Advanced Differential Equations and Complex Analysis	BS	2-1-0	3
2	CV200	Mechanics of Solids	DC	3-0-0	3
3	CV201	Mechanics of Fluids	DC	3-0-0	3
4	CV202	Surveying	DC	3-0-0	3
5	CV203	Engineering Geology	DC	2-1-0	3
6	CV204	Building and Construction Materials	DC	3-0-0	3
7	CV205	Material Testing Laboratory	DC	0-0-3	2
8	CV206	Fluid Mechanics Laboratory	DC	0-0-3	2
9	CV207	Surveying Laboratory	DC	0-0-3	2
Total Credits					**24**

IV Semester

Sl.No.	Course Code	Course Name	Type	L-T-P	Credits
1	IE250	Innovation and Entrepreneurship	OT	1-0-0	1
2	CV250	Computational Methods in Civil Engineering	DC	2-0-2	3
3	CV251	Structural Analysis	DC	3-1-0	4
4	CV252	Geotechnical Engineering	DC	3-0-0	3
5	CV253	Environmental Engineering	DC	3-0-0	3
6	CV254	Highway Engineering	DC	3-0-0	3
7	CV255	Concrete Technology Laboratory	DC	0-0-3	2
8	CV256	Building Design and Drafting Studio	DC	0-0-3	2
Total Credits					**21**

Detailed Syllabi of Second year courses

Course Code	Course Name	L	T	P	Credits
MA200	Advanced Differential Equations and Complex Analysis	2	1	0	3

Pre-requisites: Nil

Pre-requisites: Nil

Course Objectives

This course is crafted to provide engineers and scientists with a comprehensive grasp of series solutions for both ordinary differential equations and partial differential equations. Further, with a focus on key principles such as complex variables and their practical applications, students will develop a deep understanding of applied mathematics and its real-world implications

Course Outcomes

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

CO1: Acquire a solid comprehension of advanced techniques for solving ordinary differential equations (ODEs) and apply them to address challenging engineering problems.

CO2: Comprehend the significance and analytical solving methods for one-dimensional heat and wave equations, as well as two-dimensional elliptic equations.

CO3: Grasp the fundamentals of complex variables, complex functions, and the processes of complex differentiation and integration.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	M	-	-	L	L	M	-	H
CO2	H	H	H	H	H	-	-	L	L	M	-	H
CO3	H	H	H	H	H	-	-	L	L	M	-	H

Syllabus

Module 1: Series Solutions of ODEs: **Special Functions**: Power series method, Legendre's equation, Legendre polynomials and its properties, Extended power series method: Frobenius method, Bessel's equation, Bessel functions and its properties, Bessel functions of the second kind, General solution of Bessel's equation. Sturm–Liouville Problems, Orthogonal Functions, Orthogonality of Legendre Polynomials, Orthogonal Series, Generalized Fourier Series

Module 2: Advanced Partial Differential Equations: Vibrating string problem, Fourier series solutions for 1D wave equation, D'Alembert's solution of the wave equation, Fourier series solutions for 1D heat equation, Steady state 2D heat problems, Laplace equation in polar coordinates.

Module 3: Complex analysis: Functions of a complex variable, Analytic functions, Cauchy-Riemann equations, Elementary complex functions, Contours and contour integration, Cauchy's theorem, Cauchy integral formula; Power Series and properties, Taylor series, Laurent series, Zeros, Singularities, Poles, Essential singularities, Residue theorem, Evaluation of real integrals and improper integrals.

Reference Books/Material

1. Advanced Engineering Mathematics, E. Kreyszig, 8th Edition, John Wiley,1999.
2. Linear Partial Differential Equations for Scientists and Engineers, T. Myint-U and L. Debnath, Birkhäuser Boston, MA, 2006.
3. Complex variables and applications, Churchill R V, Brown J W, 7th Edition, McGraw-Hill, 2003

Course Code	Course Name	L	T	P	Credits
CV200	Mechanics of Solids	3	0	0	3

Pre-requisites: Engineering Mechanics

Course Objectives

1. Estimate solutions for elementary problems of mechanics of solids.
2. Understand the behaviour of complex stresses on plane stress problems.
3. Acquire all necessary fundamentals needed for pursuing courses on Structural Analysis and Structural Design.
4. Understand the behaviour of beams under the action of bending & torsion.
5. Develop the ability to check the stability of the columns & pressure vessels.

Course Outcomes

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

CO1: Analyze the elementary problems of mechanics of solids.

CO2: Estimate the normal and tangential stresses developed on plane stress problems.

CO3: Fulfill the basic requirements for upcoming courses like structural Analysis & Structural Design.

CO4: Compute the bending and torsional stresses of the beam problem.

CO5: Analyze the stability parameters of columns & pressure vessels under the action of loads.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	H	M	L	L	L	L	L	L	L	M
CO2	H	H	M	H	L	L	L	L	L	L	L	M
CO3	M	H	H	M	L	L	L	L	L	L	L	M
CO4	H	H	H	H	L	L	L	L	L	L	L	M
CO5	H	H	M	M	L	L	L	L	L	L	L	M

Syllabus

Module 1 Stress & Strain: Introduction to material properties, Types of forces, Concept of stress & strain, Stress tensor & strain tensor, plane stress & Plane strain, differential equations of stress equilibrium, Saint Venant's equation of compatibility, Stress-strain diagram of ductile and brittle material, Generalized Hooke's law, Principle of superposition, compound and composite bars, thermal stresses and strain, statically determinate and indeterminate problems, Stresses due to lack of fit or pre-strain, strain rosettes, Elastic Constant, Normal stress & tangential stress, Analytical & Graphical methods of stress analysis, Concept of principal stress, principal plane and its computation; Normal strain & tangential strain, Analytical & Graphical methods of strain analysis, Concept of Principal strains, principal strain in three dimensions, computation of principal stresses from the principal strains; Theory of Elastic failure, Octahedral Shear stress theory, Superposition of yield surfaces; Concept of Strain Energy, Elastic strain energy.

Module 2 Shear Force & Bending Moment: Beams and support conditions, Types of supports and loads, shear force and bending moment, their diagrams for simply supported beams, cantilevers and overhanging beams.

Module 3 Stresses in Beam (Bending & Shear Stresses): Theory of simple bending–Stress distribution at a cross section due to Bending Moment and Shear Force, Curved bars, Unsymmetrical bending, Product moment of inertia, shear center.

Module 4 Torsion: Torsion of circular elastic bars, torsion equation, introduction to warping of non-circular bars, power transmitted by shaft and hollow circular sections, Springs: Close coiled helical spring subjected to axial load and axial torque.

Module 5 Columns: Short and Long Column, stability of a long column, Euler's Theory of Columns, differential equations of beam- columns, Derivation of Buckling Load for different end conditions, Rankine's Formula.

Module 6 Pressure Vessels: Thin and Thick cylinders subjected to internal pressures, Concept of stresses & strains, Hoop stress, Longitudinal stress in a cylinder, principal stresses in sphere and change in diameter and internal volume.

Reference Books/Material

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	Course Name	L	T	P	Credits
CV201	Mechanics of Fluids	3	0	0	3

Pre-requisites: Nil

Course Objectives

1: Estimate hydrostatic forces on structures.

2: Determine discharges in closed conduits and open channels.

3: Design and analyze piping systems and pipe-networks.

4: Plan experimental studies in fluid mechanics using the principles of similitude.

5: Formulate necessary equations required for the solution of fluid flow problems.

Course Outcomes

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

CO1: Calculate hydrostatic forces on various structures submerged in fluid.

CO2: Assess the discharge in closed and open channels.

CO3: Design and assess piping systems for efficient fluid flow.

CO4: Apply principles of dimensional analysis to design experiments.

CO5: Solve fluid flow problems with development of necessary formulae and appropriate boundary conditions.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	L	L	L	L	L	L	L	L	L
CO2	H	H	M	M	L	L	L	L	L	L	L	L
CO3	H	H	H	L	L	L	L	L	L	L	L	L
CO4	H	M	M	M	L	L	L	L	L	L	L	L
CO5	H	M	H	L	M	L	L	L	L	L	L	L

Syllabus

Module 1 Properties of Fluid: Surface tension, Viscosity, Ideal and real fluids, Newtonian and non- Newtonian fluids, Incompressible and compressible fluids. Fluid pressure and Hydrostatics, Pressure measuring devices, Total pressure and centre of pressure, Buoyancy, Centre of buoyancy, Metacentric height, Equilibrium analysis.

Module 2 Kinematics of Fluid Flow: Lagrangian and Eulerian approaches, Types of fluid flow, Continuity equation, Velocity potential function and Stream Function.

Module 3 Dynamics of Fluid Flow: Euler's Equation of motion, Momentum equation, Bernoulli's equation, Applications of Bernoulli's equation, Flow through Orifice, Mouth piece, Notches and weirs. Flow through pipes, friction and losses.

Module 4 Open Channel Flow: Critical depth, Concepts of Specific Energy and Specific Force, Chezy's and Manning's equations for uniform flow, Velocity distribution, Most efficient channel section, Hydraulic Jump, Evaluation of the jump elements in rectangular and non- rectangular channels on horizontal and sloping beds.

Module 5 Dimensional Analysis and Hydraulic Similitude: Dimensional Analysis, Buckingham's theorem, important dimensionless numbers and their significance.

Reference Books/Material

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.
4. Fluid Mechanics and Hydraulic Machines, Bansal R K, Laxmi Publication Pvt. Ltd, 2019.

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. Open Channel Hydraulics, Chow V.T., Blackburn Press, 2009.
7. Theory and Applications of Fluid Mechanics, Subramanya, K., McGraw Hill, New York, 1993

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	Course Name	L	T	P	Credits
CV202	Surveying	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Carry out field surveys for location, design and construction of engineering projects
2. Adopt suitable survey technique and select equipment based on the required level of accuracy and prevailing field conditions.
3. Carry out profiling and grid leveling, for generation of profiles, contour maps for earth works computations.
4. Work effectively with modern surveying equipment to improve the quality of surveys.
5. Analyze and synthesize survey data.

Course Outcomes

After completion of the course the students will be able to:

CO1: Classify the various types of surveys.

CO2: Understand the principles involved in the compass surveying

CO3: Know the various method in leveling

CO4: Find out the distances using a Theodolite

CO5: Know the various advanced survey instruments

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	M	L	L	L	L	L	L	L	L
CO2	H	M	M	M	L	L	L	L	L	L	L	L
CO3	H	M	M	M	L	L	L	L	L	L	L	L
CO4	H	M	M	H	H	L	L	L	L	L	L	L
CO5	H	H	M	M	L	L	L	L	L	L	L	L

Syllabus

Module 1 Surveying - Basic Concepts: Surveying definition - principles of surveying - plane surveying - geodetic surveying – Types of errors. Distance Measurement: Measurement methods (Tape, Tacheometry, EDM) - Taping Equipment - Taping on smooth level ground and sloping ground – Ranging - Systematic errors in taping and corrections (Tape standardization, Temperature, Tension, Sag, Slope and Alignment) – Electronic Distance Measurement – Principle of EDMs – Systematic errors and accuracy of EDM systems.

Module 2 Angle and Direction Measurement: Definitions (True meridian, Magnetic meridian, Bearings, Azimuths, Interior angles, Deflection angles) – Methods of determining angles and directions (Magnetic compass, Theodolite, Total station) – Prismatic compass – WCB system – Magnetic declination – Local attraction. Traversing: Traverse – Traverse stations – Types of traverse – Closed traverse computations and adjustments. Triangulation and Trilateration: Triangulation – Principle – Classification of triangulation

Module 3 Combined Distance and Angular measurement: Tacheometric surveying - Stadia method – Stadia constants – Elevation difference - Staff held vertical - Tangential tacheometry – Trigonometric levelling Total station systems - Features and functions – applications. Route surveying – Curves: Curves - Types - Elements of a curve - Simple curves - Setting out of curves using various methods – Geometry of compound curves and reverse curves – Introduction to transition and vertical curves.

Reference Books/Material

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
3. Surveying and Levelling – Part 1, Kanetkar T.P., and Kulkarni S.V., Surveying and Levelling – Part 1, Pune Vidyarthi Griha Prakashan, Pune, 1994.

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
3. Engineering Surveying, Schofield W and M Breach, , Elsevier, CBSPD, 6th edition, 2007.
4. Surveying and Levelling, Subramanian R, Oxford University Press, 2nd edition, 2012

Online Resources:

1. https://nptel.ac.in/courses/105/107/105107122/
2. https://nptel.ac.in/courses/105/104/105104101/

Course Code	Course Name	L	T	P	Credits
CV203	Engineering Geology	2	1	0	3

Pre-requisites: Nil

Course Objectives

1. Understand the dynamic nature of earth, the associated surface and subsurface processes and appreciate the importance of geology in civil engineering projects.
2. Provide basic knowledge about different minerals, various rocks and their classification schemes and their engineering properties with their significance in civil engineering.
3. Understand the process involved in rock deformation and formation of various geological structures such as folds, faults, and joints unconformities.
4. Understand the significance of various geological principles in planning, designing and construction of various civil projects and mitigation measures for natural hazards.

Course Outcomes

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

CO1: Identify and classify minerals based on physical, optical and chemical properties.

CO2: Classify weathering processes and mass movement.

CO3: Identify geological formations such as folds, faults, joints unconformities and assess their critical aspects in the stability of civil engineering structures.

CO4: Perform geophysical investigations to develop subsurface profile and locate groundwater potential sites.

CO5: Apply geological principles in planning, designing and construction of various civil projects and make critical decisions and strategies to mitigate the impact of geohazards on stability of civil structures.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	L	L	M	L	L	L	L	L	L	L
CO2	L	L	L	M	L	L	L	L	L	L	L	L
CO3	M	M	L	M	L	L	L	L	L	L	L	L
CO4	M	M	H	H	H	L	L	L	L	L	L	L
CO5	M	M	M	H	M	L	L	L	L	L	L	L

Syllabus

Module 1: Introduction to Geology: Relevance of geology in Civil Engineering, Branches and scope of geology, Earth surface features and internal structure, rock weathering processes.

Module 2: Mineralogy: Minerals, mineral classifications and identification based on physical, optical, and chemical properties.

Module 3: Petrology: Rock formation and their classification- igneous, sedimentary, and metamorphic rocks, rock structures and textures. Exploration and testing of Rock, Rock Quality Designation (RQD), Borehole problems.

Module 4: Structural geology: Geological Map, outcrop, attitude of beds, geological features- folds, faults, unconformities, their types and classifications.

Module 5: Hydrogeology: Ground water table, aquifers, subsurface distribution of groundwater, groundwater in different geological formations, springs, geophysical exploration of groundwater.

Module 6: Subsurface exploration methods: Soil profile, Fundamentals of Geophysical Prospecting,- Seismic refraction method and electrical resistivity method.

Module 7: Geohazards: Causes of earthquake and landslides, Remedial measures to mitigate

damage to engineering structures.

Module 8: Dams and Tunnels: Types of dams**,** selection of dam sites, tunnels, geological investigation for a dam site, Seepage and leakage problems in dams- influencing factors and remedial measures. Geological consideration for tunneling, geothermal step, over break, stand up time, and logging of tunnels.

List of Practicals:

1. Identification of important minerals
2. Classification and identification of Igneous, Sedimentary, and metamorphic rocks
3. Structural geology- strike and dip, three and 3-point problems point problems.
4. Structural geology – Completion of outcrops maps, order of superposition.
5. Introduction to Geophysical methods for ground characterization-Electrical resistivity method, seismic refraction method

Reference Books/Material

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	Course Name	L	T	P	Credits
CV204	Building and Construction Materials	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To introduce various types of building materials used in construction
2. Study of different components of a building such as doors, windows, lintels, floor, roof and stairs
3. Identify the construction materials required for the assigned work.
4. Provide procedural knowledge of the simple testing methods of cement, lime and concrete etc.
5. Study of materials and methods of formwork, damp proofing and plastering practices

Course Outcomes

On completion of the course the students will be able to:

CO1: Know the various building materials.

CO2: Understand the basic components of a building

CO3: Understand the general principles in stone and brick masonry

CO4: Acquire knowledge of testing procedures of basic building materials

CO5: Understand the plastering and damp proofing practices employed in building construction

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	M	L	L	L	L	L	L	L	L
CO2	H	H	M	H	L	L	L	L	L	L	L	L
CO3	H	M	M	M	L	L	L	L	L	L	L	L
CO4	H	M	M	H	L	L	L	L	L	L	L	L
CO5	H	M	M	M	L	L	L	L	L	L	L	L

Syllabus

Module 1: Building Materials: Bricks, Stone, Timber, Plywood, Steel: Classification, Properties and selection criteria, Cement, fine and coarse Aggregate, Admixture: Types, Properties and selection criteria and tests. Concrete: Preparation and properties. Mortar: Types, classification and strength, I.S. specifications, Sensitization on Carbon Footprints of building materials

Module 2: Masonry: Technical terms in masonry, classification and brief specifications of stone masonry, bonds in brick masonry, general principles to be observed in stone, mud and Brick Masonry Construction. Walls: Different types (load bearing, cavity-walls and partition walls), thickness considerations. AAC blocks

Module 3: Doors, Windows and Lintels: Different types based on materials (wooden, UPVC) and methods of construction, technical terms, size and locations.

Module 4: Floors and roofs: Ground and upper floors, various types, their suitability, construction details of concrete and terrazzo floors, Floor tiles. Roofs: Technical terms and different types of pitched and flat roofs. Various roof coverings for pitched and flat roofs

Module 5: Formwork and damp proofing and plastering: Different types of formwork, stripping times. Damp Proofing: Causes and effect of Dampness, parts of a building likely to be affected most, methods of damp proofing in different locations including roofs, Types and considerations during plastering and pointing.

Module 6: Stairs, Elevators, Escalators and Ramps: Types based on geometry and material, suitability, proportioning of stairs, lifts and escalators.

Reference Books/Material

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
3. Building Construction, Punmia, B. C., Laxmi Publications, New Delhi,1999.
4. Concrete Technology, Shetty, M. S, S.Chand & Co., New Delhi, 1992.

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	Course Name	L	T	P	Credits
CV205	Material Testing Laboratory	0	0	3	2

Pre-requisites: Nil

Course Objectives

1. Understand behaviour of materials under different types of loading.
2. Conduct investigations and apply proper tools to make measurements.
3. Know about the safety measurements while conducting the experiments.
4. Conduct the experiments with teamwork.

Course Outcomes

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

CO1: Understand different types of stresses occur in different materials under different types of loads.

CO2: Collect and record data in an appropriate way.

CO3: Understand various precautions to be taken while conducting the experiments.

CO4: Learn team coordination.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	L	L	L	L	M	L	L	M	M	L
CO2	H	L	L	L	L	L	L	M	M	L	M	L
CO3	H	L	L	L	L	L	M	L	L	M	M	L
CO4	H	L	L	L	L	L	M	M	H	L	L	L

Syllabus

1. Stress-strain characteristics:
   (a) Mild Steel (b) Tor steel (c) Copper (d) Aluminium and (e) G.I. wire and sheet.
2. Compressive strength tests on building materials:
   (a) Wood (b) Brick (c) Rocks (d) Concrete.
3. Hardness tests of metals:
   (a) Steel (b) Brass (c) Aluminum (d) Copper.

4. Modulus of rigidity and Torsion test on:
   (a) Solid shafts (b) Hollow shaft.
5. Determination of deflection for different beams and application of Maxwell's reciprocal theorem:
   (a) Simply supported beam (b) Propped Cantilever beam (c) Continuous beam.
6. Ductility test for steel.
7. Shear test on steel.
8. Impact test on steel
9. Demonstration on Fire resistance tests

Reference Books/Material

1. Timoshenko and Gere, "Mechanics of Materials", CBS Publishers, New Delhi, 1996.
2. Indian Standard Codes, "IS: 1608 – 2005, IS: 516 – 1959, ISO 6506, IS: 5242 – 2006

Course Code	Course Name	L	T	P	Credits
CV206	Fluid Mechanics Laboratory	0	0	3	2

Pre-requisites: Nil

Course Objectives

1: To understand flow measurement in a pipe flow.

2: To determine the energy loss in pipe flow

3: To measure the discharge in an open channel flow.

Course Outcomes

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

CO1: Calibrate various flow measuring devices in the pipe system.

CO2: Evaluate various losses in flow through a piping system.

CO3: Experimentally calculate the discharge in the open channel.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	L	L	L	L	L	H	H	M	M	L
CO2	H	L	L	L	L	L	L	H	H	M	M	L
CO3	H	L	L	L	L	L	L	H	H	M	M	L

Syllabus

1. Calibration of Venturimeter, Orifice meter
2. Calibration of Rectangular and Triangular notch:
3. Determination of Metacentric height
4. Determination of Reynold's number
5. Determination of Friction factor of pipes
6. Determination of the Impact of jet on vanes
7. Verification of Bernoulli's theorem

8. Determination of Losses in pipes

Reference Books/Material

Text books:

1. Flow in Open Channel, Subramanya, 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	Course Name	L	T	P	Credits
CV207	Surveying Laboratory	0	0	3	2

Pre-requisites: Nil

Course Objectives

1. Use the surveying equipment to carry out field surveys for location, design and construction of engineering projects.
2. Analyze and synthesize survey data from the field notes.
3. Work effectively as a member of a survey party in completing the assigned field work

Course Outcomes

On completion of the lab the students will be able to

CO1: Find out the bearings using compass survey

CO2: Locate the instrument station using a plane table survey.

CO3: Find out the reduced levels using levelling

CO4: Determine the distances between two points using tacheometry

CO5: Calculate the area, height and distances using total station

Relationship of Course Outcomes to Program Outcomes H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	L	L	L	H	H	L	H	H	H	M	H
CO2	L	L	L	L	H	H	L	H	H	H	M	M
CO3	L	L	L	L	H	H	M	H	H	H	M	M
CO4	L	L	L	L	L	L	L	L	L	L	L	L
CO5	L	L	L	L	L	L	L	L	L	L	L	L

Syllabus

1. Setting out of a building
2. Levelling: Fly levelling and contouring
3. Theodolite surveying: Single and two plane observation of trigonometric levelling

4. Determination of Tacheometric Constants, Tangential Tacheometry
5. Total station-traversing, calculation of area, heights and distances.
6. Contour surveying – Determination of coordinates using total station and preparation of contour map using QGIS
7. Demonstration of Drone and DGPS survey

Reference Books/Material

Text books:

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

Reference books:

1. Surveying Theory and Practice, James M A, Edward M, Tata Mc Graw Hill, 2012
2. Elementary Surveying, Charles D G, Wolf P R, 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	Course Name	L	T	P	Credits
IE250	Innovation and Entrepreneurship	1	0	0	1

Pre-requisites: Nil

Course Objective

1. To introduce to a project-based learning approach from Ideation to Innovation and Entrepreneurship will be the key process considered here.
2. To learn the essential concepts of innovation and entrepreneurship through hands-on activities and the best and most relevant practical examples
3. To provide the tools necessary for starting independent innovation and businesses
4. To give students practical experience in market survey, commercialization, IPR and proactively work in projects in risky market environments

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability

CO1. To comprehend the basic theories and concepts that underlie a survey study of Innovation, Entrepreneurship and Social Business/ Entrepreneurship

CO2. To understand how to generate good large company or startup business ideas / societal ideas, and refine these ideas, to substantially increase chances for success in the marketplace

CO3. The students will be exposed to the thoughts and strategies of some very effective real-life innovators and entrepreneurs through videos and small cases.

CO4. To understand about IPR, prototyping and financial management.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	H	L	H	M	H	H	L	H	H	H	H
CO2	L	H	L	H	H	H	H	L	H	H	H	H
CO3	L	H	L	H	H	H	H	L	M	H	H	H
CO4	L	H	L	H	H	H	H	H	L	L	H	H

Syllabus

Module 1: Introduction:

Creative thinking, blocks to creativity, factors that influence creative design, engineering design and creative design, influence of society, market pull & technology push, attribute of a creative person Three levels of Design – Viceral, Behavioral and Reflective design.

Qualities and skills required for entrepreneurship, Functions of an entrepreneur, Importance of entrepreneur in economic development.

Module 2: Ideas for Entrepreneurship:

Need or identification of a problem, market survey, data collection, review & analysis, problem definition, challenge statement, problem statement initial specifications, Brain storming, analogy technique or Synectic, check list, trigger words, morphological method, interaction matrix method, analysis of interconnected decision making.

Module 3: Theory of Inventive Problem Solving (TRIZ):

20 key TRIZ principles – multifunction, compensation, nested doll, blessing in disguise, segmentation, separation, symmetry change, opaque & porous, inflate and deflate, recycle & recover, phase transformation, energy, imaging, environment, composition, economical, surface response, static & dynamic, continuous & intermittent, dimensions.

Module 4: Product Design, IPR & Finance:

Detail design, prototyping, product deployment, useful life assessment and recycling and sustainability; patent act, patent laws, Types of entrepreneurs- Based on type of business, based on use of technology, based on motivation, based on stages of development, based on motive, Based on capital ownership, Business Plan, Finance and Funding.

Reference Books/Material

1. C.B.Gupta & N.P.Srinivasan, 'Entrepreneurial Development', Sultan Chand & Sons, 2020, ISBN: 978-93-5161-132-5
2. Floyd Hurt, Rousing Creativity: Think New Now, Crisp Publ Inc. 1999, ISBN 1560525479.
3. Kalevi Rantanen & Ellen Domb, 'Simplified TRIZ' – II edn., Auerbach Publications, Taylor & Francis Group, 2010, ISBN: 978-142-0062-748
4. John Adair, 'The Art of Creative Thinking', Kogan Page Publication, 2011, ISBN 978-0-7494-5483-8

Course Code	Course Name	L	T	P	Credits
CV250	Computational Methods in Civil Engineering	2	0	2	3

Pre-requisites: Nil

Course Objectives

This course is designed to offer engineers and scientists a thorough understanding of numerical methods. It emphasizes essential concepts, including numerical solutions for algebraic, transcendental, and differential equations, and explores their practical applications.

Course Outcomes

On completion of the lab the students will be able to

CO1: Gain expertise in numerical solving techniques for single-variable equations and systems of equations, and then apply these principles to address intricate engineering challenges out the bearings using compass survey

CO2: Understanding of the significance of curve fitting, interpolation, numerical differentiation and integration

CO3: Foster a deep comprehension of the importance of numerically solving ordinary and partial differential equations (ODEs) and explore their wide-ranging applications across diverse fields.

CO4: Develop a profound understanding of the significance of employing numerical methods through the utilization of diverse programming languages.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	M	L	L	L	L	M	L	H
CO2	H	H	H	H	H	L	L	L	L	M	L	H
CO3	H	H	H	H	H	L	L	L	L	M	L	H
CO4	H	H	H	H	H	L	L	L	L	M	L	H

Syllabus

Module 1 Numerical solution of equations and systems

Equations in one variable: The Bisection method, Fixed point iteration method, Secant method, Regular-Falsi method, Newton's method and its extensions, Convergence of Newtons's method.

System of equations: Jacobi and Gauss-Seidel iterative methods, Sufficient conditions for convergence, Power method to find the dominant Eigen value and eigenvector.

Module 2 Interpolation, Numerical Differentiation and Integration

Interpolation and Curve fitting: The Lagrange polynomial, Divided differences, Method of least square approximations.

Numerical differentiation: Difference formula, Three and five point formula.

Numerical integration: Open and closed Newton-Cotes formulae, Gaussian quadrature formula.

Module 3 Numerical solution of Differential Equations

Ordinary Differential Equations: Euler's method, Euler's modified method, Taylor's method and Runge-Kutta method, Multistep methods. Elliptic partial differential equations: Fine difference method for two dimensional equations. Parabolic partial differential equations: Forward difference method, backward difference method and the Crank-Nicolson method for one dimensional equations. Hyperbolic partial differential equations: Central difference method for one dimensional equations

Lab Experiments: (2 hours per week)

1. Basic operations on Matlab/Python.
2. Program to solve one variable equation using Bisection and Fixed point method.
3. Program to solve one variable equation using Newton Raphson, Regula-Falsi and Secant method.
4. Program to solve system of equations using Gauss-Jacobi Method
5. Program to solve system of equations using Gauss-Seidal Method
6. Program to find dominant eigenvalue using the Power Method
7. Program to fit a curve using method of least square.
8. Program to interpolate using the Lagrange polynomial method.

9. Program to evaluate differentiation and integration.
10. Programs to solve ordinary differential equations using Euler's and Taylor's method.
11. Programs to solve ordinary differential equations using R-K method of order four.
12. Programs to solve ordinary differential equations using multistep methods.
13. Programs to solve elliptic equations using the finite difference method.
14. Programs to solve parabolic equations using the finite difference method.
15. Programs to solve hyperbolic equations using the finite difference method

Reference Books/Material

1. Numerical Methods for Scientific and Engineering Computation, Jain M K, Iyengar S R K, Jain R K, New Age Publishers, 6th Edition, 2012.
2. Advanced Engineering Mathematics, E.Kreyszig, 8th Edition, Wiley India Pvt. Ltd., 2010.
3. Numerical Analysis, Burden R L, Faires J D, 9th Edition, Brooks/Cole, 2012.
4. Numerical solution of Partial Differential Equations, Smith G D, Oxford University Press, 1985

Course Code	Course Name	L	T	P	Credits
CV251	Structural Analysis	3	1	0	4

Pre-requisites: Nil

Course Objectives

1. Apply the appropriate method for finding the deformation of beams under different loads.
2. Estimate deformations of structures with the help of Energy Principles.
3. To analyze 2D pin jointed and rigid jointed frames to find deformations.
4. To analyze arches, cable & suspension bridges by using energy and displacement methods.
5. Analysis of multi-storey frames for lateral loads and gravity loads.

Course Outcomes

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

CO1: Calculate deformations of beam under different loads.

CO2: Compute deformations of structures by using Elastic theorems.

CO3: Analyze pin jointed and rigid jointed frames.

CO4: Draw Influence line diagram for different types of determinate structures.

CO5: Computation of lateral loads and gravity loads on multi-storey frames.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	L	L	L	L	L	L	L	L
CO2	M	H	H	L	L	L	L	L	L	L	L	L
CO3	M	M	H	M	L	L	L	L	L	L	L	L
CO4	H	H	M	L	L	L	L	L	L	L	L	L
CO5	H	H	M	M	M	L	L	L	L	L	L	L

Syllabus

Module 1 Introduction: General introduction on concept of analysis of determinate structures. Concept of Force, Method of Analysis, Classification of Structures, Stress resultants, Degrees of freedom per node, Static and Kinematic Indeterminacy.

Module 2 Deflection of beams: Moment curvature relation of beam, differential equation of beam. Slope and deflection for determinate structures by using integration, moment area and conjugate beam method.

Module 3 Elastic theorems and Energy Principles: Strain energy and complementary energy - review of strain energy due to axial load - bending, shear and torsion - principle of superposition - principle of virtual work - Castigliano‘s theorem for deflection - theorem of complementary energy - Betti’s theorem - Maxwell‘s law of reciprocal deflections - application of method of virtual work (unit load method) and strain energy method for determination of deflections of statically determinate beams, pin-jointed trusses and rigid frames - temperature effects.

Module 5 Rolling Loads and Influence Lines: Rolling loads, influence lines for beams and trusses, Absolute maximum bending moment.

Module 6 Analysis of Arches: Analysis of Arches, Linear Arch, Eddy’s theorem, three hinged parabolic arch, moving loads & influence lines.

Module 7 Analysis of Cables and Suspension bridges: Analysis of Cables under point loads and UDL, Analysis of Suspension bridges.

Module 8 Approximate Methods of Analysis: Introduction, Analysis of multi-storey frames for lateral loads, Analysis of multi-storey frames for gravity loads.

Reference Books/Material

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**.**
4. Structural Analysis, Menon, D, Narosa publishers, New Delhi, 2008.
5. Theory of Structures, Ramamurtham S. and Narayan R, Dhanpat Rai Publications.

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
5. Theory of Structures, Timoshenko, S.P. and Young, D.H., McGraw Hill, New York, 1988

Online Resources:

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

Course Code	Course Name	L	T	P	Credits
CV252	Geotechnical Engineering	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To understand the use of a three phase system in soil mechanics and estimation of soil properties using the three phase system.
2. To study the role of water in soil behaviour and estimation of soil stresses, permeability, soil compaction and quantity of seepage including flow net.
3. To appreciate the importance of soil stress distribution and stress influence under various types of loads.
4. Understand the effect of drainage conditions on appropriate soil strength parameters along with the importance of site investigation.

Course Outcomes

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

CO1: Understand the importance of geotechnical engineering in civil engineering and perform proper soil classification and three phase systems to solve the problems.

CO2: Solve any practice problems related to soil stress estimation, permeability, seepage including flow net diagram.

CO3: Perform proper stress estimation under any system of foundation loads.

CO4: Estimate appropriate soil strength parameters with respect to the drainage conditions.

CO5: Solve any practical problems related to the field compaction method.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	L	H	L	L	L	L	L	L	L	L
CO2	H	H	M	H	L	L	L	L	L	L	L	L
CO3	H	H	L	M	L	L	L	L	L	L	L	L
CO4	H	M	L	H	L	L	L	L	L	L	L	L
CO5	M	L	M	H	M	L	L	L	L	L	L	L

Syllabus

Module 1 Soil properties and classification: Formation of soils and types, Soil as three phase system. Grain size distribution, Soil consistency, sensitivity and thixotropy. Classification of soil.

Module 2 Soil compaction: Principles, water content – dry unit weight relationships, optimum moisture content, maximum dry unit weight, factors affecting compaction. Effects of compaction on density, shear strength and permeability. Field compaction methods.

Module 3 Permeability: Soil-water systems – capillarity, flow, Darcy's law, permeability and tests for its determination, Permeability of stratified soils, estimation of permeability in the field, piping, quicksand condition, seepage, flow nets.

Module 4 Consolidation and Settlement Analysis: Equation of one-dimensional consolidation. Coefficient of compression, compression index, pre-compression pressure, over-consolidation, Coefficient of consolidation, Settlement analysis. Basics of three-dimensional consolidation, Sand drains.

Module 5 Shear strength of soil: Coulomb's law, Mohr's stress circle, strength envelope and failure conditions, Direct and triaxial shear tests and unconfined compression tests, Effect of pore pressure.

Module 6 Stresses in Soils: Boussinesq's Equation: Vertical Stress distribution on horizontal and vertical planes, Newmark's influence chart, Contact pressure distribution.

Reference Books/Material

Text books:

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

Reference books:

1. Essentials of Soil Mechanics and Foundations – Basic Geotechnics, McCarthy D F, Pearson Education Ltd., 2014
2. Soil Mechanics and Foundations, Budhu M, Wiley Publishers, 2016
3. Geotechnical Engineering Lab Manual, Kitch W A, Angelo State Universty, 2011.
4. Soil Mechanics in Engineering Practice, Terzaghi K, Peck R B, Mesri G, John Wiley, New York, 1996.
5. Relevant IS codes

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	Course Name	L	T	P	Credits
CV253	Environmental Engineering	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To explain the classifications of water sources, including surface water and groundwater.
2. To describe the biological indicators used to assess water quality, such as fecal coliforms and biological oxygen demand (BOD).
3. To estimate water demand for various purposes, including domestic, industrial, and agricultural uses.
4. To design the layout and sizing of essential components within a water treatment plant, such as sedimentation tanks and filtration units.
5. To understand the sources and defects of air, noise pollution and suggest control measures

Course Outcomes

After completion of the course the students will be able to:

CO1: Understand the classification of various water sources, causes of contamination and later effect on human health

CO2: Identify the physico-chemical and biological characteristics of water

CO3: Calculate the water demand, population forecasting

CO4. Design various components of typical water distribution networks

CO5: Assess sources, defects and associated control measures of air, noise pollution

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	L	L	L	L	L	L	L	L
CO2	H	M	M	M	L	L	L	L	L	L	L	L
CO3	H	M	L	M	L	L	L	L	L	L	L	L
CO4	H	M	M	M	L	L	L	L	L	L	L	L
CO5	H	L	M	M	L	L	L	L	L	L	L	L

Syllabus

Module 1 Introduction: Necessity and importance of water supply schemes, Water demand, Classification of water demands, Estimation of quantity of water required by a town, factors affecting demand, design period and population forecasting. Sources of water supply: Surface sources and underground sources, Intake works, site selection, type of intake works.

Module 2 Quality of Water: Common impurities, physical, chemical and biological characteristics of water, water quality standards for municipal and domestic supplies.

Module 3 Unit processes in water treatment: Sedimentation: Theory of sedimentation, sedimentation tanks, types, design parameters, sedimentation with coagulation, coagulants and coagulant aids, Jar test. Theory of filtration, slow sand and rapid sand filters, Construction and operation. Methods of disinfection, Chlorination, Softening, Methods of Softening, Iron Removal, Fluoridation.

Module 4: Water distribution networks: Distribution of water: Pipe lay-outs, pumps, storage and balancing reservoirs, water loss in distribution system, house connection, valves, plumbing fixtures- pipe network analysis- introduction to EPANET.

Module 5: Air and Noise Pollution: 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.

Reference Books/Material

Text books:

1. Environmental Engineering, Peavy, H.S, Rowe, D.R., and G. Tchobanoglous, McGraw Hill Education, 2017
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, Garg S K, Khanna Publishers, 2017, 34th Edition
2. MWH's Water Treatment: Principles and Design, Crittenden J C, Trussell R R, Hand D W, Howe K J, Tchobanoglous G, John Wiley & Sons, Inc.,2012, 3rd Edition
3. Water and Wastewater Engineering: Design Principles and Practice, Davis M L, McGraw Hill Education, 2017,1st Edition
4. Water Supply and Sewerage, Mcghee T, 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
6. C P H E E O Manual on Water Supply and Treatment Environmental Science and Engineering

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	Course Name	L	T	P	Credits
CV254	Highway Engineering	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Fix the horizontal and vertical alignments of roads and design the elements.
2. Suggest and design circulation improvement measures.
3. Identify and test the properties of pavement materials.
4. Design flexible and rigid pavements.
5. Identify probable causes of distress of pavements and suggest remedial measures.

Course Outcomes

On completion of the course, the students will be able to

CO1: Carry out surveys involved in planning the highway alignment.

CO2: Design cross section elements, sight distances, horizontal and vertical alignment

CO3: Able to able the modern methods in road construction and its recent innovations

CO4: Design flexible and rigid pavements.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	L	L	L	L	L	L	L	L
CO2	H	H	H	M	L	L	L	L	L	L	L	L
CO3	H	M	M	M	L	L	L	L	L	L	L	L
CO4	H	H	H	M	L	L	L	L	L	L	L	L
CO5	H	H	M	H	L	L	L	L	L	L	L	L

Syllabus

Module 1: Highway Classification, Alignment and Geometrical Design: Highway development in India - Classification of roads - Typical cross sections of roads - Requirements

and factors controlling the alignment of roads - Engineering surveys for highway location - Pavement surface characteristics - Camber and width requirements - Sight distances - Stopping and overtaking sight distances, overtaking zone requirements - Design of horizontal alignment - speed, radius, superelevation, methods of providing supe

Module 2: Highway Cross Section Elements: Carriageway, Shoulders, Formation, Road Margins, Width of roadway, Right of way; Kerbs, Foot paths, Medians service ducts - Design specifications; Pavement Surface characteristics; Skid resistance, Factors affecting skid resistance, Measurement of skid resistance; Road roughness, Measurement of road roughness; Camber, Objectives of camber, Design standards. Typical cross section of road –cuttings, Embankment, Hilly areas, 6 lane expressway, Divided highway.

Module 3: Geometric Design of Road: Factors influencing geometric design elements, Types of sight distances and Significance, Analysis of sight distances, Horizontal Alignment: Requirements, Super elevation, Methods of attainment of super elevation, Extra widening of curves, Transition curves, Types, Length of transition curve. Vertical Alignment: Types of gradients, Grade compensation on curves, Vertical curves Intersections: Types, At-grade Intersections, Channelization, Objectives; Traffic islands.

Module 4: Pavement Design and Pavement Failures: Design of Flexible Pavements: Methods, IRC guidelines, CBR method of design, Group index method. Design of Rigid Pavements: Factors affecting design, Stresses in rigid pavements, IRC method of design, Joints in Rigid pavements, Design of joints.

Failures in pavements: Brief study of failures in flexible and Rigid pavements and Maintenance, strengthening of existing pavements, Overlays, Worked out problems.

Module 5: Design, Construction and Maintenance: Types of pavements and its components, Factors influencing the design of pavements, Wheel load applications, pavement design traffic, Subgrade strength and Characteristics. Construction of Roads: Bituminous concrete, Cement concrete, Cement stabilized roads, Brief study of types and Uses of failures in flexible and Rigid pavements and Maintenance, Strengthening of existing pavements, Modern methods of road construction and recent innovations

Module 6: Traffic engineering: Introduction - Road user, vehicle, and traffic characteristics - Speed, volume, travel time and delay, parking, accident studies - Simple worked-out problems - Principles of design of at-grade intersections - Simple layouts - Objectives, classification, and uses of traffic signs and markings - Design of isolated signals.

Reference Books/Material

Text books:

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

Reference books:

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.
5. Relevant IRC codes

Online Resources:

1. https://nptel.ac.in/courses/105/101/105101087/

Course Code	Course Name	L	T	P	Credits
CV255	Concrete Technology Laboratory	0	0	3	2

Pre-requisites: Nil

Course Objectives

1. Integrate the hands-on experience on material testing with their theoretical understanding of mechanical behavior of materials
2. Prepare reports and present the results based on the test data complying with the codes regulations
3. Refer codes and other reference materials for standard property data
4. Interpret the results and recommend the suitability of a material for a given load case.

Course Outcomes

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

CO1: Identify quality control tests on concrete making materials

CO2: Understand the behaviour of fresh and hardened concrete

CO3: Design concrete mixes as per IS and ACI codes

CO4: Understand the non-destructive testing equipment

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	L	L	L	L	M	L	L	M	M	L
CO2	L	L	L	L	L	L	L	M	M	L	M	L
CO3	L	L	L	L	L	L	M	L	L	M	M	L
CO4	M	L	L	L	L	L	M	M	H	L	L	L

Syllabus

1. Determination of:
    a. Fineness and specific gravity of cement.

b. Consistency of standard cement paste.
c. Initial and Final Setting times of Cement.
d. Compressive strength of cement.
e. Fineness modulus of coarse and fine aggregates.
f. Percentage of voids, Bulk density, Specific Gravity of coarse and fine aggregates.
g. Workability: slump cone test, compaction factor test, vee-bee consistometer test.
h. Hardened properties of concrete – compressive strength, split tensile strength and flexural strength.
i. Stress - strain characteristics of concrete and tests for tensile strength of concrete.

2. Concrete mix design
3. Experiments to demonstrate the use of non-destructive test equipment

Reference Books/Material

Text books:

1. Properties of Concrete, AM Nevelli, Prentice Hall Publishers, 2012, 5 th 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
5. Relevant IS and ACI codes

Online resources:

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

Course Code	Course Name	L	T	P	Credits
CV256	Building Design and Drafting Studio	0	0	3	2

Pre-requisites: Nil

Course Objectives

1. To study the concept of drawing plan, elevation, sectional elevation and building byelaws.
2. To study the basic use of AutoCAD software.
3. Detailed drawing of door, window, and staircase.
4. Planning and drawing of residential, industrial and public buildings with various requirements.

Course Outcomes

CO1: Plan and design of Residential buildings - domestic units, flat, cottages and bungalows with flat and pitched roof.

CO2: Plan and design of Public buildings – utility shelters, dispensaries, banks, schools, offices, libraries, hostels, restaurants, commercial complexes, factories etc.

CO3: Prepare site plans and service plans as per building rules.

CO4: Prepare detailed drawings of septic tanks and soak-pit.

CO5: Prepare detailed drawings for plumbing, water supply and drainage for buildings.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	L	L	L	M	M	H	M	H	H	M	L
CO2	L	L	L	L	M	M	H	M	H	H	M	L
CO3	L	L	L	L	M	M	H	M	H	H	H	L
CO4	L	L	L	L	M	M	H	M	H	H	H	L
CO5	L	L	L	L	M	M	H	M	H	H	H	L

Syllabus

Module 1 Introduction to building drawing: Plan, section, elevation and sectional elevation, requirements of residential buildings, industrial structures, office and commercial units. Building bye-laws: Permissible sizes of plots, margins, area of rooms, plinth height, height of floors and other details, relevant provisions in the National Building Code

Module 2 Detailed Drawings of:

a. Panelled doors, glazed windows, and ventilators
b. Steel and Aluminium windows
c. Steel roof trusses
d. Reinforced concrete staircase

Module 3 Planning, designing from given requirements of areas & specifications and preparation of sketch design and working drawings for:

a. Residential building- flat and pitched roof, economic domestic units, cottages, bungalows and building flats
b. Public building – small public utility shelters, dispensaries, banks, schools, offices, libraries, hostels, restaurants, commercial complexes, factories etc.
c. Preparation of site plans and service plans as per Building Rules
d. Septic Tank and Soak Pit – detailed drawings.
e. Plumbing, water supply and drainage for buildings

Reference Books/Material

Text books:

1. Building Drawing and Detailing, Balagopal T S Prabhu, Spades Publishers, 2007
2. Building Construction, Punmia B. C., Jain A.J., and Jain A.J., Laxmi Publication, 2016, Eleventh Edition.
3. The Text book for Building Construction, Arora S. P., and Bindra S. P., Dhanpat Rai Publications, 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. Local Building Bye-laws

4. 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/

Semester-wise courses of Third year B. Tech. Programme

V Semester

Sl.No.	Course Code	Course Name	Type	L-T-P	Credits
1	ES300	Environmental Studies	HU/HM	1-0-0	1
2	CV301	Design of Reinforced Concrete Structures	DC	3-1-0	4
3	CV302	Advanced Structural Analysis	DC	3-1-0	4
4	CV5XX	Elective-I	DE/OE	3-0-0	3
5	CV303	Foundation Engineering	DC	3-0-0	3
6	CV304	Waste Water Engineering	DC	3-0-0	3
7	CV300	Seminar	DC	0-0-2	1
8	CV305	Transportation Engineering Laboratory	DC	0-0-3	2
9	CV306	Geotechnical Engineering Laboratory	DC	0-0-3	2
	Total Credits				**23**

VI Semester

Sl.No.	Course Code	Course Name	Type	L-T-P	Credits
1	HU300	Human Values and Professional Ethics	HU/HM	1-0-0	1
2	CV350	Estimation, Costing and Specification	DC	3-1-0	4
3	CV351	Design of Steel Structures	DC	3-1-0	4
4	CV352	Engineering Hydrology and Irrigation Systems	DC	3-1-0	4
5	CV5XX	Elective-II*	DE	3-0-0	3*
6	IKXXX	OE-IKS	OE-IKS	3-0-0	3
7	CV353	Structural Design Studio	DC	0-0-3	2
8	CV354	Environmental Engineering Laboratory	DC	0-0-3	2
	Total Credits				**23*(20)**

* offered only for students who have not opted for minor course.

Note: A student can register only one open elective (OE) per semester and a maximum of two OE in the B.Tech tenure. This is excluding the Indian Knowledge Systems (IKS) course offered in the VIth semester. Since IKS is a mandatory OE, students are not allowed to register for an OE in that semester.

Detailed Syllabi of Third year courses

Course Code	Course Name	L	T	P	Credits
ES300	Environmental Studies	1	0	0	1

Pre-requisites: Nil

Course Objectives

Understanding environment, its constituents, importance for living, ecosystem, human developmental activities vs environment, climate change, national and international environment related developments, need for public awareness, its protection and conservation activities.

Course Outcomes

At the completion of this course, the student shall acquire knowledge and ability to:

CO1: Understand in-depth knowledge on natural processes and resources that sustain life.

CO2: Understand the effect of human interference on the web of life, economy, and quality of human life.

CO3: Develop critical thinking for shaping strategies for environmental protection, conservation of biodiversity, environmental equity, and sustainable development.

CO4: Acquire values and attitudes towards understanding complex environmental economic-social challenges, and active participation in solving current environmental problems and preventing the future ones.

CO5: Adopt sustainability as a practice in life, society, and industry.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	L	L	H	-	H	H	H	H	L	L	H
CO2	-	H	H	M	L	H	H	H	H	L	L	H
CO3	-	H	H	L	-	H	H	H	M	L	L	H
CO4	-	L	L	L	-	L	H	H	L	L	L	H
CO5	-	H	H	M	M	M	H	H	H	L	M	H

Syllabus

Module 1: Introduction: Environment, interaction organism, scale of interaction, types of environment, Human interference, environmental ethics, environmental problems, sustainable society, ecological foot prints

Module 2: Ecosystem: current status, Role of organism, species, Life supporting system, Factors sustaining life, Components of ecosystem, Ecological efficiency, Matters in ecosystem, Major chemical cycles, Role of Species, Classification of species

Module 3: Biodiversity and species interaction: Biodiversity and Ecosystem, Species interaction, Natural selection, population growth, factor limiting population growth, Population dynamics, Species and reproductive pattern, Biodiversity, Population and Economy, Food and nutrition

Reference Book/Materials

1. Textbook for environmental studies for undergraduate courses of all branches of higher education (Online book-UGC website), Erach Bharucha, University Grants Commission, India.
2. Environmental science: Earth as a living planet, 8th edition, Daniel B. Botkin, Edward A. Keller, John Wiley & Sons, Inc., ISBN 978-0-470-52033-8
3. Environmental science: Problems, concepts, and solutions, 16th edition, G. Tyler Miller, Jr., Scott Spoolman, Brooks/Cole, ISBN-13: 978-0-495-55671-8
4. Principles of environmental science: Inquiry & application, 7th edition, William P. Cunningham, Mary Ann Cunningham, Mcgraw-Hill, ISBN 978–0–07–353251–6
5. Environmental science: A global concern, 12th edition, William P. Cunningham, Mary Ann Cunningham, Mcgraw-Hill, ISBN 978–0–07–338325–5.

Course Code	Course Name	L	T	P	Credits
CV301	Design of Reinforced Concrete Structures	3	1	0	4

Pre-requisites: Nil

Course Objectives

1. To equip the students with basic understanding of the constituent materials and structural system.
2. To design and detail for flexural loading.
3. To design and detail for shear, torsion and bond.
4. Design and analysis of one-way and two-way slabs
5. Introduction to special structures and earthquake engineering

Course Outcomes

CO1: Understanding of reinforced concrete as a construction material and various design philosophies & their differences.

CO2: Acquire knowledge of limit state design with respect to limit state of collapse against flexure, shear, torsion and compression and limit states of serviceability.

CO3: Analyze and design RC members under flexure, shear, and axial force in line with Indian standards. Design the two-way RC slabs using moment coefficients.

CO4: Familiarize the design principles of foundation and retaining wall.

CO5: Familiarize the design principles of seismic detailing.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	M	L	-	-	-	-	-	-	-	-
CO2	H	H	H	H	L	-	-	-	-	-	-	-
CO3	H	H	H	H	L	-	-	-	-	-	-	-
CO4	H	M	M	M	-	-	-	-	-	-	-	-
CO5	H	M	M	M	-	-	-	-	-	-	-	-

Syllabus

Module 1 General Material Properties: Properties of concrete & reinforcing steel, characteristic strength, stress-strain curves, shrinkage & creep phenomenon. Basic Design Philosophies: Working stress, ultimate load & limit state method of design. Analysis & design of structures in flexure/torsion by limit state method. Structural system: Introduction of structural load carrying and non-load carrying elements, types of structural system, gravity, and lateral load resisting elements.

Module 2 Design & Analysis of Flexural Members: Design of singly and doubly reinforced sections, rectangular sections & T sections, codal provisions. Detailing of reinforcement as per codal provisions (IS 456: 2000). Serviceability limit state of deflection and cracking. Calculation of deflection, codal requirements.

Module 3 Shear, Bond, and Torsion: The behavior of beam in shear & bond, design for shear, anchorage & slipping of reinforcement. Modes of failure in shear, critical sections, nominal shear stress, shear strength of concrete, design for shear. Modes of failure in torsion, design for torsion.

Module 4 Design & Analysis of Solid Slabs: Design of one-way, design of two-way slabs with and without corners held down. Introduction to design by moment coefficients. Compression members: Classification, short and slender columns, types of cross sections,

analysis and design of axially loaded columns, design of columns with uniaxial and biaxial eccentricity, interaction diagrams.

Module 5 Footings and retaining walls: Types of footings, design of isolated and continuous footings, types of retaining wall, stability requirements.

Module 6 Introduction to Seismic Ductile detailing: Earthquake resistant design and seismic detailing: Brief introduction to earthquake forces, relevant codes for force calculation and requirement of detailing as per relevant code.

Reference Books/Material

Text books:

1. Limit State Design of Reinforced Concrete Structures, Punmia B C, Jain A K, jain A K, Laxmi Pub. Pvt Ltd, 2016.
2. Design of Reinforced Concrete Structures, IS:456-2000, Krishnaraju N, CBS Publications, 2019, 4th Edition.

Reference books:

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

Online resources:

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

Course Code	Course Name	L	T	P	Credits
CV302	Advanced Structural Analysis	3	1	0	4

Pre-requisites: Nil

Course Objectives

1. Use different analytical tools for understanding the behavior of statically indeterminate structures using force methods.
2. To analyze a two-hinged parabolic arch to find unknowns.
3. To analyze indeterminate frames and truss by the use of force methods.
4. Use different analytical tools for understanding the behavior of statically indeterminate structures using displacement methods.
5. Understand the concept behind the influence line diagram for different indeterminate beams.

Course Outcomes

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

CO1: Analyze statically indeterminate structures by using force methods.

CO2: Analyze two hinged arches and understand the effect of rib-shortening in arches.

CO3: Analyze indeterminate frames and trusses.

CO4: Analyze statically indeterminate structures by using displacement methods.

CO5: Draw influence line diagram for different indeterminate beams.

CO6: Understand the basics of structural dynamics

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	L	-	-	-	-	-	-	-
CO2	M	M	L	M	-	-	-	-	-	-	-	-
CO3	M	H	L	L	-	-	-	-	-	-	-	-
CO4	H	H	M	M	L	-	-	-	-	-	-	-
CO5	M	M	L	M	-	-	-	-	-	-	-	-

Syllabus

Module 1 Analysis of Beams: Analysis of Fixed beam, Continuous beam and simple frames with and without translation of joints by Method of Consistent Deformation and Three moments Theorem, Analysis of Propped Cantilever beam.

Module 2 Column Analogy Method: Introduction, column analogy, Application to beams & frames.

Module 3 Two Hinged Arches: Introduction, Classification of Two hinged Arches, Analysis of two hinged parabolic & circular arches, Secondary stresses in two hinged arches due to temperature and elastic shortening of rib

Module 4 Indeterminate Frames and Trusses: Deflection of rigid frames of different geometry by consistent deformation method - settlement effects - analysis of trusses by consistent deformation method - externally and internally redundant trusses - effects of support settlement and pre-strains.

Module 5 Slope Deflection Method: Development of slope-deflection equations and analysis of fixed beam, continuous beam and simple frame without and with translation of joints.

Module 6 Moment Distribution Method: Definition of terms-Distribution factor, Carry over factor, Development of method of analysis of fixed beam, continuous beam and simple frame without and with translation of joints.

Module 7 Kani's method: Application to continuous beams and portal frames (Single bay two storeys).

Module 8 Influence Lines for Indeterminate Beams: Introduction, influence line diagram for shear force and bending moment for two span continuous beam with constant and different moments of inertia, influence line diagram for shear force and bending moment for propped cantilever beams.

Module 9: Introduction to Structural Dynamics: Single Degree of freedom system without and with damping

Reference Books/Material

Text books:

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

Reference books:

1. Intermediate Structural Analysis, Wang C K, Tata McGraw Hill Publishers, 2017.
2. Computational Structural Mechanics, Rajasekaran, Subramanian S, PHI, 2003.
3. Theory of Structures (Vol. II), Pandit G, Gupta S, Gupta R, Tata McGraw Hill Publishers 2017.
4. Analysis Of Structures (Theory, Design & Details ff Structures) - Vol.2, Vazirani V N, Ratwani M M, Duggal S K, 1994
5. Theory of Structures, Timoshenko S P, Young D H, McGraw Hill, New York, 1988.

Online resources:

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

Course Code	Course Name	L	T	P	Credits
CV303	Foundation Engineering	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Introduce to different methods of soil exploration
2. Introduce to various methods of stability analysis of finite and infinite slopes
3. Understand the approach to determine bearing capacity and settlement analysis of foundation.
4. Design and analysis of shallow, deep foundations
5. Design and analysis of earth retaining structures

Course Outcomes

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

CO1: Understand the importance of soil investigation for any civil engineering construction and be able to carry out soil exploration at the site.

CO2: Apply the concept of consolidation to carry out settlement analysis of soil

CO3: Evaluate the factor of safety of a slope

CO4: Analyze shallow foundation and pile foundation

CO5: Determine lateral earth pressure in soil and perform design analysis of retaining walls.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	L	H	M	-	-	-	-	-	-	-
CO2	H	H	H	L	L	-	-	-	-	-	-	-
CO3	H	H	M	L	L	-	-	-	-	-	-	-
CO4	H	H	H	L	-	-	-	-	-	-	-	-
CO5	H	M	H	L	-	-	-	-	-	-	-	-

Syllabus

Module 1: Soil exploration: Methods of soil exploration; boring, sampling, penetration tests, correlations between penetration resistance and soil design parameters.

Module 2: Stability of Slopes: Types of slope failures, Concept of limit Equilibrium method, Stability of infinite slopes, the stability of finite slopes.

Module 3: Earth Pressure and Retaining Walls: Earth pressure at rest, active and passive earth pressure, Rankine and Coulomb's earth pressure theories, earth pressure due to surcharge, retaining walls, stability analysis of retaining walls, proportioning and design of retaining walls
Module 4: Bearing Capacity: Definition, Types of shear failure in foundation soil, Terzaghi's bearing capacity equation, its validation and limitations, Factors influencing bearing capacity. Bearing capacity based on in-situ tests. Mat foundation.

Module 5: Settlement Analysis: Definition, Types of settlements, Computations based on theory and Test results, Effect of width and Depth of foundation, Construction time settlement, Components of settlements and their estimation, Allowable settlement values, Effects, Causes and Remedial measures of total and Differential settlements, Permissible settlements as per I.S.

Module 6: Shallow Foundation: Types of foundations and Choice, Basic requirements, Minimum depth of foundation, Contact pressure distribution, Isolated square and Rectangular footing, Combined rectangular, Trapezoidal and Strap footing and Raft foundation. Pressure distribution below mat foundation

Module 7: Pile Foundation: Load carrying capacity of a pile (Static and dynamic formulae), Under-reamed piles, Pile load test, Pile group analysis, Settlement analysis of pile.

Module 8: Caisson and machine foundations: Introduction, Shapes of wells and Component parts, types of machine foundation, vibration isolation

Reference Books/Material

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
4. Foundation Engineering, Leonards G.A., McGraw Hill Pub., 1962
5. Foundation Design & Construction, Tomlinson M.J., 7th edition, PHI Pub., 2001
6. Soil Mechanics in Engineering Practice, Terzaghi & Peck, 3rd edition, John Wiley Sons, 1996
7. Relevant IS codes

Online Resources:

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

Course Code	Course Name	L	T	P	Credits
CV304	Waste Water Engineering	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To understand sewage disposal's importance and methods.
2. To understand the concepts of dissolved oxygen, BOD and COD
3. To comprehend activated sludge process concepts
4. To get familiarize with sewer appurtenances' functions.
5. To recognize solid waste sources and properties.

Course Outcomes

On completion of the course, the student will be able to:

CO1: Explain sewage disposal significance.

CO2: Identify the key sewage parameters.

CO3: Explain activated sludge process principles.

CO4: Understand sewer appurtenances' functions.

CO5: Identify sources and properties of solid waste.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	-	-	-	-	-	-	-	-
CO2	H	M	M	M	-	-	-	-	-	-	-	-
CO3	H	M	L	M	-	-	-	-	-	-	-	-
CO4	H	M	M	M	-	-	-	-	-	-	-	-
CO5	H	L	M	M	-	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Definitions, Aim and Objective of sewage disposal. Methods of collection–conservancy system and Water carriage system. Sewerage Systems; Separate, Combined and Partially separate systems. Quantity of Sanitary Sewage: Source, Factors affecting sanitary sewage, Variation in quantity of sanitary sewage, Peak flow and Minimum flow, Determination of flow velocity using empirical formulae. Quantity of Storm Sewage: Factors affecting storm sewage, Quantity of storm water-rational method, Empirical formulae, Rainfall intensity curves.

Module 2 Characteristics of Sewage: Physical, Chemical and Biological characteristics of sewage, sampling methods, Decomposition of sewage, Dissolved oxygen, Bio chemical oxygen demand, Expression for BOD and COD Treatment of Sewage: Classification of treatment processes, Layout of treatment plants, Factors to be considered while designing a sewage treatment plant. Physical Unit Operation: Design and Description of Screens, Grit chambers, Skimming tanks, Grease traps, Sedimentation tanks.

Module 3 Biological Unit Process: Activated sludge process, its concepts, Design and Operation of aeration tanks, Types of aerators. Trickling filters, their classification, Geometry, Design and Operation, their operational difficulties and Remedies, Oxidation ponds, their classification, and Geometry \ Aerobic ponds. Lagoons, Oxidation ditches, SBR.

Module 4 On- Site Sanitation: Septic tank, Imhoff tanks. Sewage Disposal: Reuse of treated effluent, Disposal by dilution, Disposal on land, Water. Sewer Appurtenances: Manholes, Drop manholes, Street inlets, Flushing tanks, Catch basin, Sand traps.

Module 5 Solid and hazardous waste management Sources: Types, composition, Physical biological properties of solid wastes, sources types of hazardous infectious wastes in municipal solid wastes Solid waste generation collection, storage, handling, transportation, processing Treatment disposal methods Material separation recycle, physical-chemical biological stabilization solidification thermal methods, of disposal, site remediation, leachate & its control. Effects of hazardous waste on environment & its disposal.

Reference Books/Material

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, 5 th 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 McGraw Hill, 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
11. CPHEEO manual on sewage and sewage treatment

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/

Course Code	Course Name	L	T	P	Credits
CV305	Transportation Engineering Laboratory	0	0	3	2

Pre-requisites: Nil

Course Objectives

1. Characterize the pavement materials
2. Perform quality control tests on flexible pavements and flexible pavement materials
3. Prepare reports and present the results based on the test data complying to the codes/regulations
4. Refer codes and other reference materials for standard property data.
5. Interpret the results and recommend the suitability of a material for a given Highway use.

Course Outcomes

On completion of the lab the students will be able to

CO1: Able to determine the shape of the aggregates

CO2: Determine the hardness property of the aggregates and decide whether it is suitable for construction.

CO3: Ability to determine the toughness of the aggregates

CO4: To determine the grade of the bitumen.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	H	M	M	H	M	M	M
CO2	-	-	-	-	-	H	M	H	H	H	H	H
CO3	-	-	-	-	-	H	M	H	H	M	L	H
CO4	-	-	-	-	-	H	M	H	H	H	M	H

Syllabus

1. Determination of:

    a. Flakiness and Elongation Index of aggregates.
    b. Los Angeles Abrasion value.
    c. Impact value for aggregates.
    d. Crushing value for aggregates.
    e. Softening point of bitumen.
    f. Ductility value of bitumen.
    g. Penetration value for bitumen.
    h. Bitumen content in the given mix.
    i. Marshall stability value of the given mix.
2. Demonstration of Pavement roughness evaluation techniques–pendulum, bump integrator

Reference Books/Material

Textbooks:

1. Highway Materials and Pavement Testing, Khanna, S.K., Justo, C.E.G. and A. Veeraragavan, Nem Chand and Bros, Roorkee, India, 2013, Fifth Edition
2. L.R. Kadiyali, Principles and Practices of Highway Engineering, Khanna Publishers, 2009

References:

1. Relevant IRC and BIS standards
2. MoRTH (2013) Specification for Road and bridge works (5^{th} revision)

Course Code	Course Name	L	T	P	Credits
CV306	Geotechnical Engineering Laboratory	0	0	3	2

Pre-requisites: Nil

Course Objectives

1. Explain the procedures of laboratory tests used for determination of physical, index and engineering properties of soils.
2. Classify soil based on test results and interpret Engineering behavior based on test results.
3. Evaluate the permeability and shear strength of soil.
4. Evaluate settlement characteristics of soils.
5. Evaluate compaction characteristics required for field application.
6. Evaluate the subgrade strength by conducting CBR tests.

Course Outcomes

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

CO1: Classify a soil based on the index properties and understand the suitability for a given engineering application.

CO2: Determine shear strength parameters under different loading and drainage conditions.

CO3: Determine consolidation parameters to calculate settlement in soils.

CO4: Estimate the CBR value of subgrade soil in the laboratory.

CO5: Obtain maximum dry density and optimum moisture content, and utilize them to control field compaction quality.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	-	-	-	-	-	L	L	M	M	M	-
CO2	M	-	-	-	-	-	L	M	M	L	M	-
CO3	M	-	-	-	-	-	L	M	M	M	M	-
CO4	L	-	-	-	-	-	L	M	H	L	L	-
CO5	L	-	-	-	-	-	L	M	H	M	M	-

List of Experiments

Determination of:

1. Specific gravity of coarse and fine grained soils
2. Grain size analysis (a) Sieve analysis (b) Hydrometer analysis
3. Atterberg limits and indices
4. Field density (a) sand replacement method, (b) Core cutter method
5. Coefficient of permeability by (a) Constant head method, (b) Variable head method
6. Compaction characteristics of soil using (a) IS light compaction test, (b) IS heavy compaction test
7. Consolidation behavior and indices using oedometer test setup
8. CBR value of soil by California Bearing Ratio test
9. Shear strength parameters by direct shear test
10. Shear strength parameters by triaxial shear test
11. Unconfined compressive strength
12. Shear strength parameters by Laboratory vane shear test

Reference Books/Material

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. Manual of Soil Laboratory Testing, K.H. Head, Whittles Publishing, 3rd edition, 2006
2. Geotechnical Engineering Lab Manual, William A. Kitch, 2011.
3. Terzaghi, K, and Peck, Soil Mechanics in Engineering Practice, R.B John Wiley, New York, 1968.
4. Soil Testing and Instrumentation, Alam Singh, New Age International, New Delhi, 1998. (Revised Edition)
5. Relevant IS codes

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	Course Name	L	T	P	Credits
HU300	Human Values & Professional Ethics	1	0	0	1

Pre-requisites: Nil

Course Objectives:

The main objective is to inculcate human values and professional ethics among the students so that they become good human beings, which in turn will bring collective benefits. Also, the students will understand harmony at all levels of existence.

Course Outcomes

After this course, the student shall acquire knowledge of Human Values and ethics and there will be a behaviour change. They will understand the value of harmonious relationships with fellow human beings based on trust, respect, compassion, tolerance, and empathy.

.

CO1. Students will have a fair understanding of Human Values and Professional Ethics

CO2. Students will exemplify good behaviour

CO3. Students will develop a feeling of Empathy

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

Syllabus

Module 1: Introduction to Concepts of Human Values and Ethics- Origin and History (Western and Eastern Perspectives with reference to Socrates, Plato, Plotinus, Epicurus,Thomas Aquinas, Immanuel Kant, Buddha, *The Vedas*, *The Upanishads* and *The Mahabharata*) Ethics – Classification (4 Types), History, and Purposes, Utilitarianism, Duties, Rights, Responsibility, Virtue, Honesty, Morality, Moral Autonomy, Obligations of Engineering Profession and Moral Propriety.

Module 2: A comprehensive understanding of Existence, Knowledge of Self, Knowledge of Society, Nature vis-à-vis Culture, Anthropocentrism, Deep Ecology, Idea of Cosmos

Module 3: Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, technologies, and management models, Engineer's Moral responsibility for Safety and Human Rights, Risk Assessment and Communication, Product Liability, Engineers-Employers Liaison, Whistle-Blowing and its Justification, Cyber Crime and Cyber Ethics, and Ecoethics

Module 4: Case study Discussion of typical holistic technologies, management models and production systems, Strategy for the transition from the present state to Universal Human Order

Module 5: Rapid Reading of texts like *Justice*, *Crime and Punishment*, *The Model Millionaire*, & Films Discussion like *An Inconvenient Truth*, *Modern Times*, and *The Elephant Whisperers* to understand Universal Human Values.

Reference Books/Material

1. A N Tripathy, 2003, Human Values, New Age International Publishers.
2. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books
3. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
4. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain
5. Ralph T.H. Griffith, (Trans) The Vedas
6. Eknath Easwaran, (Trans) The Upanishads
7. Peter Brook directed The Mahabharata (1989) film [available on Youtube]

Course Code	Course Name	L	T	P	Credits
CV350	Estimation, Costing and Specifications	3	1	0	4

Pre-requisites: Nil

Course Objectives

1. Read, understand and interpret plans, sections, detailed drawings and specifications for a construction project.
2. Study the various methods of detailed and approximate estimates.
3. Emphasize the importance of relevant Indian standard specifications, taking out quantities from the given requirements of the work and drafting specifications.
4. Conduct material and labour surveys to understand current market rates for various materials required for construction and different categories of labour required.
5. Perform the rate analysis for various items: standard and non-standard and the use of DSR in this process.
6. Study the process of tendering and its various stages, various types of contracts and draft various clauses and conditions of a contract

Course Outcomes

On completion of the course the students will be able to

CO1: Understand the various types of estimates

CO2: Prepare an estimate of buildings and road

CO3: Write detailed specifications for some common items of civil engineering works.

CO4: Prepare a bar bending schedule

CO5: Find out the rate analysis for common items of work

CO6: Understand the methods of valuation

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

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

Syllabus

Module 1 Introduction: Definition of estimating and Costing, Purpose, Data required for preparing an estimate, Qualities of an ideal quantity surveyor.

Module 2 Types of Estimates: Approximate or preliminary estimate, Detailed, Supplementary and Revised estimate with brief description of each. Purpose of approximate estimate and Methods of approximate estimation of a building and highway, Administrative approval, Expenditure sanction and Technical sanction.

Module 3 Mode of Measurement: Standard unit of measurements, Modes of measurements for different items of work for buildings and Road work, Provision for lump sum, Spot item, and Provisional sums. Degree of accuracy in estimating; General rules for measurement of work as per IS 1200. Significance of provision for contingencies, Work charged establishment, Percentage provision for Water supply, Sanitation.

Module 4 Specification: Definition, purpose of specification, Types and principles of writing specification. Writing detailed specifications for some common items of civil engineering works.

Module 5 Detailed Estimate and Abstracting: Types of forms used for detailed measurement and Abstracting. Methods of taking out quantities; Centre line methods and Long wall and Short wall methods. Case studies with different items for a single storied residential building including working out the percentage cost for different stages of construction.

Module 6 Road Earth Work: Computation of earth work with no transverse slope using mean area and Mean depth formula including soling area for pitching/turfing. Estimate of a road with WBM and Bituminous road surface involving all basic items including computation of earth work, Quantities of various items with abstract.

Module 7 Bar Bending Schedule and rate analysis:: Detail bar bending schedule with quantity of steel for slabs, Beams, Footings, Columns, Retaining wall. Rate Analysis: Factors considered for rate analysis, Schedule of rates and Market rates for common materials and Capacity, Preparation of material estimate for common items of work. Rate analysis for common items of work (as specified in the term-work only).

Module 8 Valuation and Tenders: Definition, Importance and Necessity of valuation, Factors affecting valuation, Methods of valuation, Book value, Market value, Single and Dual rates year's purchase, Depreciation, Sinking fund, Rent fixation, Valuation for various purposes. Tenders and contracts: Definition and Purpose of tender; Salient features of processing tender. Definition of contract. Type of contracts; Salient features, Obligation of the parties to a contract. Earnest money deposit, Security deposit, Running account bill and Final bill.

Reference Books/Material

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. 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.
4. CPWD manual
5. Goa Schedule of rates

Online Resources:

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

Course Code	Course Name	L	T	P	Credits
CV351	Design of Steel Structures	3	1	0	4

Pre-requisites: Nil

Course Objectives

1. Understanding the material properties and different design methodologies.
2. Design of simple bolted or welded connections
3. Design of axial members under tension and compression
4. Design of flexural members like beams and plate girders
5. Design of connection between members

Course Outcomes

CO1: Learn the basic elements of a steel structure and the fundamentals of structural steel fasteners

CO2: Analyze and design the bolted and welded connections.

CO3: Design the rolled and built-up tension & compression members.

CO4: Design the laterally supported & unsupported flexural members and plate girders.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	L	L	-	-	-	-	-	-	-	-
CO2	H	H	H	M	-	-	-	-	-	-	-	-
CO3	H	H	H	H	-	-	-	-	-	-	-	-
CO4	H	H	H	H	-	-	-	-	-	-	-	-

Syllabus

Module 1 General Considerations: Introduction to structural steel and its design philosophies. Properties of steel and rolled sections. Limit state Method, limit state of strength serviceability (deflection, vibration, durability, fatigue, fire). Structural steel section. Classification of cross section-plastic, compact, semi-compact slender, limiting width to thickness ratio, plastic design considerations

Module 2 Simple Connections: Design of riveted, bolted connections, welded connections: concentric and eccentric connections, load transfer mechanism, failure of joints, prying action, selection of fasteners

Module 3 Axial Members: Tension Members - Types & design of tension members; rolled and built-up sections, types of failures, lug angles, and gusset plates.
Compression Members - Effective length, slenderness ratio & types of buckling, design of compression members; Rolled and Built-up sections. Design of column bases

Module 4 Flexural Members: Beams - Behaviour of beams in flexure, classification of sections, lateral torsional buckling, and shear strength of beams. Design of flexural members, laterally supported, laterally unsupported and built-up beams.
Plate Girders - Elements & proportioning of plate girder, shear buckling design methods, types & design of stiffeners, curtailment of flanges, design procedure of Plate Girders with special focus on shear buckling & use of web stiffeners.

Module 5 Connections: Bolted welded connection by limit state method, beam to beam, beam to column connection (simple frame connection, unstiffened and stiffened seat connections. Column bases: design of slab bases & gusseted bases using bolted /welded connection.

Reference Books/Material

Text books:

1. Limit State Design of Steel Structures, S K Duggal, Tata Mc Graw Hill Publishers, 2019, 3rd Edition.
2. Steel Structures: Design and Practice, N Subramanian, Oxford Publishers, 2018.

3. 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
4. Relevant IS codes

Online Resources:

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

Course Code	Course Name	L	T	P	Credits
CV352	Engineering Hydrology and Irrigation Systems	3	1	0	4

Pre-requisites: Nil

Course Objectives

1. Learn the need for irrigation and calculate the irrigation requirement for crops.
2. To gain basic knowledge about hydrology and calculate the losses occurring during precipitation.
3. Acquire skills in analyzing hydrographs and the application of unit hydrograph theory for predicting direct runoff.
4. To understand the basic concepts of irrigation systems

Course Outcomes

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

CO1: Plan an Irrigation System and estimate the Irrigation Requirements of Crops.

CO2: Analyze hydro meteorological data and estimate the abstractions from precipitation

CO3: Interpret hydrographs to assess direct runoff, separate base flow, and predict flow responses, essential for flood forecasting and water availability predictions.

CO4: Understand various irrigation systems and water requirements of crops

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	M	-	-	-	-	-	-	-
CO2	H	M	M	H	M	-	-	-	-	-	-	-
CO3	H	H	M	M	M	-	-	-	-	-	-	-
CO4	H	M	M	H	M	-	-	-	-	-	-	-
CO5	H	H	M	M	H	-	-	-	-	-	-	-

Syllabus

Module 1 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.

Module 2 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.

Module 3 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.

Module 4 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.

Module 5 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.

Module 6 Floods and flood routing: 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.

Module 7 Groundwater hydrology: Occurrence and distribution of groundwater, types of aquifers, properties, introduction to Darcy's law, Introduction to hydraulics of wells, open wells-yield test

Module 8 Basics of Irrigation Systems: Need for irrigation, Types of irrigation systems, Soil-Water-Plant Relationship, Water Requirement of Crops: Consumptive use of water, Irrigation water requirement, Duty and Delta, Irrigation efficiencies, Methods of Irrigation.

Reference Books/Material

Text books:

1. Applied Hydrology, Chow, V.T., Maidment, D., and Mays, L.W., Tata McGraw Hill Publications, 2017
2. Engineering Hydrology, Subramanya, K., Tata McGraw Hill Publications, 2017

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
3. Irrigation and Water Power Engineering, Punmia B C, Ashok Kumar Jain, Laxmi Publications, New Delhi, 2021
4. Irrigation Engineering and Hydraulic Structures, S K Garg, Khanna Publishers, New Delhi, 2023

Online resources

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

Course Code	Course Name	L	T	P	Credits
CV353	Structural Design Studio	0	0	3	2

Pre-requisites: Nil

Course Objectives

1. To equip the students with understanding various RCC and steel connections like beam column joints, bolted and welded connections, lap joints etc.
2. To visualize, sketch and accurately draw the components of a beam column joint, truss, beam, plate girder and column.
3. To learn the uses of drafting software AutoCAD.

Course Outcomes

CO1: Bolted and welded connection detailing

CO2: Detailing of different types of truss structure

CO3: Detailing of beams, columns, plate girder and connection between elements

CO4: Detailing of base plate connection for columns

CO5: Design and detailing of RCC beam column connections

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	M	M	H	M	H	H	M	H
CO2	-	-	-	-	M	M	H	M	H	H	M	H
CO3	-	-	-	-	M	M	H	M	H	H	M	H
CO4	-	-	-	-	M	M	H	M	H	H	M	H

Syllabus

List of experiments:

(Atleast 8 exercises comprising of 4 from Design of RCC structures and 4 from Design of Steel structures, which can be chosen from the following)

1. Detailing of different types of bolts and welds.
2. Bolted and welded connection detailing.
3. Detailing of a truss structure.
4. Detailing of slab base connected with primary and secondary beams, resting on columns.
5. Detailing of plate girder.
6. Detailing of beams, columns, footings and slab, stairs for RCC Beam column connections

Reference Books/Material

Text books:

1. Limit State Design of Steel Structures, S K Duggal, Tata Mc Graw Hill Publishers, 2019, 3rd Edition
2. N. Subramanian, Design of steel structures, Oxford higher education, 2008
3. Punmia, A. K. Jain and Arun Kumar Jain, Comprehensive Design of Steel Structures, Laxmi Publication, 2nd edition,2015
4. Limit State Design of Reinforced Concrete Structures, B.C. Punmia, Ashok. K.Jain and Arun K Jain, Laxmi Pub. Pvt Ltd, 2016.
5. Design of Reinforced Concrete Structures, IS:456-2000, N Krishnaraju, CBS Publications, 2019, 4th Edition.

Reference books:

1. Relevant IS Codes

Course Code	Course Name	L	T	P	Credits
CV354	Environmental Engineering Laboratory	0	0	3	2

Pre-requisites: Nil

Course Objectives

1. To identify and explain the key physical properties of water and wastewater.
2. To interpret experimental data obtained from water and wastewater samples.
3. To recognize different treatment processes used for water purification and wastewater treatment.
4. To connect water and wastewater analysis findings to broader environmental engineering concepts.

Course Outcomes

On completion of the course, the student will be able to:

CO1: Determine the physical, chemical and biological characteristics of water and wastewater.

CO2: Compare the experimental results with standards and deliberate based on the purpose of analysis.

CO3: Determine type & degree of treatment, for water and wastewater.

CO4: Relate the significance of experimental results in environmental engineering practices.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	M	M	H	M	H	H	M	H
CO2	-	-	-	-	M	M	H	M	H	H	M	H
CO3	-	-	-	-	M	M	H	M	H	H	M	H
CO4	-	-	-	-	M	M	H	M	H	H	M	H

Syllabus

1. Determination of:
    a. Solids (total, dissolved, suspended, organic, inorganic, settleable) in water.
    b. pH.
    c. Fluoride.
    d. Iron.
    e. Turbidity.
    f. Acidity and alkalinity.
    g. Chlorides.
    h. Dissolved oxygen content in water.
    i. Biochemical oxygen demand.
    j. Chemical oxygen demand.
    k. Sludge volume index of sewage sample.
2. Microbiological studies.

Reference Books/Material

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. Handbook of Water and Wastewater Treatment Technologies, Nicholas P. Cheremisinoff, Butterworth- Heineman, 2001, 1st Edition
2. Standard methods for the examination of water and wastewater, Washington: APHA, 2012, 21st Edition
3. Environmental Engineering Laboratory Manual, Kotaiah, B., and Kumara Swamy, N.,

Charotar Publishing House Pvt. Ltd., 2007, 1st Edition

4. CPCB, Guide Manual: Water and Wastewater Analysis
5. CPHEEO manual on sewage and sewage treatment
6. APHA standard methods for the examination of water and wastewater, 20th edition.
7. Lab Manual, ISO 14001 Environmental Management, Regulatory Standards for Drinking Water and Sewage disposal.

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://www.vlab.co.in/

Semester-wise courses of Fourth year B. Tech. Programme

VII Semester

Sl.No.	Course Code	Course Name	Type	L-T-P	Credits
1	HS350	Industrial Economics	HU/HM	3-0-0	3
2	CV401	Summer Project/Industrial Training	DC	0-0-2	1
3	CV402	Major Project-1	DC	0-0-3	2
4	CV400	Comprehensive Examination	DC	0-0-0	1
5	CV5XX	Elective-III	DE/OE	3-0-0	3
6	CV5XX	Elective-IV	DE/OE	3-0-0	3
7	CV5XX	Elective-V	DE/OE	3-0-0	3
8	CV5XX	Elective-VI	DE/OE	3-0-0	3
	Total Credits				**19**

VIII Semester

Sl.No.	Course Code	Course Name	Type	L-T-P	Credits
1	CV451	Major Project-II	DC	0-0-6	3
2	CV5XX	Elective-VII	DE/OE	3-0-0	3
3	CV5XX	Elective-VIII	DE/OE	3-0-0	3
4	CV5XX	Elective-IX	DE/OE	3-0-0	3
5	CV5XX	Elective-II[#]	DE/OE	3-0-0	3[#]
	Total Credits				**12 (15[#])**

[#] offered only for students who have opted for minor course

Detailed Syllabi of Fourth year courses

Course Code	Course Name	L	T	P	Credits
HS350	Industrial Economics	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Identify and analyse the behaviour of a firm under different market situations systematically.
2. Understand and assimilate the issues related to strategic behaviour in firms, R&D and innovation.
3. Have a comprehensive coverage of firms' profitability and efficiency measurements, with applications to India's industrial structure.
4. To understand the rich complexities and paradox of fourth industrial revolution.

Course Outcomes

Upon completion, students should have an in-depth knowledge of

CO1. Market structure, conduct and performance
CO2. Strategic behaviour in firms
CO3. Innovation, R&D and the market
CO4. Industrial efficiency and its applications for the Indian economy.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	M	M	M	M	M	M	L	M
CO2	M	H	H	M	M	H	M	M	H	M	M	M
CO3	M	M	H	H	H	M	M	M	H	M	M	M
CO4	H	M	M	M	L	L	H	H	M	M	M	H

Syllabus

Unit-1: Introduction to Economics – Introduction to Industrial economics - nature and scope - concept of firm and industry- types of firms - structure, conduct and performance

Unit-2: Standard forms of market structure - pricing strategies and output determination of firms - profit maximization, sales maximization (William J. Baumol), utility maximization (Oliver E. Williamson), growth maximization (George K. Yarrow) - equilibrium of firms under

perfect competition, monopoly, monopolistic competition and oligopoly - optimum price and output - economies of scale.

Unit-3: Price and non-price competition - strategic behaviour of firms - collusion and mergers - game theory - market failures and information asymmetry - advertising and product differentiation - market entry and exit - concentration and diversification

Unit- 4: Patents and technological change- the economics of patent-innovation and diffusion measures of concentration

Unit- 5: Research and Development (R&D) and market structure -- product and process innovation- R&D and patent race-licensing and incentive to innovate

Unit-6: Economics of the fourth Industrial Revolution – Industrial revolution past, present and Future, Internet-Artificial Intelligence- Blockchain technologies

Essential reading

1. Donald A. Hay, Derek J. Morris, *Industrial Economics: Theory and Evidence*, Oxford University Press, 1979
2. Carton, D. and J. Perloff. Modern Industrial Organization (Reading, Massachusetts: Addison-Wesley), 1999.
3. Lall, Sanjaya. Competitiveness, Technology and Skills (Cheltenham: Edward Elgar), 2001.
4. Shy, O. (1996). *Industrial organization: Theory and applications*. MIT Press.

Supplementary reading

1. A. Singh and A.N. Sandhu, *Industrial Economics*, Himalaya Publishing House, Bombay, 1988
2. Ferguson, Paul R. and Glenys J. Ferguson, (1994), Industrial Economics - Issues and Perspectives, Macmillan, London.
3. Stephen Martin, *Advanced Industrial Economics*, Oxford, UK Blackwell Publisher, 2002
4. R. R. Barthwal, *Industrial Economics: An Introductory Textbook*, New Age International Publishers, 2007
5. Hay, Donald A. and Derek J. Morris. Industrial Economics and Organization: Theory and Evidence, 2nd Edition (Oxford: Oxford University Press), 1991.

6. Schmalensee, R., Inter-industry studies of Structure and Performance, in Schmalensee, R. and R. D. Willig (eds.): Handbook of Industrial Organization [Amsterdam: North-Holland] Vols. 2 Chapter 16, pp. 951-1009, 1989.
7. Siddharthan, N. S. and Y.S. Rajan. Global Business, Technology and Knowledge Sharing: Lessons for Developing Country Enterprises (New Delhi: Macmillan), 2002.
8. Tirole, Jean. The Theory of Industrial Organization (Cambridge, MA: The MIT Press), 1988.

ELECTIVES

Course Code	Course Name	L	T	P	Credits
CV501	Railway, Airport and Engineering	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To understand the engineering surveys for track alignment.
2. To study the railway construction and maintenance
3. To know the airport planning and design
4. To learn the different components of harbour

Course Outcomes

The students will be able to

CO1: Understand the components of a typical railway track and alignment process

CO2: Analyze the design criteria involved in track alignment

CO3: Understand the factors involved in airport planning and design

CO4: Understand the components involved in dock and harbour design

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	M	-	-	-	-	-	-	-	-
CO2	H	H	H	M	-	-	-	-	-	-	-	-
CO3	H	M	M	L	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-	-

Syllabus

Module 1 Railway Engineering: Factors controlling alignment, engineering surveys for track alignment, Rails, Functions and requirements of component parts of railway track, Creep of rails. Sleepers; Functions and Types, Ballast; Properties, Points and Crossings, Track junctions and Simple track layouts, Transition curves, Safe speed on curves, Modernization of railways, High speed trains, Ballastless tracks. Railway Construction and Maintenance: Construction of railway track, Earthwork, Plate laying and Packing, Maintenance of track alignment, Gauge, Renewal of component parts and Drainage, Modern methods of track maintenance.

Module 2 Airport Engineering: Airport Planning and design, Layout of an airport with component parts and Functions, Site selection for airport, Aircraft characteristics affecting the design and Planning of airport, Airport classification, Runway orientation using wind rose with examples, Basic runway length, Corrections and Examples, Runway geometrics and Design, Runway safety. Taxiway Design, Factors affecting the layout, Geometrics of taxiway, Visual aids, Airport marking, Lighting, Air traffic control, Instrumental landing system.

Module 3 Docks and Harbours: Classification of harbours, Components, Site selection, Construction and Maintenance of wet and dry docks, Breakwaters, Lock gates, Quays, Jetties, Landing piers, Fenders, Dolphins, Slipways, Aprons, Transit sheds, Ware houses, Navigational aids such as light house, Buoys, Beacons, Study of important harbours, Objectives of dredging, Dredging equipment, Types of dredging in different soil conditions

Reference Books/Material

Text books:

1. Railway Engineering, Chandra, S., and Agarwal, M.M., Oxford University Press, Noida, India, 2013, Second Edition.
2. Airport Planning and Design, Khanna, S.K., and Arora, M.G., Nemchand and Bros, 6th Edition, 2005.
3. Docks and Harbour Engineering, H. P. Oza and G. H. Oza, Charaotar Publishing House, 2016

Reference books:

1. Railway Track Engineering, Mundrey, J.S., Tata McGraw-Hill Education Private Limited, New Delhi, India, 2017, Fifth 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
3. Railway Track: Design Construction, Maintenance and Renewal of Permanent Way, Antia K. F., New Book Company, Private, 5th Edition, 1960.
4. Airport systems: Planning, design, and management, De Neufville, R., Odoni, A. R., Belobaba, P. P., and Reynolds, T. G., McGraw-Hill Education, 2nd Edition, 2013

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	Course Name	L	T	P	Credits
CV502	Advanced Surveying	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To know about significance of advanced surveying in field measurements in terms of utility and precision of data collection
2. To learn on the principles of electronic distance measurements, Total station and their accuracy
3. To get introduced to the concept of photogrammetry in preliminary identification and mapmaking
4. To know in detail the concept of remote sensing in identification of land features from space and to get introduced to different data acquisition techniques like LIDAR, RADAR
5. To get introduced to the field of geodesy, coordinate systems, Map projections, GPS, its working principles, data collection, data processing and analysis.

Course Outcomes

On completion of the course the students will be able to :

CO1: Know the various types of EDM instruments

CO2: Survey using a Total Station

CO3: Understand the types of remote sensing

CO4: Know the working principle of GPS

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	H	-	-	-	-	-	-	-	-
CO2	H	M	M	H	H	-	-	-	-	-	-	-
CO3	H	M	H	M	H	-	-	-	-	-	-	-
CO4	H	M	2	H	H	-	-	-	-	-	-	-

Syllabus

Module 1: Electromagnetic distance measurement (EDM): Principle of EDM Carrier waves, Types of EDM instruments, Distomat, Total Station, Principle, procedure & surveying using Total Station, precise leveling, micro-optic theodolite.

Module 2: Photogrammetry: Terrestrial and Aerial Photogrammetry, Horizontal position of a point from photographic measurement, elevation of a point, Determination of focal length of camera, Geometry and scale of vertical photographs, Ground co-ordinates from vertical photographs, Relief displacement, Planimetric mapping from vertical photos, Stereoscopy, Photo interpretation.

Module 3: Remote sensing: concepts, Idealized remote sensing system, characteristics, Types of remote sensing system, Remote sensing from space, Data interpretation, application of remote sensing, LIDAR, RADAR, SONAR.

Module 4: Geodesy: Figure of earth, Classification, Earth surface, Geodetic reference surfaces, Coordinate systems, Geodetic datum and elements, Map, Scale of map, projection, UTM, Map projection of India, Space Geodesy, VLBI, SLR, LLR.

Module 5: GPS: Basics, system overview, working principle of GPS, Satellite ranging, calculating position, Ranging errors and its correction, GPS surveying Methods, static, Rapid static, DGPS and Kinematic methods, Real time and post processing DGPS, visibility diagram, GAGAN

Reference Books/Material

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	Course Name	L	T	P	Credits
CV503	Irrigation and Hydraulic Structures	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Understand the principles of open channel hydraulics and the factors influencing channel design.
2. Comprehend the factors affecting crop water needs and the methods for estimating evapotranspiration.
3. Study the components of a canal network and the principles of water distribution.
4. Learn the importance of diversion headworks and their role in water intake structures.
5. Analyze the functions of canal regulators, drops, escapes, and cross drainage structures.

Course Outcomes

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

CO1: Design rigid boundary channels and regime channels in erodible medium.

CO2: Compute crop water and irrigation water requirements.

CO3: Plan and execute a canal network in the field.

CO4: Plan and design diversion headworks.

CO5: Plan and design canal regulators, canal drops, canal escapes, cross drainage works.

Relationship of Course Outcomes to Program Outcomes H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	L	-	-	-	-	-	-	-	-
CO2	H	M	M	M	-	-	-	-	-	-	-	-
CO3	H	H	M	L	-	-	-	-	-	-	-	-
CO4	H	M	M	M	-	-	-	-	-	-	-	-
CO5	H	M	H	L	-	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Water resources projects, General planning philosophy. Data requirement, Environmental checklist, Irrigation schemes, Planning of Irrigation projects.

Module 2 Irrigation Engineering: Soil water system: Soil classification, Consumptive use, Irrigation water requirement. Diversion structures for direct irrigation - Weirs and Barrages Components of diversion head work. Design of weirs / barrages, Bligh‘s and Khosla‘s theories. Structural design of different elements. Training and protection works.

Module 3 Distribution system: Distribution canals: classification, alignment and components of canals. Canal regulation. Transport of sediment in canals. Design of rigid boundary canals. Design of alluvial channels. Regime channels, Kennedy‘s and Lacey‘s methods. Water logging and drainage of irrigated lands.

Module 4 Canal structures Canal regulation structures: canal falls-different types of canal falls and selection of type-Structural elements of a fall - Design of vertical, notch type and siphon drops.

Module 5 Canal headwork Head and cross regulators: Design criteria – sediment control at head regulator- Design of a regulator. Canal escapes, Weir and sluice escapes. Outlets-modular and non-modular outlets. Cross Drainage structures-Need - Types- Design considerations – design of a type III aqueduct.

Module 6 Reservoirs and Dams: Physical characteristics of reservoirs, Sedimentation control, Ideal site for reservoir, Types of Dams, Suitability of a type of dam, Elementary profile, Forces acting on dams, Failure of dams, Stability analysis, Elementary profiles, Design criteria, Causes of failures, Control of Seepage, Openings in dams, Foundation treatment for various dams.

Module 7 Spillway and Energy Dissipators: Introduction, Essential requirements of a spillway, Spillway capacity, Components, Types of spillways, Design of Ogee spillway, Energy dissipation below spillways.

Reference Books/Material

Text books:

1. Irrigation Water Resources and Hydropower Engineering, Modi, P. M., Standard Book Publishing Company, 2019
2. Irrigation, Water Power and Hydropower Engineering, Arora K. R., Standard Book Publishing, 2018, 5th Edition
3. R. S. Varshney, S. C. Gupta, and R. L. Gupta, Theory and Design of Irrigation Structures, Vol. II, Nem Chand Publication, 2009

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
3. FAO Irrigation, Water resources and Drainage Papers, 26/1,26/2 Small Hydraulic Structures, Vol 1 and 2.
4. FAO Irrigation water management Training Manuals 1(1985), 3(1986), 4(1988), and 5(1989).
5. All relevant BIS codes.

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	Course Name	L	T	P	Credits
CV504	Prestressed Concrete Structures	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To bring the civil engineers to such a level so as to enable them to take the appropriate decision in respect of choice of Prestressed section over R.C.C .
2. To make the learners be aware of such a highly mechanized technology in civil engineering construction.
3. To imbibe the culture of entrepreneurship in precast prestressed industry in mass housing, railway sleepers, electric transmission poles etc.
4. To understand the basic design considerations in prestressed concrete structures in relation to its applications.
5. To employ & develop new techniques in rehabilitation of distressed structures like buildings, Bridges & infrastructures.

Course Outcomes

CO1: Achievement of adequate knowledge in prestressed concrete structures ready for its dissemination & application.
CO2: Achievement of adequate knowledge in industrial requirements of prestressed concrete.
CO3: Explore the new field of construction and future scope of the subject knowledge.
CO4: Updating knowledge in design & research related to prestressed concrete structures.
CO5: Emergency preparedness in case repairs & rehabilitation of structures in case of disasters like earthquake, fatigue & dynamic loadings etc.

Relationship of Course Outcomes to Program Outcomes
H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	-	-	-	-	-	-	-	-
CO2	M	M	L	M	-	-	-	-	-	-	-	-
CO3	M	H	L	L	-	M	-	-	-	-	-	-
CO4	H	H	M	M	-	-	-	-	-	-	-	-
CO5	M	M	L	M	-	M	-	-	-	-	-	-

Syllabus

Module 1 Design of high strength concrete mixes. Loss of prestress in single span and continuous beams. Use of IS 1343-1980, Analysis Limit State Design of beams for Tension Type II and III problems, Cracking moment, untensioned reinforcement, Partial prestressing, Stress Corrosion.

Module 2 Transfer of prestress by bond, Transverse tensile stresses, End zone reinforcement. Behavior of Bonded and unbonded prestressed concrete beams.

Module 3 Deflection of Prestressed concrete members, short and long term, control of deflections. Crack width considerations. Flexural strength of prestressed concrete sections: Types of flexural failures, Limit state concept.

Module 4 Shear resistance of prestressed concrete members: Principal stresses and ultimate shear Resistance, Design of shear reinforcement, prestressed concrete, members in Torsion, Design of reinforcement in torsion shear and bending.

Module 5 Stress distribution in end block, Analysis and Anchorage Zone reinforcement. Composite Construction of prestressed precast and cast in situ concrete. Statically Indeterminate structures: Continuous beams, primary and secondary moments, Continuity, concordant cable profile, Analysis and Design of continuous beams.

Module 6 Prestressed concrete pipes and poles.Design of Prestressed concrete tanks. Prestressing of dams and bridges: Method of construction. Stage prestressing, Dynamic and Fatigue behavior of prestressed concrete.

Reference Books/Material

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
5. Prestressed Concrete, Raju, N.K., Tata McGraw Hill (Third Edition) 1981.
6. Relevant IS codes

Online resources:

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

Course Code	Course Name	L	T	P	Credits
CV505	Road Safety and Management	3	0	0	3

Pre-requisites: Nil

Course Objectives:

1. To understand the global road safety scenario.
2. To learn the risk factors for traffic accidents
3. To study the traffic management measures for accident prevention.
4. To understand the road safety audit.

Course Outcomes

Students will be able to:

CO1: Identify the factors contributing to accidents.

CO2: Collect data pertaining to road crashes and prepare comprehensive crash database

CO3: Perform statistical analysis of crash data.

CO4: Formulate traffic management measures for accident prevention.

CO5: Perform road safety audit and prepare an audit report.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	M	-	-	-	-	-	-	-	-
CO2	H	H	M	H	-	-	-	-	-	-	-	-
CO3	H	H	M	H	-	-	-	-	-	-	-	-
CO4	H	H	M	-	-	-	-	-	-	-	-	-
CO5						-	-	-	-	-	-	-

Syllabus

Module 1 Introduction to road safety engineering: Overview of road safety - Global road safety scenario and pattern - global trends and projections - national and state road safety level - problems in road safety in developing countries- magnitude, socioeconomic and health effects.

Module 2 Traffic Elements: Characteristics of Road user, Motor vehicle, Roadway- relationship between elements- human factors governing road user behavior- risk factors for traffic accidents- exposure to risk- crash involvement- crash severity- post crash injury outcomes

Module 3 Analysis and prevention: Collection of accident data- Statistical methods for analysis of accident data, Speed in relation of safety- Weather and its effects on accidents- Vulnerable road users safety parking influence on accidents- Traffic management measures for accident prevention- Legislation, Enforcement, Education and Propaganda- Formulating and implementing road safety policy.

Module 4 Road safety improvement program: Road safety audit (RSA) - Procedure in road safety audit- design standards- audit tasks- stages of road safety audit- key legal aspects. Road design issues in RSA's – structuring and preparation of audit report.

Reference Books/Material

Text books:

1. Traffic Engineering, Matson M T, Smith S W, Hurd W F, McGraw-Hill Book Company Inc., London, 1955.
2. Traffic Engineering and Transportation Planning, Kadiyali, Khanna Publishers, New Delhi, 2009.
3. Transportation Engineering- An Introduction, Khisty C J, Lall B K, 3rd Edition, Prentice Hall of India, New Delhi, 2006.

Reference books:

1. Transportation Engineering- Introduction to Planning, Design and Operations, Jason C Y, Elsevier, 1982.

2. Human Factors for Highway Engineers, Fuller R, Santos J A, Pergamon, 2002.
3. Road Traffic Injury Prevention Training Manual, World Health Organization, 2006.
4. Relevant IRC codes.

Course Code	Course Name	L	T	P	Credits
CV506	Earth Retaining Structures	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Introduce important geotechnical structures viz., earth dams, retaining structures, slopes and cuts.
2. Discuss lateral earth pressure theories and their application.
3. Understand the stability of slopes and earthen dams in the presence of ground water seepage and earthquake forces.
4. Discussing the analysis and geotechnical design aspects of these structures.

Course Outcomes

On completion of this course, students will be able to:

CO1: Determine the earth pressure on retaining structures under different boundary and drainage conditions.

CO2: Perform seepage analysis of earthen retaining structures and apply suitable design methodology to control seepage through dams and foundations.

CO3: Compute stability of slope and earthen dams affected by groundwater seepage and earthquake forces.

CO4: Apply geotechnical engineering principles for the design of earth dams, retaining structures and slopes.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	L	M	-	-	-	-	-	-	-
CO2	H	H	M	M	L	-	-	-	-	-	-	-
CO3	H	M	M	M	M	-	-	-	-	-	-	-
CO4	H	H	M	L	M	-	-	-	-	-	-	-

Syllabus

Module 1: Earthen Dam, seepage analysis and control: Introduction to Earthen dams, types of dams, selection of type of dam based on material availability, foundation conditions and topography, Design details, crest, free board, upstream and downstream slopes, upstream and downstream slope protection, central and inclined cores, types and design of filters, Seepage analysis and control, seepage through dam and foundations, control of seepage in earth dam and foundation

Module 2: Stability analysis: Critical stability conditions, evaluation of stability by Bishop's and sliding wedge methods under critical conditions, Construction techniques, methods of construction, quality control Instrumentation, measurement of pore pressures

Module 3: Earth pressure: Earth pressure theories, Rankine and Coulomb's earth pressure theories for cohesion less and cohesive backfills, computation of earth pressures for various cases, inclined, with surcharge, submerged and partly submerged, stratified backfills

Module 4: Rigid retaining structures: Methods of calculation of active and passive earth pressures against gravity retaining walls, computation of earth pressures by Trial wedge method and Graphical Method. Geotechnical design aspect of retaining walls, Design of gravity retaining wall, cantilever retaining walls

Module 5: Flexible retaining structure: type and methods of construction, design strength parameters, safety factor for sheet pile walls, computation of earth pressures against cantilever sheet piles in cohesion less and cohesive soils, anchored sheet piles, free earth method, fixed earth method, Rowe's moment reduction method, stability of sheet piling.

Reference Books/Material

Text books:

1. Foundation engineering, Das B M, Cengage Learning, 2007
2. Analysis & Design of Foundation & Retaining Structures subjected to seismic loads, Swami Saran, I K International Publishing House, 2012

Reference books:

1. Foundation Analysis and Design, Bowles, McGraw Hill, 2001
2. Earth Reinforcements & Soil structures, Colin JFP Jones, Elsevier, 2013
3. Analysis & Design of Foundation & Retaining Structures, Prakash S, Ranjan G, Saran S, Sarita Prakashan, 1979
4. Theoretical Soil Mechanics, Terzaghi K, John Wiley, 1965.
5. Fundamentals of Soil Mechanics, Taylor D W, John Wiley, 1948.

Course Code	Course Name	L	T	P	Credits
CV507	Construction Planning and Management	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Analyze methods, materials, and equipment used to construct projects.
2. Understand the concepts of construction risk management, construction accounting and cost control
3. Familiarize with the construction quality assurance practices and control.
4. Understand construction project control processes.
5. Understand the basic principles of sustainable construction.

Course Outcomes

On completion of the course the students will be able to

CO1: Understand the principles involved in planning, controlling projects

CO2: Schedule projects using different methods

CO3: Work on software in construction scheduling

CO4: Classify the construction materials

CO5: Understand the construction costs and construction budgets

CO6: Know the importance of quality control in construction works

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	L	-	-	-	-	-	-	-	-
CO2	H	H	M	H	-	-	-	-	-	-	-	-
CO3	H	M	M	M	-	-	-	-	-	-	-	-
CO4	H	M	H	M	-	-	-	-	-	-	-	-
CO5	H	M	H	M	-	-	-	-	-	-	-	-

Syllabus

Module 1 Fundamentals of Construction Management: Fundamental components, Construction industry, Construction projects, Principles of management (Henri Fayol), Modern scientific management, Agencies associated with the construction industries in national development Main causes of project failure, project life cycle. Importance of planning, Scheduling and Controlling projects.

Module 2 Project Planning Scope: Project clearance procedures and Necessary documentation for major works like dams, multistoried structures, Ports and Tunnels, Functions and Role of Chief planner and Project management consultants. Project Scheduling Scope: Guidelines for drawing project network, Work breakdown structure, Scheduling of bar chart and preparing construction schedule by bar chart for small projects, Advantages and Limitations of bar chart. Time estimation in CPM, PERT, RPM (Repetitive Project Modeling) techniques and Analysis, Critical path method calculation. Factors affecting work scheduling, LOB techniques, Precedence network analysis.

Module 3 Project Management Software and resources : Hands on software in construction scheduling (MSP or Primavera). Planning Construction Resources: Manpower: Necessity, Establishing workers productivity standards, Scheduling construction site workers, Project manpower grouping and designing workers financial incentive scheme, Important Acts and Labour laws related to construction activity.

Module 4 Materials and construction equipment: ABC Classification of construction materials, Materials Usage/wastage standards, Materials provisioning process, Planning materials inventory.

Module 5 Project Construction Equipment: Selecting construction equipment, Classification of major equipment, Earth factor in earthwork, Earth excavating equipment, Earth cutting and Hauling equipment, Earth compacting and Grading equipment, Concreting plant and Equipment, Cranes for materials hoisting, Equipment for dredging, Trenching, Tunneling and Pile driving.

Module 6 Planning Construction Costs and Construction Budgets: Classification of

construction costs, Elements and Classification of cost accounting, Breakeven point, Standard 'S' curve forecasting tool, Fund flow v/s cash flow. Structuring responsibility centers, Costs inflation, Escalation and Contingencies, Types of budget, Techniques for budgeting, Budgetary forecasts, Project master budget.

Module 7 Project Control: Control system framework, Monitoring performance, Resource productivity control, Project time and Cost control basics, Disputes and claims management, Concepts of quality control and its importance for construction work.

Reference Books/Material

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
4. PERT and CPM – Principles and Applications, Srinath L.S., East-West Press, 2001

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	Course Name	L	T	P	Credits
CV508	Concrete composite Materials	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Understanding the modelling of composite material by finite element analysis.
2. Fabrication techniques of various composites.
3. Understand different types of composites and their testing techniques.

Course Outcomes

CO1: Understand the concept of composite materials and the matrix within it

CO2: Classify composites based on materials used

CO3: Study the methods of fabrication of composites

CO4: Understand the different tests for composite characterization

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	M	-	-	-	-	-	-	-	-
CO2	H	M	H	M	-	-	-	-	-	-	-	-
CO3	H	H	M	M	-	-	-	-	-	-	-	-
CO4	H	M	M	L	-	-	-	-	-	-	-	-
CO5	M	M	L	L	-	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass

Matrix etc. Types of Reinforcements/Fibers: Role and Selection or reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers , Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibres. Material properties that can be improved by forming a composite material and its engineering potential

Module 2 Various types of composites: Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Comparison with Metals, Advantages & limitations of Composites

Module 3 Fabrication methods: Processing of Composite Materials: Overall considerations, Autoclave curing, Other Manufacturing Processes like filament welding, compression molding, resin-transplant method, pultrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrix performs, Manufacturing Techniques: Tooling and Specialty materials, Release agents, Peel plies, release films and fabrics, Bleeder and breather plies, bagging films

Module 4 Testing of Composites: Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc.

Reference Books/Material

Text books:

1. Mechanical Metallurgy, G. Dieter, Mc-Graw Hill, 2017, 3rd edition
2. Thermal Analysis of Materials, R.F. Speyer, CRC Press, 1993
3. Engineering Materials: Polymers, A.K Bhargava, Ceramics and Composites, Prentice Hall India, 2004

Reference books:

1. Materials characterization, Vol. 10, ASME hand book,2014

Course Code	Course Name	L	T	P	Credits
CV509	Solid Waste Management	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To understand waste types, characteristics, and the need for management.
2. To grasp waste storage, transport, and collection methods.
3. To explore waste processing and recovery techniques.
4. To learn ultimate disposal and landfill management.
5. To study the various waste management statutes.

Course Outcomes

On completion of the course, the student will be able to:

CO1: Describe waste sources, attributes, impacts, and management importance.

CO2: Explain storage containers, collection vehicles, diverse systems, routes, and transfer stations.

CO3: Discuss size alteration (shredding, compaction), separation (drying, dewatering), conversion (composting, bio-gasification), and thermal methods.

CO4: Cover landfill disposal, design, operation, closure, and remediation; introduce land farming.

CO5: Outline integrated waste management, Indian regulations (SW Rules 2016, C&D Waste Rules 2016).

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	H	-	-	-	-	-	-	-	-
CO2	H	H	H	M	-	-	-	-	-	-	-	-
CO3	H	M	M	H	-	-	-	-	-	-	-	-
CO4	H	M	M	M	-	-	-	-	-	-	-	-
CO5	M	M	L	L	-	-	-	-	-	-	-	-

Syllabus

Module 1 Solid Wastes Basics: Types and Sources, Waste Characteristics: physical- chemical, Effects on – Environment- Health, Need of Solid Waste Management, Waste collection

Module 2 Storage and Transport: Storage containers- collection vehicles, collection system types, collection routes, transfer stations, Waste Collection System design

Module 3 Waste Processing Techniques: Purpose, mechanical size alteration – shredding-compaction, component separation methods – drying and dewatering Recovery of Biological Conversion Products – Composting- stages – types, Bio-gasification- metabolic stages- types of digesters, Recovery of Thermal Conversion Products – Incineration - technologies, Pyrolysis, Energy Recovery Systems, Recycling: significance – Recycling programme elements – planning

Module 4: Ultimate Disposal: Disposal in Landfills - Site Selection - Design and Operation of Sanitary Landfills - Closure of Landfills - Landfill Remediation, Land farming.

Module 5 Waste Management Statutes: Elements of Integrated Waste Management Solid waste management statutes in India- Solid Waste Management Rules 2016, Construction and Demolition Waste Management Rules, 2016.

Reference Books/Material

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. II): Sewage Waste Disposal and Air Pollution Engineering, S.K. Garg (1999), Khanna Publishers, 2018, 40th Edition

Reference 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. Handbook of Solid Waste Management, George Tchobanoglous and Frank Kreith, New York, USA: McGraw-Hill Education, 2002
3. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2016.
4. Department of Publication, Government of India, Gazette of India- for relevant statutes
5. Standard methods for the examination of water and wastewater, Washington: APHA, 2012, 21st Edition

Online resources:

1. http://cpheeo.gov.in/cms/manual-on-sewerage-and-sewage-treatment.php

Course Code	Course Name	L	T	P	Credits
CV510	Groundwater Hydrology	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To gain an understanding of the hydrologic cycle and the role of groundwater within it.
2. To acquire knowledge on concepts of porosity, permeability, specific yield, and specific retention.
3. To learn the principles of Dupuit's and Theis equations for well analysis.
4. To gain insight into groundwater transport processes, including advection, diffusion, and dispersion.
5. To utilize groundwater models like MODFLOW and MT3D for groundwater modeling.

Course Outcomes

The students will be able to:

CO1: Explain the significance of groundwater in the hydrologic cycle and its relation to surface water.

CO2: Apply Darcy's law to describe groundwater flow and hydraulic gradients.

CO3: Analyze well hydraulics using Dupuit's and Theis equations for confined and unconfined aquifers.

CO4: Construct analytical and numerical models for groundwater flow and transport scenarios.

CO5: Utilize tools like MODFLOW and MT3D for building groundwater models.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	H	H	-	-	-	-	-	-	-	-
CO2	M	L	H	H	L	-	-	-	-	-	-	-
CO3	M	L	L	H	L	-	-	-	-	-	-	-
CO4	M	M	M	M	M	-	-	-	-	-	-	-
CO5	H	M	L	M	L	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Groundwater and hydrologic cycle, origin of ground Water, vertical distribution of groundwater, zone of aeration and zone of saturation, geologic formation as Aquifers, types of aquifers, porosity, Specific yield and Specific retention. Permeability, Darcy's law, storage coefficient, Transmissivity, Heterogeneity and Anisotropy, Direct and indirect methods for estimation of aquifer parameters, Governing equation for flow through porous medium, Steady and unsteady state flow - Initial and boundary conditions

Module 2 Aquifers: Steady flow groundwater flow towards a well in confined and unconfined aquifers-Dupit's and Theim's equations, Assumptions, Formation constants, yield of an open well interface and well tests. Unsteady flow towards a well — Non equilibrium equations-Thesis solution-Jacob and Chow's simplifications, Partially penetrating wells - Wells in a leaky confined aquifer - Multiple well systems - Wells near aquifer boundaries.

Module 3 Groundwater Transport: Groundwater transport process, Advection, diffusion, dispersion, Hydrodynamic dispersion advection dispersion equation and parameters - initial and boundary conditions - method of solutions. Saline Water Intrusion In aquifers: Occurrence of saline water intrusions, Ghyben-Herzberg relation, Shape of interface, control of seawater intrusion.

Module 4 Groundwater Modeling: Groundwater modeling, analytical and numerical approaches for the solution of groundwater flow and transport problems, model construction using MODFLOW and MT3D.

Module 5 Case Studies: Case studies using MODFLOW and MT3D, dewatering problems, Contaminant transport case studies.

Reference Books/Material

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
3. Hydrogeology and Groundwater Modeling, N. Kresic, Second Edition. Hoboken: CRC Press, 2006.

Online resources:

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

Course Code	Course Name	L	T	P	Credits
CV511	Hazardous Waste Management	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To understand waste management regulations for various waste types.
2. To grasp fundamentals of hazardous and radioactive waste management.
3. To learn environmental risk assessment methods and principles.
4. To understand physicochemical treatment and groundwater contamination.
5. To comprehend biological treatment and landfill design.

Course Outcomes

On completion of the course, the student should be able to:

CO1: Familiarize with rules governing municipal solid waste, hazardous waste, biomedical waste, fly ash, recycled plastics, and batteries.

CO2: Characterize hazardous waste and understand fate and transport mechanisms

CO3: Define environmental risk, explore risk assessment methods, and analyze case studies.

CO4: Explain physicochemical treatment processes for solid and hazardous wastes

CO5: Describe different techniques for biological treatment of solid and hazardous wastes

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	H	-	-	-	-	-	-	-	-
CO2	H	H	H	M	-	-	-	-	-	-	-	-
CO3	H	M	M	H	-	-	-	-	-	-	-	-
CO4	H	M	M	M	-	-	-	-	-	-	-	-
CO5	M	M	L	L	-	-	-	-	-	-	-	-

Syllabus

Module 1 Regulations for Municipal Solid Waste: Management and handling rules; hazardous waste (management and handling) rules; biomedical waste handling rules; fly ash rules; recycled plastics usage rules; batteries (management and handling) rules.

Module 2 Hazardous Waste Management: Fundamentals Characterization of waste; compatibility and flammability of chemicals; fate and transport of chemicals; health effects.

Module 3 Radioactive Waste Management: Fundamentals Sources, measures and health effects; nuclear power plants and fuel production; waste generation from nuclear power plants; disposal options.

Module 4 Environmental Risk Assessment: Defining risk and environmental risk; methods of risk assessment; case studies.

Module 5 Physicochemical Treatment: Physicochemical Treatment of Solid and Hazardous Waste Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation); groundwater contamination and remediation.

Module 6 Biological Treatment: Biological Treatment of Solid and Hazardous Waste Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation, Landfill design for solid and hazardous wastes; leachate collection and removal; landfill covers; incineration.

Reference Books/Material

Text books:

1. S.C. Bhatia, Solid and hazardous waste management, Atlantic Edition,2008
2. John Pichtel, Waste Management Practices, CRC Press, Taylor and Francis Group, 2005.

Reference books:

1. La Grega, M.D, Buckingham, P. L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Edition, New York, 2001.
2. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, New York, 1997.
3. Rao and Sultana, Solid and Hazardous Waste management, B S Publications, 2012

Course Code	Course Name	L	T	P	Credits
CV512	Advanced Highway Engineering	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Study highway planning surveys.
2. The students will be able to classify the different road making aggregates
3. To learn about highway construction.
4. To study the different highway construction equipment.

Course Outcomes

On completion of the course the students will be able to

CO1: Understand the highway development and planning process in India

CO2: Analyze the properties of aggregates and binders pertinent to pavement design

CO3: Understand the components and construction techniques employed in pavements

CO4: Understand the equipment used in highway construction

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	M	-	-	-	-	-	-	-	-
CO2	H	M	M	L	-	-	-	-	-	-	-	-
CO3	H	M	M	M	-	-	-	-	-	-	-	-
CO4	H	M	M	M	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	-

Syllabus

Module 1 Highway Planning: Highway development and planning in India, rural & urban road classification, planning surveys, highway alignment, computer aided planning.

Module 2 Road making aggregates, classification, properties of aggregates, design of aggregate gradation; Bituminous road binders, penetration grade, emulsions, cut backs and modified binders; rheology of bituminous binders, modified binders; mix design, Marshall method and Superpave procedure; design of emulsified mixes, viscoelastic and fatigue properties of bituminous mixtures, resilient modulus of pavement materials; requirements of paving concrete, design of mixes for recycling of bituminous and concrete pavement surfaces; soil stabilization techniques.

Module 3 Highway Construction: Earthwork & embankment construction; construction of stabilized sub-bases & base courses, drainage, surface / subsurface, sub-base & base construction techniques, WBM base, wet mix macadam, bituminous macadam, low-cost road construction, construction of shoulder, footpath, paver block areas.

Module 4 Highway Construction Equipment: Excavating, earth moving & compacting equipment, hot mix plant, pavers, and concrete mixers.

Reference Books/Material

Text books:

1. L.R.Kadiyali, Highway Engineering, Khanna Publishing ,1st Edition, 2019
2. Daniel J..Findley, Batian S., Christopher C, Tom B, Highway Engineering, Planning, design and operation, Butterworth-Heinemann 1st edition, 2015
3. Highway Materials, Soils, and Concrete, Atkins Harold N, Principles and Applications, Marcel Dekker, Inc.,2000.

Reference books:

4. Relevant IRC codes

Course Code	Course Name	L	T	P	Credits
CV513	Geotechnical Investigation of Construction Project	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To make the students capable of solving real problems related to Geotechnical engineering
2. Introduce advanced methodology, techniques and tools related to geotechnical investigation.
3. Apply theoretical knowledge of soil mechanics to solve real geotechnical challenges.
4. Discuss ground improvement with various methodologies.

Course Outcomes

On completion of this course, students will be able to:

CO1: Write geotechnical proposal, specification and reports

CO2: Perform bore logging and trial pit logging

CO3: Supervise field and lab testing of soil and rocks

CO4: Collect and analyze geotechnical data for various construct projects

CO5: Analyze and suggest proper ground improvement technique for problematic ground conditions

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	M	L	H	-	-	-	-	-	-	-	-
CO2	M	L	H	H	H	-	-	-	-	-	-	-
CO3	L	L	L	H	M	-	-	-	-	-	-	-
CO4	M	M	M	L	H	-	-	-	-	-	-	-
CO5	M	M	H	M	-	-	-	-	-	-	-	-

Syllabus

Module 1: Site Investigations: Planning of investigation programmes, Information required for planning different stages of investigations. Methods of site investigations: Direct methods, semi-direct methods and indirect methods, Drilling methods. Boring in soils and rocks, methods of stabilizing the bore holes, Geophysical methods, measurement of water table, field record.

Module 2: Field tests: In-situ shear test, in-situ permeability test, SPT, DCPT, SCPT, in-situ vane shear test, pressure meter test, plate load test.

Module 3: Sampling techniques, Sampling disturbances, storage, labeling and transportation of samples, sampler design, influence on properties. Geotechnical specification and proposal and report writing, boring log preparation, Safety measures, Geotechnical risks Geotechnical Processes

Module 4: Field compaction: Field compaction techniques- static, vibratory, impact, Earth moving machinery, Compaction control in field.

Module 5: In-situ stabilization with additives: Lime, fly ash, cement and other chemicals and bitumen. Deep Stabilization: sand column, stone column, sand drains, prefabricated drains, electro-osmosis, lime column. soil-lime column. Grouting: permeation, compaction and jet. Vibro-floatation, dynamic compaction, thermal, freezing. Dewatering systems

Module 6: Geotechnical Engineering Case Histories: Earthen dam and reservoir, Industrial Structures, Ground Liquefaction, opencast coal mining, landslides, failure of geotechnical structures under critical natural hazards, debris flow, forensic geotechnical investigation.

Reference Books/Material

Text books:

1. Ground Improvement Techniques, Raj Purushothama, Laxmi Publications, 2014
2. Subsurface Exploration and Soil Sampling, S. K. Saxena, S. A. Gill and R. G. Lukas, American Society of Civil Engineers, 2002

Reference books:

1. In Situ Testing in Geomechanics, Schnaid, F., Taylor and Francis, 2009.
2. Soil Engineering in Theory and Practice, Singh Alam, Asia Pub. House, 1981.

Course Code	Course Name	L	T	P	Credits
CV514	Advanced RCC Structures	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Design and analysis of slab system, curved beam, slender column, deep beam, corbel, raft & pile foundation, and shear wall.
2. To study the detailing requirements of the various special structures.

Course Outcomes

CO1: Design of various types of slab systems.
CO2: Analyze and design the curved beam, slender column, deep beam, corbel and various types of foundations & pile cap.
CO3: Design and ductile detailing of shear wall as per Indian standards.
CO4: Design knowledge about tower-like structures.

Relationship of Course Outcomes to Program Outcomes
H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	-	-	-	-	-	-	-	-
CO2	H	H	H	M	-	-	-	-	-	-	-	-
CO3	H	H	H	M	-	-	-	-	-	-	-	-
CO4	H	H	H	M	-	-	-	-	-	-	-	-

Module 1 Foundations design of footing: Isolated, combined/continuous, strip, raft, pile, pile cap - strut and tie approach. Design of Portal Frames: Introduction, Types of portal frames, design of portal frames using LSM.
Module 2 Structural Shear Wall: design of shear wall, short & slender wall; wall without and with an opening; rectangular, “L” & “C” shape. Ductile detailing as per Indian standards.

Module 3 Tower-like Structures: Design of chimney, communication tower, lighthouse, hyperbolic cooling tower.

Module 4: Silos and Bunkers: Lateral pressure as per Janssen's and Airy's theory, design consideration for square, rectangular and circular shapes, Design of Hopper and Support structures.

Module 5 Design of reinforced concrete elevated water tanks: Design of tank shell, beams, columns, bracing system, ancillary components, foundation

Reference Books/Material

Text books:

1. Reinforced Cement Concrete Designs, Punmia B C, Jain A K and Jain A K, Laxmi Publishers, New Delhi, 2015
2. Reinforced Concrete- Vol I, Shah H J, Charotar, 8th Edition, 2009
3. Reinforced Concrete- Vol II, Shah H J, Charotar, 6th Edition,2012

Reference books:

1. Advanced RCC Design-Vol. II, Bhavikatti S S, New Age Publishers, New Delhi, 2010
2. Advanced Reinforced Concrete Design, Krishna Raju N, CBS Publishers and Distributors, 2nd edition, 2009.
3. Advanced Reinforced Concrete Design, Varghese P C, Prentice Hall of India, 2004.
4. Reinforced Concrete Design, Pillai, S. U., Menon, D, McGraw Hill, 2017
5. Relevant IS codes

Course Code	Course Name	L	T	P	Credits
CV515	Engineering Optimization	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Formulate and solve deterministic optimization models including multi-variate optimization.
2. Apply deterministic optimization techniques for resource allocation, scheduling, inventory control and capacity expansion and transportation problems
3. Introduction and overview of optimization problems including the notion of convergence and convexity
4. To study the Engineering applications of constrained and unconstrained algorithms.
5. Learn about the genetic algorithms

Course Outcomes

On completion of the course the students will be able to

CO1: Execute the optimum design concepts

CO2: Apply the application of linear programming methods in design and manufacturing

CO3: Demonstrate the engineering applications of constrained and unconstrained algorithms

CO4: Understand the modern methods of optimization

CO5: Gain knowledge about network-based optimization

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	M	-	-	-	-	-	-	-	-
CO2	H	M	H	H	-	-	-	-	-	-	-	-
CO3	H	M	M	M	-	-	-	-	-	-	-	-
CO4	H	H	M	M	H	-	-	-	-	-	-	-
CO5	H	H	H	M	H	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction to Optimization: Engineering application of Optimization, Statement of an Optimization problem - Optimal Problem formulation - Classification of Optimization problem. Optimum design concepts: Definition of Global and Local optima, Optimality criteria - Review of basic calculus concepts Global optimality.

Module 2 Linear programming methods for optimum design: Review of Linear programming methods for optimum design, Post optimality analysis - Application of LPP models in design and manufacturing.

Module 3 Optimization algorithms for solving unconstrained optimization problems: Gradient based method: Cauchy's steepest descent method, Newton's method, Conjugate gradient method.

Module 4 Optimization algorithms for solving constrained optimization problems: direct methods, penalty function methods, steepest descent method - Engineering applications of constrained and unconstrained algorithms.

Module 5 Modern methods of Optimization: Genetic Algorithms: Simulated Annealing, Ant colony optimization, Tabu search, Neural-Network based Optimization, Fuzzy optimization techniques, Applications.

Reference Books/Material

Text books:

1. Optimization for Engineering Design, K Deb, PHI Learning Pvt. Ltd, 2nd edition, 2012
2. Optimization concepts and applications in engineering, Belegundu A D and Chandrupatla T R, Cambridge University Press; 2nd Edition, 2011

Reference books:

3. Linear and Nonlinear programming, S. Nash and A. Sofer, McGraw Hill,1995

Course Code	Course Name	L	T	P	Credits
CV516	Ocean Engineering	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To understand the fundamental characteristics of the ocean environment, including its physical properties and features.
2. To calculate wave celerity and understand its relation to wave properties.
3. To analyze the effects of shoaling, bottom friction, and damping on wave characteristics.
4. To understand the concept of non-breaking wave forces on slender structures.
5. To comprehend the applications of ocean instrumentation in monitoring and studying ocean environments.

Course Outcomes

On completion of the course, the student will be able to

CO1: Describe the main characteristics of the ocean environment and its significance in the Earth's system.

CO2: Compute wave celerity for various wave types and conditions.

CO3: Predict changes in wave properties due to shoaling, bottom friction, and damping.

CO4: Analyze non-breaking wave forces on slender structures using the Morison equation.

CO5: Discuss the significance of ocean instrumentation in collecting accurate data for scientific research and environmental monitoring.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	M	-	-	-	-	-	-	-	-
CO2	M	H	M	M	-	-	-	-	-	-	-	-
CO3	M	M	M	M	-	-	-	-	-	-	-	-
CO4	M	M	M	M	-	-	-	-	-	-	-	-
CO5	M	L	H	L	-	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Ocean environment and ocean floor characteristics, waves, tides, currents, seawater properties; Linear wave theory: Governing Equation, Boundary Conditions and solutions, Dispersion relation, Constancy of wave period.

Module 2 Wave Kinematics: Wave celerity, water particle velocities, accelerations, displacements and pressures. Approximations for deep and shallow water conditions.

Module 3 Wave Transformations: Shoaling, bottom friction and damping, refraction, reflection and diffraction. Wave Breaking: Type of breaking, Surf similarity parameter.
Non-linear wave theories-Strokes, C noidal and Solitary wave theory. Mass transport velocity. Introduction to Random and directional waves.

Module 4 Wave Loads: Non breaking wave forces on slender structures, Morison equation; Diffraction theory

Module 5 Instrumentation for ocean applications: pressure sensors, current meters, CTD, depth sounder, buoy systems etc.

Reference Books/Material

Text books:

1. Coastal Hydrodynamics, Mani J S, PHI Learning Pvt. Ltd, 2011
2. Basic Coastal Engineering, Sorenson R M, Wiley-Interscience Publication, New York, 1997
3. Shore Protection Manual Volume I and II, Coastal Engineering Research Centre, Dept, of the Army, US Army Corps of Engineers, Washington DC.

Reference books:

1. Dean, R.G. and Dalrymple, R.A., Water wave mechanics for Engineers and Scientists, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.
2. Ippen, A.T., Estuary and Coastline Hydrodynamics, McGraw-Hill Book Company, Inc., New York.

Course Code	Course Name	L	T	P	Credits
CV517	Structural Stability	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To determine the buckling loads for simple columns, frames, and plates.
2. To understand the concept of effective length and its use in design.
3. Apply advanced numerical techniques to buckling analysis of structures.

Course Outcomes

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

CO1: Derive the equation of buckling.

CO2: Analyze column and frame for buckling.

CO3: Analyze torsional -flexural buckling of frame members.

CO4: Understand the different calculation procedure for plate buckling.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	H	-	-	-	-	-	-	-
CO2	H	H	L	M	H	-	-	-	-	-	-	-
CO3	H	H	L	L	H	-	-	-	-	-	-	-
CO4	H	H	M	M	H	-	-	-	-	-	-	-

Syllabus

Module 1: Concepts of stability: Bifurcation concept, initially crooked system, shallow arch behaviour, imperfection sensitivity, energy procedure.

Buckling of Columns: Equilibrium method, large deformation theory, application of energy methods, effect of initial crookedness and eccentric loading, Southwell plot, critical load of laced, battened, and tapered columns, inelastic buckling.

Module 2: Frame Stability Analysis: Derivation of stiffness and carry-over factors, braced and unbraced frames, matrix methods, slope deflection analysis of continuous beams and frames, P-Δ method for unbraced frames.

Module 3: Torsional and Torsional-Flexural Buckling: Torsion of thin-walled, open cross-sections, energy expression for bent and twisted columns, lateral torsional buckling of axially loaded columns, lateral buckling of beams and beam columns, discussions of design formulae.

Module 4: Plate Buckling: Derivation of governing differential equation, rectangular plate buckling, energy expressions, Raleigh-Ritz Solutions; post-buckling behaviour of thin plates, inelastic plate buckling, tension field behaviour in plate girder webs. VI. Stability Bracing Systems: Winter's bracing model, discrete bracing, continuous bracing, relative bracing, torsional bracing, lean-on bracing.

Reference Books/Material

Text books:

1. Structural Stability Theory and Practice: Buckling of Columns, Beams, Plates, and Shells, Jerath S, John Wiley & Sons, 2020
2. Fundamentals of Structural Stability, Simitses G J, Hodges D H, Elsevier, 2007

Reference books:

1. Structural Stability, Chen W F, Liu E M, Pearson, 1987
2. Theory of structural stability, Timoshenko and Gere, McGraw hill international book company, 1985.

Course Code	Course Name	L	T	P	Credits
CV518	Remote Sensing and GIS	3	0	0	3

Pre-requisites: Nil

Course Objectives

1.To study the principles of electromagnetic remote sensing and its integration with GIS
2.To learn the mapping process, including plane coordinate systems, transformations, and map projections.
3.To understand the representation of geographic data using raster and vector formats.
4.To learn the techniques for raster-based GIS data analysis.
5.To develop skills in utilizing vector data for spatial analysis and decision-making.

Course Outcomes

After completion of the course the students will be able to:

CO1: Define and differentiate between Geographic Information Systems (GIS) and Remote Sensing.

CO2: Apply geo-referencing techniques and understand the significance of topographic mapping.

CO3: Perform basic data analysis using different data formats within a GIS environment.

CO4: Manage raster data by acquiring, processing, and analyzing it within a GIS framework.

CO5: Demonstrate proficiency in vector-based GIS data handling and processing.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	H	M	-	-	-	-	-	-	-
CO2	H	M	L	M	M	-	-	-	-	-	-	-
CO3	M	H	M	M	M	-	-	-	-	-	-	-
CO4	M	M	M	L	M	-	-	-	-	-	-	-
CO5	M	H	L	L	M	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction to Remote Sensing and Geographic Information System: Definitions and related terminology, evolution of GIS, components of GIS, approaches to the study of GIS. Principles of electromagnetic remote sensing, remote sensing system integration of remote sensing and GIS.

Module 2 Maps and GIS: Introduction, Map scale and classes of maps, the mapping process, plane coordinate systems and transformations, geographic coordinate system of earth, map projection, geo-referencing and topographic mapping.

Module 3 Digital Representation of Geographic Data: Introduction, database and database management systems, raster geographic data representation, vector data representation, data representation and data analysis in GIS.

Module 4 Raster Basic GIS Data Processing: Introduction, acquiring and handling raster geographic data, raster based GIS data analysis, cartographic modelling.

Module 5 Vector Based GIS Data Processing: Introduction, Characteristics of vector-based GIS data processing, topological and non-topological functions. Application of RS GIS in Water Resources.

Introduction to Drone photogrammetry

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
3. Concepts and Techniques of Geographic Information Systems, Lo C P, Young K W, PHI Pvt. Ltd, New Delhi, 2002.
4. Surveying Volume 2, Duggal S K, Tata McGraw Hill, 4th Edition, 2013.
5. Remote Sensing and Image interpretation, Lillesand T M, Kiefer R W, Chipman J, Wiley Publishers,7th Edition, 2015

Online Resources

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

Course Code	Course Name	L	T	P	Credits
CV519	Non – Destructive Testing and Evaluation	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To study the differences between NDT and mechanical testing.
2. Assess the concept of liquid penetrant testing and its application.
3. To study the theory of magnetic particle testing.
4. Assess the principles and inspection methods involved in thermography

Course Outcomes

After completion of the course the student will be able to:

CO1: Understand the different types of NDT testing.

CO2: Understand the difference between NDT testing and mechanical testing.

CO3: Understand the Interpretation and evaluation of magnetic particle test indications.

CO4: Understand the concept behind thermography and different methods of thermography.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	M	-	-	-	-	-	-	-	-
CO2	M	L	L	M	-	-	-	-	-	-	-	-
CO3	M	L	M	L	-	-	-	-	-	-	-	-
CO4	H	M	M	M	-	-	-	-	-	-	-	-

Syllabus

Module 1 NDT versus Mechanical testing: Overview of the Non-Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their

applications in NDT, Visual inspection, Unaided and aided, Fundamentals and introduction to destructive and non-destructive testing. Scope and limitations of NDT, Visual examination methods. Different visual examination aids.

Module 2 Liquid Penetrant Testing: Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results.

Module 3 Magnetic Particle Testing: Theory of magnetism, inspection materials Magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

Module 4 Thermography: Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation, infrared radiation and infrared detectors, Instrumentations and methods, applications, Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

Reference Books/Material

Text books:

1. Introduction to Nondestructive Testing: A Training Guide, 2nd Edition, Paul E M, Wiley-Interscience, 2005
2. Practical Non-Destructuve Testing, Raj B, Jayakumar T, Thavasimuthu M, Narosa, 2011
3. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005

Reference books:

1. Nondestructive Testing Techniques, Ravi P, New Age Science, 2009
2. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
3. Charles, J. Hellier, "Handbook of Nondestructive evaluation", McGraw Hill, New York, 2001.

4. ASNT, American Society for Non-Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.

Course Code	Course Name	L	T	P	Credits
CV520	Finite Element Method	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To introduce finite element analysis (FEA) as a tool to find solutions of differential governing equations.
2. To analyze the structural frameworks & stress analysis by FEA.

Course Outcomes

CO1: Solve boundary value problems and know about the basics of finite element concepts.

CO2: Analyze the structures/members based on the finite element method.

CO3: Apply natural and arial coordinate systems to constant strain triangle and linear strain

CO4: Analyze plana structural systems using finite element modelling

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	-	-	-	-	-	-	-	-
CO2	H	H	M	M	-	-	-	-	-	-	-	-
CO3	H	H	M	M	-	-	-	-	-	-	-	-
CO4	H	H	M	M	-	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction to Finite Element Method: Background and general description of the method – summary of the analysis procedure.

Module 2 Theory of Finite Element method: Discretization concept- Concept of element – various. elements shapes – displacement models – Convergence- shape functions – condensation of internal degrees of freedom-Summary of analysis procedure.

Module 3 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.

Module 4 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.

Module 5 Application to Solid Mechanics problems: Analysis of Trusses – Beams – Frames and 3D space elements.

Reference Books/Material:

Text books:

1. Finite Element Analysis: Theory and Programming, C Krishnamoorthy, McGraw Hill Publications, 2nd Edition, 2017
2. Introduction to Finite elements in Engineering, Patla T C and Belugundu, Pearson, 4th Edition, 2015
3. The Finite element Method in Engineering, S. S. Rao, Elsevier Publication, 6th Edition, 2020

Reference books:

1. Finite Element Method: Its Basic and Fundamentals, O.C. Zeinkiewicz, Butterworth Heinemann, 6th Edition, 2007
2. Textbook of Finite Element Analysis, P. Seshu, PHI Pub., 2003
3. Introduction To Finite Element Method, J. N. Reddy, McGraw Hill Pub., 4th Edition, 2020
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	Course Name	L	T	P	Credits
CV521	Pavement Design	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To study about the types, design aspects and components of pavements.
2. To introduce highway pavements, design concepts and material properties
3. To understand and enable students to carry out design of bituminous mixes, analyze and design flexible and rigid highway pavements
4. To introduce the concepts of pavement evaluation and rehabilitation

Course Outcomes

After completion of the course the student will be able to

CO1: Evaluate pavement design factors.

CO2: Design bituminous and cement concrete mixes.

CO3: Structurally evaluate the rigid pavement

CO4: Determine the structural strength of pavements and rehabilitation techniques

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	-	-	-	-	-	-	-	-
CO2	H	H	H	H	-	-	-	-	-	-	-	-
CO3	H	M	H	H	-	-	-	-	-	-	-	-
CO4	H	M	M	H	-	-	-	-	-	-	-	-

Syllabus

Module 1 : Fundamental Principles: Pavement types, Wheel loads and Design factors, Stresses inflexible and Rigid pavements, Determining ESWL for highways and Airports,

ESWL factors, Effects on pavements due to climate and Environment, Pavement costs, Economic analysis, Properties of pavement components and Material characterization; Soil classification and Application, Types of tests; Plate load test, Triaxial Test, CBR Test, Stabilometer and Cohesiometer tests; Tests for bituminous mixtures and Concrete, Resilient modulus test.

Module 2 : Pavement Design: Design of flexible pavements for airports, CBR Method, FAA method; Design of flexible pavements for highways; CBR Method, IRC method, Limiting shear failure method, Limiting deflection method, Regression method based on pavement performance, Mechanistic method for bituminous pavement design, AASHO design method. Design of Rigid Airport and Highway Pavement**s:** Modulus of subgrade reaction, Design charts, Westergaard's equations for load and Temperature stresses; Examples; Design of slab thickness only as per IRC: 58-2002, Factors affecting design and Performance, AASHTO method, PCA method; Joint and Reinforcement requirements.
Pavement Design and Construction: WBM Roads, WMM roads, Bituminous and Cement concrete roads, Design of bituminous and Cement concrete mixes.

Module 3: Soil and Base Stabilization: Mechanics of stabilization, Types of stabilization, Construction and Field control, General properties of soil aggregate mixture. Types of Bases and Sub-Bases**:** Macadam base courses, Cement treated bases, Asphalt treated bases, Base and Sub base drainage.

Module 4: Pavement Evaluation and Rehabilitation: Pavement distress, Types and Causes, Condition and Evaluation surveys; Methods of measuring condition, Skid resistance. Strengthening Existing Pavements**:** Principles of maintenance, Typical maintenance procedures, Deflection measurement as an evaluation tool, Benkelman beam, Static load deflection test procedure, Creep load deflection test procedure, Correction for temperature and Seasonal variations; Maintenance of shoulders. Structural Evaluation of Rigid Pavements**:** Direct load test method, Indirect reverse design method, Determination of pavement structural strength. Overlays: Overlays for airport and Highway pavements, Types of overlays

Reference Books/Material

Text books:

1. Highway Materials and Pavement Testing, Khanna, S.K., Justo, C.E.G. and A. Veeraragavan, Nem Chand and Bros, Roorkee, India, 2013, Fifth Edition
2. Principles of Pavement Design, Yoder E.J. and M.W. Witczak., Second Edition, John Wiley and Sons, New York, 2012

Reference books:

1. Pavement Design and Materials, Papagiannakis, A.T. and E.A. Masad, John Wiley and Sons, New Jersey, USA, 2008
2. Rajib B. Mallick and Tahar El-Korchi, Pavement Engineering: Principles and Practice, Second Edition, CRC Press, London, 2013
3. Partha Chakroborty and Animesh Das, Principles of Transportation Engineering, Prentice Hall of India, NewDelhi.-2004
4. Bituminous Road Construction in India, Kandhal P.S., PHI Learning Pvt. Ltd., New Delhi, India, 2016.
5. Relevant IRC codes

Course Code	Course Name	L	T	P	Credits
CV522	Advanced Foundation Engineering	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Studying soil exploration and evaluation of bearing capacity
2. Design and detailing of pile and well foundation
3. Studying the types of retaining wall and its foundation system
4. To study soil structure interaction and beam on elastic foundation

Course Outcomes

CO1: Understanding the different methods for soil investigation and geotechnical investigation report preparation

CO2: Design and detailing of various types of foundations

CO3: Foundation design for retaining wall

CO4: Understanding the concept of soil structure interaction and its effects

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	L	-	-	-	-	-	-	-	-
CO2	H	H	H	H	-	-	-	-	-	-	-	-
CO3	H	H	H	H	-	-	-	-	-	-	-	-
CO4	H	H	M	M	-	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Soil exploration, Analysis and Interpretation of soil exploration data, Estimation of soil parameters for foundation design. Methods for bearing capacity estimation, Total and Differential settlements of footing and raft, Codal provisions.
Shallow Foundations: Design of individual footings, Strip footing, Combined footing, rigid and Flexible mat, Buoyancy raft, Basement raft.

Module 2 Machine Foundations: Basic definitions in vibration, Free and Forced vibrations, Determination of natural frequency, Types of machine foundations, General criteria for design of machine foundation, Vibration analysis of a machine foundation, Degrees of freedom of a block foundation, Vibration isolation and Control.

Module 3 Pile Foundations: Estimation load carrying capacity of single and Pile group under various loading conditions. Pile load testing (static, dynamic methods and data interpretation), Settlement of pile foundation, Code provisions, Design of single pile and Pile groups, and Pile caps. Well Foundations: Types, Components, Construction methods, Design methods (Terzaghi, IS and IRC approaches), Check for stability, Base pressure, Side pressure and Deflection.

Module 4 Retaining Walls: Types of flexible and Rigid earth retention systems; Counterfort, Gravity, Diaphragm walls, Sheet pile walls, Soldier piles and Lagging. Support systems for flexible retaining walls (struts, anchoring), Construction methods, Stability calculations, Design of flexible and Rigid retaining walls, Design of cantilever and Anchored sheet pile walls.

Module 5 Soil-Foundation Interaction: Idealized soil, Foundation and Interface behavior. Elastic models of soil behavior; Elastic, Plastic and Time dependent behavior of soil. Beams and Plates on elastic foundation; Numerical analysis of beams and Plates resting on elastic foundation

Reference Books/Material

Text books:

1. Soil Mechanics and Foundation Engineering, Murthy V.N.S, CBS publications, Delhi, 2007.
2. Principles of Geotechnical Engineering, Das B M, Sobhan K, Cengage learning, New Delhi,2012.

Reference books:

3. Basic and applied soil mechanics, Gopal Ranjan, Rao ASR, New age Intrenational publishers, Delhi, 2016.
4. Handbook of Machine Foundations, Srinivasulu, P. And Vaidyanathan, C. V., Tata McGraw-Hill, New Delhi, 2001
5. Foundations for Machines, Analysis and Design, Prakash Shamsher and Puri Vijay K, John Wiley and Sons, USA,1988.
6. Relevant IS codes

Course Code	Course Name	L	T	P	Credits
CV523	Environmental Pollution and Control	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To understand biosphere, cycles, population impact, and pollution consequences.
2. To comprehend air pollutant dispersion, sampling, and measurement techniques.
3. To explore air pollution control methods and focus on specific pollutant mitigation.
4. To understand water pollution, sampling, analysis methods, and treatment.
5. To gain insight into waste management practices, including hazardous and e-waste.

Course Outcomes

On completion of the course, the student will be able to:

CO1: Explain biosphere, cycles, population growth impact, and pollution effects on air, water, and soil.

CO2: Analyze dispersion factors, differentiate sampling methods, and describe air pollutant analysis.

CO3: Identify control methods, explain source correction, discuss emission control, and describe specific pollutant mitigation.

CO4: Categorize pollutants, explain sampling and analysis, and differentiate water treatment stages

CO5: Identify waste sources, explain disposal methods, define hazardous waste, and describe e-waste management.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	H	L	-	-	-	-	-	-	-
CO2	H	M	H	H	M	-	-	-	-	-	-	-
CO3	H	M	M	L	L	-	-	-	-	-	-	-
CO4	H	H	M	H	L	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Biosphere, Hydrological cycle, Nutrient cycle, Consequences of population growth, Pollution of air, Water and soil. Classification and properties of air pollutants, Emission sources, Behavior and fate of air pollutants, Effect of air pollution.

Module 2 Air pollutant dispersion, Sampling and Dispersion: Temperature lapse rates and stability, Wind velocity and turbulence, Plume behavior, Dispersion of air pollutants, Estimation of plume rise. Types of pollutant sampling and measurement, ambient air sampling, Stack sampling, Analysis of air pollutants.

Module 3 Air pollution control methods & equipment: Control methods, Source correction methods, Cleaning of gaseous effluents, Particulate emission control, Selection of a particulate collector, Control of gaseous emissions, Design methods for control equipment. Control of specific gaseous pollutants: Control of NOx emissions, Control of hydrocarbons and mobile sources.

Module 4 Water pollution, Sampling and Treatment: Water resources, Origin of wastewater, types of water pollutants and their effects. Sampling, Methods of analysis, Determination of organic matter, Determination of inorganic substances, Physical characteristics, Bacteriological measurement, water treatment, Primary treatment, Secondary treatment, advanced wastewater treatment, Recovery of materials from process effluents.

Module 5 Solid waste, Hazardous waste and E-waste: Sources and classification, Public health aspects, Methods of collection, Disposal Methods, Potential methods of disposal.

Definition and sources of Hazardous wastes, classification, Treatment methods, Disposal methods. E-wastes Sources, environmental and social issues, management practices.

Reference Books/Material

Text books:

1. Air Pollution, Rao M N and Rao H V N, Tata McGraw-Hill Education, 1st edition,2013
2. Fundamentals of Air Pollution, Stern, A.C., Academic Press, 1984.
3. Air Pollution Control Engineering, Noel, D. N., Tata McGraw Hill Publishers, 1999
4. Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, McGraw Hill Education, 2017, 4th Edition

Reference books:

1. Environmental Engineering, H S Peavy, D.R Rowe, G. Tchobanoglous, McGraw-Hill, 1st edition, 2017
2. Air Pollution: Measurement, Modeling and Mitigation, Colls, J., CRC Press, 2009.
3. Fundamentals of air pollution, Boubel, R.W., Fox, D.L., Turner, D.B. and Stern, A.C., Academic Press, New York, 1994, 3rd Edition
4. Wastewater Treatment, Rao, M.N., and Dutta, A.K., IBH Publ., 1995

Course Code	Course Name	L	T	P	Credits
CV524	Quality and Safety in Construction	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To introduce the students about quality and safety related challenges in construction industry
2. To make students aware about the globally recognized guidelines/theories for quality and safety in construction
3. To make students self-efficient to audit quality and safety related challenges in construction

Course Outcomes

CO1: Gain a broad understanding of quality and safety in construction.

CO2: Understand and improve the ability to function on multidisciplinary teams

CO3: Understand the contemporary issues and development

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L	M	-	-	-	-	-	-	-	-
CO2	H	M	M	M	-	-	-	-	-	-	-	-
CO3	H	M	M	M	-	-	-	-	-	-	-	-

Syllabus

Module 1: Total quality management concepts; ISO9000; QA/QC systems and organizations, Quality Audits; Problem solving techniques.

Module 2: Statistical Quality Control; Quality Function Deployment; Material Quality Assurance; Specifications and Tolerances.

Module 3: Safety issues; Injury accidents and their causes; Safety program components; Role of workers, Supervisors, Managers and Owners; Safety Procedures for various construction operations; Safety audits; Safety laws.

Module 4: Safety Organization and Management: Safety policies, safety organization, safety committees, safety representatives, outside agencies – Govt. intervention, international agreements.

Reference Books/Material

Text books:

1. Levitt, R.E. and Samelson, N.M., Construction Safety Management, Mc. Graw Hill Book Company, Inc., N.Y. 1991
2. Construction Safety Management, Levitt R E and Samelson N M, CBS Publishers, 1993

Reference books:

1. Juran Frank, J.M. and Gryna, F.M., Quality Planning and Analysis Tata McGraw Hill 1982.
2. Statistical quality Control, Grant E.L. and Leavenworth R S, McGraw Hill, 2017.
3. ISO 9000: Meeting the New Industrial Standards, Hutchins G, McGraw Hill, 1993.
4. Total Quality in Construction Projects, Hellard R B, Thomas Telford, London, 1994

Course Code	Course Name	L	T	P	Credits
CV525	Structural Dynamics	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Explore fundamental concepts related to vibration theory.
2. To introduce fundaments of vibrations of SDOF, MDOF and continuous systems.
3. To introduce fundaments of vibrations of SDOF and MDOF systems through experiments and analytical simulations.
4. Analyze different structures and check their stability analysis of such structures under different types of earthquake loadings.

Course Outcomes

After completion of the course the students will be able to:

CO1: Convert structure into SDOF system and calculate natural frequency,
CO2: Calculate free and forced vibration response of SDOF system,
CO3: Calculate free and forced vibration response of MDOF system,
CO4: Understand numerical methods for calculation of response of SDOF and MDOF system
CO5: Understand time history analysis and concept of response spectra.

Relationship of Course Outcomes to Program Outcomes
H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	-	L	-	-	-	-	-	-
CO2	M	M	M	H	-	M	-	-	-	-	-	-
CO3	M	M	H	M	-	M	-	-	-	-	-	-
CO4	H	H	M	M	-	H	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Vibrations and the nature of time dependent phenomena, inertia, dynamic equilibrium and mathematical models of physical systems; Energy storing and dissipation mechanisms.

Module 2 Dynamics of Single Degree of Freedom Systems: Undamped and damped, free and forced vibrations; Steady-state and transient response, impulse response; Harmonic response and applications to vibration isolation; Convolution integral and solution of equation of motion; Numerical methods for solution of linear and non-linear equations of motion; response/shock spectra, Response spectrum.

Module 3 Free vibration of Multi-Degree of Freedom Systems: Lagrange's equations; equations of motion for MDOF systems; Algebraic eigen value problem and free vibration analysis; Undamped normal modes.

Module 4 Response analysis of Multi Degree of Freedom systems: Mode superposition method and response spectrum method for dynamic analysis of linear systems; Mode-truncation and correction for the missing mass.

Module 5 Approximate Methods for Vibration Analysis: Rayleigh method, Rayleigh-Ritz method, Ritz method.

Reference Books/Material

Text books:

1. Dynamics of Structures, Clough, R.W. and Penzien, L, Computers & Structures, Inc., 1995
2. Dynamics of Structures, Chopra A K, Pearson Education, 4th edition, 2012
3. Elements of vibration analysis, Meirovitch L, McGraw Hill, 1986
4. Structural Dynamics, Paz M, Leigh W, Kluwer Academic Publishers, 2004

Reference books:

1. Fundamentals of structural dynamics, Craig R R, Kurdila, A J, John Wiley and Sons, 2nd edition, 2006.
2. Mechanical Vibrations, Rao S S, Addison-Wesley Publishing Company, 2011
3. Dynamics of Structures, Humar J L, Prentice-Hall, Englewood Cliffs, 1990

Course Code	Course Name	L	T	P	Credits
CV526	River Engineering	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Introduce applications of open channel flow
2. Understand the importance of nature and the complications involved in natural processes.
3. Understand the complex scenarios and explain the importance of various equations and the concepts in handling the situations.
4. Understand the correlation between complex natural events and the difficulties in addressing them from an engineering view point.

Course Outcomes

CO1: Understand the relation between formulations and occurrences in nature.

CO2: Application of equations of Hydraulic Engineering in the understanding of river systems.

CO3: Will develop analytical skills in handling a variety of data.

CO4: State of art research and their applications.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	H	-	-	-	-	-	-	-	-
CO2	H	M	H	M	-	-	-	-	-	-	-	-
CO3	M	M	L	M	-	-	-	-	-	-	-	-
CO4	H	M	M	L	-	-	-	-	-	-	-	-

Syllabus

Module 1 Origin and properties of sediments: Nature of sediment problems, origin and formation of sediments, properties of sediments, incipient motion of sediment particles, tractive force approach, cohesive materials.

Module 2 Regimes of flow: Description of regimes of flow, ripple, dune, anti-dune, prediction of regimes of flow. Resistance to flow and velocity distribution in alluvial streams: velocity distribution in turbulent flow over rough boundaries, resistance and velocity distribution in alluvial streams.

Module 3 Bed load transport and saltation: Bed load equations, bed load equations based upon dimensional considerations and semi-theoretical equations, general comments on bed load equations, saltation

Module 4 Suspended load transport: Mechanism of suspension, equation of diffusion, sediment distribution equation, relations for suspended load, wash load, transport of suspended sediment, sediment samplers design of canals carrying sediment laden water, Types of sediment samplers.

Module 5 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/dampeners and other river/ flood protection works

Reference Books/Material

Text books:

1. Mechanics of Sediment Transportation and Alluvial Stream Problems, Garde, R. J. and Ranga Raju, K. G., New Age Publishers, 2006
2. Principles of River Engineering: The non-tidel alluvial river, Jansen, P. Ph., VSSD Publications,1994

3. Yang C.T., Sediment Transport- Theory and Practice, The McGraw Hill Companies Inc. 1996.

References:

1. Fluvial Processes in River Engineering, Chang H.H., John Wiley 1988.
2. Sediment Transport Technology, Simons D.B. and Senturk F., Water Resources Publications, Fort Collins, Colorado 1977.
3. Hydraulics of Sediment Transport, Graf W H, Water resources publications, 1984
4. Ganga: Reimagining, rejuvenating and Resurrecting, Mishra R R, Upadhyay P, Rupa Publications, 2021

Course Code	Course Name	L	T	P	Credits
CV527	Design of Concrete Bridges	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To study the IRC classes of loading for detailed calculation of loads on bridges.
2. To develop a clear understanding of conceptual design philosophies of bridge.
3. To study the different types of bridges and design criteria of various components.
4. To design the basic components of bridge structures like bridge deck slabs, longitudinal girders, transverse girders, piers and well foundations.

Course Outcomes

After completion of the course the students will be able to:

CO1: Understand different types of bridge types and loadings.

CO2: Understand the different design features integrating the principles of bridge design.

CO3: Apply principles of analysis and design different components of bridges.

CO4: Execute the drawings and detailing of reinforcement for the bridge's design.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	L	-	-	-	-	-	-	-	-
CO2	M	M	L	L	-	-	-	-	-	-	-	-
CO3	M	H	H	H	-	L	-	-	-	-	-	-
CO4	H	H	M	M	-	L	-	-	-	-	-	-

Syllabus

Module 1 Classification of Bridges: Arch, Slab, Box Culvert, Beam and Slab, Plate Girder, Composite Bridges, Components of bridges, Investigation and Planning for bridges, Design flood discharge, Linear waterways.

Module 2 Loads for Bridges: Different loading standards, IRC loadings, Dead load, Live load, Impact load, Wind load, Longitudinal and Horizontal forces.

Module 3 Design of Concrete Bridges: Introduction to bridge design code, Superstructure, Design of box culvert, Design method and Design examples

Module 4 Design of Beam and Slab Bridges: Design of interior panel of slab. Pigeaud's method, design of longitudinal girder, Calculation of longitudinal moment design example.

Module 5 Design of Reinforced Concrete Solid Slab Bridges: General design features, Effective width method. Simply supported slab bridge analysis and Design.

Module 6 Stability Analysis of Abutments and Piers: General scour at abutments and Piers, Grip length, Types of abutments and Piers and Stability of abutments and Piers for different loading combinations.

Module 7 Bridge Foundations: Types of bridge foundations, Stability of different types of foundations, Design of shallow, Pile, Well foundations and Pneumatic caissons.

Module 8 Introduction to Cable stayed and suspension bridges, construction, comparison, case studies, Modular prestressed bridges

Reference Books/Material

Text books:

1. Bridge Engineering, N. Krishna Raju, Oxford and IBH Publishing Co., 3rd edition, New Delhi, 2006
2. Design of Bridge Structures, Jagadeesh T. R., Jayaram M. A., Phi Learning Pvt. Ltd, New Delhi, 2009.

Reference books:

3. Essentials of bridge engineering, Victor J D, Oxford & IBH Publishing Co. Pvt. Ltd, 6th Edition, New Delhi, 2008
4. Bridge Engineering, Ponnuswamy S, Tata McGraw Hill, 2nd edition, 2015
5. Relevant IS and IRC codes.

Course Code	Course Name	L	T	P	Credits
CV528	Geo-Environmental Engineering	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Discuss the basic concepts and principles of Geo-environmental Engineering.
2. Impart knowledge on Geotechnical aspects in the planning and design of MSW and Hazardous waste landfills.
3. To make students learn about Geotechnical aspects of detection & monitoring of subsurface contamination and control & remediation of contaminated sites.
4. To learn about the scopes of various waste materials in different Geotechnical Engineering applications.

Course Outcomes

On the completion of this course, students will be able to:

CO1: Plan and design the facilities for disposal of different kinds of solid waste.

CO2: Plan the detection and monitoring of subsurface contamination.

CO3: Perform waste characterization for effective waste management.

CO4: Conduct research on Geo-environmental topics.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	H	H	L	-	-	-	-	-	-	-
CO2	M	M	H	H	H	-	-	-	-	-	-	-
CO3	M	M	M	L	L	-	-	-	-	-	-	-
CO4	M	H	M	H	L	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Geoenvironmental Engineering, Subsurface contamination, Sources of waste, Impact of waste dump and its remediation, classification and management of waste, waste characterization; Soil-water-waste interaction**:** contaminant transport, laboratory and field evaluation of permeability; Integrated solid waste management system.

Module 2 Geotechnical application of waste: Geotechnical use of different types such as Thermal power plant waste, MSW, mine waste, industrial waste, and construction demolition wastes.

Module 3 Waste disposal systems: Landfills, planning and design of landfills**,** Parameters controlling the selection of site for sanitary and industrial landfill. Site characterization. MoEF guidelines

Module 4 Landfill Components: Landfill layout and capacity, components of landfill and its functions. Types and functions of liner and cover systems, Compacted clay liner, selection of soil for liner, methodology of construction

Module 5 Leachate, Gas Management and Geosynthetics: Management of Leachate and gas. Various components of leachate collection and removal system and its design., gas disposal/utilization. Closure and post closure monitoring system, Geosynthetics- Geo membranes - geosynthetics clay liners -testing and design aspects.

Module 6 Remediation of Contaminated Sites: Investigation of contaminated soil, sampling, assessment, Transport of contaminants in saturated soil. Remediation of contaminated soil- in-situ / exit remediation, bio remediation, thermal remediation, pump and treat method, phyto-remediation and electro-kinetic remediation.

Reference Books/Material

Text books:

1. Geotechnical Practice for Waste Disposal, Daniel D E, Chapman and Hall, London, 1993
2. Designing with Geosynthetics, Koerner R M, 6th Edition. Prentice Hall, 2012

3. Geo-environmental Engineering: Principles and Applications, Marcel Dekker Inc Publication, Reddi L N and Inyang H I, 2000

Reference books:

1. Geo-environmental Engineering: Contaminated Soils, Pollutant Fate, Mitigation, Yong R N, Lewis Publication, 2000
2. Solid waste Management and Engineered Landfills, Rao G V, Sasidhar R S, Saimaster Geo-environmental Services Pvt. Ltd. Publication, 2009
3. Soil engineering in relation to environment, Ayyar T S R, LBS Centre for Science and Technology, Trivandrum 2000.
4. Geo-environmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, Hari D S, Reddy K R, John Wiley & Sons Inc., 2004

Course Code	Course Name	L	T	P	Credits
CV529	Occupational Safety and Health Act	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Explain that occupational health and safety is more than accident prevention – that it encompasses all aspects of working conditions.
2. Explain the role of health representatives in occupational health.
3. Recognize several occupational hazards and some of the types of work generally associated with those hazards.

Course Outcomes

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

CO1: Understand the need for occupational health.

CO2: To understand hazards and different labor acts.

CO3: Use hazard analysis and event tree analysis.

CO4: Requirement of safety related to different hazard conditions.

CO5: Use of personal protective equipment.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	M	M	-	-	-	-	-	-	-	-
CO2	M	M	L	M	M	-	-	-	-	-	-	-
CO3	H	H	L	L	-	-	-	-	-	-	-	-
CO4	M	M	M	M	-	-	-	-	-	-	-	-
CO5	H	M	L	M	L	-	-	-	-	-	-	-

Syllabus

Module 1: Occupational Health and hazards: Concept of occupational health, Occupational and Work-related diseases, History of occupational health, Characteristics of occupational diseases, Adverse health effects of noise, Vibration, Cold, Heat stress, Improper illumination, Thermal radiation, short term and Long-term effects of exposures; Preventive and Control measures.

Module 2: Accident and Incident Investigation and analysis: Definition; Incident, Accident, Injury, Unsafe acts, Unsafe conditions, Hazards, Error, Oversight, Mistakes etc., standard classification of factors associated with accident. Accident reporting: Report forms, Writing reports, Essential elements, Factories Act, Workmen's Compensation Act and Rules, ESI Act and Rules, Labour Act (Abolition And Regulation), Right to Know.

Module 3: Risk Assessment and Hazard Identification: Preliminary hazard analysis, What if analysis, Failure mode effect analysis, Hazard and Operability (HAZOP) studies, Hazard analysis techniques; Fault tree analysis, Event tree analysis, On-site and Off-site emergency preparedness.

Module 4: Meaning and Scope of Safety in Construction: Basic parameters governing the safety in construction e.g.: Scaffolding, shuttering/form work, Working at Heights, Safe access, Good housekeeping, Safety in the use of construction machinery Safety with regard to storage, Stocking and Handling materials of construction. Safety in demolition operations; Safety precautions to be taken for and during demolition, Employee Participation in Safety- Purpose, Areas of participation, Methods, Role of trade union in Safety Health and Environment Protection.

Module 4: Personal Protective Equipment: Need for personal protection equipment, selection, Applicable standards, Care and Maintenance of respiratory and Non-respiratory personal protective equipment. Non- respiratory personal protective devices: Head protection, Ear protection, Face and Eye protection. Hand protection, Foot protection, Body protection, Respiratory personal protective devices.

Reference Books/Material

Text books:

1. Occupational safety and health, Goetsch D L, Pearson India, 2010
2. Industrial safety: Management and Technology, Colling D A, Prentice Hall, 1990
3. Industrial Accident Prevention, Heinrich H W, McGraw Hill Publication, New York, 1941
4. Construction Safety, Mishra R K, AITBS Publishers, India, 2013

Reference books:

1. Industrial Safety and Pollution Control Handbook; National Safety Council and Associate (Data) Publishers Pvt. Ltd., 1991
2. Safety and Environmental Management, Daniel D G, The Scarecrow press Inc., 2007

Course Code	Course Name	L	T	P	Credits
CV530	Non-Conventional and Renewable Energy	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To understand conventional and non-conventional energy sources, with a focus on NCES potentials.
2. To grasp fundamental concepts of solar energy and its conversion.
3. To comprehend solar cell principles and photovoltaic systems.
4. To learn wind energy conversion principles and generator mechanisms.
5. To explore geothermal energy resources and harnessing methods.

Course Outcomes

On completion of the course, the student will be able to:

CO1: Differentiate energy sources, assess NCES potential, compare solar, wind, geothermal, biomass, ocean energy.

CO2: Understand solar energy, radiation data, collector types, calculate collector efficiency.

CO3: Explain solar cells, photovoltaic systems, solar engines, and grid-connected systems.

CO4: Learn wind energy conversion, rotor types, torque coefficients, induction generators.

CO5: Identify resources, well types, harnessing methods, and geothermal potential.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	H	-	-	-	-	-	-	-	-
CO2	H	M	H	H	-	-	-	-	-	-	-	-
CO3	H	M	M	L	-	-	-	-	-	-	-	-
CO4	H	H	M	H	-	-	-	-	-	-	-	-
CO5	H	M	M	L	-	-	-	-	-	-	-	-

Syllabus

Module 1 Statistics on Conventional Energy: Sources and supply in developing countries, Definition Concepts of NCES, Limitations of RES, Criteria for assessing the potential of NCES. Classification of NCES, Solar, Wind, Geothermal, Bio-mass, Ocean Energy Sources, comparison of these energy sources.

Module 2 Basics of Solar Energy: Energy available from Sun, Solar radiation data, Solar energy conversion into heat, Flat plate and Concentrating collectors, Mathematical analysis of Flat plate collectors and collector efficiency.

Module 3 Solar Cells: Principle of Natural and Forced convection, Solar engines-Stirling, Brayton engines, Photovoltaic, p-n junction, solar cells, PV systems, Stand-alone, Grid connected solar power satellite.

Module 4 Wind Energy Conversion: General formula -Lift and Drag- Basis of wind energy conversion, Effect of density, frequency variances, angle of attack, and wind speed. Windmill rotors Horizontal axis and vertical axis rotors. Determination of torque coefficient, Induction type generators-working principle.

Module 5 Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India.

Reference Books/Material

Text books:

1. Non-Conventional Energy Resources, Khan B H, 2nd Edition, Tata Mc Graw Hill Education Pvt Ltd, 2011
2. Non-Conventional Energy Resources, Saeed S H, Sharma D K, 3rd Edition, S K Kataria & Sons, 2012

Reference books:

1. Non-Conventional Energy, Ashok V D, Wiley Eastern Ltd, New Delhi, 2003
2. Renewable Energy Technologies, Ramesh R, Kumar K U, Narosa Publishing House, New Delhi, 2004

3. Power Plant Technology, Wakil M M, Mc Graw Hill Book Co, New Delhi, 2004.
4. Renewable Energy Resource: Basic Principles and Applications, Tiwari G N, Ghosal M K, Narosa Publishing House, 2004.

Course Code	Course Name	L	T	P	Credits
CV531	Water Distribution Systems	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To understand the principles of head loss in pipe networks and the significance of Darcy-Weisbach and Hazen-Williams formulas.
2. To comprehend the roles of reservoirs, pumps, and valves in water distribution systems.
3. To apply Node Flow Analysis (NFA) techniques to analyze serial networks and solve related problems.
4. To formulate optimization models for network design and interpret the cost-head loss ratio method
5. To apply the minimum spanning tree concept to design looped water distribution networks.

Course Outcomes

On completion of the course, the student will be able to

CO1: Analyze and calculate head losses in pipe networks using Darcy-Weisbach and Hazen-Williams formulae.

CO2: Perform analysis of branched water distribution networks using appropriate head loss formulae.

CO3: Apply gradient methods and other techniques to analyze flow in looped networks.

CO4: Determine optimal and economical diameters for pumping mains, considering variable scenarios.

CO5: Design looped water distribution networks using the Critical Path Method and compare with other methods.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L	M	-	-	-	-	-	-	-	-
CO2	M	M	H	M	-	-	-	-	-	-	-	-
CO3	H	M	L	M	-	-	-	-	-	-	-	-
CO4	M	M	M	L	-	-	-	-	-	-	-	-
CO5	M	M	H	M	-	-	-	-	-	-	-	-

Syllabus

Module 1 General Hydraulic Principles: Head loss formulae- Darcy-Weisbach formula, Hazen – Williams formula, Modified Hazen-Williams formula, Series and Parallel connection of Pipes, Equivalent Pipes, Analysis of branched Water Distribution Networks.

Module 2 Water Distribution Network: Formulation of Equations for looped Water Distribution Networks, Analysis of flow in looped networks, Introduction of Gradient method and other methods of analysis. Reservoirs, Pumps and Valves, Flow dependent analysis of multi-reservoir systems, Introduction to head-dependent analysis.

Module 3 Node flow Analysis: Node head–flow relationships, Direct and Indirect methods, Application of NFA technique to serial networks. Optimal and Economical diameter of pumping main, Design of pumping main considering diameter as continuous as well as discrete variable. Water hammer consideration.

Module 4 Design of Water Distribution Networks: using Critical Path Method, Formulation of optimization model, Application of Cost-head loss ratio method and Linear Programming Technique to optimal design of branched networks.

Module 5 Looped Networks: Determining number of branching configurations for a looped network, Use of path concept and minimum spanning tree concept, Application of critical path method for design of looped networks. Introduction to methods for Looped WDNs.

Reference Books/Material

Text books:

1. Analysis of water distribution Networks, Bhave P R, Gupta R, Nawas Publishing Co, New Delhi, 2006
2. Optimal Design of Water Distribution Networks, Bhave P R, Nawas Publishing Co, New Delhi, 2003

Reference books:

1. Analysis of flow in pipe networks, Jeppson R W, Ann Arbon Science, 1976.
2. Analysis of water distribution System, Walksi T M, Van Nostand Reinheld, New York USA, 1984
3. CPHEEO, Mannual on Water Supply and Treatment, Ministry of Urban Development, 2009

Course Code	Course Name	L	T	P	Credits
CV532	Smart Materials and Structures	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To equip the students with basic understanding of smart materials like piezoelectric ceramic, piezo-polymers, shape memory alloys etc.
2. Application of strain sensors, accelerometers, and smart sensors
3. Piezoelectric actuators and application
4. Composite smart materials and application

Course Outcomes

CO1: Understanding properties of smart materials and their application.

CO2: Acquire knowledge about shape memory alloy and their application.

CO3: Application of smart sensors in structural health monitoring.

CO4: Familiarizing with composite smart materials and it's micro and macro mechanics.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	H	H	M	-	-	-	-	-	-	-
CO2	H	M	H	H	M	-	-	-	-	-	-	-
CO3	H	H	H	H	M	-	-	-	-	-	-	-
CO4	H	M	M	H	-	-	-	-	-	-	-	-

Syllabus

Module 1 Overview of Smart Materials: Introduction to Smart Materials, Principles of Piezoelectricty, Perovskite Piezo-ceramic Materials, Single Crystals vs Polycrystalline Systems, Piezoelectric Polymers, Principles of Magnetostriction, Rare earth Magneto strictive materials, Giant Magnetostriction and Magnetoresistance Effect, Introduction to Electro-active

Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC), Shape Memory Effect, Shape Memory Alloys, Shape Memory Polymers, Electro-rheological Fluids, Magneto Rheological Fluids

Module 2 High-Band Width, Low Strain Smart Sensors: Piezoelectric Strain Sensors, In-plane and Out - of Plane Sensing, Shear Sensing, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Magnetostrictive Sensing, Villari Effect, Matteuci Effect and Nagoka-Honda Effect, Magnetic Delay Line Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM), System Identification using Smart Sensors

Module 3 Smart Actuators: Modelling Piezoelectric Actuators, Amplified Piezo Actuation, Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect, Wiedemann Effect, Magneto-volume Effect, Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control

Module 4 Smart Composites: Review of Composite Materials, Micro and Macro-mechanics, Modelling Laminated Composites based on Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, Governing Equation of Motion, Finite Element Modelling of Smart Composite Beams

Module 5 Advances in Smart Structures & Materials: Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials, Autophagous Materials, Self-Healing Polymers.

Reference Books/Material

Text books:

1. Smart Structures and Materials, Culshaw B, Artech House, 2004
2. Smart Structures: Physical Behaviour, Mathematical Modelling and Applications, Gauenzi P, Wiley, 2009

Reference books:

1. Piezoelectricity Volume I, Cady, W. G., Dover Publications, 2018

Course Code	Course Name	L	T	P	Credits
CV533	City and Urban Planning	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Identify the different stages involved in urban planning
2. Understand various types and principles of planning
3. Examine the urban planning agencies and their functions
4. Understand the town and country planning act and building byelaws

Course Outcomes

After completion of the course the students will be able to:

CO1: Analyze the policy for urban development

CO2: Understand the factors that influence urban policy making.

CO3: Apply sustainable development through urban renewal

CO4: Implement urban management

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	M	-	-	-	-	-	-	-	-
CO2	H	M	M	M	-	-	-	-	-	-	-	-
CO3	H	M	L	L	-	-	-	-	-	-	-	-
CO4	H	M	M	M	-	-	-	-	-	-	-	-

Syllabus

Module 1: Changing Cities & Neighbourhoods: Broad Knowledge of the Concepts and Theories Relevant to the Study of Urban development; Spatial Planning and Urban Policy

(together with an understanding of the main trends in urban development in developing countries today) Policy Analysis for Urban development**:** Introduction of Different Ways of Thinking about what Policy is and how it is formulated: The Actors, Institutions, Ideologies, Information (Evidence), Popular Opinion, The Media and Other Factors that Influence Urban Policy Making and Policy Outcomes with Respect to Urban Renewal and Regeneration

Module 2 : Regenerating Cities-Strategies & Evaluation: An Overview of the Development, Delivery and Impact of Regeneration Strategies; The Challenges of Achieving Effective Regeneration in Indian Cities in the Context of Global Change and Competition and Experiences in South East Asian and East Asian Countries The Role of Public Sector Agencies**:** Area Based development Initiatives; Property-Led Development Policies; Investment and Funding of Urban Development Schemes 25 Role of private sector in development: Nature of In-fill; Development Potential and Pricing; Land locking and stagnation; Plot reconstitution

Module 3 :Renewal through Housing and Mixed-Use Development: Community Participation in Renewal Schemes; Sustainable Development through Urban Renewal; Brownfield Development with Respect to Urban Renewal in Cities Integrated Urban Conservation: Principles, Economic, Legal and Tourism Aspects; Planning Procedures, Inspection and Surveys; Investigation Techniques; Methods for Inventories and Documentation; Identification and Reporting on Heritage Zones; Grading and Enlisting

Module 4 : Programs and Techniques for Adaptive Reuse, Restoration, Rehabilitation: New Buildings in Historic Settings, Aspects and Design Methods Implementation of Plans and Urban Management**:** Phasing, Resource Mobilization, Incentives; Acts, latest advancements.

Reference Books/Material

Text books:

1. Principles of Urban Transport Systems Planning, Hutchinson B G, Scripta, McGraw-Hill, New York, 1974.
2. Fundamentals of Town Planning, Hiraskar G K, Dhanpat Rai Publications, 1992

Reference books:

1. Hand Book of Urban Planning, Claire W H, Van Nostrand Reinhold, 1974.

2. The Urban Pattern - City Planning and Design, Gallian A, Simon E, Van Nostrand Reinhold, 1986
3. An Introduction to Town Planning Techniques, Margaret R, Hutchinson, London, 1980.

Course Code	Course Name	L	T	P	Credits
CV534	Pavement Evaluation and Management	3	0	0	3

Pre-requisites: Nil

Course Objectives:

1. To understand the project management process.
2. To know the uses of NDT at different levels of pavement management.
3. To learn the network level pavement management
4. To study framework for pavement design.

Course Outcomes

Students will be able to:

CO1: Identify the root cause of different pavement distresses.

CO2: Suggest suitable remedial measures for various distresses to improve the pavement surface condition.

CO3: Interpret the field evaluation data and pavement design data with respect to present and future traffic condition.

CO4: Optimize the maintenance alternatives based on the benefit and cost ratio of the project alternative.

CO5: Adopt new technology for pavement evaluation and maintenance with respect to field performance and funds available.

CO6: Provide the feedback data for updating the pavement performance monitoring system.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L	L	M	-	-	-	-	-	-	-
CO2	H	M	L	M	-	-	-	-	-	-	-	-
CO3	H	M	M	L	L	-	-	-	-	-	-	-
CO4	H	M	H	M	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	-

Syllabus

Module 1: Components of a Pavement Management System (PMS): Definitions and structure of the system – Pavement Management Process and data requirements – Project and Network level needs; Pavement Investment Planning for Highways. Pavement Condition Surveys and Rating Procedures: Assessment of pavement performance, Evaluation of pavement structural capacity, distress and safety, Calculation of Pavement Condition Index (PCI), combined measures of pavement quality, data management.

Module 2: Non-destructive Testing: Pavement Deflection Measurement Devices – Factors affecting Deflection Values – Uses of NDT at Different Levels of Pavement Management. Pavement Condition Prediction Models: Uses of Prediction Models - Techniques for development of pavement performance prediction models – AASTHO, CRRI and HDM models, computer applications.

Module 3: Determining Present and Future Needs: Establishing criteria – determining the future needs, Rehabilitation and Maintenance strategies, developing combined programmes for maintenance and rehabilitation. Network Level Pavement Management: Pavement Inventory and condition at the last inspection – pavement condition forecasting – Budget Forecasting Localised maintenance and Rehabilitation Program – Development of annual and long range of work plans – PMS/GIS Interface.

Module 4: Project Level Design: Framework for pavement design – Design objectives and constraints – Basic structural response models, Characterization of physical design inputs – Generating alternative pavement design – Economic evaluation of alternative design – Analysis of alternative design strategies – Selection of optimal design strategy. Implementation: Major steps in implementing PMS – pavement construction management and pavement maintenance management – information's, research needs – cost and benefit of pavement management – future directions and need for innovations in pavement management.

Reference Books/Material

Text books:

1. Pavement management for airport, roads and parking lots, Shahin M Y, Chapman and hall, 2005.
2. Highway Engineering Handbook: Building and Rehabilitating the Infrastructure, McGraw Hill, 2009.
3. The Design and Performance of Road Pavements, David C, HMSO Publications, 2008.

Reference books:

1. Principles of Pavement Design 2nd Edition, Yoder E J, Witczak M W, John Wiley and Sons, 1975.
2. Guidelines for Maintenance Management of Primary, Secondary and Urban Roads, Ministry of Road Transport and Highways, 2004.
3. Modern Pavement Management, Ralph H, Hudson W R, Zaniewski J P, Krieger Publishing Company, 1994
4. HRB/TRB/IRC/International Conference on Structural Design of Asphalt Pavements, 1988.
5. Pavement Analysis and Design, Yang H. Huang, Prentice Hall, 2003.

Course Code	Course Name	L	T	P	Credits
CV535	Irrigation Structures and Hydropower Engineering	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To understand different types of diversion works and their functions.
2. To learn the classification of canals and design methods based on Kennedy's and Lacey's theories.
3. To comprehend the importance of regulation works and their role in maintaining water distribution
4. To Learn about various types of cross drainage works and their suitability for different scenarios.
5. To Gain insights into the components and classification of hydropower plants.

Course Outcomes

On completion of the course, the students will be able to:

CO1: Design and select appropriate types of diversion structures based on site-specific requirements.

CO2: Design irrigation canals using Kennedy's and Lacey's theories to optimize water flow.

CO3: Compare different types of regulators and select appropriate ones based on hydraulic considerations.

CO4: Evaluate different types of cross drainage structures and select suitable designs.

CO5: Calculate load factors, capacity factors, utilization factors, and diversity factors in power generation.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	-	-	-	-	-	-	-	-
CO2	M	M	L	M	-	-	-	-	-	-	-	-
CO3	M	H	M	L	-	-	-	-	-	-	-	-
CO4	M	H	M	M	-	-	-	-	-	-	-	-
CO5	H	M	M	M	-	-	-	-	-	-	-	-

Syllabus

Module 1 Diversion Headworks: Introduction, Types of diversion works, Location and Components, Weir and Barrage, Effect of construction of weir on the river regime, Causes of failures of Weirs on permeable foundations, their remedies, Exit gradient, Principles of weir design on permeable formations, Bligh's creep theory and Khosla's theory.

Module 2 Distribution Systems: Classification of canals, Design of irrigation canals by Kennedy's and Lacey's theories, Canal FSL, Losses of canal water, Silting and Scouring of canals, Method of design of unlined section of irrigation canal, Lined canals, IS standard for Design of canal lining

Module 3 Regulation Works: Introduction, Definition of falls, Necessity and Location of falls, Comparative study of the main types of falls, Cross regulator and Distributary regulator. Hydraulic Gates Control equipment for out-lets, Spillway gates, Types, Design criteria for radial gates, Air vents, Canal escapes.

Module 4 Cross Drainage Works: Introduction, Types, Suitability, Design of various types of C-D Works, Aqueduct, Syphon aqueduct, Super Passage, Syphon, Level crossing, Inlets and Outlets, Site selection.

Module 5 Hydropower Engineering: Introduction, Components of hydropower, Classification of hydropower plants, Run-of-river plants, Valley dam plants, High head diversion plants, Diversion canal plants, Pumped storage plants, Tidal power plants, Environmental considerations, General load curve, Load factor, Capacity factor, Utilization factor, Diversity factor, Power canals, Alignment, Covered conduits and tunnels, Penstocks; Design considerations

Reference Books/Material

Text books:

1. Irrigation and Water Power Engineering, Punmia B C, Pande Lal, Jain A K, Jain A K; Laxmi Publications, 2021
2. Irrigation and Water Resources and Water Power Engineering, Modi P N, Standard Book House, 2019
3. Irrigation Engineering (Including Hydrology), Sharma R K, Sharma T K, S Chand Publications, 2002

Reference books:

1. Hydro Power Structures, R. S. Varshney, Nem Chand and Bros., 2014
2. Irrigation Engineering and Hydraulic Structures, Garg S K, Khanna Publishers, 2023
3. Irrigation, Water Power and Water Resources Engineering, Arora K R, Standard Publishers, New Delhi, 2010

Course Code	Course Name	L	T	P	Credits
CV536	Industrial Waste Treatment	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To understand industrial liquid waste characteristics and management.
2. To comprehend how industrial waste affects streams and the Streeter-Phelps equation.
3. To explore industrial waste treatment methods and advanced approaches.
4. To study waste characteristics and treatment in various industries.
5. To understand environmental regulations and common effluent treatment plants (CETPs).

Course Outcomes

On completion of the course, the student will be able to

CO1: Describe waste characteristics, impact on water bodies, explain sampling, treatability studies, and bioassay tests

CO2: Analyze waste impact on streams, explain Streeter-Phelps equation, solve oxygen sag problems.

CO3: Explain neutralization, equalization, sludge management, and advanced treatment techniques.

CO4: Analyze waste from sugar, distilleries, pulp & paper, textiles, dairy, tanneries, and electroplating; discuss characteristics and treatment methods.

CO5: Understand environmental acts, explain impact assessment, discuss CETPs' design, operation, and economic aspects.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	M	-	-	-	-	-	-	-	-
CO2	H	M	H	H	-	-	-	-	-	-	-	-
CO3	H	M	M	L	-	-	-	-	-	-	-	-
CO4	H	H	M	H	-	-	-	-	-	-	-	-
CO5	H	M	H	L	-	-	M	-	-	-	-	-

Syllabus

Module 1 General: Liquid wastes from industries, their volumes and characteristics, Effect of disposal into natural water courses, Municipal sewers, stream standards and effluent standards. Sampling and analysis of industrial wastes, Treatability study, good housekeeping, bioassay test, population equivalence.

Module 2 Stream sanitation: Effects of industrial wastes on self-purification of streams and fish life, Statement and significance of the parameters of Streeter and Phelps's equation and BOD equations, Deoxygenating and reaeration, Oxygen sag and numerical based on this.

Module 3 General treatment of industrial wastes: Neutralization, Equalization, segregation. Modification of conventional aerobic and anaerobic biological treatment methods. Dewatering and disposal of sludges, unit operation floatation, Vacuum filtration, Centrifugation, Filter press and membrane filters, Advanced treatment.

Module 4 Detailed consideration of wastes produced from following industries: Manufacturing processes normally followed, Volume and effects of raw and treated effluent on streams, Sewers, Characteristics of effluents and land Treatment methods, reuse-recovery, wastes produced from: Sugar-sugarcane, Distilleries, Pulp & paper, Textiles: Cotton, Dairy, Tanneries, Electroplating industries.

Module 5 Impact Assessment: Provision of various acts pertaining to industrial wastes / effluents, introduction to environmental impact assessment and environmental audit. Common Effluent Treatment Plants (CETPs): Location, Need, Design, Operation & Maintenance Problems and Economical aspects.

Reference Books/Material

Text books:

1. Waste Water Treatment, Rao & Datta, Oxford & IBH Publishing Co., 3rd revised edition, 2020
2. Environmental Pollution and control in chemical process industries: S.C. Bhatia, Khanna Publications, 2001
3. Industrial Water Pollution Control: Eckenfelder Jr W W, McGraw Hill, 1999

Reference books:

1. Biological Waste Treatment: Eckenfelder W W, Connor D J, Pergamon Press, 2013
2. Theories and Practices of Industrial Waste Treatment, Nemerow N L, Addison Wesley Publishing company, 1963
3. Pollution Control in Process Industries, Mahajan S P, Tata McGraw Hill, 2017

Course Code	Course Name	L	T	P	Credits
CV537	Ground Improvement Techniques	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Understand the engineering behaviour of various natural and engineered soil deposits and associated problems in engineering practices.
2. Understand the concept and principle behind various ground improvement techniques.
3. Site specific selection and design of ground improvement methods.
4. Learn about emerging trends in ground improvement and likely trends tomorrow.

Course Outcomes

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

CO1: Identify the problems associated with the existing ground conditions.

CO2: Propose an appropriate ground improvement method.

CO3: Provide suitable design for various ground improvement techniques

CO4: Understanding the latest trends in ground improvement

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	M	-	-	-	-	-	-	-	-
CO2	H	M	M	L	-	-	-	-	-	-	-	-
CO3	H	M	M	M	-	-	-	-	-	-	-	-
CO4	H	M	M	M	-	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Different types of problematic soils and their geological formation principles of treatment, Loading, Classification of ground modification techniques, Emerging trends in ground improvement.

Module 2 Mechanical Improvement (Treatment of Loose Sands): Mechanical Stabilization- Shallow and Deep compaction requirements, Principles and methods of soil compaction, Shallow compaction and methods. Properties of compacted soil and Compaction control, Deep compaction and vibratory methods dynamic compaction. Compaction piles, deep compaction, Dynamic compaction, Vibroflot technique, Controlled blasting for compaction.

Module 3 Hydraulic Modification - Ground improvement by drainage, Dewatering methods, Design of dewatering systems, Preloading, Vertical drains, Vacuum consolidation, Electro-kinetic dewatering, Heating and Freezing methods, Microbial geotechnology.

Module 4 Physical and Chemical Treatment (Admixtures & Grouting): Cement stabilization and cement columns, lime stabilization and lime columns, stabilization using bitumen and emulsions, stabilization using industrial wastes, construction techniques and applications. Permeation grouting, compaction technique, jet grouting, different varieties of grout materials, grouting in difficult conditions. Treatment of Expansive Soils: Lime treatment for expansive soils, injection method, lime-columns, chemical analysis.

Module 5 Accelerated Consolidation Methods for Soft Clay Soils: Preloading and the techniques of preloading, Band drains, Consolidation by sand drains, Radial consolidation, Effect of smear zone on radial consolidation, Prefabricated drains. Vacuum consolidation, Vibro compaction, Stabilization of soil by vitrification, Ground freezing, Dewatering and Electro kinetics, accelerated pre-consolidation of soft clay using geosynthetics.

Module 6 In Situ Ground Treatment for Slopes: Different types of in situ soil stabilization like soil nails, Rock anchoring, Prestressed anchors, etc. Optimum design of nailed slopes, Design methods and Construction techniques. Evaluation of zones of liquefaction in the field, Ground improvement techniques for improving liquefaction resistance of soils, Nano-technologies in ground improvement and Site remediation.

Reference Books/Material

Text books:

1. Engineering principles of ground modification, Haussmann M R, Pearson Education Inc. New Delhi, 2008.
2. Ground Improvement Techniques, Purushothama Raj, P, Laxmi Publications, 2006.
3. Ground Improvement, Mooseley M P and Kirsch K, Spon Press, 2nd Edition, Taylor and Francis Group, London, 2004

Reference books:

4. Geotechnical Investigations and Improvement of Ground Conditions, Patel A, Elsevier, 1st Edition, 2019.
5. Engineering Treatment of Soils, Bell, F.G., E & FN Spon, New York, 2006.

Course Code	Course Name	L	T	P	Credits
CV538	Repair and Rehabilitation of Structures	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Assess deterioration and deficiency in aging infrastructure.
2. To study the current repair practices employed in the field.
3. Suggest materials and techniques for repairing and rehabilitation of deteriorated concrete structures.
4. Apply cost effective retrofitting strategies for repairs in buildings and bridges

Course Outcomes

After completion of the course the students 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: elect suitable repair and rehabilitation methods for Civil Infrastructure

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	-	-	-	-	-	-	-	-
CO2	M	M	M	L	-	M	-	-	-	-	-	-
CO3	M	M	L	M	-	M	-	-	-	-	-	-
CO4	H	H	M	L	-	M	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Causes of distress in concrete structures- Permeability of concrete, aggressive chemical agents, durability aspects, Holistic models for deterioration of concrete

Module 2 Condition Survey: Preliminary inspection, planning stage, visual inspection, field laboratory testing stage, consideration for repair strategy

Module 3 Non-Destructive Evaluation tests: Estimation of Strength, Chemical and other durability tests, estimation of corrosion potential

Module 4 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

Module 5 Repair /Rehabilitation methods: Shotcreting and Guniting, Repair and strengthening of columns and beams using ferrocement jacketing, fiber wrap technique, Foundation Rehabilitation methods

Reference Books/Material

Text books:

1. Concrete Structures-Repair, Rehabilitation and Retrofitting, Bhattacharjee B, CRS Publishers and Distributors, 2017.
2. Concrete Structures-Protection, Repair and Rehabilitation, Dodge W R, 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.classcentral.com/course/swayam-maintenance-and-repair-of-concrete-structures-17678
3. https://www.classcentral.com/course/swayam-maintenance-and-repair-of-concrete-structures-17678

Course Code	Course Name	L	T	P	Credits
CV539	Computational Fluid Dynamics	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To classify equations into parabolic, elliptic, and hyperbolic types and recognize their importance in fluid flow analysis.
2. To learn the finite difference method and its formulation for solving partial differential equations.
3. To understand the principles of finite element methods and their application in solving fluid mechanics problems.
4. To study time integration methods for solving transient conduction and advection-diffusion problems.
5. To explore different methods (explicit, implicit, SIMPLE type, fractional step) for solving the Navier-Stokes equations.

Course Outcomes

After completion of this course the student should be able to:

CO1: Categorize equations into parabolic, elliptic, and hyperbolic types and understand their relevance.

CO2: Apply the finite difference method to solve partial differential equations in fluid flow.

CO3: Apply finite element methods to solve fluid mechanics problems with different types of elements.

CO4: Understand numerical grid generation techniques and their impact on simulation accuracy.

CO5: Analyze and apply Reynolds-averaged Navier-Stokes (RANS) equations for turbulence modelling.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	H	-	-	-	-	-	-	-	-
CO2	H	H	H	M	-	-	-	-	-	-	-	-
CO3	H	M	M	H	-	-	-	-	-	-	-	-
CO4	H	M	M	M	-	-	-	-	-	-	-	-
CO5	M	M	L	L	-	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Classification and Overview of Numerical Methods: Conservation equation; mass; momentum and energy equations; convective forms of the equations and general description. Classification into various types of equations, parabolic elliptic and hyperbolic; boundary and initial conditions; over view of numerical methods.

Module 2 Finite Difference Technique and Finite Volume Technique: Finite difference methods; different means for formulating finite difference equation; Taylor series expansion, integration over element, local function method; treatment of boundary conditions; boundary layer treatment; variable property; interface and free surface treatment; accuracy of finite difference method.

Finite volume methods; different types of finite volume grids; approximation of surface and volume integrals; interpolation methods; central, upwind and hybrid formulations and comparison for convection-diffusion problem.

Module 3 Finite Element Methods and Methods of Solution: Finite element methods; Rayleigh-Ritz, Galerkin and Least square methods; interpolation functions; one- and two-dimensional elements; applications.

Solution of finite difference equations; iterative methods; matrix inversion methods; ADI method; operator splitting; fast Fourier transform.

Module 4 Time integration Methods and Numerical Grid Generation: Single and multilevel methods; predictor corrector methods; stability analysis; Applications to transient conduction and advection diffusion problems.
Numerical grid generation; basic ideas; transformation and mapping.

Module 5 Navier-Stokes Equations and Turbulence modelling: Explicit and implicit methods; SIMPLE type methods; fractional step methods. Reynolds averaged Navier-Stokes equations, RANS modelling, DNS and LES.

Reference Books/Material

Text books:

1. Computational Methods for Fluid Dynamics, Ferziger J H and Peric M, 3rd Edition, Springer Verlag, Berlin, 2003
2. Computational Fluid Dynamics, Jiyuan Tu, Guan Yeoh and Chaoqun Liu, Elsevier, 2nd edition, 2012

Reference books:

1. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Versteeg H K, Malalasekara W, 2nd Edition (Indian Reprint) Pearson Education, 2008

Course Code	Course Name	L	T	P	Credits
CV540	Soil Dynamics and Design of Machine Foundations	3	0	0	3

Pre-requisites: Nil

Course Objectives

2. To impart basic knowledge of theory of vibrations and behaviour of soils under dynamic loads.
3. To present design methodologies for foundations and isolation systems subjected to different kinds of vibration.
4. To discuss the evaluation of dynamic properties of soil by laboratory and non-destructive techniques.
5. Discuss liquefaction potential of soil and assessment methodologies.

Course Outcomes

On completion of this course, students will be able to:

CO1: Determine the dynamic properties of soil by using laboratory and non-destructive field tests.

CO2: Design foundation systems subjected to vibrations

CO3: Assess the liquefaction potential of a given site.

CO4: Analyze vibration isolation techniques for various types of machine foundations.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	H	H	-	-	-	-	-	-	-
CO2	H	M	H	M	-	-	-	-	-	-	-	-
CO3	M	M	L	H	M	-	-	-	-	-	-	-
CO4	H	M	M	L	-	-	-	-	-	-	-	-

Syllabus

Module 1: Introduction: Scope and objective; nature and type of dynamic loading; importance of soil dynamics.

Module 2: Vibration theory: Vibration of elementary systems; Degrees of freedom-single, two, and multiple degrees of freedom systems; vibration isolation, vibration absorber, vibration measuring instrument.

Module 3: Wave propagation: Elastic continuum medium, semi-infinite elastic medium, soil behaviour under dynamic loading.

Module 4: Dynamic soil properties: Stiffness, damping and plasticity parameters of soil, factors affecting, and their determination by laboratory and in-situ testing; correlation of different soil parameters; Liquefaction- basic evaluation and effects.

Module 5: Machine foundation: Types of machine foundations**,** Basic design criteria; methods of analysis of machine foundations - Mass-Spring-Dashpot model, Elastic half space theory; mode of vibrations- vertical, sliding, torsional and rocking models of oscillations; coupled motion, vibration control, practical design considerations and codal provisions. Typical design problems of foundations- Reciprocating type and impact type foundations.

Module 6: Vibration Isolation Systems Vibration isolation, active and passive isolation, transmissibility, methods of isolation in machine foundations.

Reference Books/Material

Text books:

1. Soil Dynamics, Shamsher Prakash, McGraw-Hill, 1981.
2. Dynamics in Soil Engineering, Alexander M, Akademiai,1980.
3. Handbook of Machine Foundations, Sreenivasalu P, Varadarajan C P, Tata McGraw-Hill, 2017.

Reference books:

1. Fundamentals of Soil Dynamics, Das B M, Elsevier, 1983
2. Relevant IS codes

Course Code	Course Name	L	T	P	Credits
CV541	Advanced Steel Structures	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Design and analysis of special steel structures like pre-engineered buildings, communication, and transmission line towers.
2. Plastic analysis of steel buildings.
3. Design and analysis of cold-formed structures.

Course Outcomes

CO1: Design of various types of steel connections.

CO2: Analyze and design the industrial building.

CO3: Design and detailing of communication and transmission line towers.

CO4: Plastic analysis of structures

CO5: Design and analysis of light gauge steel structures

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	-	-	-	-	-	-	-	-
CO2	H	H	H	M	-	-	-	-	-	-	-	-
CO3	H	H	H	H	-	-	-	-	-	-	-	-
CO4	H	M	M	H	-	-	-	-	-	-	-	-
CO5	H	M	M	H	-	-	-	-	-	-	-	-

Syllabus

Module 1 Connections: connection classifications, semi-rigid & rigid connections, framed & seated connections, and moment-resistant connections.

Module 2 Industrial Buildings: various components of an industrial building, loads and load combinations, roof systems, design of purlins, roof trusses, and industrial building frames.

Module 3 Steel Towers - Communication and Transmission Line: introduction, types of towers, tower configurations, loads, codal provisions, analysis and design, foundations of towers.

Module 4 Plastic analysis of structures: introduction, shape factor, moment redistribution, combined mechanisms, analysis of portal frames, effect of axial force - effect of shear force on plastic moment, connections, requirements, moment resisting connections. Design of straight corner connections, hunched connections, design of continuous beams.

Module 5 Design of light gauge steel structures: introduction to direct strength method, behavior of compression elements, effective width for load and deflection determination, behavior of unstiffened and stiffened elements, design of webs of beams, flexural members, lateral buckling of beams, shear lag, flange curling, design of compression members, wall studs.

Reference Books/Material

Text books:

1. Steel Structures – Design & Behaviour, Salmon C G, Johnson J E and Malhas F A, Pearson International, 2009
2. Fundamentals of Structural Steel Design, Gambhir M L, McGraw Hill, 2017
3. Teaching Resource on Structural steel Design, Narayanan R et.al., INSDAG, Ministry of Steel Publishing, 2022
4. Design of Steel Structures, Subramanian. N, Oxford University Press, 2017

Reference books:

1. Design of Cold Formed Steel Structures, Wie Wen Yu, McGraw Hill Book Company, 2017
2. LRFD steel design using advanced analysis (Vol. 13), Chen W F, Kim S E, CRC press, 1997
3. Steel Designers Manual, Owens G W, Knowles P R, Blackwell Publishers, 2003
4. Design of Steel Structures, Gaylords E H, Gaylords C N, McGraw Hill Publishers, 1998.
5. Composite Structures of Steel and Concrete; Vol I, Johnson R P, Granado Publishing Ltd.; London; 1975.
6. Steel Structures: Design and Behaviour: Emphasizing Load and Resistance Factor Design, Salmon C G, Johnson J E, Harper Collins Publishers, 1990
7. Steel Structures controlling behavior through design, Englekirk R, John Wiley & sons, 1994

Course Code	Course Name	L	T	P	Credits
CV542	Structural Health Monitoring	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Examine the use of low-cost, long term monitoring systems to keep civil infrastructure under constant surveillance, ensuring structural integrity
2. The concepts of rapid after disaster assessment of civil infrastructure.

Course Outcomes

CO1: Implement fundamental concepts in structural health monitoring

CO2: Understand the working principle of sensors and actuators used in structural health monitoring applications

CO3: Describe and classify various methods of structural health monitoring with their advantages and disadvantages

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	-	-	-	-	-	-	-	-
CO2	H	H	H	M	-	-	-	-	-	-	-	-
CO3	H	H	H	H	-	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction to SHM: An Overview of Structural Health Monitoring, Structural Health Monitoring and Smart Materials, Structural Health Monitoring versus Non Destructive Evaluation, A broad Overview of Smart Materials, Emerging SHM Technologies using Piezo Sensors SHM using Magnetostrictive Sensors, SHM using Optical Fibres and other sensors, Overview of Application Potential of SHM Notable Applications of SHM, Aerospace and Civil

Applications, Underground Structures and Other Applications, Understanding Piezoelectric Material, Understanding Magnetostrictive Material, Optical Fibre and Lambwave method, Solution Domain for SHM Other Damage Indices.

Module 2 Vibration control for SHM: Vibration Control using SHM, introduction to FE formulation, Constitutive Relationship, Element Stiffness Matrix for High Precision Finite Element analysis, Mass Matrix for High Precision Finite Element analysis, Developing Actuator and Sensor Influence Matrix, Estimating Sensor Voltage, Active Control of Damping, SHM of Ribbon Reinforced Composite Laminate

Module 3 SHM using piezo and magnetostrictive layers: Delamination Sensing using Piezo Sensory Layer, Voltage Response from Piezopatch, Electrical Impedance Method: basic theory, SHM using Magnetostrictive Sensory Layer, Basics of Magnetization and Hysteresis Delamination, Sensing using Magnetostrictive Sensory Layer, Constitutive relationship with composite relationship, MS Layer in symmetric Laminate, MS Layer Away from the Midplane in Asymmetric Laminate, Case Studies related to MS Layer based SHM.

Module 4 SHM using Laser Doppler Vibrometers (LDV): Experimental Modal Analysis using LDV - introduction, Velocity and Displacement Measurement using LDV, Case Studies

Reference Books/Material

Textbooks:

1. Smart Materials and Structures, Gandhi M V, Thompson B D, Springer Science & Business Media, 1992
2. Structural Health Monitoring: Current Status and Perspectives, Fu Ko Chang, CRC Press, 1998

Reference books:

1. Structural Health Monitoring, Balageas D, Fritzen C P, Guemes A, John Wiley & Sons, 2006
2. Health Monitoring of Structural Materials and Components: Methods with Applications, Adams D E, John Wiley & Sons, 2007.

Course Code	Course Name	L	T	P	Credits
CV543	Reinforced Earth and Geosynthetics	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Familiarize the students with reinforced earth and its applications
2. Introduce various types of Geosynthetic product as construction materials in civil engineering projects.
3. Design common geotechnical structures- Retaining wall, Embankment and Shallow foundations based on earth reinforcing techniques
4. Design aspects of Geosynthetics for different functional requirements in Roadways, Foundations, Landfill liners and Barrier applications.

Course Outcomes

On completion of this course, students will be able to:

CO1: Identify, formulate reinforced earth techniques that are suitable for different soils and in different structures.

CO2: Understand the laboratory testing concepts of Geosynthetics

CO3: Design reinforced soil structures viz. reinforced retaining wall, embankments and foundations with reinforced soils.

CO4: Understand the application of Geosynthetics in ground improvement and design innovative approaches for treating problematic soils such as soft clays and expansive soils.

CO5: Asses the use of Geosynthetics in drainage requirements and landfill designs

Relationship of Course Outcomes to Program Outcomes H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	M	L	M	-	-	L	-	-	-	-	-
CO2	M	M	H	M	H	-	-	-	-	-	-	-
CO3	H	H	M	H	M	-	L	-	-	-	-	-
CO4	H	H	M	M	M	-	-	-	-	-	-	-
CO5	H	M	H	H	M	-	L	-	-	-	-	-

Syllabus

Module 1: Introduction to reinforced earth: Historical background; Principles, concepts and mechanism of reinforced earth; materials used for construction, advantages of reinforced earth; design consideration for reinforced earth and reinforced soil structures.

Module 2: Geosynthetics: Types of geosynthetics, their composition, manufacture, properties, functions, testing and applications in reinforced earth structures.

Module 3: Design of reinforced earth structures: Design consideration for reinforced earth and reinforced soil structures; Retaining walls- Types of soil retaining structures, Construction aspects of reinforced soil retaining walls, Design Codes for reinforced soil retaining walls, Design of Reinforced soil Retaining walls with simple geometry, sloped backfill soil, and supporting a bridge abutment; Stability analysis of reinforced soil slopes; Design of Embankments supported on Load Transfer Platforms; Reinforced soil for supporting shallow foundations

Module 4: Design with Geosynthetics: Improvement in bearing capacity- Accelerated consolidation of soft clays using geosynthetics, Geosynthetic encased stone columns for load support; Designing for Separation, Filtration, Drainage and Roadway Applications; Erosion control using geosynthetics, Natural geosynthetics and their applications; Designing for Landfill Liners and Barrier Applications.

Reference Books/Material

Text books:

1. Designing with Geosynthetics, Koerner R M, 6th edition, Xlibris Pub., 2012
2. Engineering with Geosynthetics, Rao G V, Raju G V S, Tata Mc Graw Hill Publishing Co. New Delhi, 1990
3. Geosynthetics and their Applications, Shukla S K, Thomas Telford, London, 2002

Reference books:

1. Earth Pressure and Earth Retaining Structures, Clayton C R I, Milititsky J, Woods R I, Blackie Academic & Professional, 1993.
2. Reinforced Earth, Ingold T, Thomas Telford Ltd., 1982.
3. Earth Reinforcement and Soil Structures, Jones C J F P, Butterworth, 1985.
4. Designing with Geosynthetics, Koerner R M, Prentice Hall, 1993.

Course Code	Course Name	L	T	P	Credits
CV544	Urban Stormwater Management	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To gain understanding of the challenges related to stormwater runoff in urban areas.
2. Acquire skills in calculating rainfall excess, abstractions, and runoff rates.
3. To understand the fundamentals of open-channel flow and its equations.
4. To develop skills in designing storm water drainage structures for urban areas.
5. To learn the concepts of detention basins, infiltration structures, and their design.

Course Outcomes

On completion of the course, the students will be able to:

CO1: Identify and analyze the specific challenges posed by stormwater runoff in urban settings.

CO2: Perform computations of rainfall excess, abstractions, and runoff rates for urban catchments

CO3: Utilize open-channel equations for steady gradually varied flow analysis

CO4: Design stormwater drainage structures for street pavements considering design standards and regulations.

CO5: Design detention basins and infiltration structures based on stage-discharge relationships.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L	H	-	-	-	-	-	-	-	-
CO2	M	L	H	H	-	-	-	-	-	-	-	-
CO3	H	L	L	H	-	-	-	-	-	-	-	-
CO4	M	M	M	L	-	-	-	-	-	-	-	-
CO5	M	M	H	M	-	-	-	-	-	-	-	-

Syllabus

Module 1: Rainfall and Runoff Computations Introduction, Urbanization, Storm water runoff quantity and quality issues, Rainfall design for urban catchments, Hydrologic and probabilistic description of rainfall, Design rainfall, Methods for construction of design storm hyetographs, Rainfall excess calculations, Computation of abstractions, Combined loss models Calculation of runoff rates-basic concepts, elements of urban runoff hydrographs, Time of Concentration, Definition and calculation by various methods, Unit hydrograph method, NRCS method (TR-55)

Module 2: Channel flow and Overland flow Open channel flow, Definitions, States of open channel flows – Open Channel flow equations, Steady Gradually varied flow, Normal flow, Open channel rating curve, Overland flow, Kinematic wave model, Overland flow on impervious and pervious surfaces, Channel flow routing, simplified and numerical models

Module 3: Storm Water Drainage Structures Design of stormwater drainage structures, Drainage design for street pavements, Storm sewer systems, Culverts, Surface drainage channels, Urban flooding and associated issues, Detention basins, Stage-discharge relationship, Detention basin design, Infiltration structures, Infiltration basins, Trenches Stormwater quality control, Concepts of BMPs and LID, Advantages, Computer models, EPA, SWMM

Reference Books/Material

Text books:

1. Urban Hydrology, Hydraulics, and Stormwater Quality: Engineering Applications and Computer Modeling, Osman Akan, A and Robert J. Houghtalen, John Wiley and Sons, First edition, 2003
2. Subramanya K., Flow in Open Channels, McGraw Hill Education; 4th edition, 2015
3. Applied hydrology, Ven Te Chow, David Maidment, and Larry Mays, Tata McGraw Hill, First edition, 2011

Reference books:

1. Hanif Chaudhry M., Open-Channel Flow, Springer, 2nd edition, 2008
2. National Engineering Handbook, Part 630, Natural Resources Conservation Service, United States Department of Agriculture
3. Storm Water Management Model Applications Manual, USEPA - EPA/600/R-09/077, July 2009
4. Engineering Hydrology: Principles and Practices, Victor M Ponce, Pearson, 2014
5. Hydrology in Practice, Elizabeth M Shaw, CRC Press, 2017
6. Hydrology: Water Quality and Quantity control, Wanielista M O, Kersten R, Eaglin R, Wiley Publishing, 1996
7. Urban Water Cycle: Processes and Interactions, Marsalek et al., Technical Documents in Hydrology No.78, International Hydrological Programme, UNESCO, 2006

Course Code	Course Name	L	T	P	Credits
CV545	Traffic Engineering	3	0	0	3

Pre-requisites: Nil

Course Objectives:

1. To understand the fundamentals of traffic stream characteristics
2. To learn the skills of traffic control and management
3. To learn the methods of safe intersection design
4. To learn the importance and methods of accident investigation and prevention
5. To understand the concepts of road safety audit and safety improvement methods

Course Outcomes

After completion of the course the students will be able to:

CO1: Carry out traffic surveys

CO2: Implement traffic system management

CO3: Carry out intersection design for safety

CO4: Record and analyze accident data and suggest counter measures

CO5: Carry out road safety audit

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	M	-	-	-	-	-	-	-	-
CO2	H	H	M	M	L	-	-	-	-	-	-	-
CO3	H	H	H	M	L	-	-	-	-	-	-	-
CO4	H	H	H	H	L	-	-	-	-	-	-	-
CO5	H	M	M	M	L	-	-	-	-	-	-	-

Syllabus

Module 1: Traffic stream characteristics: Road user, vehicle and highway characteristics, Fundamental parameters and relations of traffic flow, Traffic stream models. Speed data collection and analysis, Density and travel time measurement and analysis, Moving Observer Method, Automated Traffic Measurements - Traffic forecasting and growth studies. Capacity and level of services of roads. Pedestrian studies – flow characteristics - Design principles of pedestrian facilities.

Module 2: Traffic Management: Parking studies – parking statistics, parking surveys, parking requirements - on street and off-street parking. Lay-byes and bus stops. Principles of Traffic Control: Basics of traffic management. Traffic Signs, Road Markings. Traffic System Management – speed, vehicle, parking, enforcement regulations. Mixed traffic regulations – one way, tidal flow, turning restrictions etc.

Module 3: Design of Intersections for Safety: Uncontrolled intersection, Conflicts at intersection, Channelization, Traffic islands, Design of median islands, turning vehicle templates. Traffic intersection control: Traffic Rotaries – design of traffic rotaries. Traffic signal design - Design Principles of Traffic Signal, Coordinated Traffic Signal, Vehicle Actuated Signals and Area Traffic Control. Design of Grade Separated Intersection - trumpet, diamond, cloverleaf and flyovers.

Module 4: Accident Investigation and Prevention: Characteristics of road accidents, causes of accidents: road – driver – vehicle - environment, Significance of accident data, Accident recording and analysis - Crash reporting and collision diagrams - Statistical Interpretation and Analysis of Crash Data. Identification of potential sites for treatment - Safety countermeasures. Monitoring and evaluation. Roadway lighting.

Module 5: Road Safety Audit: Overview, stages of road safety audit, audit process, checklists, and elements of good road safety audit. Highway safety improvement program - Safety Education, Traffic Law Enforcement. Road Safety Management System. Case studies.

Reference Books/Material

Text books:

1. Highway Engineering, Khanna S K, Justo C E G, Veeraragavan A, Nem Chand and Bros, Roorkee, 2014.
2. Principles and Practices of Highway Engineering, Kadiyali L R, Lal N B, Khanna Publishers, 2008.

Reference books:

1. The Handbook of Road Safety Measures, Elvik R, Hoye A, Vaa T, Sorensen M, Emerald Group Publishing Limited, 2009
2. Relevant IRC codes

Course Code	Course Name	L	T	P	Credits
CV546	Disaster Management and Mitigation	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To describe the basic types of hazards and their potential consequences
2. To understand the strengths and weaknesses of disaster management approaches
3. Understand how to react effectively to natural, man-made, and technological threats.
4. Study the hazard mapping and Forecasting
5. Learn about the aspects of environmental management for disaster risk reduction

Course Outcomes

On completion of the course the students will be able to

CO1: Understand the approaches to disaster phenomena

CO2: Know the characteristics of different natural and manmade hazards

CO3: Analyze the different disaster trends

CO4: Map the hazard and forecasting

CO5: Plan for disaster management

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	H	-	-	-	-	-	-	-	-
CO2	H	H	L	H	-	-	-	-	-	-	-	-
CO3	H	M	M	H	-	-	-	-	-	-	-	-
CO4	H	H	H	M	-	-	-	-	-	-	-	-
CO5	H	M	H	M	-	-	-	-	-	-	-	-

Syllabus

Module 1: Introduction to Disasters, Classification, Causes, Impacts: Concept and Definitions of different terms of disaster. Approaches to understand disaster phenomena (natural science, applied, science, progressive and holistic approaches). Parameters of disaster risk levels of disaster as per national guideline.

Module 2: Classification of Hazards (Natural and Manmade): General characteristics and Problem areas of different natural and Man-made hazards (e.g. Flood, Erosion, Earthquake, Landslide, Lightning, Tropical Cyclone, Drought, Civil Unrest etc.).

Module 3: Disaster Trends (Global, National and Regional): Response time, Frequency Forewarning, Exposure time of different hazards. Common approaches to study natural and manmade hazards; Vulnerability and Disasters. Differential impacts- in terms of Caste, Class, Gender, Age, Location, Disability.

Module 4: Disaster Risk Mitigation: Disaster risk assessment (Hazard-Vulnerability-Capacity analysis), Hazard mapping and Forecasting. Principles and Aspects of Disaster prevention, Disaster mitigation. Preparedness for damage mitigation and coping with disasters. Capacity building for disaster/damage mitigation (structural and non-structural measures). Contingency planning for damage mitigation of different hazards. Relevance of indigenous knowledge, appropriate technology and local resources in disaster risk mitigation. Community based disaster risk reduction mechanism. Counter disaster resources and their roles. Selected models for understanding the causes of disaster and disaster risk mitigation.

Module 5: Environment and Disasters: Environment, Ecosystem and Disasters. Climate change-issues and Concerns. Industrial hazards and Safety measures. Post disaster impact on environment. Impact of developmental projects on disaster risk. Aspects of environmental management for disaster risk reduction. Environmental Impact Assessment (EIA).

Module 6: Planning for Disaster Management: Community; Hazard profile in India. Different phases of Disaster Management (DM cycle). Relief mechanism (needs assessment, relief administration and distribution, management of relief centers, external support etc.). Compensation and Insurance. Planning strategies (state and district DM planning); planning

needs. Disaster Management Act (2005); Disaster Management Policy (2009); organizational framework for disaster management in India.

Reference Books/Material

Text books:

1. Natural Hazards and Disaster Management: Vulnerability and Mitigation, R. B. Singh, Rawat Publication, New Delhi, 2006
2. Disaster management, Ghosh G K, APH Publishing Corporation, 2011

Reference books:

1. Disaster Management: Text and Case Studies, Murthy D B M, Deep & Deep Publications, 2007
2. Encyclopaedia of Disaster management, Goel S L, Deep & Deep Publications, 2006
3. Citizen's Guide to Disaster Management: How to Save Your Own Life and Help others, Satish M, Macmillan Publishers India, 2006

Course Code	Course Name	L	T	P	Credits
CV547	Environmental Impact Assessment of Civil Engineering Projects	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To understand the concepts and role of EIA in environmental planning.
2. To trace the evolution of EIA in India and comprehend related legislations.
3. To learn EIA methodologies, impact assessment, and mitigation strategies.
4. To grasp the concepts of environmental audits, compliance, and management techniques.
5. To explore environmental monitoring, sustainable development, and life cycle assessment.

Course Outcomes

On the completion of the course, the student will be able to:

CO1: Define EIA, understand its role in planning.

CO2: Trace EIA evolution in India, discuss legislations and procedures.

CO3: Grasp impact assessment methods, learn about socio-economic and ecological impacts, understand mitigation and alternatives.

CO4: Explore audits, compliance, ISO 14000, and environmental management.

CO5: Study sustainable development, life cycle assessment, and carbon footprints.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	H	-	-	-	-	-	-	-	-
CO2	H	M	H	M	-	-	-	-	-	-	-	-
CO3	M	M	L	M	-	-	-	-	-	-	-	-
CO4	H	M	M	L	-	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Concept of environment, Concept of environmental impact, Environmental impact assessment (EIA) – definitions, terminology and overview, the role of EIA in relation to the planning and decision-making process.

Module 2 Evolution of EIA: Evolution of EIA in India, Environmental legislations in India, EIA notifications, Major features of the EIA notification in India, Present status and procedures of EIA in India.

Module 3 Environmental Impact Assessment and Mitigation: Environmental baseline, Impact assessment methods – checklists – matrices - quantitative methods – networks - overlay mapping. Category of projects, Introduction to Impact Prediction, Evaluation and Mitigation-air, noise and water environment, assessment of socio-economic impacts, assessment of ecological impacts, Evaluation of alternatives, Preparing the EIA document, Environmental impact statement (EIS). Techniques for conflict management and dispute resolution, EIA case studies for selected projects.

Module 4 Environmental Audits: Definitions and concepts, partial audit, compliance audit, methodologies and regulations, Contents of EA reports, Introduction to ISO and ISO 14000, case studies in ISO 14000, environmental management techniques.

Module 5 Environmental Monitoring Plan: Concept of sustainable development, CDM initiatives in India, Life cycle assessment, procedures for LCA, Stages in LCA of a Product. Triple bottom line concept, design for environment, Energy, water, carbon and ecological footprints.

Reference Books/Material

Text books:

1. Environmental Impact Assessment Methodologies, Anjaneyulu Y, 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, 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	Course Name	L	T	P	Credits
CV548	Air and Noise Pollution Control	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To understand clean air, air pollutants, sources, and impacts.
2. To learn about air quality standards, monitoring, and pollution control legislation.
3. To comprehend principles of gaseous constituent removal and combustion.
4. To explore air pollution control methods and devices.
5. To study about the noise pollution sources, impacts, and control measures.

Course Outcomes

On completion of the course, the student will be able to:

CO1: Define clean air, list air pollutants, identify sources, and describe effects on humans, animals, vegetation, and properties.

CO2: Understand harmful concentration levels, geographical factors, and air pollution control laws; classify sampling methods, and explain atmospheric pollution monitoring

CO3: Explain removal principles, adsorption, catalytic combustion, oxidation, and decomposition processes.

CO4: Describe setting chambers, momentum separators, filters, electrostatic precipitators, bag houses, scrubbers, and basic air pollution control techniques.

CO5: Differentiate sound and noise, identify noise sources, describe environmental and industrial noise effects, explain noise prevention and control measures, and discuss noise control legislation.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	H	-	-	-	-	-	-	-	-
CO2	M	L	M	M	L	-	-	-	-	-	-	-
CO3	H	L	L	H	L	-	-	-	-	-	-	-
CO4	M	M	M	L	-	-	-	-	-	-	-	-
CO5	H	M	H	M	-	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Definition of clean air, nature, air pollutants, sources of air pollutants, effects of air pollution on man, animal, vegetation and properties.

Module 2 Ambient Air Quality Standards and Monitoring: Harmful concentration – geographical factors in air pollution – air pollution control legislation. Classification sampling; sampling techniques; monitoring atmospheric pollution.

Module 3 Fluid Resistance to Particle Motion: Principles of removal of a gaseous constituent; adsorption and combustion; catalytic combustion of organic materials; catalytic oxidation and decomposition.

Module 4 Air Pollution and Control Measures: Setting chambers; momentum separators, fibrous filters; electrostatic precipitators; bag houses centrifugal spray scrubbers; venture scrubbers; elementary principles of air pollution e-control techniques.

Module 5 Noise Pollution: Sound and noise; sources of noise pollution, environmental and industrial noise; effects of noise pollution: measures for prevention and control of noise; environmental and industrial noise; noise control legislation.

Reference Books/Material

Text books:

1. Environmental Pollution Control Engineering, Rao C S, Wiley Eastern Ltd., New Delhi, 2018
2. Air Pollution Control, Rao M N, Rao H V N, Tata-McGraw-Hill, New Delhi, 2017

Reference books:

1. Environmental Noise Pollution, Cunniff P F, John Wiley & Sons, New York, 1977
2. Environmental Pollution, Docks H M, John Wiley & Sons. New York, 1981
3. Environmental Protection, Chanlett T Emit, McGraw Hill series in Water Resources and Environmental Engineering, New York, 1973
4. Environmental noise pollution, Patrick C F, John Wiley & Sons, 1977

Course Code	Course Name	L	T	P	Credits
CV549	Earthquake Resistant Structures	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To provide a coherent development to the students for the courses in the sector of earthquake engineering.
2. To present the foundations of many basic engineering concepts related to earthquake Engineering.
3. To give an experience in the implementation of engineering concepts which are applied in the field of earthquake engineering.
4. To involve the application of scientific and technological principles of planning, analysis, design of buildings according to earthquake design philosophy.

Course Outcomes

After completion of the course the students will be able to:

CO1: Understand the fundamental principles related to earthquake engineering.

CO2: Learn how to design the foundation for superstructure in case of earthquake loading.

CO3: Interpret the behavior of different structures under the action of earthquake loading.

CO4: Interpret the safety and stability requirements of different seismic structures under the action of earthquake loading.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	-	-	-	-	-	-	-	-
CO2	H	M	H	M	-	-	-	-	-	-	-	-
CO3	H	H	H	M	-	-	-	-	-	-	-	-
CO4	H	M	H	M	-	-	-	-	-	-	-	-

Syllabus

Module 1 Elements of Earthquake Engineering: Earthquake magnitude and intensity, Focus and Epicentre, Causes and Effects of Earthquakes, Characteristics of Earthquake, Seismic zone mapping.

Module 2 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.

Module 3 Analysis for Earthquake Loads: IS: 1893-2002- Seismic Coefficient method- modal analysis- Applications to multi-storied building frames – water tanks – chimneys.

Module 4 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.

Module 5 Base Isolation: Isolation systems – Effectiveness of base isolation and applications.

Reference Books/Material

Text books:

1. Dynamics of Structures, A.K. Chopra, Prentice Hall, 2020.
2. Earthquake Resistant Design of Structures, Pankaj A, Manish S, PHI Publishers, 2011
3. Earthquake Resistant Design of Structures, Duggal S K, Oxford, 2nd Edition, 2013

Reference books:

1. Dynamics of Structures, Clough R W, 2015, CBS Publishers, 2nd Edition, 2015
2. Structural Dynamics: Theory and Computation, Mario P, Young H K, Springer Publisher, 6th Edition, 2018
3. Earthquake Resistant Design of Structures, Aggarwal P, PHI Learning, 2006
4. Seismic Design of Reinforced Concrete and masonry Buildings, Paulay T, Priestly M J N, John Wiley & Sons, 1992
5. Mechanical Vibrations, Rao S S, Pearson, 6th Edition, 2018
6. Relevant IS codes

Course Code	Course Name	L	T	P	Credits
CV550	Rapid Transport System and Smart Cities	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To understand the basic concepts of an intelligent transportation system
2. To familiarize urban transportation planning
3. To gain knowledge on transportation economics.
4. To study about smart cities and infrastructure.

Course Outcomes

After completion of the course the students will be able to:

CO1: Understand the benefits of the Intelligent Transportation System
CO2: Get familiarized with the components of urban transportation planning
CO3: Appreciate the concepts involved in transportation decision making
CO4: Understand the basic underlying principles of Smart infrastructure design and associated policy approaches

Relationship of Course Outcomes to Program Outcomes
H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	H	-	-	-	-	-	-	-	-
CO2	H	H	H	M	-	-	-	-	-	-	-	-
CO3	H	M	M	H	-	-	-	-	-	-	-	-
CO4	H	M	M	M	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction to Intelligent Transportation Systems (ITS): Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS, ITS Data collection techniques, Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

Module 2 Urban Transportation Planning: Urban morphology, Urbanization and travel demand, Urban activity systems and travel patterns, Systems approach, Trip based and Activity based approach, Urban Transportation Planning, Goals, Objectives and Constraints.

Module 3 Transportation Economics: Introductory Concepts in Transportation Decision Making: Overall transportation project development, budgeting, financial planning, the process of transportation project development, models associated with transportation impact evaluation; Transportation costs, Classification of transportation costs, transportation agency costs, transportation user costs, general structure and behavior of cost functions and road pricing.

Module 4 Smart cities and infrastructure: Defining a smart city, Smart infrastructure -smart buildings, smart mobility, smart energy, smart water, smart waste management, implementing smart infrastructure-The need to localize smart infrastructure, Policy instruments for promoting the localization of smart infrastructure, policy instruments for meeting smart city financial needs, Smart infrastructure design principles and policy approaches

Reference Books/Material

Text books:

1. Intelligent Transport System: Technologies and Applications, Asier P, Unai H, Enrique O, 1st edition, Wiley, 2015
2. Intelligent Transport Systems: Technologies and applications, Zuazola I J G, Onieva E, Unai H J, Perallos A, 1st edition, Wiley, 2015

Reference books:

1. Transportation Planning Handbook, 4th Edition, Institute of Transportation Engineers, John Wiley Transportation Economics, Herbert Mohring, Ballinger Pub. Co
2. Smart cities and urban development with special reference to planning and transportation, P. K. Garg, VC, UTU

Course Code	Course Name	L	T	P	Credits
CV551	Rock Mechanics and Engineering	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To give details of Mechanics of rock failure and other aspects of stability of underground.
2. To determine properties and behavior of various types of rock under different loading conditions for underground and open excavations.
3. To study engineering classification of rocks.

Course Outcomes

On completion of this course, students will be able to:

CO1: Understand the physical and mechanical behavior of intact rock and rock mass

CO2: Apply simple elastic and elastoplastic constitutive models to study rock behavior.

CO3: Classify the rock mass and rock quality grading.

CO4: Perform various in-situ testing to evaluate mechanical properties of rock and rock mass.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L	M	M	-	-	-	-	-	-	-
CO2	M	M	L	M	-	-	-	-	-	-	-	-
CO3	M	M	M	M	-	-	-	-	-	-	-	-
CO4	H	M	M	M	H	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Definition, Development of rock mechanics, Objectives of rock mechanics, Application of rock mechanics, Similarities and difference between soil mechanics and rock mechanics, discontinuities in rocks
Physical Properties: Specific gravity, porosity, void index, unit weight, water absorption, Degree of saturation, slake durability index, rock sampling.

Module 2 Compressive Strength of Rock: Stress distribution in specimen under compression, Modes of failure in compression, Failure mechanism of specimens in compression, Factors affecting compressive strength, End friction, specimen geometry, rate of loading, moisture and confining pressure. Elastic Constants: Static and dynamic elastic constants, Significance and application, Determination of static and dynamic elastic constants, Typical stress-strain curves for rocks, Complete stress-strain curve,

Module 3 Tensile Strength: Significance and application of tensile strength, Laboratory determination of tensile strength, Direct methods, Indirect methods, bending tests, Hydraulic extension tests, Diametral compression tests, other methods, Factors affecting tensile strength of rock.

Module 4 Shear Strength: Significance and application, Various methods of estimating shear strength, single shear test, double shear test, punch shear test, oblique shear test, rock core direct shear test, Concept of shear strength of jointed rock.

Module 5 Engineering Classification of Rocks: Necessity, aim, and process of classification, Classification of intact rocks- ISRM and Deere and Miller classification, Engineering Classification of rock mass- RQD, BGD and RMR systems of classifications.

Module 6 In situ-Tests: Necessity, plate bearing test, pressure tunnel test, pressure meter test and direct shear test and field permeability tests

Reference Books/Material

Text books:

1. Engineering geology and rock mechanics, Verna B P, 4th edition, 2017
2. Engineering in Rocks for Slopes, Ramamurthy T, Foundations and Tunnels, PHI Learning Pvt. Ltd., 2015.
3. Fundamentals and Applications of Rock Mechanics, Debasis D, Verma A K, PHI Learning Pvt. Ltd., 2016
4. Introduction to Rock mechanics, Goodman, Willey International, 2007
5. Fundamentals of Rock Mechanics, Jaeger J C, Cook N G W, and Zimmerman R W, Wiley Blackwell, 2007.

Reference books:

1. Rock Mechanics an Introduction, Sivakugan N, Shukla S K, Das B M, CRC Press, 2019**.**
2. Structural Geology, Twiss R J and Moores E M, W.H. Freeman and Co., 2007
3. Engineering Properties of Rocks, Lianyang Z, Elsevier, 2005.
4. Hand book on rock mechanics (Vol I to IV), Lama R D, Vutukuri V S, Trans Tech Publications, 1978
5. Rock Mechanics Principles in Engineering Practice, Hudson J A, CIRIA, Butterworth & Co, London, 1989

Course Code	Course Name	L	T	P	Credits
CV552	Forensic Structural Engineering	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To provide the basics for the investigation of failures and understanding some of the pertinent legal aspects
2. To prepare for the eventual practice of forensic structural engineering.

Course Outcomes

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

CO1: Analyze failure of structure and identify the lessons to learn.

CO2: Inspection of structure to identify the distress and its causes.

CO3: Effect of environment on the structure and identification of defects.

CO4: Understanding the technique of retrofitting.

Relationship of Course Outcomes to Program Outcomes H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	M	-	-	-	-	-	-	-
CO2	H	M	L	M	M	-	-	-	-	-	-	-
CO3	H	M	L	L	L	-	-	-	-	-	-	-
CO4	H	H	M	M	L	-	-	-	-	-	-	-

Syllabus

Module 1: Failure of Structures: Review of the construction theory, performance problems, responsibility and accountability, case studies, learning from failures– causes of distress in structural members, design and material deficiencies, overloading.

Module 2: Diagnosis and Assessment of Distress: Visual inspection, non-destructive tests, ultrasonic pulse velocity method, rebound hammer technique, ASTM classifications, pullout tests, Bremor test, Windsor probe test, crack patterns- crack detection techniques, case studies, single and multi-storey buildings, Fibre optic method for prediction of structural weakness assessments.

Module 3: Environmental Problems and Natural Hazards: Effect of corrosive environments, chemical and marine environments, pollution and carbonation problems– detection and measurement of corrosion durability of RCC structures, damage due to earthquakes and strengthening of buildings, provisions of BIS 1893 and 4326

Module 4: Modern Techniques of Retrofitting: Structural elements - first aid after a disaster, guniting, jacketing. Use of chemicals in repair, application of polymers– ferrocement, fiber composites and fiber reinforced concrete as rehabilitation materials, strengthening by pre-stressing, case studies, bridges, water tanks, cooling towers, heritage buildings, high rise buildings.

Reference Books/Material

Text books:

1. Deterioration, Maintenance and Repairs of Structures, Johnson S M, McGraw Hill Book Company, New York, 1965
2. Design and Construction Failures, Dovkaminetzky, Galgotia Publication, New Delhi, 2001

Reference books:

1. Structural Failures, Jacob F, Kenneth L C, Wiley Europe, 1997.

Course Code	Course Name	L	T	P	Credits
CV553	Wind Resistant Designs	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To impart the basic principles of wind engineering and estimation of the design wind speed.
2. To understand the fundamental concepts of design of structures subjected to wind loads.
3. To study behavior of various structural systems under wind loads.

Course Outcomes

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

CO1: Understand the wind map of India and different provisions of IS:875 Part 3.

CO2: Analyze different components of building using the codal provisions subjected to wind load.

CO3: Analyze high rise building and evaluate the dynamic effects.

Relationship of Course Outcomes to Program Outcomes H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	L	-	-	-	-	-	-	-
CO2	M	M	L	M	-	-	-	-	-	-	-	-
CO3	M	H	L	L	-	-	-	-	-	-	-	-

Syllabus

Module 1: Introduction to wind terminologies, Wind Characteristics: Variation of wind velocity, atmospheric circulations – pressure gradient force, coriolis force, frictionless wind balance, geostrophic flow, boundary layer. Extra ordinary winds – Foehn, Bora, Cyclones, Tornadoes etc,

Module 2:

Wind map of India from IS 875 Part 3, 2015, Importance of K1, K2, K3 and K4 factors, calculation of wind force, Internal and external pressure coefficients, calculation of gust wind and cross winds for square and rectangular buildings as per IS 875 part 3, 2015.

Module 3:

Analysis of different structures subjected to wind forces (canopy, grand stands, buildings, curved structures, different types of roofs.)

Design of beams, columns and other structural elements for wind force.

Module 4:

Dynamic wind effects: Wind induced vibrations, flow around bluff bodies, along wind and across wind response, flutter, galloping, vortex shedding, locking, ovalling; analysis of dynamic wind loads, codal provisions – gust factor

Module 5:

Introduction to Wind tunnel testing: Open circuit and closed circuit wind tunnels, rigid and aeroelastic models, wind tunnel measurements and instruments

Case studies: low rise buildings, parking sheds, workshop building, multistory building, water tanks, towers, chimneys, bridges.

Reference Books/Material

Text books:

1. IS 875 Part 3, Bureau of Indian Standards, 2015
2. Wind loading on Structures, Holmes J D, Spon Press, London, 2001.

Reference books:

1. Wind loads on structures, Dyrbye C, Hansen S O, John Wiley, New York,1997.
2. Wind Effects on Structures: fundamentals and applications to design, Simiu E, Scanlan R H, 3rd Edition, John Wiley & Sons, New York, 1996.

Course Code	Course Name	L	T	P	Credits
CV554	Tunnel and Underground Structures	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. Identify the types of underground excavations.
2. Understand the parameters affecting tunnel design.
3. Understand the working and application of a tunnel boring machine.
4. Examine the methodologies for excavation of large tunnels and special tunnel applications.

Course Outcomes

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

CO1: Development of tunnel engineering and different components.

CO2: Evaluation of tunnelling methods based on soil type.

CO3: Understand the difference between tunnelling and blasting.

CO4: Design of different supporting systems during tunnelling process.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	M	-	-	-	-	-	-	-	-
CO2	M	M	L	M	-	-	-	-	-	-	-	-
CO3	M	H	L	L	-	-	-	-	-	-	-	-
CO4	H	H	M	M	-	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Scope and application, historical developments, art of tunnelling, tunnel engineering, future tunnelling considerations. Types of Underground Excavations:

Tunnel, adit, decline, shaft; parameters influencing location, shape and size; geological aspects; planning and site investigations.

Module 2 Tunnelling Methods: Types and purpose of tunnels; factors affecting choice of excavation technique; Methods - soft ground tunnelling, hard rock tunnelling, shallow tunnelling, deep tunnelling; Shallow tunnels, cut and cover, cover and cut, pipe jacking, jacked box excavation techniques, methods of muck disposal, supporting, problems encountered and remedial measures.

Tunnelling by Drilling and Blasting: Unit operations in conventional tunnelling; Drilling - drilling principles, drilling equipment, drilling tools, drill selection, specific drilling, rock drillability factors; Blasting - explosives, initiators, blasting mechanics, blast holes nomenclature; types of cuts- fan, wedge and others; blast design, tunnel blast performance - powder factor, parameters influencing, models for prediction; mucking and transportation equipment selection.

Tunnelling by Road headers and Impact Hammers: Cutting principles, method of excavation, selection, performance, limitations and problems.

Tunnelling by Tunnel Boring Machines: Boring principles, method of excavation, selection, performance, limitations and problems; TBM applications.

Module 3 Supports in Tunnels: Principal types of supports and applicability.

Ground Treatment in Tunnelling: Adverse ground conditions and its effect on tunnelling; introduction to ground control.

Module 4 Tunnel Services: Ventilation, drainage and pumping.

Methods of Sinking Shafts: Vertical and inclined, decline; shaft/raise boring machines and their application.

Module 5 Tunnelling Hazards: Explosion, flooding, chimney formation, squeezing ground.

Reference Books/Material

Text books:

1. Tunnel Engineering Handbook (Second Edition), Bickel J O, Kuesel T R, King E H, Chapman & Hall, 1996

2. Design Methodology in Rock Engineering, Bieniawski Z T, A.A. Balkema, 1992.
3. Tunneling: Design, Stability and Construction, Whittaker B N, Frith R C, Institution of Mining and Metallurgy, London, 1990

Reference books:

1. Underground Excavation in Rock, Hoek E, Brown E T, The Institution of Mining and Metallurgy, London, 1980
2. Geomechanics Principles in the Design of Tunnels and Caverns in Rocks, Mahtab M A., and Grasso P, Elsevier Press, 1992
3. Rock Mechanics Design in Mining and Tunneling, Bieniawski Z T, A. A. Balkema, 1984

Course Code	Course Name	L	T	P	Credits
CV555	Offshore Structures	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To impart the fundamentals behind all types of fixed offshore structures
2. To understand the design, construction, and risk-based maintenance for offshore platforms, specifically, the theory and process of such design.

Course Outcomes

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

CO1: Analyze various types of ocean structures.

CO2: Analyze the effects of environmental loads on the offshore structures.

CO3: Study the different construction methodology for offshore structures.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	M	H	H	-	-	-	-	-	-	-
CO2	H	H	M	H	H	-	-	-	-	-	-	-
CO3	H	M	M	H	M	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction: Different types of ocean structures, Various structural systems deployed for shallow, medium, deep and ultra-deep waters

Module 2 Structural Systems: Jacket or Tension leg structures, Tower, Caissons, Concrete gravity platforms, Steel, Gravity platforms, FPSO spar platforms, Hybrids, Compliant structures, factors governing selection.

Module 3 Operational loads: Environmental loads due to wind, wave, current and buoyancy, Morison's Equation, Maximum wave force on offshore structure, Concept of Return waves, Principles of Static and dynamic analyses of fixed platforms, Use of approximate methods, Design of structural elements.

Module 3 Fixed Platform: Concepts of Fixed Platform, Jacket and Deck Steel Tubular Member, Design Tubular Joint, Design for Static and Cyclic Loads

Module 4 Offshore construction: Drilling techniques, logging methods, location of drill sites, Completion of walls, Marine survey, Welding, Checks on welding and codes, Corrosion and its prevention measures.

Reference Books/Material

Text books:

1. Offshore Structures: Design, Construction and Maintenance, El-Reedy M A, Gulf Professional Publishing, 2019
2. Offshore Structure Modeling, Chakrabarti S K, World Scientific, Singapore, 1994
3. Analysis and Design of Offshore Structures. HRD Center for Offshore and Plant Engineering (HOPE), Chandrasekaran S, Bhattacharyya S K, Changwon National University, Republic of Korea, 2011

Reference books:

1. Offshore Structures Volume I: Conceptual Design and Hydromechanics, Clauss G, Lehmann E, Ostergaard C, Springer, 1992
2. Advanced Theory on Offshore Plant FEED Engineering, Chandrasekaran S, Changwon National University Press, Republic of South Korea, 2014
3. Advanced Marine structures, Chandrasekaran S, CRC Press, Florida, 2015
4. Dynamic analysis and design of ocean structures, Chandrasekaran S, Springer, 2015

Course Code	Course Name	L	T	P	Credits
CV556	Numerical Modelling in Geotechnical Engineering	3	0	0	3

Pre-requisites: Geotechnical Engineering, Foundation Engineering

Course Objectives

1. Introduce numerical modelling of soil behavior to the students.
2. Discuss the constitutive modelling of soils based on elasticity and plasticity deformation theories.
3. Present multiple numerical techniques that are widely used in Geotechnical engineering.
4. Learn various finite element based software to solve Geotechnical problems.

Course Outcomes

On completion of this course, students will be able to:

CO1: Apply critical state soil mechanics for analysis of Geotechnical structures.

CO2: Understand the elastic and plastic models for soils and their applicability and limitations.

CO3: Identify the advantages and disadvantages of different numerical techniques for a specific project, and discuss the advantages and disadvantages of each technique.

CO4: Use numerical methods in stage-by-stage analysis for earth structures, and estimate seepage, pore pressures, displacement, and factor of safety.

CO5: Create numerical models for Geotechnical problems and compute solutions including various foundation systems and retaining wall elements.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	L	-	-	-	-	-	-	-	-
CO2	H	H	M	L	-	-	-	-	-	-	-	-
CO3	H	H	M	M	L	-	-	-	-	-	-	-
CO4	H	H	H	M	H	-	-	-	-	-	-	-
CO5	H	H	H	M	M	-	-	-	-	-	-	-

Syllabus

Module 1: Introduction: Historical perspective- need for numerical models, early deformation and strength studies; Critical state theory, Stress paths within and on the state boundary surface, Shear strength of clays related to the critical state concept; Basic Concept of Continuum Mechanics- Notations; stresses and strains in three dimensions; equations of equilibrium, geometric conditions and constitutive relations.

Module 2: Modelling of Soil Behavior: Elastic models, Perfect plasticity models, Coulomb model, Drucker-prager model, Hardening plasticity models, Generalized stress-strain relations and stiffness formulations; Cap model in isotropic consolidation test and triaxial shear test; simulation of pore pressure, Case studies on implementing the models.

Module 3: Finite Element Modelling: Introduction to numerical methods - FEM, FDM, BEM; FEM for 1D and 2D problems; FEM for nonlinear problems.

Module 4: Application of Finite Element Modelling: Effective stress analysis, seepage and consolidation problems; practical aspects related to foundations, embankments and retaining structures; application examples-use of ABAQUS, PLAXIS, MIDAS_GTS programs etc.

Reference Books/Material

Text books:

1. Nonlinear analysis in Soil Mechanics: theory and Implementation, Chen W F, Mizuno E, Elsevier science publishers, 1990
2. Applied Analyses in Geotechnics, Azizi F, CRC Press, 2000
3. Elementary Finite Element Method, Desai C S, Prentice-Hall, 1979.

Reference books:

1. Finite Element in Plasticity: Theory and Practice, Owen D R J, Hinton E, Pineridge Press Limited, 1980
2. Applied Soil Mechanics with ABAQUS Applications, Helwany S, John Wiley and Sons, 2007.
3. The Finite Element Method in the Deformation and Consolidation of Porous Media, Lewis, R W, Schrefler B A, John Wiley and Sons, 1984
4. Computational Geomechanics with special reference to earthquake engineering, Zienkiewicz O C, Chan A H C, Paster M, Schrefler B A, Shiomi T, John Wiley and Sons, 1999.

Course Code	Course Name	L	T	P	Credits
CV557	Hydro Climatology	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To understand the fundamental concepts of Earth's climate system, radiation, temperature, and thermal variation, as well as their role in shaping the climate.
2. To comprehend the global water balance and factors influencing precipitation patterns, including humidity, vapor pressure, and monsoons.
3. To learn about different climate extremes such as floods, droughts, and heatwaves, and understand the steps in risk characterization and assessment.
4. To explore the causes of climate change, models used for predictions, and the role of organizations like IPCC in scenario development.
5. To study the statistical techniques such as trend analysis, principal component analysis, and regression for studying hydro-climatic data.

Course Outcomes

On completion of the course, students will be able to

CO1: Describe the key components of the climate system, explain radiation and temperature principles.

CO2: Explain the hydrologic cycle's significance, calculate global water balance components, and identify the impact of climate variables on precipitation.

CO3: Identify and characterize climate extremes, outline steps for risk assessment, and evaluate their implications on different regions.

CO4: Explain the factors driving climate change, differentiate between global and general circulation models, and interpret IPCC scenarios.

CO5: Apply trend analysis and statistical downscaling techniques to hydro-climatic data.

Relationship of Course Outcomes to Program Outcomes

H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	M	-	-	-	-	-	-	-	-
CO2	H	M	M	M	-	-	-	-	-	-	-	-
CO3	H	H	L	M	-	-	-	-	-	-	-	-
CO4	M	H	L	M	-	-	-	-	-	-	-	-
CO5	M	M	M	M	-	-	-	-	-	-	-	-

Syllabus

Module 1 Introduction to Hydro-Climatology: climate system; overview of earth's atmosphere; radiation and temperature; laws of radiation; random temperature variation; modelling vertical variation in air temperature; temperature change in soil; thermal time and temperature extremes.

Module 2: Hydrologic Cycle: introduction; global water balance; cycling of water on land, climate variables affecting precipitation, precipitation and weather, humidity, vapor pressure, forms of precipitation, monsoon; wind pattern in India; global wind circulation; Indian summer monsoon rainfall.

Module 3: Climate Variability: floods, droughts, drought indicators, heat waves, climate extremes. steps of risk characterization, risk assessment as a distributed process.

Module 4: Climate Change: introduction; causes of climate change; modeling of climate change, global climate models, general circulation models, downscaling; IPCC scenarios

Module 5 Statistical Methods in Hydro-Climatology: trend analysis; empirical orthogonal functions, principal component analysis; canonical correlation; statistical downscaling with regression, Use of models like GCM, RCM.

Reference Books/Material

Text books:

1. Campbell G S, Norman J M, An Introduction to Environmental Biophysics, Springer, 1998
2. Washington W M, Parkinson C L, An Introduction to Three-Dimensional Climate Modeling, Oxford University Press, 2005

Reference books:

1. Hydroclimatology: Perspectives and Applications, Shelton M L, Cambridge University Press, 2009
2. McGuffie K, Henderson-Sellers A, The Climate Modelling Primer, 4th edition, Wiley-Blackwell, 2014
3. IPCC, Fourth, fifth and sixth Assessment Report, Intergovernmental Panel on Climate Change

Course Code	Course Name	L	T	P	Credits
CV558	Green Building Design	3	0	0	3

Pre-requisites: Nil

Course Objectives

1. To create interest among students in green buildings and motivate them to acquire knowledge in this field.
2. To study IGBC rating system.
3. To gain basic knowledge of green buildings and related terminology
4. To study the Building Management Systems
5. To understand the policies towards electrical power in India

Course Outcomes

On completion of the course the students will be able to:

CO1: Understand the concepts of green building in various building types.

CO2: Know the IGBC rating systems

CO3: Apply the economics of green building

CO4: Understand the building management system

CO5: To known the different policies towards electrical power in India

Relationship of Course Outcomes to Program Outcomes H = High correlation; M = Medium correlation; L = Low correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	M	H	-	-	-	-	-	-	-	-
CO2	H	M	L	L	-	-	-	-	-	-	-	-
CO3	H	M	L	L	-	-	-	-	-	-	-	-
CO4	H	M	M	M	-	-	-	-	-	-	-	-
CO5	H	M	H	M	-	-	-	-	-	-	-	-

Syllabus

Module1: Introduction: Definition of green buildings, Terminologies, Objectives, Benefits, Rating systems of IGBC, Green concepts in various building types viz., Industrial, Residential, Commercial complexes, Educational institutes, Global trends in green buildings, Tangible and Intangible Benefits.

Module 2: IGBC Rating System: Introduction to rating systems, IGBC rating systems, Understanding of green building measures in the areas of Site Preservation, Energy Efficiency, Materials, Water conservation and Indoor air quality.

Module 3: Tools and Resources: Introduction to quantification and Design calculations, Energy simulation basics, Fundamentals of lighting simulation, Economics of building green

Module 4: Basic Knowledge of Materials, Systems and Technologies: Fundamentals of HVAC, Innovative cooling technologies, Lighting, Building Management Systems, Rain water harvesting, Water treatment and Recycling techniques, Building materials, Paints, Glass and Glazing, Insulation, Interiors, Landscaping.

Module 5: Incentives and Policies: Carbon trust, Carbon credit, Returns on investments, Savings, Policies towards electrical power in India. Tax credits, Grants

Reference Books/Material

Text books:

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

Reference Books

1. Sustainable Construction: Green Building Design and Delivery, Kibert C, John Wiley & Sons, 2005.
2. Energetics Perspective on the Environmental and Human Impact of Buildings, Soimosan T M, Moga L M, Business Science Reference, 2020.
3. Alternative Energy Systems in Building Design, Gevorkian P, McGraw-Hill Education, 2009.

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