REVISED SCHEME AND SYLLABUS

For

UNDERGRADUATE PROGRAMME

(Bachelor of Technology)

IN

CIVIL ENGINEERING

(EFFECTIVE FROM: 2023 BATCH)

DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGYSRINAGAR

HAZRATBAL, SRINAGAR, KASHMIR, J&K, INDIA – 190006

PROPOSED SCHEME OF COURSES FOR 1ST SEMESTER – 2023 ONWARDS

1st Semester (Group A)
Civil/ Mechanical/ Chemical/ Mett. & Mat Science

S. No	Course Code	Course Title	Department Offering	Credits	Contact Hours			
					L	T	P	Total
A16	CVT102	Engineering Drawing	Civil	3	1	0	4	5

PROPOSED SCHEME OF COURSES FOR 2ND SEMESTER – 2023 ONWARDS

2nd Semester (Group A)
Civil/ Mechanical/ Chemical/ Mett. & Mat Science

S. No	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
A26	CVT101	Engineering Mechanics	Civil	3	2	1	0	3

PROPOSED SCHEME OF COURSES FOR 3RD SEMESTER – 2023 ONWARDS

S. No.	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
1	CVT201	Structural Analysis-I	Civil Engg.	3	2	1	0	3
2	CVL201	Structural Analysis Lab.	Civil Engg.	1	0	0	2	2
3	CVT202	Fluid Mechanics	Civil Engg.	3	2	1	0	3
4	CVL202	Fluid Mechanics Lab-I	Civil Engg.	1	0	0	2	2
5	CVT203	Surveying-I	Civil Engg.	3	2	1	0	3
6	CVL203	Surveying Lab-I	Civil Engg.	1	0	0	2	2
7	MAT201	Mathematics-III	Mathematics	3	2	1	0	3
8	CVT204	Building Materials and Construction	Civil Engg.	3	2	1	0	3
9	HST202	Basics of Industrial Economics and Management	Humanities	3	2	1	0	3
			Total	**21**	**12**	**6**	**6**	**24**

PROPOSED SCHEME OF COURSES FOR 4TH SEMESTER – 2023 ONWARDS

S. No.	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
1	CVT251	Structural Analysis-II	Civil Engg.	3	2	1	0	3
2	CVT252	Fluid Flow in Pipes and Channels	Civil Engg.	3	2	1	0	3
3	CVL252	Fluid Mechanics Lab-II	Civil Engg.	1	0	0	2	2
4	CVT253	Surveying-II	Civil Engg.	3	2	1	0	3
5	CVL253	Surveying Lab-II	Civil Engg.	1	0	0	2	2
6	CVT254	Engineering Geology	Civil Engg.	3	2	1	0	3
7	CVL254	Geology Lab	Civil Engg.	1	0	0	2	2
8	CVT255	Civil Engineering Drawing	Civil Engg.	3	1	0	4	5
9	CVL255	Survey Camp	Civil Engg.	2	0	0	4	4
10	MAT256	Mathematics-IV	Mathematics	3	2	1	0	3
			Total	**23**	**11**	**5**	**14**	**30**

*2-Weeks Survey camp

PROPOSED SCHEME OF COURSES FOR 5TH SEMESTER – 2023 ONWARDS

S. No.	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
1	CVT301	Design of Reinforced Concrete Structures-I	Civil Engg.	3	2	1	0	3
2	CVL301	Concrete Lab	Civil Engg.	1	0	0	2	2
3	CVT302	Highway Engineering	Civil Engg.	3	2	1	0	3
4	CVL302	Highway Engineering Lab	Civil Engg.	1	0	0	2	2
5	CVT303	Geotechnical Engineering-I	Civil Engg.	3	2	1	0	3
6	CVL303	Geotechnical Lab-I	Civil Engg.	1	0	0	2	2
7	CVT304	Water Resources Engineering	Civil Engg.	3	2	1	0	3
8	CVT305	Quantity Surveying and cost Evaluation	Civil Engg.	3	2	1	0	3
9	HST301	Philosophy for Engineers: Society, Culture and Ethics	Humanities	3	2	1	0	3
		Total		**21**	**12**	**6**	**6**	**24**
10	CVT306-CVT308	*Honors Elective-I*		3	2	1	0	3

PROPOSED SCHEME OF COURSES FOR 6TH SEMESTER – 2023 ONWARDS

S. No.	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
1	CVT351	Design of Steel Structures	Civil Engg.	3	2	1	0	3
2	CVT352	Traffic Engineering	Civil Engg.	3	2	1	0	3
3	CVL352	Traffic Engineering Lab.	Civil Engg.	1	0	0	2	2
4	CVT353	Geotechnical Engineering-II	Civil Engg.	3	2	1	0	3
5	CVL353	Geotechnical Lab-II	Civil Engg.	1	0	0	2	2
6	CVT354	Environmental Engineering	Civil Engg.	3	2	1	0	3
7	CVL354	Water Quality Lab	Civil Engg.	1	0	0	2	2
8	CVT3501	Industrial Training and Presentation	Civil Engg.	1	0	0	0	0
9	CVT355-CVT358	Elective-I	Civil Engg.	3	2	1	0	3
10	CVT359-CVT362	Elective-II	Civil Engg.	3	2	1	0	3
		Total		**22**	**12**	**6**	**6**	**24**
11	CVT363-CVT365	*Honors Elective-II*		3	2	1	0	3

PROPOSED SCHEME OF COURSES FOR 7TH SEMESTER – 2023 ONWARDS

S. No.	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
1	CVT401-CVT403	Elective-III	Civil Engg.	3	2	1	0	3
2	CVT404-CVT406	Elective-IV	Civil Engg.	3	2	1	0	3
3	CVT407-CVT409	Elective-V	Civil Engg.	3	2	1	0	3
4	CVT410-CVT412	Elective-VI	Civil Engg.	3	2	1	0	3
5	CVS4001	Seminar	Civil Engg.	1	0	0	2	2
6	CVL4002	Pre-Project work	Civil Engg.	2	0	0	4	4
			Total	**15**	**8**	**4**	**6**	**18**
7	CVT413-CVT415	*Honors Elective-III*	Civil Engg.	3	2	1	0	3
8	CVT416-CVT418	*Honors Elective-IV*	Civil Engg.	3	2	1	0	3
9	CVT419-CVT421	*Honors Elective-V*	Civil Engg.	3	2	1	0	3

PROPOSED SCHEME OF COURSES FOR 8TH SEMESTER – 2023 ONWARDS

S. No.	Course Code	Course Title	Department Offering	Credit	Contact Hours			
					L	T	P	Total
1	CVT451-CVT454	Elective-VII	Civil Engg.	3	2	1	0	3
2	CVT455-CVT458	Elective-VIII	Civil Engg.	3	2	1	0	3
3	CVT459-CVT462	Elective-IX	Civil Engg.	3	2	1	0	3
4	CVL4501	Project	Civil Engg.	6	0	3	6	9
5	CVV4502	Professional Viva	Civil Engg.	1	-	-	-	-
			Total	**16**	**6**	**6**	**6**	**18**
5	CVT463-CVT466	*Honors Elective-VI*	Civil Engg.	3	2	1	0	3
6	CVT467-CVT470	*Honors Elective-VII*	Civil Engg.	2	2	0	0	2

Important Notes:

1. There are nine professional electives in the scheme and a student has to choose any seven elective courses from these. However, a student has the choice of taking two online courses of a minimum of 3 credits each from SWAYAM and/or NPTEL platforms from the list of online courses approved by the department.
2. The student has to take two open electives courses of 3 credits each as Institute-open electives from any department other than the parent department of the student.
3. A student has to earn a minimum of 160 credits for the award of B.Tech. Degree in Civil Engineering and a minimum of 180 credits for B. Tech. Degree with Honors in Civil Engineering.

Semester	Course Title	Course Code	Credit-L-T-P
1st	**Engineering Drawing**	**CVT102**	**3-1-0-4**
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To inculcate the ability to translate geometric and topological information of common engineering objects (two/three dimensional) into engineering drawings using standard graphical techniques.

Pre-requisites: None

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

CO No.	Course Outcomes
CO1	Know and understand the conventions and methods of engineering drawing. Interpret engineering drawings using fundamental technical mathematics.
CO2	Draw the projection of points, lines, planes, and solids. Introduce the concept of drawing in real-world applications.
CO3	Understand the intersection and development of surfaces and enhance the visualization skill of the objects.
CO4	To interpret Orthographic, Isometric, and Perspective views of objects.

Detailed Syllabus:

Unit	Course Contents	Hours
Unit 1	Types of projection, Concept of solid as 3-dimensional object, lines, and planes, first and third angle practices. Projections of simple geometrical solids, placed in simple positions with single rotation of the face, edge or axis of solid with respect to one of the principal planes of projection.	**25**
Unit 2	Section of simple geometrical solids, types of sectional planes, true shape of sections	**15**
Unit 3	Intersection of surfaces, simple case of intersection of two prisms, two cylinders, and cone and a cylinder Development of surfaces of simple sectional solids and intersecting solids	**15**
Unit 4	Isometric projections of given orthographic projections. Orthographic projections of simple blocks	**15**

Text book:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.

References:

1. Gopalakrishna K. R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
2. Shah M. B., and Rana B. C., "Engineering Drawing", Pearson, 2nd Edition, 2009.
3. Luzzader, Warren. J. and Duff, J. M., "Fundamentals of Engineering Drawing with an Introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Venugopal K. and Prabhu R. V., "Engineering Graphics", New Age International (P) Limited, 2008.
5. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2009.
6. Basant A. and Agarwal C. M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
7. Gowri S., and Jeyapoovan T., "Engineering Graphics" Vikas Publishing House (P) Limited, 2011.

Semester	Course Title	Course Code	Credit-L-T-P
2nd	Engineering Mechanics	CVT101	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: Develop an understanding of the fundamental concepts, theories, and principles of Engineering Mechanics for their applications in Solving Engineering Problems.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Utilize the fundamentals of Static Equilibrium and Stress-Strain Concepts to Solve Engineering Problems.	**3**
CO2	Analyze the Properties of Plane Surfaces and the Concept of Friction in Mechanical Problems.	**4**
CO3	Determination of Forces in Plane Trusses and Explain the Principle of Virtual Displacement.	**5**
CO4	Apply the Concept of Dynamics of Rigid Bodies and Energy Principles to Solve Engineering Problems.	**3**

Detailed Syllabus:

Unit	Contents	Contact Hours
01.	**Introduction to Engineering Mechanics:** Statics: Fundamental concepts and laws of mechanics. Equilibrium of bodies: Free-body diagrams, Statical determinacy. Force systems: Principle of Moments, Resultant of forces, Couple systems, Equilibrium of Rigid Bodies, Support reactions. Torque due to a force. **Concept of Stress and Strain:** Compatibility and Stress-Strain Relations. Stress-Strain diagrams, Hooke's law, Modulus of elasticity (E), Lateral strains, Poisson's ratio, Multi-axial stress system, Volumetric strain, Bulk modulus (K), Shear stress concept, Modulus of rigidity (G). Relation between E, G, and K.	18
02.	**Properties of plane surfaces:** Centroid and Center of Gravity, First moment of area, Second Moment of Area. **Friction**: General concept of Friction. Static and Dynamic Friction.	10
03.	**Plane Trusses:** Forces in members of a Truss by Method of Joints and Method of Sections. **Virtual Work:** Principle of Virtual Work, Calculation of Virtual Displacement and Virtual Work.	10
04.	**Dynamics of Rigid Bodies:** Newton's Laws, D'Alembert's Principle, Energy	4

Textbook:

1. Hibbeler, R.C., "Mechanics of Materials", 6th SI edition, Prentice Hall.
2. Hibbeler, R.C., Engineering Mechanics: Statics and Dynamics, Prentice Hall (2012).
3. Singer, F. L., Engineering Mechanics Statics & Dynamics, Prentice Hall.

References:

1. Beer, P.F. and Johnston (Jr.) E.R. "Mechanics of Materials", S.I. Version, Tata McGraw Hill, India, 2001.
2. Beer, Johnston, Clausen and Staab, Vector Mechanics for Engineers, Dynamics, McGraw-Hill Higher Education (2003)
3. Timoshenko and Young, Engineering Mechanics, Tata McGraw Hill Education Private Limited (2000).
4. Shames, I. H. Engineering Mechanics: Dynamics, Pearson Education India (2002).
5. Popov, E.P., Engineering Mechanics of Solids, Prentice-Hall, 1999.
6. Gere J.M. and Goodno, B. J., Strength of Materials, Cengage Learning.
7. Craig, R.R., "Mechanics of Materials", 2nd edition, John Wiley and Sons.

Semester	Course Title	Course Code	Credit-L-T-P
3rd	Structural Analysis –I	CVT201	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: Structural analysis-I introduces the fundamental principles and methods for analyzing the linear-elastic behavior of determinate structures under applied loads, including understanding and applications of static equilibrium, stability, free-body diagrams, internal forces, deflections, and basics of stresses and strains.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Comprehend and analyze different types of stresses and strains from a simple bending theory and evaluate resulting principal stresses and maximum shear stress in two-dimensional (2D) structures.	4
CO2	Evaluate and sketch various internal-force diagrams using static equilibrium and determine slopes and deflections of determinate beams using various methods.	5
CO3	Articulate and apply the theory of pure torsion to the analysis of circular shafts; and fundamentals of column-buckling theory for analysis of the columns to evaluate their critical buckling loads under various end conditions.	3
CO4	Evaluate internal forces in beams and frames using approximate analysis methods and then compare the results with those obtained from a software tool.	5

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	2	1	1	2	1	-	-	1	2	1	1	2	2
CO2	3	3	2	1	1	2	1	-	-	1	2	1	2	2	2
CO3	2	3	2	1	1	2	1	-	-	-	1	1	1	2	3
CO4	2	2	1	1	3	1	1	-	2	2	2	2	3	3	2

1-Slightly; 2-Moderately; 3-Substantially.

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Review of Basic Concepts of Stress and Strain:** Hooke's law; Poisson's ratio; Stress-strain diagram of ductile and brittle materials; Elastic limit; Modulus of elastiCVTy; Bulk Modulus: **Determinate Beam Statics:** Support reactions, concepts of redundancy, free body diagrams, and equilibrium equations. Sketching of axial force, shear force, and bending moment diagrams for concentrated, uniformly distributed, linearly varying load, concentrated moments in simply supported beams, cantilever, and overhanging beams.	**12**

Module 2	**Symmetric Beam Bending:** Simple theory of bending, bending and shear stress for regular sections, shear center. **Two-Dimensional Stress Problems:** Principal stresses, maximum shear stresses, Mohr's circle of stresses, construction of Mohr's circle, applications.	**12**
Module 3	**Torsion Theory:** Pure torsion, torsion of the circular solid shaft and hollow shafts, torsional equation, torsional rigidity. **Column Buckling Theory:** Fundamentals, column buckling theory, Euler's load for columns with different end conditions, limitations of Euler's theory – problems.	**10**
Module 4	**Approximate Methods for Structural Analysis:** Portal and cantilever methods for the analysis of 2D frames. **Introduction to Software Tool:** Modeling continuous beams and frames in a simple software tool, performing analysis, and comparing results with approximate analysis.	**08**
Total		**42**

Books Recommended:

1. Hibbler, R.C., 2018. *Mechanics of Materials,* 9th Ed. Pearson.
2. Hibber, R.C., 2018. *Structural Analysis*, 10th Ed. Pearson.
3. Aslam, K., 2020. *Structural Analysis*, 5th Ed. Cengage.
4. West, H. H., 2002. Fundamentals of Structural Analysis, 2nd. Wiley.
5. Beer, P. F., Johnston (Jr.), E. R., Dewolf, J. T., and Mazurek, D. F., 2014. *Mechanics of Materials*, 7th Ed. McGraw-Hill.
6. Jindal, R. L., Kaul, B.K., 1980. *Elementary Theory of Structures*, 3rd Ed. S. Chand and Company Ltd.

Semester	Course Title	Course Code	Credit-L-T-P
3rd	Structural Analysis Laboratory	CVL201	1-0-0-2
Evaluation Policy		**Internal Assessment**	**End-Term**
		60 Marks	40 Marks

Course objective: Demonstrate the behavior of structural elements, systems, and building materials under different loading conditions, and provide the test results using standard testing procedures and specifications of Indian standards/codes.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Examine and evaluate the mechanical properties of various building materials under different loadings.	3
CO2	Identify the experimental behavior and failure modes of structural elements and systems under applied loadings.	4
CO3	Verify the fundamental behavior of cantilever beams, portal frame, arch and columns under respective applied loadings and compare test results with classical theoretical solutions.	6
CO4	Examine detailed testing procedures and specimen design outlined in Indian standards for testing of various engineering building materials.	3

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	3	3	1	3	1	-	1	1	2	1	2	2	2
CO2	3	2	3	1	1	2	1	-	-	1	1	1	2	2	2
CO3	3	2	3	1	1	2	1	-	-	-	1	1	2	2	2
CO4	2	1	3	3	1	3	1	-	2	1	2	1	3	2	2

1-Slightly; 2-Moderately; 3-Substantially.

Detailed Syllabus:

Exp. No.	Name of Experiment	Contents	Hours
1	Tensile testing of steel	Determine the yield strength, ultimate tensile strength, percentage of elongation, and modulus of elasticity for steel specimens (rebar and structural steel coupons).	**4**
2	Tensile and compressive strength testing of Timber	Determine the tensile and compressive strengths of the timber specimens. Identify parallel and perpendicular strengths to grain.	**2**
3	Shear testing of steel.	Determine the ultimate shear strength and modulus of rigidity (shear modulus) of steel specimens.	**2**

4	Compressive testing of brick and stones	Determine the compressive strength of brick and stone specimens.	**4**
5	Deflection of curved beams.	Determine the deflection of curved beams: (i) circular, (ii) semi-circular, (iii) quarter circle beams.	**2**
6	The behavior of portal frame	Illustrate the behavior of the portal frame under different loads	**2**
7	Deflection of truss joint.	Illustrate the behavior of truss deflection and determine the deflection of the truss joint under an applied load.	**2**
8	Flexural behavior of cantilever beam	Demonstrate the flexural behavior of a cantilever beam under symmetrical and un-symmetrical loading.	**2**
9	Verification of Maxwell's theorem.	Verify Maxwell's reciprocal theorem using measured deflections at two points on a simple beam.	**2**
10	Analysis of two hinged arch.	Evaluate the horizontal thrust in a two-hinged arch using a test setup.	**2**
11	Buckling load of columns for various end conditions.	Determine the buckling load of columns for different end conditions and compare them with theoretical Euler-buckling values.	**2**
		Total	**26**

Books / IS Standards Recommended:

1. Hibbler, R.C., 2018. *Mechanics of Materials,* 9th Ed. Pearson.

IS Standards:

Note: The revised /reaffirmed or new standards on the date of lab class may be adopted, if any.

2. IS 1608 – Metallic Materials - Tensile Testing
    a. Part 1: 2018 – Method of Test at Room Temperature
3. IS 1786: 2008 – High Strength Deformed Steel Bars and Wires for Concrete Reinforcement – Specification
4. IS 1708 – Methods of Testing Small Clear Specimens of Timber
    a. Part 11: 1986 – Determination of Shear Strength Parallel to Grain
    b. Part 12: 1986 – Determination of Tensile Strength Parallel to Grain
    c. Part 13: 1986 – Determination of Tensile Strength Perpendicular to Grain
5. IS 2408: 1963 – Methods of Static Tests of Timbers in Structural Sizes
6. IS 5242: 1979 – Method of Test for Determining Shear Strength of Metals
7. IS 800: 2007 – General Construction in Steel – Code of Practice
8. IS 1077: 1992 – Common Burnt Clay Building Bricks – Specification
9. IS 13757: 1993 – Burnt Clay Fly Ash Building Bricks – Specification

10. IS 3495 – Burnt Clay Building Bricks - Methods of Tests
    a. Part 1: 2019 – Determination of Compressive Strength
11. IS 1121 – Determination of Strength Properties of Natural Building Stones - Methods of Test
    a. Part 1: 2013 – Compressive Strength.

Semester	Course Title	Course Code	Credit-L-T-P
3rd	Fluid Mechanics	CVT202	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: This course explores the fundamentals of fluid mechanics, from fluid properties to flow dynamics. Students will learn key concepts like fluid statics, kinematics, and momentum equations and apply them to analyze flow in various scenarios. The course also covers dimensional analysis, model analysis, and boundary layer theory, providing a foundation for advanced fluid mechanics studies.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Develop an understanding of various fluid properties, Pascal's law, and pressure intensity.	3
CO2	Categorize and understand the kinematics of fluid flow and Energy equation and its applications.	4
CO3	Analyze the Momentum equation and its applications, make use of Dimensional analysis in fluid mechanics.	4
CO4	Explain the Importance of boundary layer theory concept and its applications in fluid flow analysis.	5

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	1	1	-	2	1	-	-	-	-	2	3	3	-
CO2	3	2	3	3	-	2	2	-	-	-	-	2	3	3	-
CO3	3	3	3	2	-	2	1	-	-	-	-	2	3	3	-
CO4	3	3	2	3	-	2	2	-	-	-	-	-	3	3	-

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**INTRODUCTION:** Physical properties of fluids viz, mass density, viscosity, compressibility, vapour pressure, surface tension, capillarity, etc. Ideal Fluids and Real Fluids; Newtonian and Non-Newtonian Fluids. **FLUID STATICS:** Pressure Intensity, Pascal's law; Pressure- density-height relationships, manometers; pressure on the plane and curved surfaces, the centre of pressure; Buoyancy, Stability of immersed and floating bodies.	**14**
Module 2	**KINEMATICS OF FLUID FLOW:** Types of flow; Streamlines, and path lines; Continuity equation; Rotation and Elementary explanation of stream function and velocity Graphical and Experimental methods of drawing flow nets.	**12**

	DYNAMICS OF FLUID FLOW: Euler's equation of motion along a streamline and its integration to yield Bernoulli's equation; Flow measurement, flow through orifice meter, Venturi meter, orifices, mouthpieces, pitot and Prandtl tubes, sluice gates under free and submerged conditions, Various types of Notches and weirs under free and submerged flow conditions, Aeration of the nape.	
Module 3	**MOMENTUM EQUATION:** Momentum equation and its application to stationary and moving vanes, pipe bends. **DIMENSIONAL ANALYSIS AND HYDRAULIC SIMILITUDE:** Dimensional analysis, Reyleigh's method, Buckingham's theorem, Important dimensionless numbers and their significance, Geometric, Kinematic, and dynamic similarity; Model analysis.	**10**
Module 4	**BOUNDARY LAYER ANALYSIS:** Boundary layer over a flat plate, Boundary layer parameters, Laminar sub-layer, Laminar and Turbulent boundary layers, local and Average friction coefficients, separation.	**6**
Total		**42**

Books Recommended:

1. Kumar, D.S. "Fluid Mechanics and Fluid Power Engineering". Seventh Ed. S.K. Kataria& Sons Publishers, New Delhi,2008-2009.
2. Garde R.J "Engineering Fluid Mechanics",1988.
3. Kumar, K.L. "Engg. Fluid Mechanics", Eurasia Publishing House (P) Ltd. New Delhi, 1984.
4. Streter, V.L., Wylie, E.B. and Bedford, K.W. "Fluid Mechanics" McGraw Hill, New York, 2001.
5. Asawa, GL, Fluid Flow in Pipes & Cannels 2008? CBS Publishers, new Delhi, 2000.
6. Mohanty "Fluid Mechanics"Printice Hall of India second Ed.,2010.
7. Jain A.K. "Fluid Mechanics including Hydraulic Machines", Khanna Publisher
8. Bansal, R.K. (2018) A text book of Fluid Mechanics and Hydraulic Machines, Laxmi Publications.
9. Cimbala, J.M., Cengel, Y. A. (2019) Fluid Mechanics: Fundamentals and Applications, McGraw-Hill; Fourth edition

Semester	Course Title	Course Code	Credit-L-T-P
3rd	Fluid Mechanics Lab-I	CVL202	1-0-0-2
Evaluation Policy	**Continuous Assessment**		**End-Term**
	60		40

Course objective: To immerse students in the practical aspects of fluid mechanics, bridging theoretical concepts with real-world applications through engaging experiments. Students will explore fluid behavior, stability, and dynamic flow characteristics, gaining hands-on experience that enhances their analytical and problem-solving skills in fluid mechanics.

Pre-requisites: None.

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

CO No.	Course Outcomes	BTL
CO1	Analyze the hydrostatic law, buoyancy, and stability of a floating body and the application of mass, momentum, and energy equation	4
CO2	Evaluate the flow equations used for the analysis of fluid motion.	5
CO3	Evaluate the coefficient of discharge, coefficient of veloCVTy, and coefficient of contraction of fluid flow and its applications	5
CO4	Examine the fundamental equations related to flow through weirs and verifying momentum equation	4

Course articulation matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PS03
1	3	2	2	2	3	-	-	-	-	-	-	-	3	3	-
2	3	2	2	2	3	-	-	-	-	-	-	-	3	3	-
3	3	2	2	3	3	-	-	-	-	-	-	-	3	3	-
4	3	2	3	3	3	-	-	-	-	-	-	-	3	3	-

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Experiment No.	Contents (Experiment Name)	Hours
1	To determine experimentally the metacentric height of a ship model.	4
2	To verify Bernoulli's equation experimentally	4
3	To determine the coefficient of discharge, coefficient of veloCVTy, and coefficient of contraction of an orifice or a mouthpiece of a given shape.	4
4	To calibrate an orifice meter and to study the variation of coefficient of discharge with Reynold's number.	4
5	To calibrate a venture meter and to study the variation of coefficient of discharge with Reynold's Number	4
6	To calibrate sharp-crested rectangular and triangular weirs.	4
7	To verify the momentum equation experimentally	4
	Total	**28**

Books Recommended:

1. Bireswar, M. (2015). Fluid Mechanics with Laboratory Manual, PHI Learning Pvt Ltd; 2nd edition
2. Kumar, D.S. “Fluid Mechanics and Fluid Power Engineering”. Seventh Ed. S.K. Kataria & Sons Publishers, New Delhi, 2008-2009.
3. Jain, A.K. “Fluid Mechanics including Hydraulic Machines”, Khanna Publisher

Semester	Course Title	Course Code	Credit-L-T-P
3rd	Surveying I	CVT203	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: This course aims to provide conceptual knowledge about basic principles of field surveying procedures and practices for civil engineering applications.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Apply the fundamental surveying principles for vertical, horizontal, linear, and angular measurements and to solve the basic surveying problems	3
CO2	Apply the basic principles of linear/angular measurements in methods like compass surveying and basic knowledge in plotting the plan of an area using plane table surveying	3
CO3	Analyze the elevation data collected through levelling in order to establish the relative heights of various field objects	4
CO4	Estimate the area and volume of the earthwork required for a new construction	5

Course articulation matrix

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

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction:** Basics of surveying: Introduction, concept of Geoids and reference spheroids, coordinate systems, plane and geodetic surveys, errors in measurements, surveying instruments, maps, scales and uses, topographic maps, map layout. **Distance measurements:** Direct and indirect methods, Chain and tape measurements and corrections, Optical methods- tacheometers, sub tense bar, electronic methods- EDMs.	**10**
Module 2	**Prismatic compass surveying**: Instruments; Principle, Procedure, and precautions; closed traverse; corrections; local attraction; plotting. **Plane Table Surveying:** Field equipment, Methods of plane tabling, Two-point and Three-point problem, Precautions, Accuracy	**12**

Module 3	**Levelling:** Methods of height determination, Field book recording, classification and permissible closing error; profile leveling and cross-sectioning, reciprocal levelling Contours- characteristics, uses and methods of contouring.	**10**
Module 4	**Earthwork:** Area of a traverse, determining area from plans, area of X-section, volume from X section, corrections, mass haul diagram	**10**
Total		**42**

Books Recommended:

1. Punmia, B.C., 2014. *Surveying Vol. I & II*. Laxmi Publications.
2. Arora, K.R., 2020. *Surveying Vols. I & II*. Standard Book House.
3. Duggal, S.K., 2022. *Surveying Vols. I & II*. McGraw Hill India.
4. Basak, N.N., 2020. *Surveying & Levelling*. McGraw Hill Education.
5. Kanetkar, T.P. and Kulkarni, S.V., 2015. *Surveying & Levelling Vols. I & II*. Vidyarthi Griha Prakashan.
6. Chandra, A.M., 2015. *Plane Surveying*. New Age International.
7. Anderson, J.M. and Mikhail, E.M., 2001. *Surveying: Theory and Practice*. McGraw-Hill Education.

Semester	Course Title	Course Code	Credit-L-T-P
3rd	Surveying Lab-I	CVL203	1-0-0-2
Evaluation Policy	**Internal Assessment**	**External Assessment**	
	60 Marks	40 Marks	

Course objective: To provide skills for using surveying equipment ordinarily employed in surveying practice

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Apply the fundamental surveying principles for vertical, horizontal, linear, and angular measurements	3
CO2	Apply field and office survey procedures using a prismatic compass and plane table equipment to complete simple, but meaningful, civil engineering mapping problems	3
CO3	Analyze the reduced levels using various methods of levelling and contouring to establish the relative heights of various field objects	4
CO4	Estimate the volume of earthwork required for new road construction by plotting longitudinal and cross sections of existing roads	5

Course articulation matrix

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

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction:** Importance, Principles of Surveying. Types of Surveying, Introduction to different equipment **Linear Measurement by Tape/Chain:** Study of chains and its accessories, Aligning, Ranging, Chaining and Marking Perpendicular offset, Foundation marking using tapes single Room and Double Room	**10**
Module 2	**Prismatic Compass Surveying:** Using surveyors and prismatic compass, Measurement of bearings of sides of traverse with prismatic compass and computation of correct included angle. **Plane Table Surveying:** Plane table equipment and its temporary adjustments, plotting a plane table traverse using method of radiation and intersection, and traversing, Two point and three-point problem	**12**

Module 3	**Levelling:** Methods of height determination, Field book recording, classification and permissible closing error; profile leveling and cross sectioning, reciprocal levelling Contours- characteristics, uses and methods of contouring.	**10**
Module 4	**Earthwork:** Volume of cutting and filling of earth using level, mass haul diagram	**10**
Total		**42**

Books Recommended:

1. Basak, N.N., 2018. *Surveying and Levelling: Lab Manual*. McGraw Hill Education.
2. Duggal, S.K., 2013. *Surveying Lab Manual*. McGraw Hill Education.
3. Gopi, S., 2009. *Global Positioning System: Principles and Applications*. Tata McGraw Hill Education.
4. Kanetkar, T.P. and Kulkarni, S.V., 2004. *Surveying and Levelling: Part I Lab Manual*. Vidyarthi Griha Prakashan.
5. Punmia, B.C., Jain, A.K. and Jain, A.K., 2005. *Surveying Practice and Theory*. Laxmi Publications.
6. Subramanian, R., 2012. *Surveying and Levelling Lab Manual*. Oxford University Press.

Semester	Course Title	Course Code	Credit-L-T-P
3rd	Mathematics -III (Integral Transforms, Probability & Statistics)	MAT201	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: The main objective of the course is to equip the students with the mathematical tools and concepts needed to analyze and solve a variety of engineering problems. The emphasis is on practical applications and problem-solving techniques relevant to civil engineering problems.

Pre-requisites: A student should have basic knowledge of calculus.

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

CO No.	Course Outcome	BTL
CO1	Solve Laplace transform and Fourier transform of various functions.	3
CO2	Apply Fourier Transform to solve ordinary and partial differential equations.	3
CO3	Evaluate various engineering problems by the concepts of statistics.	5
CO4	Apply the concepts of probability and statistics to various engineering problems.	3

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	Basics of Laplace transform and its properties. Unit Impulse function, Dirac-delta function and its Laplace transform, Heaviside's expansion theorem. Definition of Fourier transform, Fourier Integral Theorem, Properties of Fourier transform: Linearity, Shifting property, Modulation theorem, Fourier sine and cosine.	**10**
Module 2	Inverse Fourier transform, Convolution Theorem and properties of Convolution. Parseval's Identity for Fourier transform, Solution of Integral equations, Evaluation of definite integrals using Fourier transform, Applications of Fourier transforms to Ordinary and Partial differential equations.	**10**
Module 3	Introduction to basic Statistics, moments, correlation, regression, methods of least square, curve fitting (polynomials, exponentials).	**8**

Module 4	Basic definitions of probability, conditional probability with standard results, Bays theorem with examples. Random variable, Probability density function, Mode and median of distribution of a random variable, Probability distribution function and its properties, Mathematical expectation, Laws of expectation, Mean, Variance, Moments, Moment generating function. Binomial, Poisson and normal Distributions, Chi-square Distribution and their applications	**14**

Recommended Books:

1. L. Debnath and D. Bhatta, *Integral Transforms and their Applications*,2nd Edition, CRC press, (2007).
2. Murray R. Spiegel, *Schaum's OutlineSeries,s Laplace Transforms*, Tata Mc-Graw Hill Edition, (2005).
3. R.K Jain and S.R.K Iyengar, *Advanced Engineering Mathematics*, 3rd Edition, Narosa Pub. House, (2008).
4. Sheldon M. Ross, *Introduction to Probability and Statistics for Engineers and Scientists*,4th Edition, Elsevier. Academic Press (2017).

Semester	Course Title	Course Code	Credit-L-T-P
3rd	Building Materials and Construction	CVT204	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: At the end of this course the students should have learnt about the various materials, both conventional and modern, that are commonly used in civil engineering construction.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Develop knowledge of various building materials used in construction.	3
CO2	Provide procedural knowledge of the testing methods of materials and adopt suitable methods to enhance the durability of buildings.	3
CO3	Understand the properties and role of ingredients like cement, aggregate etc. to produce better-quality concrete	4
CO4	Understand the behavior of concrete and apply design mix to produce concrete with adequate strength	4

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	2	2	2	-	2	-	-	-	-	2	3	3	-
CO2	3	3	3	3	2	2	2	-	-	-	-	2	3	3	-
CO3	3	3	3	3	2	-	2	-	-	-	-	2	3	3	-
CO4	3	3	3	3	2	2	2	-	-	-	-	2	3	3	2

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
1	**Stone as building material;** Requirement of good building stones. **Bricks;** Classification, Manufacturing of clay bricks, Requirement of good bricks. Field and laboratory tests on Stones and Bricks; **Cement Concrete blocks;** Autoclaved Aerated Concrete Blocks. Timber as construction material.	4
2	**Lime–Cement–Aggregates-Mortar:** Cement – chemical composition, Manufacturing process, Types and Grades, Properties of cement and Cement mortar, Hydration. **Fine aggregate:** Natural and manufactured: Sieve analysis, zoning, specify gravity, bulking, moisture content, deleterious materials.	6

Module No.	Contents	Hours
	Coarse aggregate: Natural and manufactured: Importance of size, shape and texture. Grading of aggregates, Sieve analysis, specific gravity, Flakiness and elongation index, crushing, impact and abrasion tests.	
3	Definition and terms used in masonry **Stone masonry:** Joints in stone masonry. Types of walls; load bearing, partition walls, cavity walls. **Brick masonry:** Header, Stretcher, English, Flemish bond. Cavity wall: components and construction, **Arches:** Terminology and classifications Doors and Windows: Types, materials used	8
4	**Foundation:** Preliminary investigation of soil, safe bearing capacity of soil, Function and requirements of good foundation, types of foundation introduction to spread, combined, strap, mat and pile foundation **Floors;** Requirement of good floor, Components of ground floor, Selection of flooring material Procedure for laying of Concrete (VDF), Mosaic, Kota, Slate, Marble, Granite, Tile flooring, Cladding of tiles. **Roof**: Requirement of good roof, Types of roof, Elements of a pitched roof, Trussed roof, King post Truss, Queen Post Truss, Steel Truss, Different roofing materials, R.C.C. Roof.	8
5	**Ventilation:** Doors, Windows and Ventilators: Location of doors and windows, technical terms, Materials for doors and windows: PVC, CPVC and Aluminum. Types of Doors and Windows: Paneled, Flush, Collapsible, Rolling shutter, Paneled and glazed Window, Bay Window, French window. Steel windows, Ventilators. Sizes as per IS recommendations.	8
6	**Finishing:** Services and Special constructions Wall Finishes: Plastering, pointing, distempering and painting: Purpose, methods, defects and their solutions. **Vertical communication**: Stairs: Terminology, requirements of good staircase, classification; ramps, lifts and escalators. **Damp proofing:** causes, effects, prevention and treatments **Formwork:** Introduction to formwork, scaffolding, shoring, underpinning. **Fire resistant construction:** Fire resistant properties of common building materials, requirements for various building components.	8
	Total	42

Books Recommended: Textbooks:

1. Rangwala, 2022 “Building Constructions”.
2. P. Purushothamaraj, 2016, “Building Construction Materials and Techniques”.

References:

1. S.K.Duggal , 2019, “Building Materials”.

Semester	Course Title	Course Code	Credit-L-T-P
3rd	Basics of Industrial Economics and Management	HST202	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objectives: The core objectives of the course are to:

1. To introduce the economic concepts
2. To familiarise the students with the importance of economic approaches in managerial decision-making and to understand the applications of economic theories in business decisions
3. To provide an understanding of basic concepts, principles and practices of management
4. To inculcate the ability to apply multifunctional approaches to organisational objectives.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Identify the process and role of various concepts related to industrial development and management.	
CO2	Examine the fundamental characteristics of demand analysis and operation of various market forms in devising the price and output decisions	
CO3	Appraise the various key concepts and functions of management for efficient organisational operations.	
CO4	Evaluate the role of functions of management such as Communication, controlling and coordinating in different managerial operations	

Course Contents:

Unit – I

General Foundations of Managerial Economics - Economic Approach - Circular Flow of Activity - Nature of the Firm - Objectives of Firms - Demand Analysis and Estimation - Individual, Market and Firm demand - Determinants of demand - Elasticity measures and Business Decision Making - Demand Forecasting.

Unit-II

Product Markets -Determination Under Different Markets - Market Structure – Perfect Competition – Monopoly – Monopolistic Competition – Duopoly - Oligopoly - Pricing and Employment of Inputs Under Different Market Structures.

Unit-III

Definition, Functions, Process, Scope and Significance of Management. Nature of Management, Planning and Organizing Nature, Scope, Objective and Significance of Planning, Elements and Steps of Planning, Span of Control, Line and Staff Relationship, Authority, Delegation and Decentralization. Effective Organizing, Organizational Structures, Formal and Informal Organizations

Unit-IV

Directing Effective Directing, Supervision, Motivation, Concept of Leadership- Theories and Styles. Communication Process, Channels and Barriers, Effective Communication, Controlling and Coordinating- Elements of Managerial Control, Control Systems, Management Control Techniques, Effective Control Systems. Coordination Concept, Importance, Principles and Techniques of Coordination.

Suggested Readings:

1. H.L. Ahuja: "*Managerial Economics*", S. Chand & Company Ltd.
2. Mithani D M: ' *'Managerial Economics*", Himalaya Publishing House.
3. Koontz, H. and Donnel C., *Essentials of Management*, Tata McGraw Hill.
4. Kumar, Rao, Chhalill: *Introduction to Management Science*, Cengage Publications.
5. Koushil P: "*Managerial Economics*", Cengage Learning.
6. Agarwal V: "*Managerial Economics*", Pearson.
7. Bhattacharyya DK *Principles of Management-Text and Cases*, Pearson.
8. Tripathi P.C: *Principles of Management*, Tata McGraw Hill.

Semester	Course Title	Course Code	Credit-L-T-P
4th	Structural Analysis – II	CVT251	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: Structural Analysis-II introduces the fundamental principles and methods for analyzing the linear-elastic behavior of indeterminate structures under applied loads, including applications of strain energy, classical force and displacement-base methods.

Pre-requisites: CVL 201 Structural Analysis-I

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

CO No.	Course Outcomes	BTL
CO1	Classify and differentiate beams, 2D-truss, and frames following degrees of static and kinematic indeterminacy and stability.	4
CO2	Analyze basic structures using strain energy concepts to determine their slopes and deflections under applied loadings.	4
CO3	Formulate and apply classical force-based methods for the analysis of indeterminate structures.	5
CO4	Formulate and apply classical displacement-based methods for the analysis of indeterminate beams and 2D frames, and compare results obtained from a software tool.	5

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	2	2	1	1	1	-	-	1	2	1	1	2	2
CO2	3	3	2	1	1	1	1	-	-	1	2	1	2	2	2
CO3	3	3	2	2	2	1	1	-	-	-	1	1	3	3	3
CO4	3	3	2	2	3	2	1	-	2	2	2	2	3	3	3

1-Slightly; 2-Moderately; 3-Substantially.

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Review of Basic Concepts:** Equilibrium, stability, indeterminacy (static and kinematic); classify beams, trusses and 2D frames using stability and indeterminacy. **Determination of deflections and slopes:** Strain energy and strain energy density – strain energy due to axial load (gradual, sudden and impact loadings), shear, flexure and torsion. Castigliano's theorems, Maxwell's reciprocal theorem , Principle of virtual work , unit load method - application of energy theorems for computing deflections in truss, deflection and slopes in determinate beams, plane frames. Lack of fit and temperature effects included.	**12**

Module 2	**Force-based Methods of Structural Analysis:** Method of least work; method of consistent deformation for analysis of indeterminate beams; continuous beams, trusses, two-hinged arches, etc. Clepryon's Three-Moment Equation.	**12**
Module 3	**Displacement-based Methods of Structural Analysis:** Analysis of indeterminate beams & frames (with & without sway) by classical displacement methods viz.; slope deflection method, Kani's method & moment distribution method.	**12**
Module 4	**Introduction to Software Tool:** Modeling continuous beams and frames in a simple software tool, performing analysis, and comparing results with classical analysis methods.	**06**
Total		**42**

Books Recommended:

1. Aslam, K., 2020. *Structural Analysis*, 5th Ed. Cengage.
2. Leet, K.M., Uang, C.M., Lanning J., 2017. *Fundamentals of Structural Analysis*, 5th Ed. McGraw Hill.
3. Wang, C. K, 1983 . *Intermediate Structural Analysis*, 1st Ed. McGraw Hill.
4. West, H. H., 2002. *Fundamentals of Structural Analysis*, 2nd. Wiley.
5. Hibber, R.C., 2018. *Structural Analysis*, 10th Ed. Pearson.
6. Jindal, R. L., Kaul, B.K., 1980. *Elementary Theory of Structures*, 3rd Ed. S. Chand and Company Ltd.
7. Reddy, C. S., 2017. *Basic Structural Analysis*, 3rd Ed. McGraw Hill.

Semester	Course Title	Course Code	Credit-L-T-P
4th	Fluid Flow in Pipes and Channels	CVT252	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26	24	50

Course objective: This course delves into the complexities of fluid flow in pipes and open channels, covering concepts like uniform and varied flow, energy losses, and hydraulic jumps. Students will learn to analyze flow in complex pipe systems and understand phenomena like water hammer. The course also covers the principles and applications of hydraulic machines such as turbines and pumps.

Pre-requisites: None.

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

CO No.	Course Outcomes	BTL
CO1	Explain open channel flows, Determine water surface profiles, hydraulic jump characteristics.	5
CO2	Analyze the performance of pipe flow problems involving turbulent flow, the concept of friction factor, head loss, design of pipes, pipe networks, and determine drag and lift forces on submerged bodies.	4
CO3	Determine water hammer phenomenon in closed conduits and design of surge tanks.	5
CO4	Discuss hydraulic machines viz., pumps and turbines.	6

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	1	1	-	1	1	-	-	-	-	3	3	-	3
CO2	3	3	3	3	-	2	2	-	-	2	-	3	3	2	3
CO3	3	2	2	2	-	2	1	-	-	-	-	3	3	2	3
CO4	3	3	2	3	2	2	2	-	-	2	-	3	3	-	3

1-Slightly; 2-Moderately; 3-Substantially;

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**FLOW IN OPEN CHANNELS:** Uniform flow, Critical depth, Normal depth, Specific energy, Resistance formulae, gradually varied flow equations, Classification of water surface profiles, Computation of water surface profiles, step-by-step method and graphical integration method. Hydraulic Jump, Momentum Principle for open channels, Evaluation of the jump elements. Venturi flumes.	**14**
Module 2	**FLOW THROUGH PIPES:** Nature of turbulent flow in pipes, Hydraulic and energy grade lines. Equation for velocity distribution over smooth and rough pipes, Resistance coefficient and its variation, Nikuradse	**14**

	experiments, Moody diagram, Flow in sudden expansion, Contraction, diffusers, Bends, Valves, and Siphons; Concept of equivalent length, branched pipes, pipes in series and parallels, Simple networks, Transmission of power. **FLUID FLOW PAST SUBMERGED BODIES:** Drag and lift, Drag on a sphere, cylinder and disc: Lift, Magnus effect, and Circulation	
Module 3	**WATER HAMMER AND SURGE TANKS:** Sequence of events after sudden value closure, pressure diagrams, Gradual closure or opening of the valve, Instantaneous closure of valve in a rigid pipe, Instantaneous closure of valve in an Elastic pipe and Compressible fluid, Methods of Analysis; Surge Tanks, Location of Surge Tanks, Types, Design of surge Tanks	**6**
Module 4	**HYDRAULIC MACHINES:** Types of Turbines, Description and principles of Impulse and reaction Turbines, Unit quantities and specific speed, Runaway speed, Turbine characteristics, Selection of Turbines, Cavitation; Draft Tube, Draft Tube dimensions, Types of draft tubes; Governing of Turbines; Centrifugal pumps, specific speed, power requirements, Reciprocating pumps.	**8**
Total		**42**

Books Recommended:

1. Kumar, D.S. "Fluid Mechanics and Fluid Power Engineering". Seventh Ed. S.K. Kataria& Sons Publishers, New Delhi,2008-2009.
2. K. Subramanaya "Open channel Flow" 3rd.Tata McGraw Hill Pub. Co. New Delhi, 1999
3. Asawa, GL "Fluid Flow in Pipes and Channels" CBS publishers and distributors pvt ltd
4. RangaRaju, K.G., "Flow Through Open Channels", 2nd.Tata McGraw Hill Publishing Company Ltd., New Delhi,1986.
5. Nigam "Handbook of Hydroelectric Engg.", 2001.
6. Garde R.J "Engg. Engineering Fluid Mechanics", 1988.
7. Deshmukh, M.M, " Water PowerEngineering"DanpatRai&Sons,NaiSarak New Delhi, 1978. 7.

Semester	Course Title	Course Code	Credit-L-T-P
4th	Fluid Mechanics Lab-II	CVL252	1-0-0-2
Evaluation Policy	**Continuous Assessment**		**End-Term**
	60		40

Course objective: To provide students with comprehensive practical insights into fluid mechanics, focusing on key concepts such as flow resistance, pipe energy losses, and hydraulic roughness in open-channel flows. Students will develop skills to analyse head distributions in vortices, examine hydraulic jump characteristics, and evaluate energy and momentum correction factors in flumes.

Pre-requisites: None.

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

CO No.	Course Outcomes	BTL
CO1	Develop a practical understanding of flow resistance in pipes, consequent energy losses, and hydraulic roughness in free-surface flows.	3
CO2	Determine head distribution in surface profiles of free and forced vortices.	5
CO3	Examine various characteristics of the hydraulic jump	4
CO4	Evaluate energy and momentum correction factors and assess velocity contours in a flume	5

Course articulation matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PS03
1	3	2	2	3	3	-	-	-	-	-	-	-	3	3	-
2	3	2	2	2	3	-	-	-	-	-	-	-	3	3	-
3	3	2	3	3	3	-	-	-	-	-	-	-	3	3	-
4	3	3	3	3	3	-	-	-	-	-	-	-	3	3	-

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Experiment No.	Contents	Hours
1	To find friction factors for pipes of different materials.	**4**
2	To determine the minor head loss coefficient for different pipe fittings.	**4**
3	To determine the surface profile and total head distribution of a free vortex.	**4**
4	To determine the surface profile and total head distribution of a forced vortex.	**4**
5	To determine the elements of a hydraulic jump in a rectangular channel.	**4**
6	To determine Manning's rugosity coefficient of a laboratory flume.	**4**
7	To obtain the velocity distribution for an open channel and to determine the values of α, β, and n.	**4**
Total		**28**

Books Recommended:

1. Bireswar, M. (2015). Fluid Mechanics with Laboratory Manual, PHI Learning Pvt Ltd; 2nd edition
2. Kumar, D.S. “Fluid Mechanics and Fluid Power Engineering”. Seventh Ed. S.K. Kataria & Sons Publishers, New Delhi, 2008-2009.
3. Jain, A.K. “Fluid Mechanics including Hydraulic Machines”, Khanna Publisher

Semester	Course Title	Course Code	Credit-L-T-P
4th	Surveying- II	CVT253	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: This course aims to develop an understanding of the basic principles of conventional and advanced methods of surveying

Pre-requisites: Basic knowledge on the principles of surveying

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

CO No.	Course Outcomes	BTL
CO1	Apply the concept of Theodolite and Tacheometry for surveying in difficult and hilly areas	3
CO2	Apply the concepts of trigonometrical levelling and estimate and control the accumulation of errors in different surveying projects	3
CO3	Examine the site and perform setting out of buildings, bridges, tunnels, etc. and ability to analyze and interpret data from geodetic methods of survey like triangulation	4
CO4	Adapt to advanced surveying equipment like Total Station, and GPS by understanding it's working principles	3

Course articulation matrix

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

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Theodolite:** Vernier theodolite; Temporary and permanent adjustments; Measurement of horizontal and vertical angles; Methods of repetition and reiteration; errors in theodolite surveying; elimination of errors; Area and volume computation; area from latitude and departure; Simpson's rule and Trapezoidal rule **Tacheometry:** Principles; Methods- Stadia system, Fixed and Movable hair methods, Methods with staff held vertical and normal; Analytic lens; Subtense bar; Tangential method	**12**
Module 2	**Trigonometrical levelling:** Observations for heights and distances; Geodetic observations; Corrections for refraction, curvature, axis signal; Reciprocal observations.	**10**

	Theory of Errors: Errors – Types of errors – Theory of least squares – weighted observations – most probable value – computations of indirectly observed quantities – method of normal equations – conditioned quantities, method of correlates, method of differences.	
Module 3	**Setting out works:** Setting out Buildings, Culverts and bridges, Tunnels. Transfer of alignment. Fixing of horizontal and vertical controls. **Geodetic surveying:** Triangulation-principles: choice of stations, Base line measurements, Triangulation adjustments-Heights-figure adjustments; Spherical excess, Computations of sides of spherical triangles.	**10**
Module 4	**Advanced Survey Equipment:** Electromagnetic distance measurement (EDM); Principle; Types; Total station: parts, working with total station; Introduction to: Photogrammetry; Terrestrial and Aerial photographs; Photo interpretation; Stereoscopy; Remote Sensing; GPS	**10**
Total		**42**

Books Recommended:

1. Duggal, S.K., 2023. *Surveying Vols. I & II*. McGraw Hill India.
2. Punmia, B.C., 2015. *Surveying Vol. I & II*. Laxmi Publications.
3. Arora, K.R., 2021. *Surveying Vols. I & II*. Standard Book House.
4. Basak, N.N., 2018. *Surveying & Levelling*. McGraw Hill Education.
5. Kanetkar, T.P. and Kulkarni, S.V., 2010. *Surveying & Levelling Vols. I & II*. Vidyarthi Griha Prakashan.
6. Gopi, S., 2010. *Advanced Surveying: Total Station, GIS and Remote Sensing*. Pearson Education India.

Semester	Course Title	Course Code	Credit-L-T-P
4th	Surveying Lab- II	CVL253	1-0-0-2
Evaluation Policy	**Internal Assessment**	**External Assessment**	
	60 Marks	40 Marks	

Course objective: To provide skills for using conventional and advanced surveying equipment

Pre-requisites: Basic knowledge of the principles of surveying

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

CO No.	Course Outcomes	BTL
CO1	Apply the principles of theodolite surveying to measure the horizontal and vertical angles	3
CO2	Relate the fundamental principles and theoretical knowledge on surveying while performing trigonometric levelling	4
CO3	Apply the principles of tacheometry to locate the details of various objects on the field	3
CO4	Practice to perform traversing using Total Station	3

Course articulation matrix

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

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Theodolite Surveying:** Study of different parts of ordinary theodolite and its temporary adjustments, Measurement of horizontal angle using theodolite by repetition and reiteration method, Measurement of vertical angle using theodolite, plotting a closed traverse using theodolite	**10**
Module 2	**Trigonometric levelling:** Introduction to trigonometric levelling, finding elevation of distant objects using trigonometric levelling	**12**
Module 3	**Tacheometric Surveying**: Introduction to tachometer, graduated staff and its temporary adjustments, Determination of K and C constants of tachometer, Location of details by tacheometric methods	**10**
Module 4	**Total Station:** Study of total station and its applications, Determine the area using total station, Traversing	**10**
Total		**42**

Books Recommended:

1. Bannister, A., Raymond, S. and Baker, R., 1998. *Surveying*. 7th ed. Pearson Education.
2. Basak, N.N., 2018. *Surveying and Levelling: Lab Manual*. McGraw Hill Education.
3. Chandra, A.M., 2005. *Higher Surveying*. New Age International.
4. Duggal, S.K., 2013. *Surveying Lab Manual*. McGraw Hill Education.
5. Ghilani, C.D. and Wolf, P.R., 2017. *Elementary Surveying: An Introduction to Geomatics*. 14th ed. Pearson.
6. Gopi, S., 2007. *Advanced Surveying: Total Station, GIS and Remote Sensing*. Pearson Education.
7. Kanetkar, T.P. and Kulkarni, S.V., 2004. *Surveying and Levelling: Part I Lab Manual*. Vidyarthi Griha Prakashan.
8. Leick, A., Rapoport, L. and Tatarnikov, D., 2015. *GPS Satellite Surveying*. 4th ed. John Wiley & Sons.
9. Punmia, B.C., Jain, A.K. and Jain, A.K., 2005. *Surveying Practice and Theory*. Laxmi Publications.
10. Subramanian, R., 2012. *Surveying and Levelling Lab Manual*. Oxford University Press

Semester	Course Title	Course Code	Credit-L-T-P
4th	Engineering Geology	CVT254	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To impart the basic understanding of the formation of rocks and to expose the students to the basic erosional and depositional processes.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	undersatnd the dynamic nature of earth, the associated surface and subsurface processes and determine the efefct of geology in civil engineering projects.	6
CO2	to stablish link between rock mechanics, geology and hydrogeology.	3
CO3	classify the rock metrial and asses the various engineering properties of earth's materials.	6
CO4	Assess in-situ character of rocks in quarries/ outcrops, road cuttings, dams, tunnels and underground excavations.	6

Course articulation matrix

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

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	Physical Geology; geology and its relevance to civil engineering, geological work of wind, rivers, glaciers and seas	**6**
Module 2	Petrology; formation of rocks, types/field classification, weathering of rocks, origin of soils	**6**
Module 3	Structural Geology; folds, faults, joints, unconformities.	**4**
Module 4	Engineering Geology; geological considerations in tunnels, dams, bridges, building sites; landslides	**6**
Module 5	Earthquakes; basic definitions, types and causes, distribution in the world, seismic zones.	**6**
Total		**28**

Books Recommended:

1. Bangar, K.M, Principles of Engineering Geology Standard Publishers Distributors, New Delhi.
2. Parbin Singh Engineering Geology, Katson Publishers New Delhi.
3. Billings, M.P., Structural Geology, Prentice-Hall India, New Delhi.
4. Blyth, F.G.H and de Freitas, M.H. Geology for Engineers, ELBS, London.
5. Gokhale, KVG.K and Rao, D.M., Experiments in Engineering Geology, Tata- McGraw Hill, New Delhi.
6. Kesavulu, C. Textbook of Engineering Geology, Macmillan, India Ltd. New Delhi.
7. Geology for Civil Engineers by McLean and Gribble, Spon Press, Taylor &Francis Group, London.
8. Building Materials by Parbin Singh, Katson Publishers New Delhi.
9. Civil Engineering Material by Gurbachan Singh, Standard Publishers New Delhi.
10. Building Material by Dutta.
11. Building Materials by Duggal S. K., New Age International (P) Ltd. Publishers, New Delhi

Semester	Course Title	Course Code	Credit-L-T-P
4th	Geology Lab	CVL254	1-0-0-2
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
		60 Marks	40 Marks

Course objective: To impart the basic understanding rocks behaviour at different scales, under various loading conditions at ground surface and in the subsurface. The link between rock mechanics, geology and tectonics (i.e., the conditions under which seismicity will occur) will be clearly established. The student shall understand the various engineering properties of earth's materials along with a general comprehension of stress-strain regime in the earth's lithosphere principles and the ability to operate both basic and advanced surveying equipment.
Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	To determine the physical properties of minerals	3
CO2	To develop an understanding of rock characteristics.	3
CO3	To develop an understanding of different geological structures.	5
CO4	To use the determined properties for design of civil engineering projects	5

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	1	1	-	3	2	-	-	-	3	-	-	-	2	2	-
CO2	1	-	-	3	2	-	-	-	3	-	-	-	2	2	-
CO3	1	-	-	3	2	-	-	-	3	-	-	-	2	2	-
CO4	2	1	3	2	2	-	1	-	3	-	-	2	2	2	-

Detailed Syllabus:

Experiment No.	Contents	Hours
1	The study of physical properties of minerals. identification of minerals.	**4**
2	Determination of specific gravity by: a) Jolly's spring balance b) Walkers steel yard balance	**3**
3	Study of rocks and their characteristics and identification.	**3**
4	Study and sketching of various types of geological structures	**6**
5	Determination of dip and strike with a clinometer compass.	**2**
6	Geological cross sections and study of geological maps.	**4**
Total		**22**

Semester	Course Title	Course Code	Credit-L-T-P
4th	Civil Engineering Drawing	CVT255	3-1-0-4
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To develop the knowledge and skills of designing and developing 2D plans as well as 3D modelling in civil engineering drawing.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Make use of building codes and principles of planning.	3
CO2	Develop two-dimensional drawings to demonstrate spatial visualization skills.	3
CO3	Evaluate the technical drawings appropriate for civil engineering applications and modify them as necessary.	5
CO4	Adapt computer applications to design and draw civil engineering projects and develop 3-dimensional models of civil engineering structures.	6

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	1	-	2	-	2	1	1	3	2	3	2	3	3	1	3
CO2	1	1	2	-	2	-	-	-	1	3	1	2	3	2	2
CO3	2	2	3	-	3	1	-	-	1	3	1	1	3	2	3
CO4	3	3	3	-	3	3	-	-	3	3	1	3	3	3	3

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
1	**Basic principles of planning and design in buildings:** Building by-laws. National Building Code.	**04**
2	**Plans:** Spatial plans. Line diagram. Development of building plans using standard specifications.	**06**
3	**Building elements** – Doors, Windows, Staircase, Footings, Beams, Columns, Slabs	**06**
4	**Elevations & Sectional plans:** Substructure and superstructure. Building components, Joinery, fixtures (Electrical & Plumbing), Fittings and Finishes	**08**
5	**2D Modelling** - Introduction of AutoCAD, working on basic commands & toolbars, Drawing basic shapes and figures	**10**
6	**3D Modelling** - Introduction of Autodesk Revit, working with basic commands & toolbars, Modelling of various 3D figures	**8**

Total	42

Books Recommended:

1. Bhavikatti, S.S., and Chitawadagi, M.V., 2019. Building Planning and Drawing. Wiley Publication.
2. Kale C.M., Shah, M.G and Patki S.Y., 2017. Building Drawing. McGraw-Hill Inc.
3. Sharma S.K., 1960. A Textbook of Building Construction. S Chand Publishing.
4. Autodesk AutoCAD and Autodesk REVIT Manuals.

Semester	Course Title	Course Code	Credit-L-T-P
4th	Survey Camp	CVL255	2-0-0-4
Evaluation Policy	**Field Performance**	**Survey Camp report**	**External viva**
	40 Marks	30 Marks	30 Marks

Course objective: To gain practical experience in utilizing advanced surveying techniques and equipment, conducting accurate measurements, and analyzing spatial data in field settings
Pre-requisites: Proficiency in fundamental surveying principles and the ability to operate both basic and advanced surveying equipment
Course Outcomes: At the end of the course, the student will be able to:

CO No.	Course Outcomes	BTL
CO1	Apply survey equipment like theodolites, levels, Total Stations, and tools for precise distance and angle measurements in surveys	3
CO2	Apply fly levelling techniques to ensure accurate elevation measurements for campus roads, and interpret level data to create contour maps depicting terrain features and slopes	3
CO3	Evaluate longitudinal and cross-sectional survey data of campus roads to inform road design, and analyze cutting and filling calculations to optimize earthwork volumes for construction	5
CO4	Develop and execute precise setting out of building plans, integrating advanced skills in processing survey data with AutoCAD or GIS to produce comprehensive maps and reports	6

Course articulation matrix

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

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Experiments	Contents	Days
Set 1	**Introduction to Survey Equipment:** Familiarization with theodolites, levels, Total Stations, and other survey instruments for distance and angle measurements	**1**
Set 2	**Fly Levelling for Campus Roads:** Using automatic levels or digital levels to measure precise elevations along the length of campus roads. This ensures proper grading and drainage. **Contouring:** Mapping elevation contours using level data to depict terrain features and slopes.	**3**

Set 3	**Longitudinal and Cross-Section Surveys of Campus Roads:** Measure and plot profiles and cross-sections of campus roads to understand elevations, gradients, and road geometries. **Cutting and Filling Analysis:** Calculate and analyze the volume of earthwork required for road construction or modifications based on the longitudinal and cross-section survey data	**3**
Set 4	**Setting Out Building Plan:** Mark points and dimensions on the ground for construction projects based on architectural drawings of buildings **Field Data Processing and Report Preparation:** Process and analyze survey data using software like AutoCAD or GIS to create detailed maps and reports summarizing the findings and recommendations from the surveying exercises	**5**
Total		**12**

Books Recommended:

1. Ghilani, C.D. and Wolf, P.R., 2017. *Elementary Surveying: An Introduction to Geomatics.* 15th ed. Boston: Pearson.
2. Anderson, J.M. and Mikhail, E.M., 1998. *Surveying: Theory and Practice.* New York: McGraw-Hill Education.
3. Roy, S.K., 2009. *Fundamentals of Surveying.* 3rd ed. New Delhi: Prentice-Hall of India.
4. Leick, A., Rapoport, L., and Tatarnikov, D., 2015. *GPS Satellite Surveying.* 4th ed. Hoboken: Wiley.
5. Bhatta, B., 2010. *Remote Sensing and GIS.* New Delhi: Oxford University Press.
6. Punmia, B.C., 2011. *Total Station and Its Applications in Surveying.* New Delhi: Laxmi Publications.
7. Bolstad, P., 2017. *GIS Fundamentals: A First Text on Geographic Information Systems.* 5th ed. Redlands: Esri Press.
8. Punmia, B.C., 2014. *Surveying Volume 1 and 2.* New Delhi: Laxmi Publications.
9. Schofield, W., 2007. *Engineering Surveying.* 6th ed. Amsterdam: Butterworth-Heinemann.
10. Uren, J. and Price, W.F., 2010. *Surveying for Engineers.* 5th ed. London: Macmillan Education.

Semester	Course Title	Course Code	Credit-L-T-P
4th	**Mathematics-IV (Numerical Methods)**	**MAT256**	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: The objective of this course is to provide the students with a strong foundation in numerical methods and their applications, preparing them to tackle complex engineering challenges efficiently and effectively.

Pre-requisites: A student should have basic knowledge of calculus.

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

CO No.	Course Outcomes	BTL
CO1	Evaluate algebraic and transcendental equations by numerical solutions	5
CO2	Solve the problems related to inverse by various numerical methods.	3
CO3	Apply how to approximate the functions using interpolating polynomials and finding intermediate values.	3
CO4	Apply numerical techniques for solving ordinary differential equations.	3

Detailed Syllabus:

Module No.	Contents	Hours
1	Numerical Solution of Algebraic and Transcendental equations. Graphic Method, Regula-Falsi Method, Balzano's Bisection Method, Newton Raphson Method, Iteration method and its geometrical significance.	**10**
2	Gauss elimination method, Gauss-Jordan method, Computation of Inverse by Gauss's Method, LU decomposition, Gauss Siedel iteration method, Jacobi method, The Eigen value problem.	**10**
3	Interpolation Forward, Backward and Shift operators, Central differences, their relations, Existence, Uniqueness of interpolating polynomial, error of interpolation - unequally spaced data; Lagrange's formula, Newton's divided difference formula. Equally spaced data : finite difference operators and their properties, Newton's forward and backward interpolation formulae, Gauss's forward and backward.	**12**
4	Numerical solution of ordinary differential equations: Picard's method, Taylor's series methods, Euler's method, Runge-Kutta method.	**10**

Recommended Books:

1. M.K. Jain, S. R. Iyengar& R.K. Jain, *Numerical Methods for Scientists and Engineering,* 7th Edition, Wiley Eastern Ltd New age international publishers, (2019).
2. S.S. Sastry, *Introductory methods in Numerical Analysis*, 5th Edition, Prentice Hall India learning Pvt Ltd, ISBN: 9788120345928, 9788120345928.

3. Kendall E. Atkinson, Han, *Elementary Numerical Analysis*, 3rd Edition, Wiley India Pvt Ltd, (2006).
4. J.B. Scarborough, *Mathematical Numerical Analysis*, 6th Edition, Oxford and IBH Publishers, (2020).
5. Steven C. Chapra and Raymond P. Canale, Numerical Methods for engineering, 7th Edition, Tata Mc-Graw Hill Education, (2015).

Semester	Course Title	Course Code	Credit-L-T-P
5th	Design of Reinforced Concrete Structures	CVT301	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To equip students with a basic understanding of the behaviour of reinforced concrete (RC) structures and to develop the skill to analyse and design reinforced concrete members.
Pre-requisites: Structural Analysis

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

CO No.	Course Outcomes	BTL
CO1	Appraise reinforced concrete as a construction material and understand various design philosophies.	5
CO2	Analyze and design RC members under flexure, shear, and axial force in line with Indian standards.	5
CO3	Design the two-way RC slabs using moment coefficients	5
CO4	Interpret the design of structural elements by a software tool.	6

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	3	2	-	-	1	-	-	-	-	2	3	3	-
CO2	3	3	3	3	1	-	1	-	-	-	-	2	3	3	-
CO3	3	3	3	3	1	-	1	-	-	-	-	2	3	3	-
CO4	3	3	3	3	3	-	1	-	-	-	-	2	3	3	2

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**General Material Properties:** Properties of concrete & reinforcing steel, characteristic strength, stress-strain curves, shrinkage & creep phenomenon.	4
Module 2	**Basic Design Philosophies:** Working stress, ultimate load & limit state method of design.	2
Module 3	**Design & Analysis of Flexural Members:** Design of singly and doubly reinforced sections: rectangular sections & T sections; codal provisions. The behaviour of beam in shear & bond, design for shear, anchorage & slipping of reinforcement. Detailing of reinforcement as per codal provisions (IS 456: 2000). Serviceability limit state of deflection and cracking. Calculation of deflection, codal requirements.	16
Module 4	**Design & Analysis of Columns:** Design of columns: short columns, eccentrically loaded columns using interaction curves.	8
Module 5	**Design & Analysis of Solid Slabs:** Design of one-way and two-way slabs with and without corners held down. Introduction to design by moment coefficients.	6

Module 6	**Introduction to Design Software:** Modelling of structural elements (beam, column, slab, and entire building system). Bending moment – shear – axial force diagram, deflection profile.	6
Total		**42**

Textbooks:

1. Pillai, S. U., and Menon, D. "**Reinforced Concrete Design**" Tata McGraw Hill.
2. Raju, N. K. "**Design of Reinforced Concrete Structures: IS:456-2000**", CBS Publishers & Distributors Pvt. Ltd.
3. Subramanian, N. "**Design of Reinforced Concrete Structures**", Oxford University Press.

References:

1. Kong, F. K., and Evans, R. H. "**Reinforced and Pre-stressed Concrete**", CRC Press.
2. Mosley, B., Bungey, T., and Hulse, R. "**Reinforced Concrete Design to Eurocode 2**", Palgrave Macmillan.
3. Wight, J. K., and Macgregor, J. G. "**Reinforced Concrete: Mechanics and Design**", Pearson Prentice Hall.

Semester	Course Title	Course Code	Credit-L-T-P
5th	Concrete Lab.	**CVL301**	1-0-0-2
Evaluation Policy	Internal Examination	External Examination	**Total**
	60 Marks	40 Marks	100 Marks

Course objective: The objective of this course is to know the properties of fresh and hardened concrete and also to determine the higher structural properties of RCC members.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	To know the properties of fresh concrete.	3
CO2	To understand the behaviour and properties of hardened concrete.	4
CO3	To measure the bond strength between concrete and reinforcement.	4
CO4	To determine the structural behaviour and ultimate strength of RCC members are subjected to various loading conditions.	5

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	-	-	-	-	-	2	-	-	-	-	3	3	-
CO2	3	3	3	3	2	-	2	2	-	-	-	2	3	3	-
CO3	3	3	3	3	2	-	2	2	-	-	-	2	3	3	-
CO4	3	3	3	3	2	-	2	2	-	-	-	2	3	3	3

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

S No	Name of Experiment	Objective	Hours
1	Compressive Strength Test of Cement Mortar	To determine the compressive strength of cement mortar cubes.	2
2	Workability Test on Cement Concrete	To determine the workability of the fresh cement concrete using (i) Slump Cone Test, & (ii) Compaction Factor Test.	2
3	Compressive Strength Test of Cement Concrete	To determine the compressive strength of the cement concrete cube.	2
4	Tensile Strength Test of Cement Concrete	To determine the tensile strength of the cement concrete cylinder.	2
5	Flexural Strength Test of Cement Concrete	To determine the flexural strength of the cement concrete beam.	2
6	Determination of Bond Strength	To determine the bond strength between cement concrete and (i) mild steel plain reinforcement, & (ii) Tor steel/cold twisted reinforcement.	2
7	Ultimate Flexural Strength of RCC Beam	To determine the ultimate flexural strength of (i) under-reinforced, & (ii) over-reinforced RCC beams.	2
8	Ultimate Shear Strength	To determine the ultimate shear strength of the cement	2

S No	Name of Experiment	Objective	Hours
	of RCC Beam	concrete beam.	
9	Ultimate Axial Strength of RCC Column	To determine the ultimate axial strength of the cement concrete column.	2
		Total	18

Indian Standards:

Note: The revised /reaffirmed or new standards on the date of lab class may be adopted, if any.

1. IS 4031 – Methods of Physical Tests for Hydraulic Cement
   a. Part 6: 1988 – Determination of Compressive Strength of Hydraulic Cement (Other than Masonry Cement)
2. IS 269: 2015 – Ordinary Portland Cement – Specification
3. IS 1199 – Fresh Concrete – Methods of Sampling, Testing and Analysis
   a. Part 2: 2018 – Determination of Consistency of Fresh Concrete
4. IS 516 – Hardened Concrete – Methods of Test
   a. Part 1 – Testing of Strength of Hardened Concrete
      - Section 1: 2021 – Compressive, Flexural and Split Tensile Strength
5. IS 2770 – Methods of Testing – Bond in Reinforced Concrete
   a. Part 1: 1967 – Pull-Out Test
6. IS 456: 2000 – Plain and Reinforced Concrete - Code of Practice
7. SP 24: 1983 – Explanatory Handbook on Indian Standard Code of Practice for Plain and Reinforced Concrete (IS 456:1978).

Semester	Course Title	Course Code	Credit-L-T-P
5th	Highway Engineering	CVT302	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To equip students with the understanding and ability to apply the principles of highway geometric design, including the design of horizontal and vertical alignments, to ensure safe and efficient road transportation systems.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Illustrate the development of roads and road alignment, including comparison with other modes of transportation.	3
CO2	Analyze the appropriate cross-sections and sight distances considering geometric design principles for urban and rural roads for safety and economic aspects.	4
CO3	Design of Alignment and Geometrics of roads considering safety and vehicle dynamics. Design of bituminous and concrete mixes suitable for specific road applications.	5
CO4	Evaluate the properties and suitability of stone aggregates and bitumen materials for roads by conducting a wide range of tests as per standards.	6

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	1	1	-	1	2	-	-	-	-	-	-	1	1	1
CO2	1	3	1	2	2	2	1	-	-	-	-	-	2	2	1
CO3	1	-	-	3	2	-	1	-	3	-	-	2	3	2	2
CO4	-	2	3	2	2	1	1	-	-	-	-	-	3	3	2

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction:** Scope, Road transportation, comparison with other modes of transportation, Road Development around the world, Road development plans of India, Road pattern, Classification of roads, Present status of roads in India, Road alignment, Engineering survey, Alignment requirements and controlling factors.	7

Module 2	**Highway Geometric Design:** Design controls and criteria, Typical cross-section of roads, Various cross-section elements- Pavement surface characteristics, Width of carriage-way, Camber, Medians, Kerb, Road Margins, Width of formation, Right of way, Sight Distance-Stopping sight distance, Passing sight distance, Headlight sight distance, Sight distance at uncontrolled intersection. Design of Horizontal alignment- Horizontal alignment, Superelevation, Extra widening, Horizontal transition curve, Design of horizontal transition curve, Set back distance, Curve resistance, Design of Vertical alignment- Vertical alignment, Gradient, Grade compensation, Vertical curve, Design of vertical summit curve, Design of vertical valley curve.	16
Module 3	**Pavement Design:** Pavement types and comparison, Function of various pavement components, Factors affecting pavement design, Flexible pavement design- Stresses in flexible pavement, Design methods-GI method, CBR, Triaxial method, McLeod method, Burmeister's method, IRC method, Rigid pavement design- stresses in rigid pavement, Combination of stresses, Westergaard's approach, Joints in rigid pavements, design of dowel & tie bars.	12
Module 4	**Highway Materials:** Properties of Aggregate, Test on Aggregates – Gradation test, Impact test, crushing test, Abrasion Test, Shape test, Soundness test, Specific gravity and Water absorption test, Stripping value test. Properties of bitumen Materials, Test on Bitumen- Penetration test, Ductility test, Softening point test, Specific gravity test, Flash and Fire point test, Viscosity test, Test on Bituminous mix-Marshall stability test.	7
Total		**42**

1. References:

1. Khanna, S.K. and Justo, C.E.G. 2002. "Highway Engineering". Nem Chand Brothers, Roorkee.
2. L.R.Kadiyali & N.B.Lal, 2005 "Principles & Practices of Highway Engg, Khanna Publishers",.
3. Bhanot, K.L.1990. "Highway Engineering", S. Chand and Company (P) Ltd., New Delhi.
4. Rao, G.V. 1996. "Principles of Transportation and Highway Engineering", Tata McGraw Hill, New Delhi.
5. M. W. Witczak E. J. Yoder., 2008, "Principles of Pavement Design", Wiley, 2nd edition, India Pvt. Ltd.-New Delhi.
6. Ralph Haas, 1996, "Pavement Design and Management Guide", Ottawa, Ontario, Edn. University of Waterloo.
7. IRC:37-2018, "Guidelines for the Design of Flexible Pavements", IRC new Delhi
8. IRC:58-2021, "Guidelines for Design of Plain Jointed Rigid Pavements for highway", IRC new Delhi.

Semester	Course Title	Course Code	Credit-L-T-P
5th	Highway Engineering Lab	CVL302	1-0-0-2
Evaluation Policy	**Internal Assessment**		**End-Term**
	60 Marks		40 Marks

Course Objective: Develop the skills to classify and analyze aggregate and bitumen properties using various testing methods to ensure their suitability for road construction applications.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Make use of the sieve analysis method to classify the particle size distribution of aggregates.	3
CO2	Analyse aggregate properties to check their suitability for road construction.	4
CO3	Design and develop a bituminous mix and conduct the Marshall stability test to ensure the stability and flow values of the mix meet the required standards.	5
CO4	Assess bitumen properties by various tests for effective road construction.	6

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	1	1	-	3	2	-	-	-	3	-	-	-	1	-	-
CO2	1	-	-	3	2	-	-	-	3	-	-	-	2	1	-
CO3	1	-	-	3	2	-	-	-	3	-	-	-	2	1	-
CO4	-	1	3	2	2	-	1	-	3	-	-	-	2	2	1

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

S. No.	Name of Experiment	Objective of Experiment	Lecture Hours (28)
I	**Test on Aggregates**		**12**
1	Gradation Test	To classify and analyse the particle size distribution of a given sample of aggregates.	2
2	Impact Test	To determine the impact value of a given sample of aggregates	2
3	Crushing Test	To determine the crushing value of a given sample of aggregates	2
4	Los Angeles Abrasion Test	To determine the abrasion value of a given sample of aggregates	2
5	Specific gravity and water	To determine the specific gravity and water absorption of a given sample of aggregates	2

	absorption test		
6	Shape test	To determine the Flakiness and Elongation index of a given sample of aggregates.	2
II	**Test on Bitumen**		**12**
7	Penetration test	To determine the penetration value of a given sample of bitumen.	2
8	Ductility test	To determine the ductility of a given sample of bitumen.	2
9	Softening point test	To determine the softening point of a given bitumen sample.	2
10	Flash and Fire point test	To determine the flash and fire point of a given sample of bitumen.	2
11	Specific gravity test	To determine the specific gravity of a given sample of bitumen.	2
12	Viscosity test	To determine the viscosity of a given sample of bitumen.	2
III	**Test on Bituminous Mix**		**4**
13	Stripping Test	To determine the stripping value of a given sample of bituminous mix.	2
14	Marshall Stability test and Mix Design	To design bituminous mix and determine the Marshall stability and flow values of bituminous mix.	2
Total			**28**

References:

1. Khanna, S.K. and Justo, C.E.G. 2002. “Highway Engineering”. Nem Chand Brothers, Roorkee.
2. L.R.Kadiyali & N.B.Lal, 2005 “Principles & Practices of Highway Engg, Khanna Publishers”,.
3. Bhanot, K.L.1990. “Highway Engineering”, S. Chand and Company (P) Ltd., New Delhi.
4. IS: 2386-1963, Indian Standard Methods of Test for Aggregate for Concrete, Indian Standards Institution.
5. Morth, ministry of road transport and Highways, 2013, “Specification for Road Bridge works”, Fifth Rivision, IRC new Delhi.
6. IS:6241-1971, Method of test for determination of stripping value of road aggregate, Indian Standards Institution.
7. IS:73-2006, Indian Standard Paving Bitumen — Specification.
8. Relevant IRC Codes/Specifications

Semester	Course Title	Course Code	Credit-L-T-P
5th	Geotechnical Engineering-I	CVT303	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To develop analytical and experimental skills for determining engineering properties of soils and solving problems involving stresses in soil masses and seepage through soils.

Pre-requisites: None

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

CO No.	Course Outcomes	BLT
CO1	Analyze phase relationships in soils. Solve problems related to soil classification and the phase systems	5
CO2	Analyze flow through soils and, solve practice problems related to permeability, and seepage including flow net diagram.	5
CO3	Analyze stress distribution in soils, soil compressibility and solve practice problems related to soil compaction and consolidation under any system of foundation loads	5
CO4	Analyze the importance of soil investigation for any civil engineering construction and utilize various methods of soil investigation in the field and laboratory.	5

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	3	-
CO2	3	3	3	3	2	-	2	-	-	-	-	2	3	3	-
CO3	3	3	3	3	2	-	2	-	-	-	-	2	3	3	-
CO4	3	3	3	3	2	-	2	-	-	-	-	2	3	3	-

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

S. No.	Course Contents	Hours
1	**Introduction:** Introduction to Geotechnical Engineering. Origin and formation of soils & Rocks, Weathering of Rocks & Soildeposits, Types of Soil Deposits, Clay and Clay Mineralogy, Types of clay minerals, Structure of Clay Minerals, Physical and Geochemical Properties of Clays and Clay Minerals, Role of Soils in Engineering, Problems in Soil Engineering, Application of properties of soils	06
	Solids-Water-Air Relationships, Index Properties of Soils, and Classification of Soils: Soil as a Three/Two Phase Soil System- Phase	

2	Diagrams and Weight-Volume Relationships, Description & Evaluation of Index Properties of soils, Engineering Soil Classification systems	06
3	**Determination of Compaction Characteristics**: Need for soil compaction, Compaction Mechanism, Influencing factors, Proctor theory of compaction, Compaction tests, Compaction curve & parameters, Zero-air-void or saturation curve,Properties of compacted soils, Field compaction, and field compaction control.	04
4	**Principles of Effective Stress, Capillarity, and Permeability:** Total and effective stresses, pore water pressure, Different forms of water flow through soils, Hydraulic heads, Pore water pressure, Capillarity, Darcy's law, Permeability ofsoils, factors influencing permeability, Lab & field methods of determination ofpermeability, Permeability of stratified soil deposits. Seepage & Flow Nets, Laplace equation for steady-state flow, Seepage force, Quicksand & Critical Gradient, Construction of flow nets and their typical applications, Flow nets for homogeneous embankments/dams with and without toe filters, Concrete dams without & with sheet-pile at U/S, D/S, or at both locations. *Application of FEA commercial software Geo5, GeoStudio*	08
5	**Stress Distribution:** Concept of stresses & Strains in soils,Settlement, Soil Modulus for Soils under application of stresses, Stress distribution under concentrated load. Boussineq's method, Westergard's method, and Burmister's Approach.	04
6	**Compressibility of Soil and Consolidation:** Fundamental concepts of consolidation, Types ofVolume changes in Soil masses**,** Terzaghi's One-dimensional consolidation equation- Consolidation concept by Spring Analogy & Soil Skeleton, One-dimensional consolidation, Terzaghi's equation, **Consolidation Lab. tests**, e - □ and e -log□ curves, Compressibility parameters, Pre- consolidation pressure, OCR, Rate of Consolidation, Consolidation settlement, Degreeof Consolidation, Secondary Consolidation, Time required for settlement, Field consolidation curve. *Application of FEA commercial softwares Geo5*	08
7	**Soil Exploration** Soil Exploration **-** Soil Types: Coarse-grained and Fine-grained soils, Objectives of SoilExplain Planning of Soil Exploration, Boring & Sampling in Soils, Field and Laboratory Investigation methods, Penetration methods, Geophysicalmethods- electric resistivity method and Seismic method. *Application of FEA commercial softwares Geo5, GeoStudio*	04
Total Credits		**42**

Textbooks:

1. Das, Braja M. (1999). *Principles of Geotechnical Engineering.* PWS Publishing, Pacific Grove,Calif.
2. Ranjan, G and Rao, P.,"Basic and Applied Soil Mechanics", New Age International Pvt.Limited, New Delhi, 2002.

References:

1. Das, B. M. (1999). Principles of Foundation Engineering", PWS Publishing, USA.
2. Singh, A., "Basic Soil Mechanics & Foundations", CBS Publishers & Distributors, 2004.
3. Taylor, D.W., "Fundamentals of Soil Mechanics", Wiley, New York, 1948.
4. Bowles, J.E., "Physical and Geotechnical properties of Soils", McGraw Hill Publishers, 1979.
5. Terzaghi, K., "Theoretical Soil Mechanics", Wiley, New York, 1943.
6. Terzaghi, K., Peck, R.B. and Mesri, G., "Soil Mechanics in Engineering Practice", 1996.
7. Purushothama, P. "Geotechnical Engineering", McG00raw Hill Education, 1995.
8. Venkataramaiah, C., "Geotechnical Engineering", New Age International Publishers,Daryagunj, New Delhi, 1995.
9. Kasmalkar, B. J. (1997). Foundation Engineering. Pune Vidyarthi Griha Prakashan-1786, Sadashiv Peth, Pune-411030

Semester	Course Title	Course Code	Credit-L-T-P
5th	**Geotechnical Lab- I**	CVL303	1-0-0-2
Evaluation Policy	**Internal Assessment**	**External Examination**	
	50 Marks	50 Marks	

Course Objective: Develop practical skills in conducting soil testing and analyzing various output parameters for design and analysis.

Pre-requisites: None.

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

CO No.	Course Outcomes	BLT
CO1	Determines the index properties of soils, and make the qualitative assessment of soil behavior.	5
CO2	To classify the soils based on the particle size distribution and plasticity chart.	3
CO3	Determine the Compaction characteristics of a given soil and use the same for real field problem related to compaction.	5
CO4	Determine the Permeability of any given soil specimen.	5

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	-	-	-	-	-	-	-	-	2	2	1	-	1	1	-
CO2	-	-	-	-	-	-	-	-	2	2	1	-	2	2	-
CO3	2	2	-	-	-	2	-	-	2	2	1	-	2	2	-
CO4	2	2	-	-	-	2	-	-	2	2	1	-	2	2	-

1-Slightly; 2-Moderately; 3-Substantially

Expt. No.	Name of the Experiment
1	Soil Identification Tests
2	Water Content Determination Test
3	Field Density Measurement
4	Specific Gravity Test
5	Sieve Analysis Test
6	Sedimentation Analysis Test
7	Atterberg and Shrinkage Limits
8	IS Light Heavy Compaction Tests
9	Permeability Tests

Text Books/ Manuals:

1. Head, K. H. (2006). *Manual of soil laboratory testing*. USA.
2. Germaine, J. T., & Germaine, A. V. (2009). *Geotechnical laboratory measurements for engineers*. John Wiley & Sons.

Semester	Course Title	Course Code	Credits-L-T-P
5th	Water Resources Engineering	CVT304	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: Water is an essential component of environmental life, and its resources are limited. The course aims at equipping students with the fundamental knowledge of the quantify of water flow in the earth and the atmosphere so that water resources are developed with a scientific rational approach.

Pre-requisites: None.

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

CO No.	Course Outcomes	BTL
CO1	Develop a comprehensive understanding of the critical elements of the hydrologic cycle	3
CO2	Estimation of various components of surface hydrology	5
CO3	Application of 1-D groundwater flow equations	3
CO4	Development and evaluation of hydrologic models	6
CO5	Estimation of peak flood magnitudes and frequency	5

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	2	2	3	2	2	1	1	1	1	3	1	2	3
CO2	3	3	2	2	3	2	2	1	1	1	1	3	1	2	3
CO3	3	2	3	3	3	1	2	1	1	2	1	3	2	1	2
CO4	3	3	3	3	3	2	3	2	2	2	2	3	3	1	2
CO5	3	3	3	3	3	2	3	2	2	2	2	3	3	3	2

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction:** Definition and scope; Hydrologic cycle; Hydrologic systems; Definition of Watershed; Streamflow network Water Balance Equation. Water Balance Components: Regional and Global Scales; Temporal and Spatial Variations	**4**
Module 2	**Precipitation:** Types; Formation; Point Measurements; Conventional and Non-Conventional gauges, Estimation of Areal-Average Precipitation	**4**

Module 3	**Evapotranspiration:** Estimation of Lake Evaporation: Water Balance Approach; Energy Balance Approach; Mass Transfer; Penman Method, Pan Evaporation. Evapotranspiration: Interception losses, Potential Evapotranspiration; Water Balance Approach, Energy Balance approach, Actual Evapotranspiration, Reference-Crop Evapotranspiration; Lysimeters	**8**
Module 4	**Subsurface Hydrology:** Soil Properties: Properties of Porous Media, Surface Tension and Capillarity, Hydraulic conductivity; Field Capacity Infiltration: Definition, Factors Affecting Infiltration Process; Potential Infiltration, Simple Models for estimating Potential Infiltration Groundwater Hydrology: Definition of Aquifers, Aquitards, Confined and Unconfined Aquifers, Storage Characteristics of Aquifers; Basic principles of Subsurface Flow; Darcy's law, Well hydraulics: Dupuit Assumptions, Steady One-Dimensional Aquifer Flow.	**10**
Module 5	**Streamflow:** Overland flow and runoff, Streamflow Measurement by Direct and Indirect methods, Rating Curves Streamflow Response to Precipitation Inputs, Hydrographs; Unit Hydrograph theory; S-curve hydrograph; Instantaneous Unit Hydrographs, Baseflow separation, Effective rainfall, Rainfall-Runoff models: Water Balance Method, Curve-Number Approach	**8**
Module 6	**Floods and Reservoirs:** Hydrologic Routing: Reservoir and Channel Routing Flood Estimation: Rational method, Empirical Methods, Unit Hydrograph Method, Design Flood Definition; Flow duration curves, Intensity-Duration-Frequency curves Reservoirs: Types of reservoirs, Storage Capacity, Fixation of Capacity, Safe Yield, Reservoir Sedimentation: Estimation Approaches	**8**
	Total	**42**

Books Recommended:

1. Philip B. Bedient, Wayne C. Huber, Baxter E. Vieux, 2019, *Hydrology and Floodplain Analysis*, Sixth Edition, Pearson Education
2. S. Lawrence Dingman, 2014, *Physical Hydrology*, Waveland Pr Inc; Third Edition
3. Ven Chow, David Maidment, Larry Mays, 2017, *Applied Hydrology*, McGraw Hill Education; First Edition

Semester	Course Title	Course Code	Credit-L-T-P
5th	**Quantity Surveying and Cost Evaluation**	CVT305	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objectives: To impart knowledge to students in preparing the estimates for construction projects and gain the exposure of contracts and their process.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Prepare quantity estimates for buildings, roads, rails and canal works	3
CO2	Calculate the quantity of materials required for civil engineering works as per specification.	4
CO3	Evaluate contracts and tenders in construction practices.	4
CO4	Prepare cost estimates.	5

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	-	-	2	-	-	-	1	-	-	2	-	3	-	2
CO2	2	-	-	1	-	-	-	-	-	-	2	-	3	-	2
CO3	1	3	-	-	-	1	-	-	-	-	3	-	3	-	1
CO4	3	2	-	-	1	-	-	-	-	-	3	-	3	-	1

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

S. No.	Contents	Contact Hours
1	**Methods of Estimation**: Main items of work; Deduction for openings; Degree of accuracy. Methods of Building Estimates: Individual wall method; Centre line method; Plinth area, Floor area & Carpet Area **Estimation Types:** Approximate Estimate; Plinth area estimate; Revised Estimate; Supplementary estimate.	12
2	**Estimate of RCC works**: Estimate of RCC slab; RCC beam; and RCC column with foundation. **Earthwork Estimate:** Estimate of earthwork; Estimate of pitching of slopes; Estimate of earthwork of road from longitudinal sections; Estimate of earthwork in hill roads.	10
3	**Specifications**: Purpose and method of writing specifications; Detailed Specifications for Brick work; R.C.C; Plastering; Mosaic Flooring; R.R.Stone Masonary.	8

	Analysis of Rates: Preparing analysis of rates for the following items of work: i) Concrete ii) RCC Works iii) Brick work in foundation and super structure iv) Plastering preparing leed statements	
4	**PWD accounts and works**: Contract; Tender; Tender notice; Tender Schedule; Earnest money; Security money; Measurement book; Administrative approval; Technical sanction; **Contracts:** Contract: types of contracts, Contract Law, EMD, Tenders, Acceptance of Contract, Branch of Contract, Cancellation of Contract, Re-tendering – work order, running payment, Final Bill, Deviations orders, Completion Certificate**.**	12

References:

1. Dutta B.N. 2021. Estimating & Costing in Civil Engineering. UBS Publishers & Distributors, New Delhi.
2. Chakraborti, M. 2010. Estimation, costing, specifications and valuation in civil engineering (includes computer estimation).
3. Birdie, G.S. 2014 A Text Book of Estimating and Costing for Civil Engineering. Dhanpat Rai Publishing co. ltd.
4. Standard Schedule of Rates such as PAR, DSR, DAR & MES manuals

Semester	Course Title	Course Code	Credit-L-T-P
5th	**Philosophy for Engineers: Society, Culture and Ethics**	HST301	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: The aim of the course is to develop in students a human understanding of the role and purpose of an enlightened engineer with a profound consideration to the social, moral and ethical values and responsibilities; and hence making them socially responsible engineers.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Identify the workings of social structures and distinguish the levels of social frameworks by applying critical perspectives developed during the course.	3
CO2	Analyze the importance and role of culture and social institutions in human life and interpret the relationship between human and the socio-cultural structures	6
CO3	Assess the various perspectives and trends in the field of epistemology and relate as well as apply the deep knowledge in the professional purposes	5
CO4	Elaborate overall professional ethical consciousness, seek solutions to engineering problems motivated by ethical judgement	6

Detailed Syllabus:

Module-1	**Introduction to Sociological concepts** ▪ Concepts in Sociology: Society, Culture, Socialization, Social Control, Social Change, Social Groups and Institutuins, Social Construction ▪ Foundation of Society: Social Structure and Sub Structure ▪ Power and Authority ▪ Social Control: Its Types and Means	11 Hrs
Module-2	**Culture and Socialisation** ▪ Culture: Definition and Nature; Types- Material and Non- Material. ▪ Meaning of Culture; Man in Society; Society in Man ▪ Culture and Personality ▪ Socialization: Its importance, Process and Stages ▪ Institutions for socialization	10 Hrs
Module-3	**Introduction to Philosophy** ▪ Definition of Philosophy; its nature and scope ▪ Branches of Philosophy – Metaphysics, Epistemology, Ethics, Logic, Aesthetics ▪ Greek Philosophy: Plato and Aristotle ▪ Schools of Thought in Western Philosophy: *Rationalism, Empiricism, Positivism, Existentialism*	10 Hrs
Module-4	**Philosophy of Ethics (Contact Hours: 10)**	11 Hrs

	▪ Introduction to Ethics: Classical and Modern Perspectives (Aristotle and Kant) ▪ Descriptive Ethics: Anthropology and Psychology ▪ Normative Ethics: Philosophy and Religion ▪ Engineering Ethics: Engineering as a Profession, Aim of Engineering, Responsibility of Engineers; Basic Values—Honesty, Integrity, Reliability, Safety and Liability	

Text Books Recommended:

1. Jayaram, N. Introductory Sociology, Macmillan, 1998
2. Russell, B. History of Western Philosophy, Oxford University Press, USA, 2004.
3. Fullerton, G.S. Introduction to Philosophy, Andrews UK Limited, Luton, 2012
4. Higgins, Kathleen M. and Robert C. Solomon. The Big Questions: A Short Introduction to Philosophy, Wadsworth Publishing Company, 2013.

Reference books:

1. Haralambos, M. Sociology: Themes and Perspectives, OUP, New Delhi,1998.
2. R.G. Frey and Christopher Heath Wellman (ed), A Companion to Applied Ethics, John Wiley & Sons, New York, 2008

Semester	Course Title	Course Code	Credit-L-T-P
5th	Engineering Seismology	CVT306	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To impart basic understanding of earthquakes, physics of the earth's interior from a practical side, to foresee the potential consequences of strong earthquakes on urban areas and civil infrastructure and how to do more efficient hazard management and mitigation. This module will communicate how science can enhance community resilience and has relevance far beyond any site for earth sciences, earthquake engineering, preparedness, mitigation, emergency response, decision-making, and public policy.

Pre-requisites: Hydrology and related course

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

CO No.	Course Outcomes	BTL
CO1	To learn the properties of the Earth's interior, physical characteristics of seismic sources, and estimate the seismic hazard and associated risk.	4
CO2	To analyse the effects of earthquakes on humans, objects and surroundings.	4
CO3	To learn and evaluate the site and path effects on the propagation of seismic waves.	5
CO4	To evaluate the parameters needed in order to plan and design seismically safe and sound structures.	6

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	-	2	-	-	2	-	-	-	-	-	3	3	3
CO2	3	2	-	2	-	3	3	-	-	-	-	3	3	3	3
CO3	3	3	2	3	3	-	-	-	-	-	-	-	3	3	3
CO4	3	3	3	3	-	3	3	-	-	-	-	3	3	3	3

Detailed Syllabus:

Module No.	Contents	Contact Hours
Module 1	**Introduction to Engineering Seismology:** Seismology and seismic exploration (definitions). Introduction to earthquake phenomenon and seismic hazards, Significant historical earthquakes and lessons learnt, Global seismicity – Analysis of earthquake focal mechanisms, Seismic zoning of India (IS:1893 Part 1), Microzonation.	**06**
Module 2	**Seismology and Earthquakes:** Internal structure of the earth, Seismic waves, Mechanism of faulting, Elastic rebound theory, Location of earthquake epicenter, Size of earthquakes – magnitude, intensity, and energy, Earthquake forecasting.	**08**

Module 3	**Strong Ground Motion and Seismic Instrumentation:** Ground motion parameters – amplitude, frequency content, and duration, Seismograph – principles and data acquisition	**08**
Module 4	**Ground Motion Variability:** Source effect – magnitude and distance, Path effect – basic introduction to seismic hazard analysis, Site response – effect of local geology and soil conditions on ground motions, Basic introduction to ground response analysis, Site investigations, dynamic soil tests, Dynamic design criteria for a given site	**08**
Module 5	**Earthquake Risk and Preparedness:** Social consequences; codes and public policy.	**08**

Books Recommended:

1. Bolt, B.A., W.H. Freeman, Earthquake, New York, 1993.
2. Kearey P and Brooks, An Introduction to Geophysical by Exploration, M. Blackwell
3. PublishersOxford, 1991.
4. Robinson, E.S andCoruch, Basic Exploration Geophysics, C. John Wiley & Sons, 1998.
5. Walker, B.S., Earthquake Time-Life Books Inc.,Alexandria, Virgina, 1982.
6. Bott, M.H.P., EdwardArnold, The Interior of the Earth. London, 1982.
7. Flower, C.M.R, The Solid Earth: An Introduction to GlobalGeophysics., CambridgeUniversity Press, 1990.
8. Lay, T. and Wallace,T.C, Modern Global Seismology., Academic Press, San Diego, 1995.

Semester	Course Title	Course Code	Credit-L-T-P
5th	Numerical Method in Civil Engineering	CVT307	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: Application of numerical methods in solving civil engineering problems

Pre-requisites: None

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

CO No.	Course Outcomes	BLT
CO1	Understand various numerical methods and associated errors. Determine the numerical solution of linear and non-linear system of equations	5
CO2	Understand the numerical solution of ODEs and application of various curve fitting methods	5
CO3	Understand different probability and statistical aspects used in different engineering problems.	5
CO4	Able to apply numerical methods for solving different engineering problems.	5

Detailed Syllabus:

Sr. No.	Course Contents	Contact Hours
1	Introduction to Numerical Methods Approximations & Error: Round-off Error, Taylor Series Introduction to Excel, MATLAB, & Blackboard Approximations & Error: Taylor Series, Truncation Errors, Precision, Numerical Differentiation Roots of Equations: Applications, Bracketing Methods, Newton Raphson Numerical Differentiation using MS Excel Roots of Equations: Secant Methods, Failure of Methods, Multivariate Methods Linear Systems of Equations: Intro & Round-off Errors, Gauss Elimination Finding roots with Excel & MATLAB Linear Systems of Equations: Scaling & Pivoting, FLOPS Linear Systems of Equations: LU Decomposition, Matrix Inversion Gauss Elimination in MATLAB Linear Systems of Equations: Norms, Error Bounds Linear Systems of Equations: Iterative Methods, Applications LU Decomp. & Iterative Methods in Matlab	12
2	ODE's: Euler & Runge-Kutta Methods ODE's: Systems of ODE's, Stiff ODE's; Course Project ODE's: Boundary Value Problems: Finite Difference Method	10

	Curve Fitting: Least Squares Regression Curve Fitting: Non-Linear Regression, Statistical Treatment, Interpolation Curve Fitting: Interpolation: Newton Divided Difference & Splines Curve fitting in Excel and Matlab"	
3	Probability & Statistics: Introduction, Basic Terms & Axioms Probability & Statistics: Random Variables (Distributions & Moments) Probability & Statistics: Confidence Intervals Probability & Statistics: Hypothesis Testing	10
4	PDE's: Introduction, Elliptic Equations PDE's: Parabolic Equations w/ Explicit Solution & Implicit Solution PDE's: Parabolic Equations w/ Implicit Solution, Applications PDE's: Stability, ADI Method Numerical Integration: Trapezoid & Simpson's Rules, Probability Distributions Numerical Integration: Richardson Extrapolation, Romberg Integration, Applications to Differentiation Numerical integration in Matlab and Excel Numerical Integration: Gaussian Quadrature, Multivariate Integration	10
	Total	**42**

Textbooks:

1. Numerical Methods for Engineers, by Chapra & Canale, 8th edition 2021

Semester	Course Title	Course Code	Credit-L-T-P
5th	Hydrometeorology	CVT308	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: Hydrometeorological extremes, such as extreme precipitation, have serious impacts on the society and economy. The objective of this course is that students learn the critical hydrometeorological process and how they interact to cause extreme events.

Pre-requisites: Hydrology and related course

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

CO No.	Course Outcomes	BTL
CO1	Explain different components involved in water and energy transfer	2
CO2	Examine process involved in water and energy transfer	4
CO3	Estimate energy and water fluxes between land and atmosphere	5
CO4	Analyze energy and transfer schemes in Land Surface Models	5

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	2	3	2	1	2	1	1	1	1	2	1	1	2
CO2	3	2	2	3	2	1	2	1	1	1	1	2	1	1	2
CO3	3	3	2	3	3	2	2	1	2	1	1	3	2	1	2
CO4	3	3	2	3	3	2	2	1	2	1	1	3	2	1	2

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
1	Overview of Hydrologic Cycle and Water Balance Water Vapor in the atmospheric: Ideal Gas Law, Virtual temperature, Saturated Vapor pressure, Measures of saturation	4
2	Energy balance: Latent and sensible heat fluxes, Net radiation, Soil heat flux, Biochemical energy storage, Advected energy; Description of radiative energy; Radiative Transfer: Absorption and emission by atmospheric gases, and land surfaces, long-wave and shortwave radiations, Energy Budget, thermal properties of soil and storage of heat content in the soil surfaces; Radiative heating of the surface. Clouds and Radiation, The role of clouds in energy balance and net radiation	10
3	Atmospheric Boundary layer: Turbulence and Eddies, Sensible and latent heat fluxes in the boundary layer; Measures of the strength of turbulence; Mean and turbulent kinetic energy Advective and turbulent fluxes; Vertical Structure, Evolution of atmospheric boundary layer; Terrain and urbanization effects. Evapotranspiration: Energy approach, Eddy Correlation and Mass	12

	transfer; transpiration	
4	Precipitation: Atmospheric processes: Dry and saturated adiabatic lapse rates; Potential temperature; Virtual potential temperature; Stability and convection in the atmosphere; The growth of precipitation particles; Precipitation systems, Local and mesoscale convective systems; Topographic and Orographic effects on precipitation distribution Snow Processes: formation of snow and snow cover and its effects on the atmosphere; Formation and characteristic ice and glaciers The physics of melting and water movement through snow	8
5	Land-atmosphere interaction; Water circulation in the soil–plant–atmosphere system; Soil–vegetation–atmosphere transfer schemes. Introduction to Land Surface Models	8
	Total	**42**

Books Recommended:

1. S. Lawrence Dingman, 2014, *Physical Hydrology*, Waveland Pr Inc; Third Edition
2. Hartmann, Dennis L, 2015, *Global physical climatology*, Elsevier, Second Edition.
3. Shuttleworth, W. James, 2012, *Terrestrial hydrometeorology*. John Wiley & Sons, 1st Edition.

Semester	Course Title	Course Code	Credit-L-T-P
6th	Design of Steel Structures	CVT351	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To introduce the behaviour and design of structural steel members according to the limit state method of design and to obtain basic knowledge about the failure mode of structural steel members.

Pre-requisites: Structural Analysis

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

CO No.	Course Outcomes	BTL
CO1	Analyze and design the bolted and welded connections.	5
CO2	Design the rolled and built-up tension & compression members.	5
CO3	Design the laterally supported & unsupported flexural members.	5
CO4	Interpret the design of structural elements by a software tool.	6

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	3	2	-	-	1	-	-	-	-	2	3	3	-
CO2	3	3	3	3	1	-	1	-	-	-	-	2	3	3	-
CO3	3	3	3	3	1	-	1	-	-	-	-	2	3	3	-
CO4	3	3	3	3	3	-	1	-	-	-	-	3	3	3	2

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**General Considerations:** Introduction to structural steel and its design philosophies. Properties of steel and rolled sections.	4
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	12
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.	12
Module 4	**Flexural Members:** *Beams* - Behaviour of beams in flexure, classification of sections, lateral torsional buckling, and shear strength of beams. Design of flexural member, laterally supported, laterally unsupported and built-up beams.	8
Module 5	**Introduction to Design Software:** Modelling of structural elements (beam,	6

	column, truss, and entire building system), Bending moment – shear – axial force diagram, deflection profile.	
Total		**42**

Textbooks:

1. Subramanian, N. "Design of Steel Structures – Limit States Method", Oxford University Press.
2. Duggal, S. K. "Design of Steel Structures", Tata McGraw Hill.

References:

1. Salmon, C. G., Johnson, J. E., and Malhas, F. A. "Steel Structures – Design & Behaviour", Pearson.
2. Vizrani, V. N., Ratwani, M. M., and Kumar, V. "Design and Analysis of Steel Structures", Khanna Publishers.

Semester	Course Title	Course Code	Credit-L-T-P
6th	Traffic Engineering	CVT352	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: Develop a comprehensive understanding of traffic characteristics, studies, and control methods to effectively design and manage road intersections and ensure safe and efficient traffic flow.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO-1	Apply the fundamental knowledge of road user and vehicle characteristics to analyze their impact on road design and traffic management.	3
CO-2	Analyse and interpret data from various traffic studies for improvement of traffic flow, congestion, and potential safety concerns in road networks.	4
CO-3	Design of intersections and traffic signals along with traffic signs, and road markings to improve transportation systems.	5
CO-4	Assess the traffic capacity and level of service (LOS) by evaluating traffic flow parameters.	6

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	1	1	-	1	1	1			-	-	-	1	1	1
CO2	1	2	2	1	1	2	2			-	-	-	2	2	1
CO3	2	2	1	-	1	-	-			-	-	-	2	2	1
CO4	2	1	3	1	1	1	1			-	-	-	2	2	1

Note: ***1****: Slight,* ***2****: Moderate &* ***3****: Substantial*

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction:** Scope, Traffic characteristics, Road user characteristics- Physical, Mental Psychological, Environmental factors, Reaction time, and PIEV theory. Vehicular characteristics- Vehicle Size and weight, Power, Speed, and Braking characteristics.	6
Module 2	**Traffic Studies and Analysis:** Purpose and Types of traffic studies, Spot speed studies-Speed measurement methods, Speed data analysis, Traffic volume studies- Methods, Analysis of traffic volume data and applications. Speed and delay studies-Causes of delay, methods and application, Traffic capaCVTy	20

	studies: Traffic flow parameters; fundamental relation of traffic flow parameter, Traffic capaCVTy, level of service concept, Factors affecting capaCVTy and level of service. O-D Studies- Methods, Planning and Sampling, Analysis of Data, Parking studies- method and application, Accident studies- Causes of accident, Condition and collision diagram, Preventive measures.	
Module 3	**Road Intersections:** Types of intersections, Traffic manoeuvres, Design Principle, Relative speed, Intersection geometrics and their influence on design, Design of rotary and roundabout intersection.	8
Module 4	**Traffic Regulations and Control:** Traffic regulation, One-way streets- advantages and limitations, Traffic control devices, Traffic signs- Role and types, traffic signal- Role and types, signal design methods, Signal timing design, Signal coordination, Road Marking- importance and types.	8
Total		**42**

References:

1. Khanna, S.K. and Justo, C.E.G. 2002. "Highway Engineering". Nem Chand Brothers, Roorkee.
2. L. R. Kadiyali, 1999, "Traffic Engineering and Transport Planning", Khanna Publishers, 2-B, Nai Sarak, Delhi- 110006.
3. CA O'Flaherty, 2002, "Transport Planning and Traffic Engineering", John Wiley & Sons, Inc., New York; Toronto.
4. McShane & Roess, 1990 "Traffic Engineering", Prentice-Hall of India Private Ltd, NewDelhi-110001.
5. Chakraborty & Das, 2017, "Principles of Transportation Engineering", Prentice-Hall of India Private Ltd, New Delhi-110001.

Semester	Course Title	Course Code	Credit-L-T-P
6th	Traffic Engineering Lab	CVL352	1-0-0-2
Evaluation Policy	**Internal Assessment**		**End-Term**
	60 Marks		40 Marks

Course Objective: Develop practical skills in conducting and analyzing various traffic studies, and traffic signal design to improve traffic management and safety.
Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Organize Origin & Destination and parking study to obtain travel information for determining future traffic patterns.	3
CO2	Analyze fundamental traffic characteristics (flow, density, and speed) by performing traffic volume and speed study in the field	4
CO3	Design traffic signals at intersections using various methods and identify traffic control devices at a road section.	5
CO4	Assess a driver's vision in the lab to ensure safe driving practices in the road.	6

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	**3**	1	2	1	2	1	1		2	1	-	-	1	-	-
CO2	**2**	1	2	1	2	1	1		1	1	-	-	2	1	-
CO3	**2**	1	1	2	2	3	1		2	-	-	-	2	1	-
CO4	**2**	1	3	2	1	1	1		1	-	-	-	2	2	1

Note: ***1****: Slight,* ***2****: Moderate &* ***3****: Substantial*

Detailed Syllabus:

S. No.	Name of Experiment	Objective of Experiment	Lecture Hours
1	Driver Vision Study	To conduct a vision screening test with the use of a driver vision screening instrument in the lab	2
2	Spot Speed Study	To conduct a spot speed study and calculate various speed statistical measures, develop a cumulative frequency speed distribution curve.	6
3	Traffic Volume Study	To conduct a traffic volume study and determine different volume statistics for a particular road section.	4
4	Traffic Flow Parameters Study	To determine fundamental/ macroscopic characteristics, i.e., flow, density, and speed of a traffic stream and their interdependencies, using the moving observer method.	2

5	Parking Study	To identify various elements related to a parking study by examining an existing parking area using an in-out survey.	4
6	Origin and Destination Study	To conduct an Origin & Destination study to obtain travel information for determining future traffic patterns	2
7	Geometrics of Rotary Intersection	To study the geometrics of a rotary intersection.	2
8	Traffic Signal Design	To record and analyze traffic counts at an intersection and design a traffic signal using the IRC method.	2
9	Traffic Control Devices Itemization	To identify, classify, and record various traffic control devices, such as signs and signals installed along a street/corridor.	4
Total			**28**

References:

1. Khanna, S.K. and Justo, C.E.G. 2002. "Highway Engineering". Nem Chand Brothers, Roorkee.
2. L. R. Kadiyali, 1999, "Traffic Engineering and Transport Planning", Khanna Publishers, 2-B, Nai Sarak, Delhi- 110006.
3. CA O'Flaherty, 2002, "Transport Planning and Traffic Engineering", John Wiley & Sons, Inc., New York; Toronto.
4. McShane & Roess, 1990 "Traffic Engineering", Prentice-Hall of India Private Ltd, NewDelhi-110001.
5. Chakraborty & Das, 2017, "Principles of Transportation Engineering", Prentice-Hall of India Private Ltd, New Delhi-110001.

Semester	Course Title	Course Code	Credit-L-T-P
6th	**Geotechnical Engineering – II**	CVT353	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: Determining the shear strength and bearing capaCVTy of soils.
Analyzing problems related to slope stability and earth pressure.

Pre-requisites: None

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

CO No.	Course Outcomes	BLT
CO1	Analyze the shear strength behavior of soils and determine shear strength characteristics of soil	5
CO2	Analyze the concepts of bearing capaCVTy and estimate the bearing capaCVTy of foundations.	5
CO3	Analyze earth pressure theories and determination of earth pressure.	5
CO4	Analyze slope stability and solve problems related to slope stability	5

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	2	2	2	2	-	-	-	-	-	2	3	3	-
CO2	3	3	3	3	2	2	2	-	-	-	-	2	3	3	-
CO3	3	3	3	3	2	2	2	-	-	-	-	2	3	3	-
CO4	3	3	3	3	2	3	2	-	-	-	-	2	3	3	-

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Sr. No.	Course Contents	Hours
1	**Shear Strength:** Shear Strength Concept, Theories of shear strength, Mohr-Coulomb Law, Laboratorydetermination of: • Triaxial Compression Test under Different Drainage Conditions, viz undrained,drained, and consolidated undrained. • Direct Shear Test • Unconfined Compression Test, and. • Vans shear test	12
2	**Earth Pressure Theory and Slope Stability:** Lateral earth pressure. Rankine's theory ofActive and Passive States. Lateral earth pressureunder various conditions, like surcharge, sloping backfill, and high-water table behind the wall. Earth pressure diagrams, Total thrust, Tension Cracks, and bracing of excavations. *Application of FEA commercial software Geo5*	10

	Introduction: modes of slope failure. Finite and Infinite Slopes. Factor of Safety Analysis of Slope by Culman's Method, Swedish, and Friction circle methods. Submergence case, complete draw down case, Steady seepage case. *Application of FEA commercial softwares Geo5, GeoStudio*	
3	**Introduction to Foundation Engineering**	10
	Foundation, Foundation types, Construction materials, Principles of Foundation Engineering, Foundations applications**,** Challenging problems: Introduction to Ground Improvement Techniques **Bearing CapaCVTy and Settlement of Foundations:** Basic terminology, bearing capaCVTy of shallow foundations. Methods of determination of bearing capaCVTy, Terzaghi's solution for ultimate bearing capaCVTy.Size effects. Effects of rigidity of footings. Plate load test. Settlement of different foundation on different soils. Contact pressure distribution for footings	
4	**Foundation Design**: **Basic Design Parameters for Safe Foundation Design** Design principles for footing and rafts. Foundations on clays and sands. Pile foundation types, classifications, and determination of load carrying capaCVTy,dynamic and static methods. Pile load test, pile groups efficiency of pile groups. *Application of FEA commercial software Geo5*	10
	Total	**42**

Textbooks:

1. Das, Braja M. (1999). *Principles of Geotechnical Engineering.* PWS Publishing, Pacific Grove,Calif.
2. Ranjan, G and Rao, P.,"Basic and Applied Soil Mechanics", New Age International Pvt.Limited, New Delhi, 2002.
3. Das, B. M. (1999). Principles of Foundation Engineering", PWS Publishing, USA.

References:

1. Das, B. M. (1999). Principles of Foundation Engineering", PWS Publishing, USA.
2. Singh, A., "Basic Soil Mechanics & Foundations", CBS Publishers & Distributors, 2004.
3. Taylor, D.W., "Fundamentals of Soil Mechanics", Wiley, New York, 1948.
4. Bowles, J.E., "Physical and Geotechnical properties of Soils", McGraw Hill Publishers, 1979.
5. Terzaghi, K., "Theoretical Soil Mechanics", Wiley, New York, 1943.
6. Terzaghi, K., Peck, R.B. and Mesri, G., "Soil Mechanics in Engineering Practice", 1996.
7. Purushothama, P. "Geotechnical Engineering", McG00raw Hill Education, 1995.
8. Venkataramaiah, C., "Geotechnical Engineering", New Age International Publishers,Daryagunj, New Delhi, 1995.
9. Kasmalkar, B. J. (1997). Foundation Engineering. Pune Vidyarthi Griha Prakashan-

1786, Sadashiv Peth, Pune-411030

Semester	Course Title	Course Code	Credit-L-T-P
6th	**Geotechnical Lab- II**	CVL353	1-0-0-2
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: Equip the students with basic methodology to perform basics geotechnical field and laboratory tests and determine various engineering properties of soil and make them able to stablish correlations between engineering properties of soils and field tests.

Pre-requisites: None

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

CO	Course Outcomes	BLT
CO1	Determine the compressibility parameters of the soil	5
CO2	Determines Shear Strength Parameters of the soil	5
CO3	Perform Field Tests	5
CO4	Examine correlations between engineering properties of soils and field tests	5

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	2	-	-	2	-	-	-	-	3	3	2	-	3	2	-
CO2	-	-	-	2	-	-	-	-	3	3	2	-	3	2	-
CO3	-	-	-	2	-	-	-	-	3	3	2	-	3	2	-
CO4	-	2	-	3	-		-	-	3	3	2	-	3	2	-

1-Slightly; 2-Moderately; 3-Substantially;

Expt. No.	Name of the Experiment
1	Consolidation Test
2	Direct Shear Test
3	Unconfined Compression
4	Unconsolidated Undrained Triaxial Test
5	Vane Shear Test
6	Consolidated Undrained Triaxial Test
7	Standard Penetration Test
8	Plate Load Test

Text Books/ Manuals:

1. Head, K. H. (2006). *Manual of soil laboratory testing*. USA.
2. Germaine, J. T., & Germaine, A. V. (2009). *Geotechnical laboratory measurements for engineers*. John Wiley & Sons.

3. Lade, P. V. (2016). *Triaxial testing of soils*. John Wiley & Sons.

Semester	Course Title	Course Code	Credit-L-T-P
6th	Environmental Engineering-I	CVT354	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To enable students to understand and design engineering components of drinking water supply systems.

Pre-requisites: None.

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

CO No.	Course Outcomes	BTL
CO1	Develop a comprehensive understanding of water quality parameters and water demand estimation methods.	3
CO2	Design the various treatment units in an engineered systems for water purification.	6
CO3	Develop a comprehensive understanding of activated carbon filtration, microfiltration, reverse osmosis, and advanced oxidation processes.	3
CO4	Assess and estimate various hydraulic components of a water distribution system.	5

CO articulation matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PS03
1	3	2	2	1	-	2	3	-	-	-	-	-	3	3	-
2	3	2	3	3	-	2	3	-	-	-	-	-	3	3	-
3	3	1	2	1	-	2	3	-	-	-	-	-	3	3	-
4	3	3	2	3	-	2	3	-	-	-	-	-	3	3	-

Detailed syllabus

S. No	Content	Contact Hours
Module 1	**Introduction:** Environment and role of environmental engineers, Sources of Water, water quality parameters (physical, chemical, and biological), water quality requirements and codal recommendations of limits for various uses. population forecast and water demand	7
Module 2	**Engineered systems for water purification:** Introduction to drinking water treatment plant, Design of sedimentation tanks, Design of Coagulation flocculation system, Filtration process and design of slow and rapid sand filters, Disinfection and design of chlorination contact tanks, water softening and design of softening units	14
Module 3	**Advance water treatment systems:** Activated carbon filtration, Micro Filtration, Reverse osmosis and advance oxidation processes	4

Module 4	**Water distribution systems:** Distribution reservoirs, Distribution system components, Design of distribution systems, Hydraulic analysis of distribution systems,	10
Module 5	**Piping and pumps:** Codal requirements for pipe materials and joints, leakage prevention, design of pumps for water supply systems	7
Total		42

Books Recommended:

1. Peavy, H.S., Rowe, D.R. and Tchobanoglous, G., 1985. Environmental engineering (Vol. 2985). New York: McGraw-Hill.
2. Davis, M.L. and Cornwell, D.A., 2008. *Introduction to environmental engineering*. McGraw-Hill.
3. Birdie, G. S., Birdie, J.S., 2021. Water supply and sanitary engineering. Dhanpat Rai Publishing Company.

Semester	Course Title	Course Code	Credit-L-T-P
6th	Water Quality Lab	CVL354	1-0-0-2
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	-	60	40 Marks

Course Objective: To provide hands on practice to students with the water quality analysis in order to understand how to test water quality.
Pre-requisites: None.

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

CO No.	Course Outcomes	BTL
CO1	Develop a comprehensive understanding of physicochemical water quality parameters	3
CO2	Develop laboratory skills to analyse the physicochemical water quality parameters	3
CO3	Assess and estimate various physical water quality parameters in water samples	5
CO3	Assess and estimate various chemical water quality parameters in water samples	5

CO articulation matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PS03
1	3	2	2	1	-	2	3	-	-	-	-	-	3	3	-
2	3	2	3	3	-	2	3	-	-	-	-	-	3	3	-
3	3	1	2	1	-	2	3	-	-	-	-	-	3	3	-
4	3	3	2	3	-	2	3	-	-	-	-	-	3	3	-

1-Slightly; 2-Moderately; 3-Substantially;

Detailed syllabus

S. No	List of Experiments	Lecture hours
1	Determination of the pH of water.	2
2	Determination of turbidity of water.	2
3	Determination of total solids in given sample of water	2
4	Determination of suspended solids in given sample of water	2
5	Determination of total dissolved solids of a given sample of water	2
6	Determination of hardness for a given sample of water	2
7	Determination of alkalinity of a given sample of water	2
8	Determination of acidity of a given sample of water	2
9	Determination of chloride of a given sample of water.	2
10	Determination of dissolved oxygen of a given sample of water.	2
	Total	**20**

Books Recommended:

1. Chemistry for environmental engineering and science by by Clair Sawyer, Perry Mccarty , Gene Parkin, Publisher: Tata McGraw Hill

Semester	Course Title	Course Code	Credit-L-T-P
6th	**Structural Analysis-III**	CVT355	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To learn the method of drawing influence lines for determinate and indeterminate structures. The students are expected to analyse the arches and suspension bridges and learn the plastic analysis of beams and rigid frames.

Pre-requisites: Structural Analysis – I and Structural Analysis – II

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

CO No.	Course Outcomes	BTL
CO1	Apply the influence line method for statically determinate and indeterminate structures and calculate critical force resultants.	4
CO2	Analyse three-hinged, two-hinged and fixed arches.	4
CO3	Analyse the suspension bridges with stiffening girders.	4
CO4	Analysis and design of beams and frames by the concept of plastic analysis.	5

Course articulation matrix:

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

Detailed Syllabus:

S. No.	Contents	Contact Hours
1	**Influence Line Diagrams for Determinate Structures:** Influence lines for reactions in statically determinate beams, Girders with floor systems, Trusses: ILD for deflections. Calculation of critical stress resultants due to concentrated and distributed moving loads – absolute maximum bending moment – influence lines for member forces in pin-jointed plane frames. Muller-Breslau Principle	10
2	**Arches:** Types of arches – Analysis of three-hinged, two-hinged and fixed arches – Parabolic and circular arches – Rib shortening and temperature effects.	8
3	**Cables and Suspension Bridges:** Statics of a suspension cable. Analysis of cables and suspension bridges with and without stiffening girders.	8
4	**Plastic Analysis:** Plastic theory, Plastic Section Modulus, Shape factor and Moment of resistance, Plastic hinge and Mechanism – Collapse load – Static and Kinematic methods- Upper and Lower Bound Theorems – Plastic Analysis of	10

	Indeterminate beams and frames including Gable Frames. Plastic moment distribution for multi-storey and multi-bay frames.	
5	**Influence Line Diagrams for Indeterminate Structures:** Influence lines for shear force, bending moment and support reaction components of indeterminate beams.	6

Textbooks:

1. Hibbeler, R. C. "**Structural Analysis**", Pearson Prentice Hall.
2. Leet, K. M., and Uang, C. M. "**Fundamentals of Structural Analysis**", Tata McGraw-Hill.
3. Manicka Selvam, V. K. "**Fundamentals of Limit Analysis of Structures (A Course in Plastic Analysis of Structures)**", Dhanpat Rai Publications.
4. Menon, D. "**Structural Analysis**", Narosa Publishing House.
5. Menon, D. "**Advanced Structural Analysis**", CBS Publishers & Distributors Pvt. Ltd.

References:

1. Ashok, K. Jain. "**Elementary Structural Analysis**", Nem Chand & Bros.
2. Ashok, K. Jain. "**Advanced Structural Analysis with Finite Element Method**", Nem Chand & Bros.
3. Reddy, C. S. "**Basic Structural Analysis**", Tata McGraw Hill.
4. Wang, C. K. "**Intermediate Structural Analysis**", Tata McGraw Hill.
5. Junnarkar, S. B., and Shah, H. J. "**Mechanics of Structures Vol. II (Theory and Analysis of Structures)**", Charotar Publishing House Pvt. Ltd.

Semester	Course Title	Course Code	Credit-L-T-P
6th	Watershed Management	CVT356	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: This course covers the various concepts for effective use of watershed, integrated water resources management, renewable energy, biomass, rural technological delivery systems and low cost technology that can be used in the farm. The course culminates in studying the watershed management to effectively utilise the available water resources.

Pre-requisites: None.

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

CO No.	Course Outcomes	BTL
CO1	Utilize the Engineering Surveys for effective use of Watershed concepts	3
CO2	Explain the concept of Integrated Water Resources Management	5
CO3	Classify the concepts of renewable energy, biomass, etc.	4
CO4	Asses the rural technological delivery systems and low cost technology that can be used in the farm.	5

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	2	3	3	2	1	1	2	2	2	2	3	3	2
CO2	3	3	2	3	3	2	1	1	2	2	2	2	3	3	2
CO3	3	3	3	3	3	2	1	1	2	2	2	2	3	3	2
CO4	3	3	3	3	3	2	1	1	2	2	2	2	3	3	2

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction** Need of Water Shed Development, Status of Watershed Development in India, Engineering surveys; Data requirement, and Watershed Concepts.	**06**
Module 2	**Land:** Survey (layout), Soil and Soil Moisture Conservation, Rainwater Management, Reclamation of saline soils. **Water:** Data and Analysis, Integrated Water Resources Management, Conjunctive Use.	**14**
Module 3	**Greenery:** Agriculture, Crop Husbandry, Sustainable Agriculture, Biomass, Management, Dryland Agriculture, Irrigation, Pastures and Silvipastures, Horticulture, Social Forestry, Afforestation. **Energy:** Renewable Resources, Biomass, small hydropower, Ocean Tides and Waves.	**12**

Module 4	**Socioeconomics:** State and Integrated Approach, Sustainable Society, Economics. **Appropriate Technology:** Farm Equipment, Contour Methods, Check Dams, Water Catchment and Harvesting, Low Cost Technology, Rural Technological Delivery Systems.	**10**
	Total	**42**

Books Recommended:

1. Murthy, J.V.S. Watershed Management, New Age International Publishers (P) Ltd. India.
2. Suresh, R. Watershed Hydrology, Standard Book House, India.
3. Das, Ganshyam. Hydrology and Soil Conservation Engineering, Prentice Hall of India.

Semester	Course Title	Course Code	Credit-L-T-P
6th	Railway and Airport Engineering	CVT357	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To provide students with comprehensive knowledge and practical skills in the design, construction, and management of railway and airport infrastructure, ensuring safety, efficiency, and sustainability in transportation engineering.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Apply the role and properties of materials required to make the railway track and various types of runways and taxiways.	3
CO2	Compare different types of design-analysis methods, various types of airport and railway structures suitable for prevailing conditions.	4
CO3	Design railway and airport components by applying suitable specifications.	5
CO4	Evaluate the appropriate railway track and airport runway by applying relevant design standards according to assigned site needs and issues.	6

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	1	1	2	1	-	1	-	-	-	-	-	1	1	-
CO2	1	3	2	1	-	1	1	-	-	-	-	-	1	1	-
CO3	1	1	2	-	-	-	-	-	-	-	-	-	2	1	-
CO4	-	-	3	1	1	-	1	-	-	-	-	-	2	1	-

Note: ***1****: Slight,* ***2****: Moderate &* ***3****: Substantial*

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction:** Historical development of Indian Railway, Advantages and limitation of different types rail systems, Railway track alignment- Basic requirements, Factors, Engineering surveys for track alignment, Permanent way- Typical cross-section, requirements, Concept of gauges, coning of wheels, Rails–Functions, Requirements, Types of rail sections, Creeps and kinks, Sleepers – Functions, Requirements, types, sleeper density, Ballast – Functions, Materials, Ballast less Tracks. Track fitting and fastenings.	14

Module 2	**Geometric Design of Railway Tracks:** Gradients, Grade compensation, speed of train, Superelevation, Cant deficiency Horizontal/Vertical curves- Necessity, Transition curves, Design of transition curve. Widening of gauges in curves, Design of tracks for high speeds: Geometrical requirements, Challenges	10
Module 3	**Track Maintenance and Rehabilitation:** Points and Crossings - Design of turnouts, working principles, Automated maintenance and upgrading. Signalling and Interlocking: Signalling, Interlocking and track circuiting-Construction and maintenance.	8
Module 4	**Airport Engineering:** Classification of airports; planning, Surveys and site selection of airports. Runway Length, Patterns and orientation-wind rose diagram. Width and grades of runway; Taxiways and aprons. Difference between Highway and airport pavements; Introduction to various design methods. Airport drainage.	10
Total		**42**

References:

1. Satish Chandra, M. M. Agarwal, 2013, "Railway Engineering", Oxford University Press (Latest Edition).
2. S. Ponnuswamy, 2016, "Railway Transportation- Engineering, Operation and Management", Narosa Publishing House, New Delhi (Latest Edition).
3. Rangawala, S.C, 2015, “Principles of Railway Engineering”, Charotar Publishers, Anand (Latest Edition).
4. Arora, S.P. and Saxena, 2010 “A Text Book Of Railway Engineering”, Dhanpat Rai Publishers, New Delhi (Latest Edition).
5. Khanna, Arora and Jain, 1999 “Airport Planning and Design”, Nem Chand and Brothers, Roorkee (Latest Edition).

Semester	Course Title	Course Code	Credit-L-T-P
6th	**Construction Technology and Management**	CVT358	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To inculcate the knowledge of technology in construction, and to understand how complex projects can be effectively managed in the construction industry.
Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Identify the roles and responsibilities of a project manager.	3
CO2	Asses the schedule of activities in a construction project.	5
CO3	Demonstrate various advanced construction practices.	5
CO4	Classify the equipment used in construction.	4

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	-	2	-	-	3	2	2	3	-	-	-	-	1	-	1
CO2	-	-	-	-	3	2	2	3	-	-	-	-	2	2	3
CO3	-	-	-	-	3	3	-	3	-	-	-	-	3	3	3
CO4	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-

1-Slightly; 2-Moderately; 3-Substantially;

Detailed Syllabus:

S. No.	Course Contents	Contact Hours
1	Construction classification, Construction Team, Phases in construction. Construction Planning - Objectives & Principles, Advantages and Limitations, Stages, Planning by Owner, and Contractor.	4
4	Project management, Role of Project manager, Stakeholders in a construction project, Project organization. Project types, similarities & dissimilarities.	8
5	Project planning, milestone schedules, Network techniques, CPM, PERT	12
6	Cost Control, Projected Cost Estimates, status reporting, variance and earned value Project, MIS reporting, Daily, Weekly, and monthly reporting, Actual vs. Planned cost reports, Crashing of project, Cost Optimization, Invoicing, Preparation of RA bill.	8
7	Advanced construction techniques, Piles construction, viaduct construction method, Formwork – types: timber, steel, modular shuttering, slip forms, scaffolding	10

References:

1. Kumar Neeraj Jha. "**Construction Project Management**", Pearson Publication.
2. Puerifoy, R. L. "**Construction Planning Equipment & Methods**", McGraw Hill Education; 7th edition.
3. Harold Kerzner, "**Project Management**", CBS Publishers & Distributors.
4. Roy Pilcher, "**Principles of Construction Management**", McGraw Hill.
5. Punmia, and Khandelwal, K. K. "**Project Planning and Control**", Laxmi Publ.

Semester	Course Title	Course Code	Credit-L-T-P
6th	Concrete Technology	CVT359	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: The students will develop logical thinking skills in applying Concrete Technology to Civil Engineering, gaining hands-on experience in implementing concrete materials for construction field applications.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Relate material characteristics and their influence on the microstructure of concrete.	3
CO2	Distinguish concrete behavior based on its fresh and hardened properties.	3
CO3	Illustrate the proportioning of different types of concrete mixes for required fresh and hardened properties using professional codes.	4
CO4	Adopt suitable concreting methods to place the concrete based on requirements. Select a suitable type of concrete based on specific application.	5

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	-	-	3	-	-	-	-	-	-	3	3	3	-
CO2	3	3	3	3	-	-	2	-	-	-	-	2	3	3	-
CO3	3	3	3	3	2	2	2	3	-	-	-	2	3	3	2
CO4	3	3	3	3	2	-	2	-	-	-	-	2	3	3	3

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
1	**Concrete Ingredients:** Cement manufacturing process, steps to reduce carbon footprint, chemical composition and their importance, hydration of cement, types of cement. Testing of cement. **Fine aggregate:** Functions, requirements, Alternatives to River sand, M-sand introduction and manufacturing. **Coarse aggregate:** Importance of size, shape and texture. Grading and blending of aggregate. Testing on aggregate, requirement. Recycled aggregates **Water** – Qualities of water.	8

Module No.	Contents	Hours
	Chemical admixtures – plasticizers, accelerators, retarders and air entraining agents. **Mineral admixtures** – Pozzolanic and cementitious materials, Fly ash, GGBS, silica fumes, Metakaolin and rice husk ash. **Microstructure of Concrete-** using SEM, EDS and XRD techniques	
2	**Fresh Concrete Workability**-factors affecting workability. Measurement of workability–slump, Compaction factor and Vee-Bee Consistometer tests, flow tests. Segregation and bleeding. **Process of manufacturing of concrete**- Batching, Mixing, Transporting, Placing and Compaction. **Curing** – Methods of curing – Water curing, membrane curing, steam curing, accelerated curing, self- curing. Good and Bad practices of making and using fresh concrete and Effect of heat of hydration during mass concreting at project sites.	10
3	**Hardened Concrete Factors** influencing strength, W/C ratio, gel/space ratio, Maturity concept, Testing of hardened concrete, Creep –factors affecting creep. **Shrinkage of concrete** – plastic shrinking and drying shrinkage, Factors affecting shrinkage. **Definition and significance of durability**. Internal and external factors influencing durability, Mechanisms- Sulphate attack – chloride attack, carbonation, freezing and thawing. **Corrosion**, Durability requirements as per IS-456, In situ testing of concrete-Penetration and pull out test, rebound hammer test, ultrasonic pulse veloCVTy, core extraction – Principal, applications and limitations.	10
4	**Concept of Mix Design** with and without admixtures, variables in proportioning and Exposure conditions, Selection criteria of ingredients used for mix design, Procedure of mix proportioning. Numerical Examples of Mix Proportioning using IS-10262:2019.	6
5	**Special Concretes and RMC-**Special Concrete: Self- Compacting concrete-concept, materials, tests, properties, application and typical mix Fiber reinforced concrete - Fibers types, properties, application of FRC. Light weight concrete-material properties and types. Typical light weight concrete mix and applications, materials, requirements, mix proportion and properties of Geo polymer Concrete, High Strength Concrete and High-Performance Concrete, Ultra High-Performance Concrete, Carpet Concrete. **RMC:** Manufacture and requirement as per QCI-RMCPCS, properties, advantages and disadvantages	8
	Total	42

Textbooks:

1. M S Shetty 2005, “Concrete Technology”, S.Chand Publication New Delhi.
2. P Kumar Mehta, Monteiro, 2014, “Concrete Technology”, Indian Concrete Institute.

References:

1. A R Santhakumar, 2006, Concrete Technology, Oxford University Press.
2 A.M.Neville, 2011, Properties of Concrete, Pearson Education.
3. M L Gambhir, 2004, Concrete Technology, Tata McGraw Hill.

Semester	Course Title	Course Code	Credit-L-T-P
6th	Building Information Modelling	CVT360	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: Building Information Modelling (BIM) and its application on small and large construction projects are covered in this course. By using Autodesk Revit, students will be able to develop BIM models and learn terminology associated with buildings.

Pre-requisites: None

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

CO No	Course Outcomes	BTL
CO1	Asses the BIM importance and its distinctive characteristics in the construction industry.	5
CO2	Identify variety of data exchange standards and their significance in construction projects.	3
CO3	Analyze how BIM can assist in decision-making during design coordination.	4
CO4	Develop BIM models for building construction projects using BIM tools.	6

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	-	-	1	-	3	3	-	3	3	3	3	3	3	1	1
CO2	-	-	2	-	3	1	-	-	3	3	3	3	2	-	-
CO3	-	-	1	-	3	3	-	-	3	3	3	3	3	2	-
CO4	-	-	3	-	3	2	-	-	3	3	3	3	3	-	-

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

S. No.	Course Contents	Contact Hours
1	**Introduction:** Building components and systems; the role of various stakeholders in the building design process; BIM and its Evolution; BIM vs 3D CAD, BIM Platforms.	8
2	**BIM in Construction Projects:** Project Delivery Methods. Data exchange methods. Format - IFC, IDM & MVD, COBie. BIM Servers	12
3	**BIM in Project Planning:** VDC, BIM Coordination, nD modelling, 4D & 5D BIM, 5D. Quantity Take off, Clash Detection and Construction Logistics.	10
4	**BIM Applications:** Modeling of Residential Buildings and 3D Rendering in Revit; Structural Modelling, MEP Modelling, Quantity Surveying, Cost Estimations. Introduction to Revit Dynamo.	12

References:

1. De Wilde, P., Mahdjoubi, L., and Garrigós, A. G. "**Building Information Modelling (BIM) in Design, Construction and Operations**", WIT Press.
2. Kymmell, W. "**Building Information Modelling: Planning and Managing Construction Projects with 4D CAD and Simulations**", McGraw-Hill Education.
3. BIM Handbook: A Guide to Building Information Modelling for Owners, Designers, Engineers, Contractors, and FaCVLity Managers.

Semester	Course Title	Course Code	Credit-L-T-P
6th	Rock Mechanics and Tunnelling Technology	CVT361	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To develop analytical skills for determining engineering properties and stress-strain behaviour of rock materials and solving problems associated with tunnelling in soft and hard ground.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Understand the concept of rock mechanics and rock exploration and utilise the exploration methods for civil engineering construction.	5
CO2	To classify the rock material and asses the rock mass behaviour based on Geological and engineering properties.	5
CO3	Understand the basics of tunnelling and design tunnels on soft and hard ground.	5
CO4	To understand the various possible support systems and analyse the rock support system for safe tunnel construction.	5

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	2	2	2	3	-	-	-	-	-	-	-	2	3	3	-
CO2	2	2	3	3	2	-	-	-	-	-	-	2	3	3	-
CO3	3	3	3	3	2	2	2	-	-	-	-	2	3	3	-
CO4	3	3	2	2	2	2	-	-	-	-	-	2	3	3	-

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

S. No.	Course Contents	Hours
1	**Rock Mechanics:** Rock mechanics and associated problems; geological and Engineering Classification of rocks, Methods for rock exploration, Index and engineering properties of rock, stress and Strain in Rock, Structural feature of mass rocks and their effects on engineering properties and rock mass behaviour Rock and rock mass failure criteria, Support pressure and slip of the joint,	08

	Rock Slope failure	
2	**Tunneling Technology: An Introduction:** Necessity and advantage of a tunnel, Associated basic terminology and application, Site investigations, Geological and geotechnical considerations of tunnelling, Portals and Shafts, Selection of site, Data collection, Stages of investigation, Problems in Tunneling	08
3	**Tunnelling in hard and soft grounds:** Analysis of stresses: Methods to determine stresses around openings, Kirsch equation, Greenspan's method. Basic concepts for lined, unlined, and pressure tunnels, Tunnelling in hard rock, Tunneling in soft ground, Methods of tunnelling in soft rocks.	14
4	**Lighting, ventilation and dust control and Engineering application:** Tunnel Lighting, Ventilation of tunnel, Methods of ventilation, Dust and gas control, Drainage and safety Bearing capaCVTy of rocks and rock support systems, Reinforcement of fractured, jointed and laminated rocks-shotcreting, bolting, anchoring, steel mats, precast concrete segments, shotcrete, grouting etc, Strength enhancement of rock mass in Tunnelling	12
Total contact hours		**42**

References:

1. Szechy, K. (1973). Art of Tunnelling. Atademiaikiado Publication, Budapest.
2. Kolymbas, D. (2005). Tunnelling and tunnel mechanics: A rational approach to Tunnelling. Springer Science & Business Media.
3. Debasis, D., & Kumar, V. A. (2016). Fundamentals and applications of rock mechanics. PHI Learning Pvt. Ltd.
4. Hudson, J. A., & Harrison, J. P. (2000). Engineering rock mechanics: An introduction to the principles. Elsevier.
5. Hudson, J. A. (1993). Comprehensive rock engineering: principles, practice and projects. Volume 3. Rock testing and site characterisation.
6. Ramamurthy, T. (Ed.). (2010). Engineering in rocks for slopes, foundations and tunnels. PHI Learning Pvt. Ltd.
7. Feng, X. T. (Ed.). (2017). Rock mechanics and engineering volume 2: Laboratory and field testing. CRC Press.
8. Chapman, D. N., Metje, N., & Stark, A. (2017). Introduction to tunnel construction. CRC Press
9. Bickel, J. O. Kuesel, T. R. & King, E. H. (2012). Tunnel engineering handbook. Springer Science & Business Media.

Semester	Course Title	Course Code	Credit-L-T-P
6th	Photogrammetry and Digital Image Processing	CVT362	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: This course aims to provide conceptual knowledge about the basic elements of photogrammetry and Digital Image Processing.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Apply the basic principles of photogrammetric analysis in Civil Engineering	3
CO2	Analyse the principles of stereoscopy and image parallax in the context of photogrammetric analysis for Civil Engineering	4
CO3	Analyse and process the digital images after image enhancement	4
CO4	Interpret the key features of digital images and perform image classification	3

Course articulation matrix

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

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction to Photogrammetry:** Geometric characteristics of aerial photographs; Ground coverage of aerial photographs; Vertical and Tilted Photographs - Photographic Scale, Photo coordinates and Ground co-ordinates, Relief displacement, Tilt distortion.	**10**
Module 2	**Stereoscopy & Image Parallax:** Ground coordinates and Object height from parallax measurement; Mapping with aerial photographs - Ground control for aerial photography; Flight planning	**10**
Module 3	**Image Interpretation:** Elements of visual image interpretation - Image interpretation keys; Introduction to Digital Image processing. **Image enhancement:** Contrast enhancement; Spatial feature enhancement - Spatial filtering, Edge enhancement, Texture enhancement, Multi image manipulation - Multispectral band ratios and differencing, Principal component analysis, IHS transformation	**12**

Module 4	**Image Classification:** Supervised classification - Minimum distance to mean, Parallelepiped, Maximum likelihood, and Baye's methods; Unsupervised classification, Evaluation of accuracy. Change detection	**10**
Total		**42**

Books Recommended:

1. Chowengerdt, R.A., 2007. *Remote Sensing: Models and Methods for Image Processing*. 3rd ed. Academic Press: Elsevier.
2. Duda, R.O. and Hart, P.E., 2001. *Pattern Classification*. 2nd ed. John Wiley and Sons.
3. Tou, J.T. and Gonzalez, R.C., 2004. *Pattern Recognition Principles*. 2nd ed. Addison Wesley.
4. Swain, P.H. and Davis, S.M. (Eds.), 1997. *Remote Sensing: The Quantitative Approach*. 3rd ed. McGraw-Hill Book Co.
5. Lillesand, T.M. and Kiefer, R.W., 2000. *Remote Sensing and Image Interpretation*. 5th ed. John Wiley and Sons.
6. Sabins Jr., F.F., 1997. *Remote Sensing: Principles and Interpretation*. 3rd ed. Freeman & Co., San Francisco.
7. Jensen, J.R., 2005. *Introductory Digital Image Processing: A Remote Sensing Perspective*. 3rd ed. Upper Saddle River, Prentice-Hall.
8. Mather, M., 2004. *Computer Processing of Remotely Sensed Images: An Introduction*. 4th ed. John Wiley and Sons, New York.

Semester	Course Title	Course Code	Credits-L-T-P
6th	Architecture and Town Planning	CVT363	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objectives: To impart knowledge to students on the principles of architectural design and historical background of town planning.
Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Analyze the significance of architecture and evaluate its role in the design process	4
CO2	Apply your understanding of the contributions made by different architects to the field of architecture.	3
CO3	Examine different town planning strategies developed over time.	4
CO4	Design a comprehensive town plan that incorporates and evaluates the necessity of town planning and its various components.	6

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	1	1	1	2	-	-	-		-	-	-	-	1	-	-
CO2	-	-	-	3	-	1	-	2	-	-	-	-	-	-	1
CO3	1	-	-	3	-	-	1	-	-	-	-	-	-	-	-
CO4	2	1	-	2	-	1	-	-	-	-	-	-	2	1	1

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

S. No.	Contents	Contact Hours
1	**Architecture**: General introduction to various aspects of architectural projects. **Basic Perception**: Perception of shapes, symmetry and balance, shapes and modified shapes, the field of vision, perception of space and objects in space, movement, and attention; Continuity order and similarity, colours, lighting, emotional response and behaviour patterns, personal space and territory. **Design Principles and Elements:** The design terms, methods, process and procedures, emotional characteristics, planning sequence, massing, organisation of space, enclosure plans, elements affecting the organised space, circulation and control of spectators, movement and scale, forms, utility control, patterns and texture, proportions, and scale. **Built Environment:** Built Environment design and stages of design. **Functional Analysis:** Analytical study of buildings in respect of functional efficiency, architectural efficiency.	12
2	**Solar Architecture**: Description of basic systems, principles and procedures of design, appliances, and application of solar energy.	10

	Landscape Design: Kinds of landscape and their relation to the climate, topography, subsoil, vegetation and their correlation. Various elements and materials of landscape design. **Contemporary Architecture:** Introduction of analytical study of various works/projects of some architects like F.L. Wright, LE-Corbusier, Phillip Jhonson, etc.	
3	**Town Planning:** Planning at various levels – National Regional CVTy and village. **Growth of Towns**: Origin and growth of towns, horizontal and vertical development **History:** Brief history review of some ancient towns. Present day planning in India. **Urban Land Use**: Economics of Urban Land Use - Various theories	10
4	**Master Plan**: Importance of master plan for redevelopment of existing towns and planning of new towns, Implementation, Building Byelaws. Concepts of Redburn neighbourhood pattern. **Zoning:** Zoning regulations for various urban land uses including density and height zoning. Multistorey buildings and their implication on urban planning **Town Forms:** Various road patterns, Junctions, express ways, parkways etc., **Garden CVTy:** Garden CVTy movement and concept. Chandigarh project of Le-Carbusier.	10

References:

1. F.D.K Ching. 2015. ARCHITECTURE FORM SPACE AND ORDER. Wiley Publishers.
2. J. McMorrough. 2018. The Architecture Reference & Specification Book updated & revised: Everything Architects Need to Know Every Day.
3. B. Daniel, E. Jerzy, T. Joni, Turek. 2008. Architecture: A World History
4. M.P Rao. 2019. Urban Planning Theory and Practice
5. SK. Kulushreshta. 2012. Urban and Regional Planning in India: A Handbook for Professional Practice

Semester	Course Title	Course Code	Credits-L-T-P
6th	Solid Waste Management	CVT364	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To enable students to learn characteristics of municipal solid waste and design engineering solutions for solid waste management.

Pre-requisites: None.

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

CO No.	Course Outcomes	BTL
CO1	Develop a comprehensive understanding of solid waste types and its characteristics	3
CO2	Estimate the solid waste generation rates and related requirements for the collection of solid waste	5
CO3	Design the components of a solid waste management faCVLity (landfills, material and energy recovery systems).	6
CO4	Develop a comprehensive understanding of various components of muncipal wastewater management rules and regulations	3

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	2	1	-	2	3	-	-	-	-	-	3	3	-
CO2	3	2	2	3	-	1	3	-	-	-	-	-	3	3	-
CO3	3	1	3	1	-	2	3	-	-	-	-	-	3	3	-
CO4	2	3	2	3	-	2	3	-	-	-	-	-	3	3	-

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

S.No	Content	Lecture Hours
Module 1	**Introduction to Solid Waste Management:** Evolution of Solid Waste Management, Sources and classification of solid wastes, propoerties (physical, chemical and biological) of solid waste.	7
Module 2	**Generation and collection of solid waste:** Generation of solid waste and its estimation, onsite handling, storage and processing, types of collection systems, determining vehicle and labor requirements for collection, collection routes	7
Module 3	**Transport and processing of solid waste:** Tranfer methods, transfer stations and locations, Processing at solid waste treatment faCVLity (mechanical and thermal volume reduction), Landfills, design and operation of landfills	10
Module 4	**Systems for resource and energy recovery from solid waste:** Material recovery systems, biological recovery methods (composting and anaerobic digestion), thermal conversion processes (incineration, refuse derived fuel and pyrolysis)	14

Module 5	**Solid waste legislations:** Municipal solid waste (management and handling) rules of India	4
	Total	42

Books Recommended:

1. Tchobanoglous,G., Theisen, H., and Vigil, S.A.Integrated Solid Waste Management, McGraw Hills, 1993.
2. Peavy, H.S., Rowe, D.R. and Tchobanoglous, G., 1985. Environmental engineering (Vol. 2985). New York: McGraw-Hill.
3. Manuals, Rules and regulations in India for Municipal Solid Waste, Biomedical waste, fly ash, nuclear waste, hazardous waste and E-waste, Government of India.

Semester	Course Title	Course Code	Credit-L-T-P
6th	Resource Planning in Construction	CVT365	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To develop the basic knowledge and skills in construction industry resource planning and management by providing an understanding of resource management concepts.
Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Apply the concepts of construction resource planning, scheduling, and allocating resources according to needs.	3
CO2	Determine the methods for estimating construction projects.	5
CO3	Simplify the construction materials and equipment, as well as procurement strategies.	4
CO4	Discuss labour management and construction regulations, including resource levelling and resource allocation.	6

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	1	-	1	1	-	-	-	-	1	-	2	1	1	-	-
CO2	1	1	2	2	-	-	-	-	2	-	3	1	2	-	-
CO3	-	-	1	-	-	-	-	-	2	-	1	1	-	-	-
CO4	-	-	2	-	-	2	-	3	2	-	2	2	-	-	-

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

S. No.	Course Contents	Contact Hours
1	**Resources**: Manpower, Equipment, Material, Money. Resource Planning - manpower, Equipment, Material, Money. Scheduling, Procurement management.	6
2	Estimation Methods, classification of construction cost, unit rate, cost inflation, Escalation and Contingencies, earned value budget, Project master budget, Cost Controlling	12
3	**Procurement of Material**: Time of purchase, quantity of material, sources, Transportation, Delivery and Distribution. Procurement methods. Inventory basics, Inventory Planning. Equipment: Planning and selecting, Depreciation and Replacement.	8
4	Resource Allocation, Levelling and Smoothening, Importance of Project Scheduling, Time-cost trade-off, Value Management.	16

Books:

1. Kumar Neeraj Jha. 2015. Construction Project Management, Theory and Practices. Pearson

Publication.
2. Puerifoy, R. L. 1996. Construction Planning Equipment & Methods. McGraw Hill. 7th edition.
3. Canter M.R. 1993. Resource Management for Construction: An Integrated Approach (Building & Surveying Series)
4. Chitkara K.K. 2019. Construction Project Management. Mc Garw Hill. 4th Edition.

Semester	Course Title	Course Code	Credit-L-T-P
7th	Dynamics of Structures	CVT401	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To understand the behaviour of structures, especially buildings to various dynamic loads: such as earthquake, machine vibration and ambient vibration.

Pre-requisites: Engineering Mathematics, Structural Analysis

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

CO No.	Course Outcomes	BTL
CO1	Illustrate the importance of dynamic load on the structural design.	4
CO2	Formulation of the equation of motion and obtaining the response to single degree of systems.	6
CO3	Solution methodology for dynamic response of multi-degree of freedom system and continuous system.	5
CO4	Interpret the design of structural elements by a software tool.	6

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	2	2	-	-	1	-	-	-	-	2	3	3	-
CO2	3	3	3	3	1	-	1	-	-	-	-	2	3	3	-
CO3	3	3	3	3	1	-	1	-	-	-	-	3	3	3	-
CO4	3	3	2	2	3	-	1	-	-	-	-	3	3	3	2

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Basics of Structural Dynamics**: Importance and Applications of Structural Dynamics. Basic Concepts and Definitions (Degrees of Freedom, Damping, Natural Frequency). Equations of motion.	6
Module 2	**Single Degree of Freedom Systems –** Free Vibration of Damped and Undamped SDOF Systems; Forced Vibration of Undamped and Damped SDOF Systems; Response to Harmonic and Periodic ExCVTations. Response to General Dynamic Loading (Duhamel's Integral)	16
Module 3	**Multi-Degree of Freedom Systems**: Equations of Motion for MDOF Systems; Free Vibration Analysis of MDOF Systems. Mode Shapes and Natural Frequencies. Orthogonality of Modes. Rayleigh's Principal and its application for determination of fundamental frequency. Evaluation of dynamic response by mode superposition method.	14
Module 4	**Discussion on Indian standards:** codal provisions for earthquake resistant design. Design of buildings (plane frames only) based on Codal provisions.	6
Total		**42**

Textbooks:

1. Chopra, A. K. "**Dynamics of Structures: Theory and Applications to Earthquake Engineering**", Prentice Hall College Div.
2. Chopra, A. K. "**Earthquake Dynamics of Structures - A Primer**", Earthquake Engineering Research Institute, Oakland.
3. Hosur, V. "**Earthquake-Resistant Design of Building Structures**", Wiley India Pvt. Ltd.

References:

1. Clough, R. W. and Penzien, J. "**Dynamics of Structures**", Computers & Structures.
2. Paz, M., and Kim, Y. H. "**Structural Dynamics: Theory and Computation**", Springer.

Semester	Course Title	Course Code	Credit-L-T-P
7th	Design of Reinforced Concrete structures-II	CVT402	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To design various reinforced concrete (RC) special structures as per Indian standards and to understand reinforcement detailing based on the type of structure.

Pre-requisites: Structural Analysis and basics of RCC Design

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

CO No.	Course Outcomes	BTL
CO1	Design of RC & masonry footings.	5
CO2	Design of RC & masonry retaining walls.	5
CO3	Understand the design of water-storing structures.	5
CO4	Design knowledge of domes.	5

Course articulation matrix:

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

Detailed Syllabus:

S. No.	Contents	Contact Hours
1	**Foundations**: Design of RC footings, isolated footings and various types of combined footings, design of masonry foundations.	14
2	**Retaining Wall**: Design of cantilever and counter-fort type RC retaining walls. Design of masonry retaining walls.	12
3	**Water Tank**: Design of underground, circular and rectangular water tanks.	10
4	**Domes**: Design of domes and ring beams.	8

Textbooks:

1. Raju, N.K., 2020. Advanced reinforced concrete design. CBS Publishers & Distributors Pvt Limited.
2. Punmia, B.C., Jain, A.K. and Jain, A.K., 2015. Comprehensive Rcc. Designs. Laxmi Publications.
3. Pillai, S. U., Menon, D., 2017. Reinforced Concrete Design. Tata McGraw Hill.

References:

1. Park, R., and Paulay, T., Reinforced Concrete Structures. John Wiley and Sons.
2. Sheppard, D. A., and Phillips, W. R., Plant-cast: Precast and Prestressed Concrete. Mc Graw Hill.

Semester	Course Title	Course Code	Credit-L-T-P
7th	Matrix Structural Analysis	CVT403	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To perform matrix computations and to analyse determinate and indeterminate structural systems using the matrix method.

Pre-requisites: Structural Analysis – II

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

CO No.	Course Outcomes	BTL
CO1	Derivation of flexibility matrices for bars, trusses, beams and frame structures.	5
CO2	Derivation of stiffness matrices for bars, trusses, beams and frame structures.	5
CO3	Analysis of structures using flexibility and stiffness matrix methods.	5
CO4	Analysis of structures using the direct stiffness method.	5

Course articulation matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	3	3	-	1	1	-	2	2	1	2	3	1	-
CO2	3	3	3	3	-	1	1	-	2	2	1	2	3	1	-
CO3	3	3	3	3	-	1	1	-	2	2	1	2	3	1	-
CO4	3	3	3	3	-	1	1	-	2	2	1	2	3	1	-

Detailed Syllabus:

S. No.	Contents	Contact Hours
1	**Introduction**: Structural systems, principle of superposition, equilibrium and compatibility conditions, principle of minimum potential energy and minimum complementary energy, concepts of stiffness and flexibility, flexibility and stiffness matrices of beam and truss elements. Local and global coordinates systems.	12
2	**Flexibility Matrix Method:** Force transformation matrix, global flexibility matrix, analysis of continuous beams, rigid frames and trusses. Effects of temperature changes and lack of fit.	8
3	**Stiffness Matrix Method**: Displacement transformation matrix, global stiffness matrix, analysis of continuous beams, rigid frames and trusses. Effects of temperature changes and lack of fit.	8
4	**Matrix Method Analysis** of grid floors systems.	4
5	**Direct Stiffness Method**: Principle of contra gradience, global stiffness matrices of beam and truss elements, analysis of continuous beams and trusses.	8

Textbooks:

1. Martin, H. C. "**Introduction to Matrix Methods of Structural Analysis**", McGraw-Hill Book Company.
2. Rajasekaran, S, and Sankarasubramanian, G. "**Computational Structural Mechanics**", Prentice Hall India Learning Pvt Ltd.
3. Rubinstein, M. F. "**Matrix Computer Analysis of Structures**", Prentice Hall, Inc.
4. Weaver, W and Gere, J. H. "**Matrix Analysis of Framed Structures**", CBS Publications.

References:

1. Jain, A. K. "**Advanced Structural Analysis**", Nem Chand & Bros.
2. Kanchi, M. B. "**Matrix Methods of Structural Analysis**", New Age International.
3. Manicka Selvam, V. K. "**Elements of Matrix Analysis and Stability of Structures**", Khanna Publishers.
4. Pandit, G. S. and Gupta, S. P. "**Structural Analysis: A Matrix Approach**", Tata McGraw-Hill.

Semester	Course Title	Course Code	Credits- L-T-P--
7th	Irrigation and Hydraulic Structures	CVT404	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: This course covers the various methods of irrigation and water application to agricultural fields, soil-water-plant relationship, and crop water requirements, hydraulic design of irrigation canals, diversion head works, cross-drainage works and water logging issues. The course culminates in studying the irrigation and corresponding hydraulic structures to effectively utilise the available water resources.

Pre-requisites: None.

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

CO No.	Course Outcomes	BTL
CO1	Assess various methods of irrigation and water application to agricultural fields, soil-water-plant relationship, and crop water requirements	5
CO2	Develop hydraulic design of irrigation canals	3
CO3	Analyze and evaluate hydraulic design of diversion head works and cross-drainage works	4
CO4	Examine various aspects of water logging of agricultural lands.	4

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	3	2	2	1	1	1	2	2	2	2	3	3	3
CO2	3	3	3	2	2	1	1	1	2	2	2	2	3	3	3
CO3	3	3	3	3	2	1	1	1	2	2	2	2	3	3	3
CO4	3	3	3	3	2	1	1	1	2	2	2	2	3	3	3

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction:** Present status of irrigation in India, Advantages of irrigation, a brief description of Gravity, Lift, and Sprinkler irrigation. **Soil-Water-Plant Relationship and Crop Water Requirements:** Soil moisture and crop water relationships, Duty, Delta, Consumptive use, Irrigation requirements, Principal Indian crops, Multiple Cropping.	**10**
Module 2	**Canal Irrigation:** Types of canals, parts of canal irrigation system, channel alignment, assessment of water requirements, estimation of channel losses, Design of channels (lined and earthen), Regime and semi-theoretical approaches, Canal lining, factors affecting the choice of various types of canal linings.	**9**
Module 3	**Diversion Head works:** Selection of site and layout, Parts of diversion head works, types of weirs and barrages, Design of weirs on permeable foundations, control of silt entry into a canal, Silt excluders and different types of silt ejectors	**10**

Module 4	**Cross Drainage Works:** Necessity of cross drainage works, their types, and selection, Design of various types of cross drainage works-Aqueduct, Siphon aqueduct, Super passage, Siphon, Level crossing. **Water Logging:** Causes, preventive and curative measures, drainage of irrigated lands, saline and alkaline lands.	**13**
	Total	**42**

Books Recommended:

1. Garg, S.K. Irrigation Engineering and Hydraulic Structures, Khanna Publisher
2. Varshney, Gupta and Gupta, Irrigation Engineering and Hydraulic Structures. Nem Chand & Brothers, Roorkee.
3. Singh Bharat. Fundamentals of Irrigation Engineering, Nem Chand & Brothers, Roorkee.
4. Arora, K.R. Irrigation, water power and Water Resources Engineering", Standard Publishers Distributors, Delhi.
5. Asawa, G.L. Elementary Irrigation Engineering, New Age International (P) Ltd. Publishers, New Delhi.

Semester	Course Title	Course Code	Credits- L-T-P--
7th	Applied Hydrology	CVT405	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: This course aims at equipping the students with tools they can use to understand and predict important hydrologic processes. The main objective is to learn multiple hydrologic models and to use them for river flow forecasting, including hydrologic extremes, such as floods and droughts

Pre-requisites: CVL304: Water Resources Engineering

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

CO No.	Course Outcomes	BTL
CO1	Understand different hydrological processes	3
CO2	Design key hydrologic variables	5
CO3	Develop models for lumped and distributed routing	6
CO4	Forecast river flows from hydrologic models	6

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2.5	2	2	3	2	2	1	1	1	1	3	2	1	2
CO2	3	3	3	2.5	3	2	3	1	1	2	1	2	3	2	1
CO3	2	2	3	3	3	2	2	1	1	1	1	2	3	1	2
CO4	2	3	3	3	3	2	3	1	2	2	1	2	3	1	2

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	Evapotranspiration: heat-exchange, turbulent exchange, and mass transfer approaches for estimation of potential evapotranspiration. Infiltration and Baseflow: Richard's equation, Green-Ampt model, baseflow approximations and lumped-scale baseflow parameterizations	**8**
Module 2	Hydrologic design computations: intensity-duration-frequency relationships, design storms, probable maximum precipitation, design flows, applications of extreme-value distributions	**8**
Module 3	Flow Routing: flow and flood routing, level-pool routing, hydrologic routing, distributed flow routing approaches, stage-discharge relationships, flood routing in natural rivers.	**12**
Module 4	Hydrologic models: some important lumped and distributed hydrologic models, input requirements, parameter estimation approaches, applications in flow forecasting, application in flood and drought management, sources of uncertainties in flow forecasts.	**14**
	Total	**42**

Books Recommended:

1. Ven T. Chow, David Maidment, Larry Mays, *Applied Hydrology*, McGraw-Hill Professional, 2013, 2nd Edition, ISBN-10: 007174391X, ISBN-13: 978-0071743914
2. Philip B. Bedient, Wayne C. Huber, and Baxter E. Vieux: *Hydrology and Floodplain Analysis*, Pearson Education Limited, Harlow, Essex, England, 2018, 6th Edition, ISBN-10:0 134751973, ISBN-13: 978-0134751979
3. George M. Hornberger, Patricia L. Wiberg, Jeffrey P. Raffensperger, Paolo D`odorico: *Elements of Physical Hydrology,* Johns Hopkins University Press, 2014, ISBN-10: 1421413736
4. S. Lawrence Dingman: *Physical Hydrology*, Waveland Press, Inc, 2014, 3rd Edition, ISBN-10: 1478611189, ISBN-13: 978-1478611189
5. Wilfried Brutsaert: *Hydrology, An Introduction*, Cambridge University Press, 2005. 1st Edition, ISBN-10: 0521824796, ISBN-13: 978-0521824798

Semester	Course Title	Course Code	Credit-L-T-P
7th	Fluvial Hydraulics	CVT 406	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: This course covers the various concepts of origin and properties of sediments, bed forms development, establishment of the threshold of particle transport, resistance to flow with rigid boundary and movable boundary, and calculations leading to stable channel design. The course culminates in studying the fluvial hydraulics to understand the sediment transport and their effects on the fluid flow.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Develop an understanding about the origin and properties of Sediments.	3
CO2	Analysis of bed forms development and establishment of threshold of particle transport using various methods.	4
CO3	Evaluate the Resistance to flow with rigid boundary and movable boundary	5
CO4	Categorize and analyze the sediment load transport (Bed, Suspended and Total load Transport) to perform calculations leading to stable channel design.	4

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	2	3	2	1	2	1	2	2	2	2	3	3	1
CO2	3	3	2	3	2	1	2	1	2	2	2	2	3	3	1
CO3	3	3	2	3	2	1	2	1	2	2	2	2	3	3	1
CO4	3	3	2	3	2	1	2	1	2	2	2	2	3	3	1

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction:** Sediment and fluvial hydraulics, nature of sediment problems. **Properties of sediment:** Particle size, shape, density, fall veloCVTy. Bulk properties viz particle size distribution, specific weight, and porosity.	**06**
Module 2	**Threshold of particle Transport:** Incipient motion criteria: Competent veloCVTy, lift concept, critical tractive force (Shields and White). **Bed Forms:** Terminology, Theoretical analysis of bed forms, empirical and graphical analysis, factors affecting bed forms.	**08**
Module 3	**Channel roughness and resistance to flow: Resistance to flow with movable boundary:** Grain roughness and form roughness, surface drag	**12**

	and form drag, different approaches viz. Einstein's, Einstein-Barbarossa, Engelund and Hansen.	
Module 4	**Bed Load Transport** using Meyer-peter, meyerPeter and Mueller, Discharge approach, veloCVTy and Bed form approaches. **Suspended Load Transport** using The Rouse equation **Total Load Transport** using Einstein's bed load function. **Stable Channel Design:** The empirical stable channel design, Tractive force method of stable channel design: Drag distribution and resistance to motion, design values for boundary shear, the stable cross section, Design by tractive force method.	**16**
	Total	**42**

Books Recommended:

1. Graf, W.H. Hydraulics of Sediment Transport, McGraw Hill international.
2. Garde, R.J. and Rangaraju, K.G. Mechanics of sediment transportation and alluvial stream problems.
3. Yang, Chih Ted., 1996. Sediment Transport Theory and Practice, McGraw Hill Companies Inc. New York.
4. Raudkivi, A.J. Loose Boundary Hydraulics, Pergamon Press.

Semester	Course Title	Course Code	Credit-L-T-P
7th	Ground Improvement Techniques	CVT407	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: Geotechnical Engineering I and II

Pre-requisites: The course deals with the techniques to improve properties like shear strength, stiffness and stability of the ground for use as a foundation or construction material.

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

CO No.	Course Outcomes	BTL
CO1	Understand the need of ground improvement and basic approach and methods.	2
CO2	Use of various improvement methods.	3
CO3	Illustrate ground improvement methods with numerical problems.	4
CO4	Plan an appropriate ground improvement proposal for a given situation.	5

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	3	3	-	2	2	-	-	-	-	2	3	3	3
CO2	3	3	3	3	-	2	2	-	-	-	-	2	3	3	3
CO3	3	3	3	3	3	2	2	-	-	-	-	2	3	3	3
CO4	3	3	3	3	-	2	2	-	-	-	-	2	3	3	3

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

S. No.	Contents	Contact Hours
1	Introduction: Soil Types and Soil Investigation. Need for Engineered Ground Improvement, its Classification, Suitability, Feasibility and Desirability, Current & Future Developments	**04**
2	Mechanical Modification: Basic principles, methods , Compaction Control, Specifications for Compaction Requirements, Compaction Equipment	**06**
3	Hydraulic Modification: Objectives & Techniques, Dewatering Systems, Soil-Water Relationships, Single & Multiple Well Formulas, Pre loading, PVD etc.	06
4	Chemical Modification/Stabilization: Effect of various admixtures on Engineering Properties of Soils. Grouting- Applications to Embankments, Foundations & Sensitive Soils,	06
5	Thermal Modification: Thermal Properties of Soils, Heat Treatment of Soils, Ground Freezing, Strength &Behaviour of Frozen Ground.	**04**

6	Modification By Inclusions & Confinement: Evolution of Soil Reinforcement, Soil Nailing, Soil Anchors, Ground Improvement by Stone columns	**08**

References Books

1. Methods of Treatment of Unstable Ground : Belt – Butterworths, 1975
2. Engineering Principles of Ground Modification: Manfired, R. H.
3. Engineering Treatment of Soils : Bell, F. G
4. Geosynthetics for Soil Improvement : ASCE, GST No. 18,New York
5. Grouting Theory & Practice : Nonveiller, E
6. Soil Stabilization : Ingles, O. G. &Metcalf, J. B

Semester	Course Title	Course Code	Credit-L-T-P
7th	Earth Retaining Structures	CVT408	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: This course aims to enable the students to understand lateral earth pressure theories and perform stability analysis and design of retaining walls.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Understand the need for, types of, and practical aspects of earth retaining structures.	**2**
CO 2	Solve the earth pressure problems for various practical situations.	**3**
CO 3	Illustrate the adoption of the different retaining structures for a given situation	**4**
CO4	Stability analysis for design of an earth retaining structure	**5**

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	2	2	2	-	-	-	-	-	-	-	-	-	2	3	-
CO2	3	3	3	3	3	2	2	-	-	-	-	2	3	3	-
CO3	3	3	3	3	2	2	2	-	-	-	-	2	3	3	-
CO4	3	3	3	3	2	2	2	2	2	2	2	2	3	3	-

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

S. No.	Contents	Contact Hours	BTL
1	Introduction: Lateral Earth Pressure concept. Need of Earth Retaining Structures and their classification, types and application/suitability.	**04**	**2**
2	Determination of earth pressure with surcharge, sloping backfills and other field conditions.	**08**	**3**
3	Proportioning and stability analysis of Rigid Retaining walls.	08	**4**
4	Analysis and design of Flexible and temporary retaining structures like sheet pile walls, cofferdams and bracing systems.	08	**5**
5	Reinforced Earth Walls, concept, analysis and design	**08**	**5**

References Books:

1. Advanced Geotechnical Engineering by B.M. Das; Thomson
2. Basic and Applied Soil Mechanics by Gopal Ranjan and A. S. Roa; New Age International
3. Soil Mechanics and Foundation Engineering By R.N.D. Narsingha Roa; Wiley

Semester	Course Title	Course Code	Credit-L-T-P
7th	Geotechnical Field Measurements	CVT409	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To provide students with the basics geotechnical field test and various measurement techniques and make them able to plan a site investigation program to design of shallow foundations and deep foundations.

Pre-requisites: The student should have attended courses of Soil Mechanics and Foundation Engineering.

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

CO No.	Course Outcomes	BTL
CO1	Plan and implement subsurface investigation based on the requirement of Civil Engineering project and site conditions.	5
CO2	Execute different subsurface exploration tests, collect disturbed/undisturbed samples for laboratory tests and can suggest design parameters	6
CO3	Estimation of various soil properties based on field measurement.	5
CO4	Prepare the site investigation report.	4

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	2	3	2	3	-	1	-	-	3	3	2	3	3	1	-
CO2	3	3	2	3	-	-	-	-	2	3	2	3	3	2	-
CO3	3	2	1	1	-	-	-	-	-	-	-	3	3	2	-
CO4	3	3	3	3	3	3	-	-	-	3	1	3	3	3	-

Detailed Syllabus:

Module No.	Contents	Hours
1	**Soil Exploration and Sampling Techniques:** Objectives of Soil Explain, Data required for soil investigation, Methods of site investigation, Boring & Sampling in Soils, Type and collections soil smaple, Underwater Sampling, Exploration of Closed Landfills or Hazardous Waste Sites Planning of Soil Exploration, miscellaneous exploratory techniques	**08**
2	**Test and Measures for Soils:** Strength tests: Cone Penetration (CPT, CPTE, CPTU, SCPT) and Cone Pressure Penetration test, Standard Penetration test (SPT), Dynamic Penetration test (DP), Field Vane test FVT); Deformability tests: Marchetti's Flat Dilatometer test (DMT),	**12**

	Pressuremeter (PMT), Static Plate Load test (PLT). Geophysical Methods and pile load testing: Electrical resistivity, and seismic refraction methods, MASW, Pile load tests	
3	**Test And Measures for Rocks:** Strength tests: Point Load strenght Test, Field Strength test; Deformability tests: Flat Jack Test, Dilatometer test, Static Plate Load test, CSIR, DHTV measures. In situ Permeability Test for soils (Lefranc) and rocks (Lugeon). Drilling techniques and field tests for geological monitoring. Geophysical Methods: Electrical resistivity, and seismic refraction methods, MASW Rock Sampling – RQD – Strength and modulus from classifications, Classification based on strength & modulus and strength and fracture strain, Geoengineering classification.	**12**
4	**Data Interpretation:** Correlation of filed and lab measurements, Data interpretation for determination of engineering properties of soils and their application to geotechnical design, preparation of site investigation reports Design of shallow and deep foundations based on field measurement.	**12**
Total		**42**

Books Recommended:

1. Clayton R, Mathews, C. M. and Simons, N E, Site Investigation, Wiley Blacwell, 1995
2. Bowles J Foundation Analysis and Design, McGrawHill, 2008
3. Handbook of Geotechnical Investigation and Design Tables, Routledge, (2007
4. Geotechnical Investigation Methods: A Field Guide for Geotechnical Engineers. Roy. E HUNT, Taylor & Francis, .2006.
5. Subsurface Exploration and Sampling of Soils for Civil Engg. Purposes –Hvorslev M J,
6. Manual of Geotechnical Laboratory Soil Testing, CRC Press, Taylors and Francis Group, New York, USA

Semester	Course Title	Course Code	Credit-L-T-P
7th	Intelligent Transportation Systems	CVT410	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To equip students with comprehensive knowledge of Intelligent Transportation Systems (ITS), advanced management systems, traveller information systems, and real-world case studies.

Pre-requisites: Traffic Engineering (CVT 352)

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

CO No.	Course Outcomes	BTL
CO1	Apply the fundamentals of Intelligent Transportation Systems (ITS) to learn the framework of ITS architecture.	3
CO2	Analyse and propose innovative solutions in Advanced Transport Management Systems through integrated evaluation of technologies and strategies.	4
CO3	Design ITS systems like Advanced Traveller Information System (ATIS).	5
CO4	Evaluate various International and National case studies on ITS.	6

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	1	2	1	2	1	1	-	2	1	-	-	2	2	-
CO2	2	1	2	1	2	1	1	-	1	1	-	-	2	2	1
CO3	2	1	1	2	2	3	1	-	2	-	-	-	2	2	1
CO4	2	1	3	2	1	1	1	-	1	-	-	-	1	1	1

Note: ***1****: Slight,* ***2****: Moderate &* ***3****: Substantial*

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction to Intelligent Transportation System:** Introduction to Intelligent Transportation Systems (ITS) -Definition – Role and Responsibilities – Advanced Traveller Information System – Fleet Oriented ITS Services – Electronic Toll Collection – Critical issues-Security-Safety	10

	ITS Architecture and Hardware: Architecture: ITS Architecture Framework – Hardware Sensors – Vehicle Detection – Techniques – Dynamic Message Sign – GPRS – GPS – Toll Collection	
Module 2	**Advanced Transport Management System:** Video Detection – Virtual Loop - Cameras - ANPR – IR Lighting – Integrated Traffic Management – Control Centre – Junction Management Strategies- ATMS – Advanced Traveler Information Systems (ATIS)- Route Guidance – Issues -– Historical – Current – Predictive Guidance – Data Collection – Analysis – Dynamic Traffic Assignment (DTA) – Components – Algorithm.	10
Module 3	**Advanced Traveler Information System:** Travel Information – Pre-Trip and Enroute Methods- Basic ATIS Concepts – Smart Route System – Data Collection – Process – Dissemination to Travelers – Evaluation of Information – Value of Information – Business Opportunities	12
Module 4	**Case Studies:** Automated Highway Systems - Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.	10
Total		**42**

References:

1. Korth, H.F. and Silberschatz, A., 1992. Database System Concepts. McGraw Hill.
2. Turban, E., 1998. Decision Support and Expert Systems: Management Support Systems. Maxwell Macmillan.
3. Mittra, S.S., 1986. Decision Support Systems – Tools and Techniques. John Wiley, New York.
4. Halsapple, W. and Winston, A.B., 1987. Decision Support Systems – Theory and Application. Springer Verlog, New York.
5. Chen, K.P. and Miles, J., 2000. ITS Handbook 2000: Recommendations for World Road Association (PIARC).
6. Ghosh, S. and Lee, T.S., 2000. Intelligent Transportation Systems: New Principles and Architectures. CRC Press.
7. Chowdhury, M.A. and Sadek, A., 2003. Fundamentals of Intelligent Transportation Systems Planning. Artech House, Inc.
8. Roess, R.P., Prassas, E.S. and McShane, W.R., 2004. Traffic Engineering. Pearson Educational International, 3rd ed

Semester	Course Title	Course Code	Credit-L-T-P
7th	Pavement Evaluation and Maintenance	CVT411	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: Enable students to effectively evaluate the functional and structural condition of pavements to promote optimal performance and longevity.

Pre-requisites: Highway Engineering (CVT 302)

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

CO No.	Course Outcomes	BTL
CO1	Compute the causes of pavement surface distresses and suggest suitable remedial measures.	3
CO2	Examine and optimize the maintenance alternatives based on the benefit and cost ratio of the project alternative.	4
CO3	Design the overlay for flexible and rigid pavements.	5
CO4	Interpret the field evaluation data and pavement design data with respect to present and future traffic condition.	6

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	1	1	2	2	1	-	-	-	-	-	1	1	-
CO2	2	2	2	1	2	1	2	-	-	-	-	-	2	1	-
CO3	2	2	1	2	2	1	1	-	-	-	-	-	2	2	1
CO4	2	1	3	2	2	1	1	-	-	-	-	-	3	2	1

Note: ***1****: Slight,* ***2****: Moderate &* ***3****: Substantial*

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Pavement functional condition evaluation:** Pavement evaluation, Types, Need, Pavement Functional Condition Evaluation: Various Aspects of Surface and their Importance; Causes, Factors Affecting, Deterioration and Measures to Reduce, Measurement of Skid Resistance, Unevenness, Ruts, Pot holes, and Cracks; Methods of Measurement of Skid Resistance, Unevenness, Ruts and Cracks	10
Module 2	**Pavement structural condition evaluation:** Factors affecting Structural Condition of Flexible and Rigid Pavements; Effects of Subgrade Soil, Moisture, Pavement Layers, Temperature, Environment and	10

	Traffic on Structural Stability, Pavement Deterioration; Evaluation by Non-Destructive Tests such as Falling Weight Deflectometer (FWD), Benkelman Beam Rebound Deflection.	
Module 3	**Design of Pavement Overlays:** Pavement Overlays, Design of Flexible Overlay over Flexible Pavement by Benkelman Beam Deflection, Flexible Overlays and Rigid Overlays over Rigid Pavements.	12
Module 4	**Pavement Maintenance:** Routine Maintenance, Preventive Maintenance, Periodic Maintenance, Maintenance strategies and prioritization, Pavement life cycle cost analysis, components and methods.	10
Total		**42**

References:

1. Haas R. C. G., Hudson W. Ronald, Zaniewski John P., 1994, *Modern Pavement Management*, Krieger Publishing Company,
2. Oecd, 1987, *Pavement Management Systems*, O E C D.
3. Shahin M. Y., 1994, *Pavement management for airport, roads and parking lots*, Chapman and hall.
4. Susan Brown, 1993, *Pavement Management Systems*, Transportation Research Board.
5. R Srinivasa Kumar, 2014, *Pavement Evaluation and Maintenance Management System.*
6. IRC-82: 2015 *Code of Practice for Maintenance of Bituminous Road Surfaces*, Indian Roads Congress
7. IRC: SP-83: 2018 *Guidelines for Maintenance, Repair and Rehabilitation of Cement Concrete Pavements*, Indian Roads Congress.

Semester	Course Title	Course Code	Credit-L-T-P
7th	Road Safety Analysis & Audit	CVT412	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To enable students to understand and apply comprehensive knowledge of the road safety and environment to contribute effectively to traffic safety planning and management.

Pre-requisites: Traffic Engineering (CVT 352)

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

CO No.	Course Outcomes	*BTL*
CO1	Apply a multidisciplinary approach to enhance traffic safety and rehabilitation.	3
CO2	Analyse the effect of the transport sector on sustainability.	4
CO3	Perform environmental auditing by applying the advanced principles of Environmental Impact Assessment (EIA)	5
CO4	Evaluate the causes of road accidents and carry out road safety audits.	6

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	1	1	2	1	-	1	-	-	-	-	-	2	1	2
CO2	1	3	2	1	-	1	1	-	-	-	-	-	2	1	1
CO3	1	1	2	-	-	-	-	-	-	-	-	-	2	1	1
CO4	-	-	3	1	1	-	1	-	-	-	-	-	2	1	1

Note: ***1****: Slight,* ***2****: Moderate &* ***3****: Substantial*

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction to Road Safety:** Road traffic accident scenario in India and in the world, Road safety and its importance, traffic rules, and driving behavior, characteristics of accidents, Multidisciplinary approach to planning for traffic safety and injury control; pre-crash and post-crash models; Roles of vehicle, roadway traffic, driver, and environment, crash and injury causations; Accident analysis, Conflict points at intersections, Pedestrian safety	14
Module 2	**Road safety Audit:** Principles-procedures and practice, code of good practice and checklists, structuring of report, diagnosing crash problem and solutions	10
Module 3	**Energy-related aspects of different transport technologies:** Traffic calming Measures. Road transport-related air pollution, sources of air	8

Module No.	Contents	Hours
	pollution, effects of weather conditions, Vehicular emission parameters, pollution standards, measurement and analysis of vehicular emission; Imitative measures, Urban and non-urban traffic noise sources, Noise pollution	
Module 4	**EIA requirements of Highways projects:** Procedure; MOEF World Bank/RC/UK guidelines; EIA practices in India.	10
Total		**42**

References:

1. Evans, S.K., 2009, *Traffic Engineering Handbook,* Institute of Traffic Engineers, USA.
2. Wohl, M. and Martin, B.V., 1967, *Traffic System Analysis of Engineers & Planners*. McGraw Hill, New York.
3. Babkov, V.F., 1975. *Road Conditions & Traffic Safety*. MIR Publishers, Moscow.
4. Kadiyali, L.R., 2003. *Traffic Engineering & Transport Planning*. Khanna Publishers.
5. Little, A.D., 1970. *The State of Art of Traffic Safety*. Paraeger Publishers, New York.
6. Relevant IRC codes.

Semester	Course Title	Course Code	Credit-L-T-P
7th	Durability of Concrete Structures	CVT413	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To examine all of the major physical and chemical mechanisms that threaten the durability of concrete and to address the options available for achieving appropriate durability.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Examine the factors that influence the ability of concrete to offer resistance to physical and chemical degradation.	4
CO2	Interpret the behaviour of steel rebars embedded in concrete and exposed to corrosion	3
CO3	Evaluate the various NDT techniques for testing of concrete structures.	5
CO4	Design the specifications for special durable concrete mixes.	5

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	2	2	3	3	1	-	1	-	-	-	-	2	3	3	-
CO2	2	3	3	3	3	-	1	-	-	-	-	2	3	3	-
CO3	2	3	3	3	2	-	1	-	-	-	-	3	3	3	-
CO4	3	3	3	2	1	-	2	-	-	-	-	3	3	3	2

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Physical Mechanisms of Concrete**: Degradation: Shrinkage, Thermal Cracking, Freeze-Thaw Attack, Abrasion and Erosion.	7
Module 2	**Chemical mechanisms of concrete degradation:** Sulphate Attack, Alkali-Aggregate reactions, Acid Attack	7
Module 3	**Corrosion of steel reinforcement in concrete:** Corrosion of steel in concrete, Chloride ingress into concrete, Carbonation.	6
Module 4	**Evaluation of Concrete Buildings:** Visual Investigation, Destructive Testing Systems, Non-Destructive Testing Techniques, Semi-Destructive Testing Techniques, Chemical Testing	10
Module 5	**Specification and design of durable concrete:** Concrete mix design for Special concrete viz. Self-compacting concrete, High-strength concrete, Foamed concrete, Lightweight concrete. Porous Concrete. Geopolymer Concrete.	12
Total		**42**

References:

1. Thomas, D, “Concrete Durability”, CRC Press Canada.

2. Dodge Woodson. R, ”Concrete Structures – protection, repair and rehabilitation”, Elsevier Butterworth – Heinmann, UK, 2009

3. Dayaratnam. P and Rao. R, “Maintenance and Durability of Concrete Structures”, University Press, India, 1997

4. Peter H. Emmons, “Concrete Repair and Maintenance Illustrated”, John Wiley & Sons.

Semester	Course Title	Course Code	Credits- L-T-P
7th	Urban Hydrology	CVT414	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: The economic growth since the industrial revolution has led to increases in urban areas and changes in climate. This course aims to expose students to common challenges in water management in urban areas and the scientific approaches that can be taken to overcome them.

Pre-requisites: Water Resources Engineering

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

CO No.	Course Outcomes	BTL
CO1	Explain the main elements relevant to quality and quantity of urban stormwater	2
CO2	Apply common models for estimating urban water runoff	3
CO3	Examine the common approaches taken for management of stormwater quantity and quality.	4
CO4	Determine urban stormwater hydrograph using the HEC-HMS and EPA-SWMM	5

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	2	2	2	3	3	2	2	2	1	2	3	2	2
CO2	2	3	3	2	3	3	2	2	2	2	1	3	2	1	2
CO3	3	2	2	2	3	3	3	3	1	2	1	3	2	2	2
CO4	2	2	3	3	3	2	3	1	1	2	2	2	3	2	2

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	Urban water cycle; Water budget analysis Impact of urbanization on surface runoff; Impact of Climate change on urban runoff; Rainfall returns period and hydrologic risk, Frequency analysis; Intensity-Duration-Return Period Curves; Design rainfall depth, return period, and storm duration; Some methods for developing design-storm hyetographs. Rainfall Excess: Rainfall Abstractions, interception, depression storage, and infiltration; Soil Conservation Service (SCS) method for combined loss rainfall loss computations.	**12**

Module 2	Elements of urban runoff hydrograph; Time of Concentration: SCS Method; Kinematic Formulas; Unit Hydrograph Method; application of the Unit Hydrograph Method. Review of open-channel flow equations; Overland flow; Kinematic-wave model; Overland Flow on pervious and impervious surfaces. Channel flow routing: Muskingum Method; Muskingum-Conge Method; Routing with lateral Inflow SCS methods for runoff computations: USGS regression equations; The rational method; Introduction to some physically based lumped rainfall-runoff models: GR4J, VIC; SAC-SMA	**12**
Module 3	Drainage structures for stormwater: Drainage of street pavements; Design considerations; Flow in gutters; Pavement drainage inlets and their locations. Storm-sewer systems: Design discharge for storm sewers; Sizing storm sewers; Hydraulic grade line; Design of storm-sewer system. Culverts: flow control and sizing.	**8**
Module 4	Urban stormwater quality; solids buildup and wash-off from pervious and impervious areas; Quantity and characteristics of pollutants; Modeling urban stormwater quality; Common management practices for stormwater quality control	**4**
Module 5	Computer models for simulating and predicting stormwater flow: HEC-HMS and EPA-SWMM: Overview and features of the models. Practical applications	**6**
	Total	**42**

Books Recommended:

1. Chow, V.T., Maidment, D.R. & Mays, L.W., 1988. *Applied Hydrology*. McGraw-Hill, Singapura.
2. Akan A.O and Hioughtalen R.J., 2003, *Urban Hydrology, Hydraulics and Stormwater Quality: Engineering Applications and Computer Modeling*, 1st Edition, John Wiley & Sons
3. David Butler, Christopher James Digman, Christos Makropoulos, John W. Davies, 2018, *Urban Drainage*, 4th Edition CRC Press.

Semester	Course Title	Course Code	Credit-L-T-P
7th	Geosynthetics in Civil Engineering	CVT415	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To understand the various tests to determine the properties of Geosynthetics and their functions and also to understand and apply the various design approaches to analyse the reinforced soil.

Prerequisites: Knowledge of Basic Soil Mechanics and Foundation Engineering/ Geotechnical Engineering

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

CO No.	Description	BTL
CO1	To identify the different types of Geosynthetics and their application in civil engineering construction.	**2**
CO2	To evaluate various engineering properties of geosynthetics for its applications in civil engineering design.	**2** **4**
CO3	Review different Codal provisions for reinforced earth and incorporate them in the design of reinforced soils.	**2**
CO4	To learn and implement the design methodology for geosynthetic reinforced structures.	**3** **5**

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	-	2	-	-	-	-	-	-	-	-	-	1	3	3	-
CO2	1	1	-	-	2	-	2	-	2	2	-	2	3	3	-
CO3	2	2	2	-	-	-	2	-	-	-	-	2	3	3	-
CO4	3	3	3	3	3	-	2	2	-	1	2	3	3	3	-

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Sr. No.	Course Contents	Contact Hours
1	**Reinforced Earth:** Historical background of reinforced soil, Concept, Effects of Reinforcement on soils, Principles of reinforced soil through Mohr circle analysis.	04
2	**Geosynthetics:** Types, Raw materials and Manufacturing processes, Functions, Tests on Geosynthetics, Durability Aspects, Applications, Properties and test methods, Standards and Codes of Practice	10
3	**Application areas and Design Methodology:** Reinforced Earth Retaining	20

	Walls, Reinforced Embankments, Reinforced Soil Beds, Reinforced Pavements, Shallow foundations, Railway tracks, Reinforced Slopes, Containment ponds, Reservoirs, Canals, Drainage systems	
4	**Case studies and Quality control**: Quality control and in-situ monitoring, Cost analysis, Case studies and learning	8

Textbooks:

1. Koerner, R. M. (2012). Designing with Geosynthetics, 6th Edition, Vol. 1 and 2, Xlibris
2. Corp.
3. Shukla, S. K. (2017). An introduction to geosynthetic engineering. CRC Press.
4. Shukla, S. K. (Ed.). (2012). Handbook of Geosynthetic Engineering: Geosynthetics and their applications. ICE publishing.

References:

1. Giroud, J. P. (1984). "Geotextiles and Geomembranes. Definitions, Properties and Design," Selected Papers, Revisions and Comments, 4th ed., IFAI Publishers
2. Holtz, R. D., Christopher, B. R. and Berg, R. R. (1997) Geosynthetic engineering, Bitech
3. Publishers Ltd.
4. Hausmann, M. R. (1990). Engineering Principles of Ground Modification, McGraw-Hill
5. Publishing Company, New York
6. Ingold, T. S. (1982). Reinforced Earth, Thomas Telford Ltd., London
7. Jones, C. J. (2013). Earth reinforcement and soil structures. Elsevier.

Semester	Course Title	Course Code	Credit-L-T-P
7th	**Soil Dynamics**	CVT416	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To familiarise the students with approaches for understanding the fundamentals of the response of soils and foundations under dynamic loadings and the design criteria of foundations subjected to machine vibrations.

Prerequisites: Geotechnical Engineering-I and II; Basics of theory of Vibrations

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

CO No.	Course Outcomes	BTL
CO1	To understand the dynamic behaviour of soil and the propagation of waves in elastic half-space.	**2**
CO2	To evaluate the dynamic soil properties through field and laboratory tests.	4
CO3	To learn the methods of design of machine foundations and understand the concept of soil-structure interaction.	**5**

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	3	3	-	2	2	-	-	-	-	2	3	3	3
CO2	3	3	3	3	-	2	2	-	-	-	-	2	3	3	3
CO3	3	3	3	3	-	2	2	-	-	-	-	2	3	3	3
CO4	3	3	3	3	-	2	2	-	-	-	-	2	3	3	3

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Sr. No.	Course Contents	Contact Hours	BTL
1.	**Introduction to soil dynamics:** Importance of soil dynamics, nature and types of dynamic loading, between soil mechanics and soil dynamics, discuss engineering problems involving dynamic loading, theory of vibration, vibration measuring instruments.	**02**	**BTL2**
2.	**Wave propagation in elastic half-space:** Wave propagation (longitudinal and torsional wave propagation in an elastic rod, longitudinal and torsional wave propagation in an elastic infinite medium, wave propagation in a semi-infinite elastic half-space)	**06**	**BTL2, BTL3**
3.	**Dynamic soil properties:** Stresses in soil element, concept of soil stiffness, damping ratio and plastiCVTy properties of soil, techniques for estimation of dynamic soil properties from field - invasive and non-invasive testing – (seismic reflection, refraction etc.) and laboratory testing (resonant column test, cyclic triaxial test, torsional shear test, block vibration test etc.). Correlation for obtaining various geotechnical parameters.	**12**	**BTL2, BTL4**

4.	**Design of machine foundations:** Types of machine foundation, Mass-spring dashpot model, concept of vibration isolation, Design criteria for machine foundations, Elastic homogeneous half-space and lumped parameter solutions, Vertical, sliding, torsional (yawing) and rocking (and pitching) modes of osCVLlations, Design guidelines as per codes, Introduction to dynamic soil-structure interaction, Typical design problems.	**16**	**BTL2, BTL3 BTL5**

Textbooks:

1. Shamsher Prakash "Soil Dynamics", McGraw Hill Book Company (1981).
2. Steven L. Kramer, "Geotechnical Earthquake Engineering", Prentice Hall Inc (2003).
3. Swami Saran, "Soil Dynamics and Machine Foundations", Galgotia Publications (1999)

References:

1. Robert W. Day, "Geotechnical Earthquake Engineering Handbook", McGraw Hill, New York. (2002)
2. Kenji Ishihara, "Soil Behaviour in Earthquake Geotechnics", Oxford University Press, USA. (1996).
3. G.V. Ramanna and B.M. Das "Principles of Soil Dynamics" CENGAGE Learning, USA. (2011).
4. Richart, F.E., Woods, R.D. and Hall, J.R. Vibrations of soils and foundations. Prentice-Hall, 1970.

Semester	Course Title	Course Code	Credit-L-T-P
7th	Design of Special Structures	CVT417	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To gain knowledge about the design and analysis of special concrete structural members like various slab system, curved beam, slender column, deep beam, corbel, raft & pile foundation, and shear wall.

Pre-requisites: Design of Reinforced Concrete Structures; Advanced Design of Concrete Structures.

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

CO No.	Course Outcomes	BTL
CO1	Design of various types of slab systems.	5
CO2	Analyse and design the curved beam, slender column, deep beam, corbel and various types of foundations & pile cap.	5
CO3	Design and ductile detailing of shear wall as per Indian standards.	5
CO4	Design knowledge about tower-like structures.	5

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	3	3	-	-	1	-	-	-	-	2	3	3	-
CO2	3	3	3	3	1	-	1	-	-	-	-	2	3	3	-
CO3	3	3	3	3	2	-	1	-	-	-	-	3	3	3	-
CO4	3	3	2	2	3	-	1	-	-	-	-	3	3	3	2

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Floor/Roof Slab**: design of flat slab, grid floor, voided slab, folded plate, and sloped & curved roof.	10
Module 2	**Beam-Column & Foundation**: design of curved beam, moment redistribution in continuous beams, beam-column joint. *Column* – slender, inclined, and second-order effect. *Design of deep beam & corbel*– strut and tie model. *Foundation*: design of footing - isolated, combined/continuous, strip, raft, pile, pile cap - strut and tie approach.	12
Module 3	**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.	8
Module 4	**Tower-like Structures**: design of chimney, communication tower, lighthouse, and hyperbolic cooling tower.	8

Module 5	**Design Software**: Exposure to the finite element software to model, analyse and design the above-mentioned special structural members.	4
Total		**42**

Textbooks:

1. Krishna Raju, N. "**Advanced Reinforced Concrete Design**", CBS Publishers and Distributors Pvt Ltd.
2. Punmia, B. C., Jain, A. K., and Jain, A. K. "**Comprehensive RCC Design**", Laxmi Publications.
3. Pillai, S. U., Menon, D. "**Reinforced Concrete Design**" Tata McGraw Hill.

References:

1. Darwin, D., Dolan, C. W., and Nilson, A. H. "**Design of Concrete Structures**", McGraw-Hill Education.
2. Jain, A. K. "**Reinforced Concrete: Limit State Design**", Nem Chand & Bros.
3. Park, R., and Paulay, T. "**Reinforced Concrete Structures**", John Wiley and Sons.
4. Sinha, S. N., "**Reinforced Concrete Design**", McGraw Hill Education.
5. Varghese, P. C. "**Advanced Reinforced Concrete Design**", Prentice-Hall of India Pvt. Ltd.

Semester	Course Title	Course Code	Credit-L-T-P
7th	Offshore Renewable Energy	CVT418	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: This course covers the fundamentals of ocean wave mechanics, wave energy transport, operation of various wave energy converters, extraction of offshore wind energy and tidal energy using various wave energy converters. The course culminates in studying the offshore renewable energy sources to design and evaluate the various wave energy converters.

Pre-requisites: None.

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

CO No.	Course Outcomes	BTL
CO1	Develop the knowledge on the basics of ocean wave mechanics, and wave kinematics.	3
CO2	Analyze the concept of wave energy transport, and operation of various wave energy converters for onshore and offshore applications.	4
CO3	Evaluate the significance of offshore floating devices and wave energy converters to extract the wave energy.	5
CO4	Explain the Aero-foil Theory, extraction of offshore wind energy and tidal energy using various devices.	5

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	2	2	2	1	3	1	2	2	2	2	3	3	1
CO2	3	3	2	3	3	1	3	1	2	2	2	2	3	3	1
CO3	3	3	2	3	2	1	3	1	2	2	2	2	3	3	1
CO4	3	3	2	3	2	1	3	1	2	2	2	2	3	3	1

1-Slightly; 2-Moderately; 3-Substantially;

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction to Wave Mechanics:** Potential Flow, Laplace equation, Boundary value problem, small amplitude waves, Linearized boundary Conditions, Periodic, progressive, and Standing waves, **Wave Kinematics:** Wave kinematics, basic dispersion relation, Shallow and Deep-water waves.	**10**
Module 2	**Transport of Wave Energy:** Description of wave osCVLlation, Wave power, Energy Transport, Resonance absorption, and Momentum; **Methods of Approach:** Description and operation of various wave energy converters for onshore and offshore applications. Analysis based on analytical and numerical methods.	**10**
Module 3	**Integrated Offshore Floating Structures:** Design of wave environment,	**12**

	maximum power absorption from ocean waves using floating structures, the response of floating structures, Overtopping Devices, Wave absorbing devices, Time and frequency domain of numerical methods. **Wave Energy Converters:** Global energy demand, Hydrodynamic characteristics of wave energy converters, OsCVLlating Water Columns (OWC), Point absorbers, Terminators, Wave attenuators, Pelamis Wave Energy Converter, Wave Dragon, Wave Roller.	
Module 4	**Offshore Wind Turbines:** Design of offshore wind turbines, Mounting/mooring arrangements, installation, Design of wind turbine, aerodynamic characteristics of horizontal and vertical axis wind turbines, Aero-foil Theory. **Tidal Energy Converters:** Tidal energy, Current stream devices, Barrage systems, hydrodynamic characteristics of tidal devices, wave and current effects, energy storage, Transmission and Distribution issues, and solutions.	**10**
	Total	**42**

Books Recommended:

1. Johannes, F., 2002. Ocean waves and OsCVLlation Systems, Cambridge University Press.
2. Mani, J.S., 2012. Coastal Hydrodynamics, WIT Press.
3. Sundar, V., 2015. Ocean wave Mechanics, Wiley Publication.
4. Charlier, R. H., Finkl. C.W. 2009. Ocean Energy, Tidal and Tidal Power, Springer Verlag.

Semester	Course Title	Course Code	Credit-L-T-P
7th	Finite Element Methods in Civil Engineering	CVT419	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To introduce finite element analysis (FEA) as a tool to find solutions of differential equations and to analyse the structural frameworks & stress analysis by FEA.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Development of finite element equations and learn about its application to civil engineering field	5
CO2	Analyse the structures/members based on the finite element method.	5
CO3	Formulate solution methodology for one-dimensional boundary value problems.	5
CO4	Apply the mapping of elements and shape functions for filed applications.	3

Course articulation matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	3	3	-	1	1	-	2	2	1	2	3	1	-
CO2	3	3	3	3	-	1	1	-	2	2	1	2	3	1	-
CO3	3	3	3	3	-	1	1	-	2	2	1	2	3	1	-
CO4	3	3	3	3	-	1	1	-	2	2	1	2	3	1	-

Detailed Syllabus:

S. No.	Contents	Contact Hours
1	**Basic Finite Element Concepts**: Basic ideas in a finite element solution, General finite element solution procedure, Approximate solution using a variational method, Modified Galerkin method. Development of finite element equations, Application: Axial deformation of bars, Axial spring element.	10
2	**Analysis of Truss**: Two-dimensional truss element, Three-dimensional space truss element, Stresses due to lack of fit and temperature changes.	5
3	**Analysis of Beam**: Governing differential equation for beam bending, two-node beam element, Exact solution for uniform beams subjected to distributed loads using superposition, Calculation of stresses in beams, Thermal stresses in beams.	10

S. No.	Contents	Contact Hours
4	**Analysis of Frame**: Plane frame element, Thermal stresses in frames, Three-dimensional space frame element.	5
5	**Boundary Value Problem**: General one-dimensional boundary value problem (BVP) and its applications – Column buckling. Higher order elements for one dimensional problems−Shape functions for second order problems, Isoparametric mapping concept, Quadratic isoparametric element for general one-dimensional boundary value problems, One-dimensional numerical integration. Introduction to two-dimensional BVP.	12

Textbooks:

1. Bhatti, M. A. "**Fundamental Finite Element Analysis and Applications: with Mathematica and MATLAB Computations**", John Wiley & Sons.
2. Bhatti, M. A. "**Advanced Topics in Finite Element Analysis of Structures: With Mathematica and MATLAB Computations**" John Wiley & Sons.
3. Reddy, J. N. "**An Introduction to the Finite Element Method**", Tata McGraw-Hill Education.

References:

1. Seshu, P. "**Textbook of Finite Element Analysis**", PHI Learning.
2. Rao, S. S. "**The Finite Element Method in Engineering**", Elsevier.
3. Liu, G. R., and Quek, S. S. "**The Finite Element Method**", Butterworth-Heinemann.
4. Chandrupatla T. R., and Belegundu, A. D. "**Introduction to Finite Elements in Engineering**", PHI Learning.
5. Bathe, K. J. "**Finite Element Procedures**", PHI Learning.

Semester	Course Title	Course Code	Credit-L-T-P
7th	Advanced Steel Design	CVT420	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To gain knowledge about the design and analysis of special steel structures like pre-engineered buildings, communication and transmission line towers, and cold-formed steel buildings.

Pre-requisites: Design of Steel Structures

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

CO No.	Course Outcomes	BTL
CO1	Design of various types of steel connections	5
CO2	Analyse and design the industrial building.	5
CO3	Design and detailing of communication and transmission line towers.	5
CO4	Design of cold-formed steel structures.	5

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	3	3	-	-	1	-	-	-	-	2	3	3	-
CO2	3	3	3	3	1	-	1	-	-	-	-	2	3	3	-
CO3	3	3	3	3	2	-	1	-	-	-	-	3	3	3	-
CO4	3	3	2	2	3	-	1	-	-	-	-	3	3	3	2

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Connections**: connection classifications, semi-rigid & rigid connections, framed & seated connections, and moment-resistant connections.	6
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.	10
Module 3	**Steel Towers -** *Communication and Transmission Line*: introduction, types of towers, tower configurations, loads, codal provisions, analysis and design, foundations of towers.	12
Module 4	**Cold-Formed Steel**: introduction, application, advantages of cold-formed sections, local buckling, beam, column, combined bending & compression, tension members, empirical method.	8
Module 5	**Design Software**: Exposure to the finite element software to model, analyse and design the above-mentioned steel structures.	6
Total		**42**

Textbooks:

1. Srinivasan Chandrasekaran. "**Advanced Steel Design of Structures**", CRC Press.
2. Subramanian, N. "**Design of Steel Structures – Limit States Method**", Oxford University Press.
3. Duggal, S. K. "**Design of Steel Structures**", Tata McGraw Hill.

References:

1. Salmon, C. G., Johnson, J. E., and Malhas, F. A. "**Steel Structures – Design & Behaviour**", Pearson.
2. Gambhir, M. L. "**Fundamentals of Structural Steel Design**", McGraw Hill.
3. Vizrani, V. N., Ratwani, M. M., and Kumar, V. "**Design and Analysis of Steel Structures**", Khanna Publishers.

Semester	Course Title	Course Code	Credit-L-T-P
7th	Construction Laws and Claims	CVT421	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: Exploring best practices regarding claim management in construction firms, including a clear understanding of construction law and its application to civil engineering and project management.

Pre-requisites: None

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

CO No.	Description	BTL
CO1	Determine how construction firms are governed by the legal system.	5
CO2	Identify which legal issues are relevant to construction contracts and claims.	3
CO3	Categorize the construction contract disputes & know ways to resolve them.	5
CO4	Discuss the various Indian Acts that are likely to be encountered in construction projects.	6

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	-	-	-	-	-	3	-	3	3	-	3	-	3	-	3
CO2	-	-	-	1	-	3	-	1	-	-	-	-	2	-	1
CO3	-	-	-	2	-	3	-	2	2	-	3	-	-	-	-
CO4	-	-	-	2	-	3	-	2	-	-	-	-	-	-	-

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

S. No.	Course Contents	Contact Hours
1.	The Law and the Legal System, application of law, contractor, subcontractor, consultant, supplier, government, funder, etc.	4
2.	Contract specification, types of contract documents used for construction, selection of a contractor, Remedies: Contract Breach, Design Professionals and Liability, Ethics / Public Contracts	10
3.	Contract claims and damages, grounds for claims, claims procedures, quantification of procedure, insurance, bonds and guarantees, disputes and its resolution methods	12
4.	CONTRACT ACT: Essentials, valid contract, discharge of a contract by performance, breach of a contract, etc., RERA ACT: functions, rights and duties, offences and penalties, agreement for sale	10
5.	Introduction to FIDIC, the necessity of FIDIC contract, contract administration and claims, risk, insurance, and securities.	6

References:

1. Kelley, G. "**Construction Law: An Introduction for Engineers, Architects, and Contractors**", John Wiley & Sons.
2. Bhatt, V., and Vyas, P. "**Laws for Engineers (Contract, Arbitration, Evidence, Limitations)**", ProCare.
3. Coggins, J., Davie, T., Ears, T., and Evans, P. "**Understanding Construction Law**", LexisNexis Butterworths.
4. Baker, E., Mellors, B., Chalmers, S., and Lavers, A. "**FIDIC Contracts Law and Practices**", Taylor & Francis Group.
5. Bailey, J. "**Construction Law**", Taylor and Francis Group.

Semester	Course Title	Course Code	Credit-L-T-P
8th	Earthquake Resistant Design	CVT451	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To design and detail the structures especially buildings which are resistant to earthquakes as per Indian standards.

Pre-requisites: Structural Dynamics

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

CO No.	Course Outcomes	BTL
CO1	Develop the basic concept of earthquake engineering and response spectrum.	4
CO2	Analyze the response of building structures under ground motion followed by computation of seismic forces on buildings based on various methods (equivalent static method, dynamic analysis (i.e. Modal analysis).	5
CO3	Design structures that can resist seismic forces effectively.	5
CO4	Apply ductile detailing techniques for reinforced concrete structures.	4

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	3	3	-	-	1	-	-	-	-	2	3	3	-
CO2	3	3	3	3	1	-	1	-	-	-	-	2	3	3	-
CO3	3	3	3	3	2	-	1	-	-	-	-	3	3	3	-
CO4	3	3	2	2	3	-	1	-	-	-	-	3	3	3	2

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	Introduction to Seismology and Earthquake Engineering. Types of Earthquakes and Seismic Waves. Ground Motion Parameters. Response Spectra. Design Spectra.	8
Module 2	Overview of IS 1893 (Part 1): 2016. General Provisions and Building Configuration Load Combinations. Seismic Weight and Distribution of Seismic Forces. Analysis Methods (Equivalent Static Method, Response Spectrum Method.) Torsion in Buildings and Methods to Counteract. Introduction to seismic design of masonry structures.	20
Module 3	Overview of IS 13920: 2016. Importance of Ductility in Seismic Design. Detailing Requirements for Beams, Columns, and Joints. Detailing Requirements for Shear Walls and Frame-Shear Wall Systems.	8
Module 4	Introduction to Advanced Topics in Seismic Design. Performance-Based Seismic Design. Nonlinear Static and Dynamic Analysis (Pushover Analysis). Introduction to Seismic Design Software (SAP2000, STAAD Pro)	6
Total		**42**

Textbooks:

1. Duggal, S. K. "**Earthquake-Resistant Design of Building Structures**", Oxford University Press.
2. Hosur, V. "**Earthquake-Resistant Design of Building Structures**", Wiley India Pvt. Ltd.
3. Ingle, R. K. and Jain, S. K. "**Explanatory Examples for Ductile Detailing of RC Buildings**", Indian Institute of Technology Kanpur, India.

References:

1. Willians, A. "**Seismic Design of Building & Bridges**", Oxford University Press.
2. Pauley, T, and Priestley, M. J. N. "**Seismic Design of Reinforced Concrete and Masonry Buildings**", John-Wiley & Sons.
3. Murty, C. V. R. "**Earthquake Tips – Learning Earthquake Design and Construction**", National Information Centre of Earthquake Engineering, IIT Kanpur, India.
4. Murty, C. V. R., Goswami, R., Vijayanarayanan, A. R., and Mehta, V. V. "**Some Concepts in Earthquake Behaviour of Buildings**", Gujarat State Disaster Management Authority, Government of Gujarat, India.
5. NDMA. "**Simplified Guidelines for Earthquake Safety of Buildings from National Building Code of India 2016**", National Disaster Management Authority, India.

Semester	Course Title	Course Code	Credit-L-T-P
8th	Bridge Engineering	CVT452	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To gain knowledge about types of bridges & their structural components and exposure to the design of bridges as per Indian specifications.

Pre-requisites: Structural Analysis, Steel and RCC Design

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

CO No.	Course Outcomes	BTL
CO1	Demonstrate fundamental knowledge of the types, design of bridges and evaluation of design forces.	5
CO2	Design of various types of bridge decks.	6
CO3	Design of steel truss bridges.	6
CO4	Design of plate girder bridge and composite decks.	6

Course articulation matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	1	2	2	-	-	1	1	-	-	3	-	3	3	1	3
CO2	3	3	2	1	1	-	1	-	1	3	2	3	3	2	2
CO3	3	3	2	2	1	1	1	-	1	3	1	3	3	2	3
CO4	3	3	2	2	1	3	1	-	3	3	1	3	3	2	3

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

S. No.	Contents	Contact Hours
1	**Introduction**: historical evolution of bridges; types of bridges; modern trends in bridge engineering. *Bridge loading standards*: evolution of bridge loading standards; Indian Roads Congress (IRC) bridge loading standards; impact factors. *Influence line diagrams*: use of influence line diagrams to calculate the effect of IRC standard moving loads on the truss bridge elements and plate girder bridges. Evaluation of design forces, moment, etc. in bridges.	10
2	**Concrete Slab Bridges (Culverts)**: Effective width method; Grillage analogy for standard IRC loads. Analysis of RC slabs using Pigaurd's Curves subjected to standard IRC loads. Design of slab decks based on Ultimate limit state and Serviceability limit state.	8
3	**Steel Truss Bridges**: general features of steel trussed bridges; various types of truss bridges; Analysis of truss bridges subjected standard IRC loads; design specifications, design of steel truss bridges elements.	10
4	**Plate Girder Bridges and Composite Decks**: Introduction to plate girder bridges; general features of plate girder bridges; Non-composite plate girder bridges and design specifications. Composite plate girder bridges and design principles.	14

Textbooks:

1. Johnson, D.V., 2017. Essentials of bridge engineering. Oxford and IBH Publishing.
2. Krishna R.N., 2019. Design of Bridges. Oxford & IBH Publishing Co. Pvt. Ltd.
3. Rajgopal, N., 2006. Bridge Superstructure. Narosa Publishing House.

4. Frýba, L., 1996. Dynamics of railway bridges. Thomas Telford Publishing.

References:

1. Raina, V.K., 2004. Concrete bridge practice: analysis, design and economics. Shroff Publishers and Distributors Pvt Limited.
2. Aswani, M.G., Vazirani, V.N. and Ratwani, M.M., 2004. Design of concrete bridges. Khanna Publishers.
3. Ponnuswamy, S., 2008. Bridge Engineering. Tata McGraw-Hill.
4. Jagadish, T. R., and Jairam, M. A., 2011. Design of Bridge Structures. Prentice Hall of India.
5. Phatak, D. R., 2014. Bridge Engineering. Satya Prakashan.
6. Bakht, B., and Jaegar, L. G., Bridge Analysis Simplified. McGraw-Hill.

Semester	Course Title	Course Code	Credit-L-T-P
8th	Design of Prestressed Concrete Structures	CVT453	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To acquire knowledge about prestress technology in structural systems and to analyse & design pre-stress members subjected to various types of loading at service & ultimate limit states.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Understand the prestress technology and materials' properties & behaviour	3
CO2	Estimate the losses in the prestressed members.	4
CO3	Analyse and Design prestressed members (axial, flexure, shear, and torsion).	5
CO4	Calculate the deflection and crack width of prestressed members.	4

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	2	3	2	-	-	-	-	-	-	2	3	3	2
CO2	3	3	3	3	3	-	2	-	-	-	-	2	3	3	-
CO3	3	3	3	3	3	-	-	-	-	-	-	2	3	3	-
CO4	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
1	**Introduction** - *Prestressing Systems and Material Properties*: basic concept; early attempts of prestressing; brief history; types of prestressing; prestressing systems and devices - pre-tensioning & post-tensioning; materials' properties – concrete, reinforcement, and tendon.	4
2	**Losses in Prestress:** elastic shortening; pre-tensioned axial members; pre-tensioned bending members; post-tensioned axial members; post-tensioned bending members; friction; anchorage slip; force variation diagram; creep of concrete; shrinkage of concrete; relaxation of steel; total time-dependent loss.	4
3	**Analysis and Design of Members for Axial & Flexure**: *analysis of members under axial load* – introduction; analysis at transfer; analysis at services loads; analysis of ultimate strength; analysis of behaviour. *analysis of member under flexure* - introduction; analysis at service loads; based on stress concept; based on force concept; based on load balancing concept; cracking moment; kern point; pressure line; analysis for ultimate strength; variation of stress in steel;	10

Module No.	Contents	Hours
	condition at ultimate limit state. Analysis of rectangular & flanged sections; partially prestressed sections; un-bonded post-tensioned beams. *design of members*: calculation of demand; design of members for axial tension, and flexure (type I and II); detailing requirements for flexure.	
4	**Analysis and Design for Shear & Torsion:** analysis for shear and torsion; detailing requirements for shear and torsion.	6
5	**Calculations of Deflection and Crack Width**: deflection due to gravity loads and prestressing force; limits of deflection; determination moment of inertia; limits of span-to-effective depth ratio. *Crack Width* - method of calculation; limits of crack width.	8
6	**Transmission of Prestress**: *Pre-tensioned members* - transmission length; development length; end zone reinforcement. *Post-tensioned members* - end zone reinforcement; bearing plate.	4
7	**Special Topics:** design of prestressed cantilever and continuous beams; cable profile. Analysis and design of composite sections, one-way slab, two-way slab, compression member, circular prestress.	6
	Total	42

Textbooks:

1. Rajagopalan, N, 2010, "Prestressed Concrete", Narosa Publishing House.
2. Krishna Raju, N. 2006, "Prestressed Concrete", Tata McGraw-Hill Publishing Company Limited.

References:

1. Lin, T. Y., and Burns, N. H. 2010,"Design of Prestressed Concrete Structures", John Wiley and Sons.

Semester	Course Title	Course Code	Credit-L-T-P
8th	Instrumentation in Geotechnical Engineering	CVT454	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To provide students with the knowledge of basic geotechnical instrumentation; principles of instrumentation and their application in field to monitor slopes, embankments, settlements etc. Exposure to case studies and future disasters which will help students to mitigate and investigate failures in geotechnical engineering.

Pre-requisites: The student should have attended courses of Soil Mechanics/Geotechnical Engineering.

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

CO No.	Course Outcomes	BTL
CO1	Understand instrumentation used in Geo Technical Engineering.	4
CO2	Apply principles and knowledge of using instrumentation technique	6
CO3	Control various parameters and innovate by using the technique of Instrumentation.	5
CO4	Design proper system to meet the requirement and failure investigation	6

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	2	3	2	3	2	1	-	-	3	-	1	2	3	1	-
CO2	2	2	2	3	2	-	-	-	2	3	2	2	3	2	-
CO3	3	2	2	3	3	-	2	-	-	3	3	3	3	3	2
CO4	3	3	3	3	3	3	2	-	-	3	3	3	3	3	3

Detailed Syllabus:

Module No.	Contents	Hours
1	Introduction to geotechnical instrumentation; Purpose and selection of geotechnical instruments; Pore pressure-Ground water table-Strain gauges	**06**
2	Types of field measurements; Principles of instrumentation; Settlement gauges, Piezometers, earth pressure cells and inclinometers; Planning of instrumentation; Vibration measurements.	**12**
3	Case histories; Building settlement; in-situ stresses in soils; Underground construction and tunnelling in soft ground; Observation studies during construction – Post construction; Innovation in Geotechnical Instrumentation	**12**

4	Dams and embankments; Failure investigations in Geo technical Engineering; Good practices in instrument installation, monitoring and protection; Roles and responsibilities of project stakeholders	**12**
Total		**42**

Books Recommended:

1. Geotechnical Instrumentation for Monitoring Field Performance; John Dunnicliff, Gordon E. Green; Wiley
2. A Guide to Field Instrumentation in Geotechnics: Principles, Installation and Reading; Richard Bassett; CRC Press
3. Geotechnical Instrumentation and Monitoring in Open Pit and Underground Mining; T. Szwedzicki; CRC Press
4. Field Instrumentation in Geotechnical Engineering, Hanna T.H., Trans Tech., 1985.
5. Pressuremeter Testing Methods and Interpretation, Nair, R.J. and Wood, P.M.,Butter worths, 1987.

Semester	Course Title	Course Code	Credits- L-T-P
8th	Hydropower Engineering	CVT455	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: This course covers the hydropower potential using various categories, different types of dams, design of gravity, embankment dams and spill ways, and importance of power house, layout, pertinent structures, and transmission systems. The course culminates in studying the hydro power engineering to identify and use the various sources of power generation.

Pre-requisites: None.

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

CO No.	Course Outcomes	BTL
CO1	Analyze and perform hydro power potential assessment studies	4
CO2	Categorize different types of dams and design water conveyance system	4
CO3	Classify and design the Embankment dams and Spill ways	4
CO4	Importance of power house, pertinent structures, Transmission systems, and economic feasibility of hydropower plants.	5

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	3	3	3	-	3	-	2	2	2	2	3	3	2
CO2	3	3	3	3	3	-	3	-	2	2	2	2	3	3	2
CO3	3	3	3	3	3	-	3	-	2	2	2	2	3	3	2
CO4	3	3	3	3	3	-	3	-	2	2	2	2	3	3	2

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction** Introduction and historical Development, Hydropower development, Power equation, Assessment of potential, Comparison of Hydropower, thermal power plant and nuclear power plant. **Classification** High, medium and low Head schemes, Run off river plants, Storage power station Tidal power plant, Recent experiences, Underground Power plant. Pumped Storage Schemes, Various hydropower systems. Power demand, Role of power grid.	**10**
Module 2	**Water Conveyance System** Introduction to Power Canals, Power canals, Alignment Design of Power Canals, Flumes, Covered conduits and Tunnels Penstocks, Types of	**10**

	penstocks, Design of Penstocks, Anchor blocks. **Dams** Arch dam and classification with example Buttress dam, types Design: basic principles Design of gravity dams, Numerical questions for design of gravity dam Construction of Gravity Dams, Details of construction of Gravity Dams.	
Module 3	**Embankment Dams** Introduction to embankment dams Types of embankment dams, considerations for embankment dam. Introduction to Earthen dams. Rock fill dams, types of rock fill dams. Design considerations for embankment dams. Design of embankment dams **Spillway** Introduction, uses of spillway. Types of spillway, spillway as gate. Conditions for spillway. Design of silting basin. Numerical questions	**12**
Module 4	**Power House Details** Forebay, intake of a power house with general Introduction. Layout of a power house, site selection for a power house. Hydropower units arrangement, underground power station. **Transmission system** Introduction to transmission system Importance and use of transmission system	**10**
	Total	**42**

Books Recommended:

1. Arora, K.R. “Irrigation water power and Water Resources Engineering”, Standard Publisher Distributors, Delhi. 2002.
2. Dandekar, M.M. “Water Power Engineering” , Vikas Publishing House Gaziabad, U.P. India 1985
3. Nigham, P.S. (1979) Handbook of Hydroelectric Engineering, Nem Chand & Brothers, Roorkee.

Semester	Course Title	Course Code	Credits- L-T-P
8th	Environmental Engineering- II	CVT456	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective:
To enable students to understand and design various components of wastewater treatment plants and air pollution.

Pre-requisites: None.

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

CO No.	Course Outcomes	BTL
CO1	Develop a comprehensive understanding of sewage characteristics, self-purification of streams and sewage disposal methods	3
CO2	Design the various components of sewers and pumping stations for sewage treatment.	6
CO3	Design treatment units of a sewage treatment plant.	6
CO4	Analyse and understand various components of air pollution and its reduction technologies	4

Course articulation matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PS03
1	3	2	2	1	-	2	3	-	-	-	-	-	3	3	-
2	3	2	3	3	-	2	3	-	-	-	-	-	3	3	-
3	3	1	3	1	-	2	3	-	-	-	-	-	3	3	-
4	3	3	2	3	-	2	3	-	-	-	-	-	3	3	-

Detailed syllabus

S. No	Content	Contact Hours
Module 1	**Sewage disposal: -** Methods of sewage disposal, sewage collection and disposal, planning and design of domestic wastewater disposal systems, effects of disposal on land and in water bodies, Self-purification of streams, Sewage characterization; BOD, COD, solids, dissolved oxygen and nutrients., Standards of Disposal in normal water course and on land.	7
Module 2	**Sewers and sewage pumping stations** Design of sewers, components and layout of sewerage systems, Types of sewers, sewer appurtenances, Design of sewage pumping stations.	10

Module 3	**Wastewater treatment plants** Introduction and design of screening units, grit chamber, primary sedimentation, activated sludge process, secondary sedimentations, disinfection of effluents. Design of septic and Imhoff tanks, biological nitrogen, and phosphorus removal processes.	14
Module 4	**Sludge treatment and disposal** Sludge characteristics, sludge thickening, Anaerobic digestion of sludge, sludge disposal	4
Module 5	**Air pollution: -** Air pollution, Air quality standards, measurement of air pollution, factors responsible for pollution, technologies to control air pollution.	7
	Total	42

Books Recommended:

1. Peavy, H.S., Rowe, D.R. and Tchobanoglous, G., 1985. Environmental engineering (Vol. 2985). New York: McGraw-Hill.
2. Davis, M.L. and Cornwell, D.A., 2008. Introduction to environmental engineering. McGraw-Hill.
3. Birdie, G. S., Birdie, J.S., 2021. Water supply and sanitary engineering. Dhanpat Rai Publishing Company.

Semester	Course Title	Course Code	Credit-L-T-P
8th	Fundamentals of GIS and Remote Sensing	CVT457	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: This course aims to acquaint students with the basic elements of Remote Sensing and Geographic Information Systems

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Interpret and examine satellite imagery	4
CO2	Organize and visualize the Geographical database	3
CO3	Apply the principles of Geographic Information Systems to perform various geospatial analysis	3
CO4	Apply the concept of GIS and remote sensing in different civil engineering applications	3

Course articulation matrix

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

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Aerial and Satellite Data** - Types of Aerial images, Basic principles of satellite image scanners, spectral characteristics of earth's surface, range of sensing system. Multispectral, multitemporal, multisensoral, and multistage concepts**,** Earth Observation Satellite images, coarse, medium, and high resolution. Errors in remote sensing data Airborne LiDar images Digital Data: DEM derivation from aerial photographs, Hydrologic Data, Landcover Data, Soil Data, other digital data for water resources management.	**10**
Module 2	**Fundamentals of Geographic Information System** - geo-data - type - Input Sources - Raster and Vector data structures - Comparison of Raster and Vector data - errors in data - Projection and transformation - Reclassification - proximity analysis – Digitization techniques – cartography principles - various geo-spatial analysis – Concepts of RDBMS – Network analysis – web based GIS.	**10**

Module 3	**Analysis using Raster and Vector data** – Operations – Overlaying - Buffering –Modelling in GIS - Digital Terrain Modelling, Analysis and application – Products of DEMs and their uses – Sources of errors in GIS and their elimination.	**12**
Module 4	**Applications:** Urban planning, Hydrology and floods, Soil management, Water supply, Water distribution, Storm water, Solid and hazardous waste management, Transportation and utility system.	**10**
Total		**42**

Books Recommended:

1. Chang, K.T., 2010. *Introduction to Geographic Information Systems*. 7th ed. McGraw-Hill.
2. Sabins, F.F., 2007. *Remote Sensing: Principles and Interpretation*. 3rd ed. W.H. Freeman and Company, New York.
3. Lillesand, T.M. and Kiefer, R.W., 2008. *Remote Sensing and Image Interpretation*. 6th ed. John Wiley.
4. Lai, P.C. and Mak, A.S.H. (Eds.), 2007. *GIS for Health and Environment*. Springer.
5. Uzair, M.S., 2002. *GIS Tools for Water, Wastewater, and Stormwater Systems*. ASCE Press.
6. Joseph, G., 2006. *Fundamentals of Remote Sensing*. 3rd ed. University Press.
7. Agarwal, C.S. and Garg, P.K., 2002. *Remote Sensing in Natural Resources Monitoring and Management*. A.H. Wheeler & Co. Ltd., New Delhi.

Semester	Course Title	Course Code	Credit-L-T-P
8th	Risk and Reliability Analysis in Geotechnical Engineering	CVT458	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To provide students with the basics of risk and reliability analysis applied to geotechnical engineering, as well as an overview of recent applications and developments in Reliability Geotechnical Engineering Practices.

Pre-requisites: The student should have attended courses of Soil Mechanics and Foundation Engineering.

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

CO No.	Course Outcomes	BTL
CO1	Demonstrate uncertainty and risk analysis in geotechnical problems and apply recent applications and developments of Reliability analysis in Geotechnical Engineering Practices.	3
CO2	Analyze Uncertainty characterization of soil properties and Geotechnical Anomaly using Analytical approaches and Modelling uncertainties in risk and reliability analysis	4
CO3	Manage Quantitative Risk Assessment in geotechnical problems and formulate Probabilistic Risk Assessment, Risk Ranking and Importance Analysis, Interpretation of Results	5
CO4	Evaluating Reliability analysis in Geotechnical Engineering problems using simulation approach to system reliability and estimate foundation design based on relevant codal procedures	6

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	1	-	2	-	2	1	1	3	2	3	2	3	3	1	3
CO2	1	1	2	-	2	-	-	-	1	3	1	2	3	2	2
CO3	2	2	3	-	3	1	-	-	1	3	1	1	3	2	3
CO4	3	3	3	-	3	3	-	-	3	3	1	3	3	3	3

Detailed Syllabus:

Module No.	Contents	Hours
1	**Risk Analysis:** Determination of Risk Values, Uncertainty and risk in geotechnical engineering, Balancing risk and reliability in a geotechnical design, Some terminological and philosophical issues. Reliability Engineering in Perspective	

	Overview of basic statistical principles and reliability: Probability density functions, the normal, log-normal, uniform and exponential distributions, performance functions, Probabilities of failure from normally distributed capaCVTy and demand functions. The concept of the reliability index and the relationship with to the probability of failure.	**10**
2	**Part II: Site Characterization and Geotechnical Anomaly** Developments in site characterization-Analytical approaches to site characterization, Modeling site characterization activities, Uncertainty characterization of soil properties. Discriminant analysis, Modeling uncertainties in risk and reliability analysis. Measurement error, Spatial variability within homogeneous deposits, Stationary processes, Mathematical properties of autocovariance functions, Multivariate (vector) random fields, Gaussian random fields, Functions of random fields	**12**
3	**Part-III: Quantitative Risk Assessment** Identification of Hazards, Estimation of Hazard Exposure, Consequences of Evaluation, Risk, decisions and judgment, Managing risk and achieving reliable geotechnical designs using various codes, Practical risk assessment for embankments, dams, and slopes; Probabilistic analyses of a slope failure	**08**
4	**Part-IV: Evaluating Reliability in Geotechnical Engineering** Purpose of reliability analysis, Reliability as a basis for geotechnical design, Probability of failure and factor of safety, Taylor Series method with assumed normal & lognormal distribution of the factor of safety, Verification of geotechnical reliability using load tests and integrity tests; Example of reliability-based shallow foundation design; Reliability analysis of slope	**12**
Total		**42**

Books Recommended:

1. Jie Zhang · Te Xiao · Jian Ji · Peng Zeng · Zijun Cao (2023). Geotechnical Reliability Analysis Theories, Methods and Algorithms, Springer, https://doi.org/10.1007/978-981-19-6254-7.
2. Kok-Kwang Phoon Jianye Ching (2015). Risk And Reliability In Geotechnical Engineering, CRC Press, Taylor & Francis Group
3. B. Simpson (2011). Reliability in geotechnical design – some fundamentals, Arup Geotechnics, London, UK
4. K.K. Phoon and J.V. Retief (2016). Reliability of Geotechnical Structures in ISO2394, CRC

Press

5. Honoring Wilson H. Tang (2017). Geotechnical Safety and Reliability, Geo-Institute of the American Society of Civil Engineers, USA.
6. Mohammad Modarres, Mark P. Kaminskiy, Vasiliy Krivtsov (2016). Reliability Engineering and Risk Analysis-A Practical Guide, 3/E, CRC Press, Taylor & Francis Group

Semester	Course Title	Course Code	Credit-L-T-P
8th	Foundation Analysis	CVT459	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To develop proficiency in the design, analysis, and evaluation of various foundation systems including shallow foundations, raft/mat foundations, pile foundations, and drilled shaft foundations, with a thorough understanding of bearing capaCVTy, settlement behavior, and load transfer mechanisms

Pre-requisites: A fundamental understanding of soil mechanics and basic structural analysis.

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

CO No.	Course Outcomes	BTL
CO1	Apply principles of soil mechanics and bearing capaCVTy for design of shallow foundations and rafts	**3**
CO2	Estimate settlements of footings and rafts on elastic foundation	**5**
CO3	Analysis and estimation of axially and laterally loaded piles	**5**
CO4	Design and analysis of drilled shaft foundation	**5**

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	3	3	-	2	2	-	-	-	-	2	3	3	3
CO2	3	3	3	3	-	2	2	-	-	-	-	2	3	3	3
CO3	3	3	3	3	-	2	2	-	-	-	-	2	3	3	3
CO4	3	3	3	3	-	2	2	-	-	-	-	2	3	3	3

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction to Bearing CapaCVTy Theories:** A brief review of bearing capaCVTy theories, Terzaghi's, Meyerhof's and Hansen's bearing capaCVTy theories	**06**
Module 2	**Design and Analysis of Shallow Foundation** Types of Shallow foundations, Bearing CapaCVTy of shallow foundations. Settlement of Shallow Foundations, proportioning of foundations using field test data, IS codes.	**08**
Module 3	**Design and Analysis of Raft/Mat Foundation** Bearing CapaCVTy of Raft/Mat foundations, Settlement of Shallow Raft/Mat foundations, Structural design and analysis of Mat foundations	**08**

Module 4	**Design and Analysis of Pile Foundations** Types of Piles, Load Transfer Mechanisms in Piles, Static Pile CapaCVTy Pile settlements, Pile Groups, Laterally Loaded Piles	**10**
Module 5	**Design and analysis of drilled shaft foundation** Types of drilled shafts, Load transfer mechanism in drilled shafts Estimation of Load-Bearing CapaCVTy of Drilled Shafts, Settlement of Drilled Shafts	**10**
Total		**42**

Books Recommended:

1. Das, B. M. (1999). Principles of Foundation Engineering", PWS Publishing, USA.
2. Bowles, J. E. (1988). *Foundation analysis and design*.

References:

1. Kasmalkar, B. J. (1997). Foundation Engineering. Pune Vidyarthi Griha Prakashan-1786, Sadashiv Peth, Pune-411030
2. Poulos, H. G., & Davis, E. H. (1980). *Pile foundation analysis and design* (Vol. 397). New York: Wiley.
3. Hemsley, J. A. (Ed.). (2000). *Design applications of raft foundations*. Thomas Telford.
4. Peck, R. B., Hanson, W. E., & Thornburn, T. H. (1991). *Foundation engineering*. John Wiley & Sons.

Semester	Course Title	Course Code	Credit-L-T-P
8th	Disaster Management	CVT460	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: The course aims to cover both natural disasters beyond human control and those caused by human activities, focusing on disaster preparedness, response, and recovery.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	To understand the basic principles and various stages of disaster management and develop a know-how about regional, national, and international level regulatory authorities.	3
CO2	To have an understanding of various aspects of floods as disasters and various planning and mitigation measures.	3
CO3	To develop an understanding of Droughts and their socio-economic impacts - drought management.	3
CO4	To comprehend various aspects of landslides, earthquakes, and their effects on civil engineering structures, as well as strategies for their control and mitigation.	4

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	-	2	-	2	2	3	-	-	-	2	3	3	-
CO2	3	3	2	3	2	3	2	2	-	-	-	2	3	3	-
CO3	3	3	3	3	2	-	2	-	-	-	-	2	3	3	2
CO4	3	3	2	3	2	3	3	2-	-	-	-	3	3	3	3

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
1	Introduction to Disasters. Different Types of Disasters: **(A) Natural Disasters:** Flood, Cyclone, Earthquakes, Landslides **(B) Man-made Disasters:** Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures (Building and Bridge), War & Terrorism etc. Causes, effects and practical examples for all disasters. Introduction to disaster management, various stages of disaster management, Indian setup: National Disaster Management Authority, state-level authorities, Objectives of NDMA	8

Module No.	Contents	Hours
2	**Risk and Vulnerability Analysis;** 1. Risk: Its concept and analysis 2. Risk Reduction 3. Vulnerability: Its concept and analysis 4. Strategic Development for Vulnerability Reduction	8
3	**Disaster Preparedness and Response Preparedness** 1. Disaster Preparedness: Concept and Nature 2. Disaster Preparedness Plan 3. Prediction, Early Warnings, and Safety Measures of Disaster. 4. Role of Information, Education, Communication, and Training, 5. Role of Government, International and NGO Bodies. 6. Role of IT in Disaster Preparedness 7. Role of Engineers in Disaster Management. Response1. Disaster **Response:** 1 Introduction 2. Disaster Response Plan 3. Communication, Participation, and Activation Preparedness Plan 4. Search, Rescue, Evacuation and Logistic Management 5. Role of Government, International and NGO Bodies 6. Psychological Response and Management 7. Relief and Recovery 8. Medical Health Response to Different Disasters	10
4	**Rehabilitation, Reconstruction, and Recovery** 1. Reconstruction and Rehabilitation as a Means of Development. 2. Damage Assessment 3. Post Disaster effects and Remedial Measures. 4. Creation of Long-term Job Opportunities and Livelihood Options, 5. Disaster Resistant House Construction 6. Sanitation and Hygiene 7. Education and Awareness, 8. Dealing with Victims' Psychology, 9. Long-term Counter Disaster Planning 10. Role of Educational Institute.	8
5	Flood Disasters: Occurrence, Causes and effects of floods; flood plain delineation, mitigation measures viz., structural and non-structural measures, flood fighting, etc. Droughts: Various definitions, drought monitoring indices, combating drought Landslides: Causes, effects, and control measures, instrumentation and monitoring. Earthquakes: Causes and effects, earthquake resistant design of buildings.	8
	Total	42

Textbooks:

1. Nidhi Gauba Dhawan, 2012, " Disaster Management and Preparedness" CBS Publishers and Distributors.
2. P. Kumar, 2021 " Disaster Management" Foreword by Dhruv Mittal

Semester	Course Title	Course Code	Credit-L-T-P
8th	Construction Safety Management	CVT461	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To provide awareness of various safety issues related to construction projects as well as relevant standards and measures to consider.

Pre-requisites: None

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

CO No.	Description	BTL
CO1	Develop the knowledge of understanding the safety issues that are faced in the construction industry.	3
CO2	Examine that safety measures are adopted and implemented in the construction industry according to all applicable safety standards.	4
CO3	Determine the safety issues associated with the handling of labour, materials, and equipment on construction sites by construction personnel.	5
CO4	Adapt various codes, standards, acts and rules relevant to the construction industry's safety management.	5

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	-	-	1	-	-	3	-	3	-	-	2	1	1	-	-
CO2	-	-	1	-	-	2	-	2	-	-	-	-	-	-	-
CO3	2	3	2	1	-	3	-	2	-	3	-	-	-	-	-
CO4	3	-	1	2	-	3	-	3	-	-	-	-	2	-	-

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

S. No.	Course Contents	Contact Hours
1	**Introduction to Safety Issues in Construction:** Human factors in construction safety management. Roles of various groups in ensuring safety in the construction industry. Framing Contract conditions on safety, and related matters. Relevance of ergonomics in construction safety	6
2	**Safety in Various Construction Operations**: Excavation- under-water works- under-pinning & shoring Ladders & Scaffolds- Tunnelling- Blasting- Demolition- Pneumatic caissons- confined Space Temporary Structures. Indian Standards on construction safety- National Building Code Provisions on construction safety.	12
3	**Safety in Material Handling and Equipment**: Safety in storage & stacking of construction materials.	6
4	**Safety of Construction Equipment**: Vehicles, Cranes, Tower Cranes, Lifting gears, Hoists & Lifts, Wire Ropes, Pulley blocks, Mixers, Conveyors, Pneumatic and hydraulic tools in construction. Temporary power supply.	8

5	**Contract Labor Act**: Definitions, Registration of Establishments, Licensing of Contractors, Welfare and Health provisions in the Act, Penalties, Rules regarding wages. Construction Workers Act and Rules, Applicability, Administration, Registration, Welfare Board & Welfare Fund, Training of Construction workers, General Safety, Health & Well fare provisions, Penalties.	10

References:

1. Jha K.N, Dilip A Pate/ & Amarjit Singh. 2022. Construction Safety Management, Pearson Publications. 1st edition.
2. Mishra R.K. 2013. Construction Safety. AITBS Publishers, India
3. Bhattacharjee S.K. 2011. Safety Management in Construction (Principles and Practice). Khanna Publishers.
4. Rahshad Islam. M. 2021. Construction Safety: Health, Practices and OSHA: Health, Practice, and OSHA. Mc Graw Hill.
5. Construction Safety Manual for Works Contract by BARC, Mumbai, India.
6. National Building Code of India published by Bureau of Indian Standards.

Semester	Course Title	Course Code	Credit-L-T-P
8th	Pavement Analysis and Design	CVT462	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To equip students with the understanding and ability to analyze and design flexible and rigid pavements using current IRC guidelines, ensuring robust pavement performance.

Pre-requisites: Highway Engineering (CVT 302)

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

CO No.	Course Outcomes	BTL
CO1	Apply the principles of pavement design to analyze and compare different types of pavement structures, considering their suitability for various traffic conditions and environmental factors.	3
CO2	Analyze the factors affecting pavement design, such as traffic load, material properties, climatic conditions, and subgrade characteristics, to develop effective and durable pavement designs.	4
CO3	Design of flexible and rigid pavement using different methods and as per the latest IRC guidelines.	5
CO4	Evaluate the stresses and deflections developed in the flexible and rigid pavement.	6

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	-	1	-	1	1	-	-	-	-	-	1	1	-
CO2	2	3	1	1	1	-	1	-	-	-	-	-	1	1	-
CO3	-	-	3	1	1	1	1	-	-	-	-	-	3	2	1
CO4	-	-	3	1	1	-	-	-	-	-	-	-	2	1	1

Note: ***1****: Slight,* ***2****: Moderate &* ***3****: Substantial*

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction** Pavement Structures, Types & comparison, Function of various pavement components, Pavement design, factors affecting pavement design, Airport pavement, Difference between Highway and airport pavements	8
Module 2	**Analysis of Pavements:** Theories of Pavement Analysis. Analysis of Stresses and Deflections developed in flexible and rigid pavements	10

Module 3	**Design of Flexible Pavement** Cross section of flexible pavement, stresses in Flexible pavements, Analytical approach, ESWL, repetitions of load, techniques of design methods, wheel load analysis, traffic analysis, Burmister's method, group index method, CBR approach, IRC guidelines, CRV method, triaxial & McLeod method, Design practices as per latest IRC guidelines.	14
Module 4	**Design of Rigid Pavement:** Cross section of rigid pavement, stresses in rigid pavement, Westergaard's approach, design of expansion & longitudinal joints, design of dowel & tie bars, Design practices as per latest IRC guidelines.	10
Total		**42**

References:

1. Yoder and Witezak, 1975, *Principles of Pavement Design*, John Wiley and sons.
2. Yang, 1972, *Design of functional pavements*, McGraw-Hill.
3. Kadiyali L.R., 2003, *Principles & Practice of Highway Engineering*, Khanna Publishers.
4. Khanna S.K., Justo C.E.G., 2001, *Highway Engineering*, Nem Chand & Bros., Roorkee.
5. IRC:37-2018, *Guidelines for the Design of Flexible Pavements*, IRC New Delhi
6. IRC:58-2021, Guidelines for Design of Plain Jointed Rigid Pavements for highway, IRC New Delhi

Semester	Course Title	Course Code	Credits- L-T-P
8th	**Hazardous Waste Management**	CVT463	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objective: To enable students to understand characteristics of hazardous waste and design engineering solutions for its management.

Pre-requisites: None.

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

CO No.	Course Outcomes	BTL
CO1	Distinguish hazardous waste from conventional waste	4
CO2	Determine and assess the components of biomedical waste and nuclear waste management	5
CO3	Design the processes for the treatment and disposal of hazardous waste	6
CO4	Develop a comprehensive understanding of management rules and regulations pertaining to hazardous waste management	3

Course articulation matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PS03
1	3	2	2	1	-	2	3	-	-	-	-	-	3	3	-
2	3	2	2	3	-	1	2	-	-	-	-	-	3	3	-
3	3	1	3	2	-	2	3	-	-	-	-	-	3	3	-
4	3	3	2	3	-	2	3	-	-	-	-	-	3	3	-

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

S. No	Content	Lecture Hours
Module 1	**Introduction:** Fundamentals, and classification of Hazardous waste, Characterization of waste; compatibility and flammability of chemicals; fate and transport of chemicals; health effects.	7
Module 2	**Medical waste management :** Bio-medical waste Management; Sources; Generation; Classification; Storage; Transportation; Disposal; Waste Treatment: Disinfection, Incineration, and Irradiation.	7
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.	10
Module 4	**Treatment and disposal of hazardous waste:**	14

	Physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation); biodegradation of toxic waste (inhibition; co-metabolism; oxidative and reductive processes), slurry phase, incineration. Landfill design for hazardous wastes; leachate collection and removal; landfill covers;	
Module 5	**Hazardous waste Regulations:** Hazardous waste (management and handling) rules; biomedical waste handling rules; fly ash rules; recycled plastics usage rules; batteries (management and handling) rules.	4
	Total	42

Books Recommended:

1. LaGrega, M.D., Buckingham, P.L. and Evans, J.C., Hazardous Waste Management, Waveland Press, 2010.
2. Waltes, R.J. Hazardous Wastes - Sources, Pathways, Receptors, John Wiley and Sons, 1998.
3. Manuals, Rules and regulations in India for Municipal Solid Waste, Biomedical waste, fly ash, nuclear waste, hazardous waste and E-waste, Government of India

Semester	Course Title	Course Code	Credit-L-T-P
8th	Design of Masonry Structures	CVT464	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To gain knowledge about masonry as construction material and to analyse & design unreinforced, reinforced and confined masonry structures.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Understand the properties of masonry and exposure to design standards.	3
CO2	Examine the mechanical behaviour of masonry assemblages	4
CO3	Analyse and design of unreinforced, reinforced and confined masonry structures, for vertical and lateral loads.	5
CO4	Aware of structural assessment and strengthening of existing masonry structures.	4

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	3	2	-	-	2	3	-	-	-	2	3	3	-
CO2	3	3	3	3	2	-	2	-	-	-	-	2	3	3	-
CO3	3	3	3	3	3	-	2	-	-	-	-	2	3	3	-
CO4	3	3	3	3	2	-	2	-	-	-	-	2	3	3	2

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Hours
1	**Introduction**: overview of masonry in ancient and modern times; methods of design; codes and standards; structural-functional requirements of masonry buildings; classification of masonry construction and loads.	6
2	**Masonry Materials and Properties**: properties and experimental testing of components (masonry units, mortars, grout, reinforcement). **Strength and Behaviour of Masonry**: axial compression, eccentric compression, direct and flexural tension, shear and compression, biaxial state of stresses, P-M interaction and deformation characteristics.	8
3	**Design of Reinforced Masonry**: basic principles and methods of reinforcing; working stress and limit states design; serviceability limit states (deflection and cracking); design for combined out-of-plane bending, axial compression, in-plane flexure, shear walls; Detailing requirements; international design standards and multi-storey building design.	10
4	**Confined Masonry**: development and application; configuration; response under seismic loads; seismic resistance verification; practical aspects and normative provisions.	10

Module No.	Contents	Hours
5	**Infill Masonry**: behaviour, modelling and design. Assessment and strengthening of existing masonry structure.	8
	Total	42

Textbooks:

1. Drysdale, R.G., Hamid, A. A., and Baker, L. R., 2007, "Masonry Structures: Behaviour and Design", Prentice Hall.
2. Taly, N. 2001, "Design of Reinforced Masonry Structures", Mc-Graw Hill Companies Inc.
3. TomaÅževic, M. 1998, "Earthquake-Resistant Design of Masonry Buildings", Imperial College Press.

References:

1. Klingner, R. E. 2010, "Masonry Structural Design", McGraw-Hill Companies, Inc.
2. Priestley, M. J. N., and Paulay, T. 1997, "Seismic Design and Assessment of Reinforced Concrete and Masonry Buildings", John Wiley and Sons.
3. Chakrabarti, A., Menon, D. Sengupta, A. K. 2008, "Handbook on Seismic Retrofit of Buildings", Central Public Works Department and Indian Buildings Congress, Narosa Publishing House Pvt. Ltd.

Semester	Course Title	Course Code	Credit-L-T-P
8th	Design of Traffic FaCVLities	CVT465	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To equip students with the understanding and ability to analyze the influence of intersection geometrics on the design and operational efficiency of various types of intersections.

Pre-requisites: Traffic Engineering

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

CO No.	Course Outcomes	BTL
CO1	Apply the fundamental concepts of intersections and design principles for efficient intersection management.	3
CO2	Examine the geometrics, types, advantages, and limitations of both at-grade and grade-separated intersections.	4
CO3	Design the various public transport infrastructures faCVLities.	5
CO4	Evaluate terminal faCVLities and operational performance of various intersection types.	6

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	2	1	1	1	-	-	-	-	-	-	-	-	1	1	-
CO2	3	1	1	-	-	-	-	-	-	-	-	-	1	1	-
CO3	2	1	3	2	2	1	1	-	-	-	-	-	3	2	1
CO4	1	2	1	2	1	-	-	-	-	-	-	-	2	1	-

Note: ***1****: Slight,* ***2****: Moderate &* ***3****: Substantial*

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Introduction:** Fundamental concepts of intersections, various types of intersections and different types of manoeuvres. Conflict points and areas, and the design principles. Grade-separated and At-grade intersections, intersection geometrics, types, advantages, and limitations.	6
Module 2	**Intersection Design and Operational Analysis:** Influence of intersection geometrics on design and operation. Design guidelines for	8

	rotary and roundabout intersections. Operational analysis of two-way and all-way stop-controlled intersections.	
Module 3	**Terminal Planning:** Terminal functions, analysis of terminals, process flow charts of passenger & goods terminals, terminal processing time, waiting time, study of typical faCVLities of highway, transit, airport and waterway terminals, concept of inland port.	14
Module 4	**Public Transport Infrastructures:** Design of bus stops, design of terminals, principles of good layout, types of layouts, depot location, twin depot concept, crew faCVLities and amenities.	14
Total		42

References:

1. C. S. Papacostas and P. D., 2001, *Transportation Engineering & Planning.*
2. Fred L Mannering, Walter P. Kilareski and Scott S. Washburn, 2007, *Principles of Highway Engineering and Traffic Analysis*, Wiley India.
3. C. Jotin Khistya and B. Kent Lall 2006, *Transportation Engineering*, Prentice Hall of India Private Limited, New Delhi
4. C A O Flaherty, 1997, *Transport Planning and Traffic Engineering*, Hodder Headline Group, London.
5. Highway CapaCVTy Manual, 2010, Transportation Research Board, Washington DC.

Semester	Course Title	Course Code	Credit-L-T-P
8th	Traffic Flow Theories	CVT466	3-2-1-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To equip students with the knowledge and skills to analyse traffic stream characteristics, and to apply traffic stream models and queuing theory to real-world traffic scenarios.

Pre-requisites: Traffic Engineering (CVT 352)

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

CO No.	Course Outcomes	BTL
CO1	Apply statistical methods for describing vehicle arrivals, headways, speeds, gaps, and lags using distributions, performing goodness of fit tests.	3
CO2	Analyze microscopic and macroscopic traffic stream characteristics, including flow, speed, and concentration.	4
CO3	Categorize various traffic flow models and car-following models to predict traffic behaviour.	5
CO4	Evaluate deterministic and stochastic queuing models, including multiple service channels to improve traffic management systems.	6

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	1	1	1	-	-	-	-	-	-	-	-	1	1	-
CO2	2	1	1	-	-	-	-	-	-	-	-	-	1	1	-
CO3	3	1	2	2	2	1	-	-	-	-	-	-	2	2	1
CO4	1	3	1	2	1	-	-	-	-	-	-	-	2	1	-

Note: ***1****: Slight,* ***2****: Moderate &* ***3****: Substantial*

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Traffic Stream Characteristics:** Measurement, microscopic and macroscopic Study of Traffic Stream Characteristics - Flow, Speed, and Concentration.	8
Module 2	**Distributions:** Describing Vehicle Arrivals, Headways, Speeds, Gaps and Lags; Fitting of Distributions, Goodness of Fit Tests, Gap acceptance.	10

Module 3	**Traffic Stream Models:** Fundamental Equation of Traffic Flow, Speed-Flow-Concentration Relationships, Normalised Relationship, Fluid Flow Analogy Approach, Shock Wave Theory, Platoon Diffusion and Boltzman Like Behaviour of Traffic Flow, Car-Following Theory, Linear and Non-Linear Car-Following Models, Acceleration Noise.	14
Module 4	**Queuing Analysis:** Fundamentals of Queuing Theory, Demand Service Characteristics, Deterministic Queuing Models, Stochastic Queuing Models, Multiple Service Channels.	10
Total		**42**

References:

1. May, A D., 1982, *Traffic Flow Fundamentals*, Prentice-Hall, NJ.
2. Drew, D.R., 1968, *Traffic Flow Theory and Control*, McGraw-Hill, New York.
3. TRB Special Report 209, 1985, *Highway CapaCVTy Manual*, Transportation Research Board, Washington DC.
4. Wohl M. and Martin, B V., 1967, *Traffic System Analysis for Engineers and Planners*, McGraw-Hill, New York.
5. McShane W R & Roess R P, 2019, *Traffic Engineering*, Prentice-Hall, NJ.

Semester	Course Title	Course Code	Credit-L-T-P
8th	Landfill Engineering	CVT467	2-2-0-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objectives: To learn and apply the fundamental principles and key technologies that are used to manage and design the landfills.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Identify suitable sites and determine the configuration for landfills	3
CO2	Plan and design the major components of the landfill as per regulatory standards	5
CO3	Evaluate the performance of landfill facilities.	6
CO4	Design and implement the site's post-construction control techniques.	5

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	-	3	-	3	-	2	-	-	2	-	-	2	2	2	2
CO2	3	3	3	2	-	2	2	-	-	2	-	3	2	2	2
CO3	3	3	3	2	3	3	3	-	-	2	-	3	2	2	1
CO4	3	3	3	2	-	3	3	-	-	2	-	3	2	2	1

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

Module No.	Contents	Contact Hours
1	**Evolution of Solid Waste:** Solid Waste-Sources and Types, Properties of Solid waste, Waste Handling and Separation, Storage & Processing at Source, Disposal & Residual Matter, Sitting	04
2	**Soil-Fluid Interaction:** Soil- Water- Environment Interaction, Soil-contaminant Interaction, Contaminant transport and Fate of contaminants	06
3	**Landfill Engineering:** Introduction and types of Landfills, Physical Characteristics of Landfills, Concept of Barrier Systems & Engineering Design, Filter Criteria, Property characterization of Landfill Components. Analysis, design & Construction of various components of the landfill	12
4	**Post-construction monitoring and Controls:** Evaluation of Landfill Performance, Risk Assessment of Landfills	06
Total		28

References:

1. Qian, X., Koerner, R.M. and Gray, D.H., 2001. *Geotechnical aspects of landfill construction and design*. Prentice Hall.
2. Daniel, D.E. ed., 2012. *Geotechnical practice for waste disposal*. Springer Science & Business Media.

3. Newton, D.E., 2008. *Waste management: A reference handbook*. Bloomsbury Publishing USA.
4. Tchobanoglous, G., 2009. Solid waste management. *Environmental engineering: environmental health and safety for municipal infrastructure, land use and planning, and industry. Wiley, New Jersey*, pp.177-307.
5. Townsend, T.G., Powell, J., Jain, P., Xu, Q., Tolaymat, T. and Reinhart, D., 2015. *Sustainable practices for landfill design and operation*. Springer.
6. Central Public Health and Environmental Engineering Organisation (India), 2000. *Manual on municipal solid waste management*. Central Public Health and Environmental Engineering Orgnisation, Ministry of Urban Development, Government of India.

Semester	Course Title	Course Code	Credit-L-T-P
8th	Pre-Engineered and Prefabricated Structures	CVT468	2-2-0-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course Objectives: To impart knowledge to students on modular construction, industrialized construction and design of prefabricated elements and construction methods.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Identify various pre-engineered building materials.	3
CO2	Examine the prefabricated load-bearing members and determine if they are adequate.	4
CO3	Evaluate precast unit design and detailing for factories and warehouses.	5
CO4	Elaborate the design of pre-engineered buildings.	6

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	-	1	-	3	-	1	-	-	-	-	-	2	-	2
CO2	1	1	3	-	1	-	2	-	-	-	-	-	2	-	2
CO3	1	1	3	-	2	-	3	-	-	-	-	-	2	-	1
CO4	1	2	3	-	2	-	3	-	-	-	-	-	2	-	1

1-Slightly; 2-Moderately; 3-Substantially

Detailed Syllabus:

S. No.	Contents	Contact Hours
1	**Introduction to Pre-Engineered Buildings**: Introduction – History - Advantages of PEB - Applications of PEB – Materials used for manufacturing of PEB. Difference between Conventional Steel Buildings and Pre-Engineered building	4
2	**Pre-Engineered Building Components**: Primary System: Mainframes, Gable End Frame - Secondary frame system: Sizes and Properties of Purlins & Girts – Bracing System: Rod, angle, Portal, Pipe bracing – Sheeting and Cladding: Roof Sheeting and Wall sheeting – Accessories: Turbo Ventilators, Ridge vents, Sky Lights, Louvers, Insulation, Staircases.	8
3	**Design Loads on Pre-Engineered Buildings**: Design of PEB frame under the influence of Dead, Live, Collateral, Wind, Seismic and Other applicable Loads. Serviceability Limits as per code.	8
4	**Design Methodology**: Design Parameters of PEB Frames - Depth of the section, Depth to Flange width ratios, Thickness of Flange to thickness of Web ratio. d/tw, bf/tf ratios of sections as per IS code. Section Sizes as per Manufacturing Limitations. Analysis and Design of Rigid Frames. Rigid Frame Moment Connection, Shear Connection- Anchor bolt and base plate design (Pinned and	8

	Fixed)	
5	**Need for Prefabrication**: General Principles of Prefabrication - Comparison with monolithic construction, types of prefabrication, site and plant prefabrication, economy of prefabrication, modular coordination, standardization – Materials – Modular coordination – Systems – Production – Transportation – Erection.	8
7	**Applications:** Designing and detailing of precast unit for factory structures, purlins, principal rafters, roof trusses, lattice girders, gable frames, singe span single storied simple frames, single-storied buildings, slabs, beams and columns.	6

References:

1. Alexander Newman, "**Metal Building Systems Design and Specifications**", McGraw-Hill Education; 3rd edition.
2. Vivek, K. S. and Vaishavi, P. "Pre-Engineered Steel Buildings", Lambert Academic Publishing.
3. CBRI, **Building Materials and Components**, India.
4. Gerostiza, C. Z., Hendrikson, C., and Rehat, D. R. "**Knowledge-based Process Planning for Construction and Manufacturing**", Academic Press Inc.
5. Koncz, T. "**Manual of Precast Concrete Construction**", Vols. I, II and III, Bauverlag, GMBH.
6. Structural design manual, Precast concrete connection details, Society for the studies in the use of precast concrete, Netherland Betor Verlag.
7. Mokk, L. "**Prefabricated Concrete for Industrial and Public Structures**", Publishing House of the Hungarian Academy of Scien

Semester	Course Title	Course Code	Credit-L-T-P
8th	Transport Economics and Evaluation	CVT469	2-2-0-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: To equip students with the knowledge and skills necessary to analyse, plan, and evaluate transportation systems and policies.

Pre-requisites: Traffic Engineering (CVT 352)

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

CO No.	Course Outcomes	BTL
CO1	Apply the principles of transportation economics to evaluate construction, maintenance, and vehicle operation costs.	3
CO2	Analyze the impact of transportation planning strategies on urban development and land use.	4
CO3	Develop public transportation routes and schedules based on travel demand analysis and transit system operations.	5
CO4	Evaluate the feasibility of highway projects and their impacts on economic growth using different economic evaluation methods.	6

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	2	1	-	-	-	-	-	-	-	-	-	-			
CO2	1	3	2	-	1	-		-	-	-	-	-			
CO3	1	1	3	2	1	2	1	-	-	-	-	-			
CO4	2	2	2	1	1	1	2	-	-	-	-	-			

Note: ***1****: Slight,* ***2****: Moderate &* ***3****: Substantial*

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Transportation Planning:** Scope of Transportation Planning, Scope of Transportation Economics, Transportation Planning Issues.	6
Module 2	**Public Transportation:** Public transport modes, Desirable Characteristics of Public Transport Systems, Transit System Operations Route Development, Stopping Policy, Stop Location, Scheduling Travel Demand Analysis, Operational Transportation and Land Use Models.	8
Module 3	**Transport Analysis and Forecasting:** Transport Planning Process, Transportation and Land Use, Transport Planning Strategies, Travel	14

	Demand Analysis, Growth Factor Models, Synthetic Models-1, Synthetic Models-2.	
Module 4	**Transport Economics and Finance:** Construction Cost; Maintenance Cost and Vehicle Operation Cost, Economic Evaluation of Highway Projects- Basic Principles, Time Value of Money, Net Present Value (NPV) Method, Benefit-Cost (B/C) Ratio Method, Internal Rate of Return (IRR) Method. Freight Transport-Trends and Economic Growth.	14
Total		42

References:

1. CA O'Flaherty, 1997, *Transport Planning and Traffic Engineering,* John Wiley & Sons, Inc., New York; Toronto.
2. Papacostas and Prevedouros, 2002, *Transportation Engineering and Planning*, Saddle River, NJ: Prentice Hall.
3. Chakarborty & Das, 2017, *Principles of Transportation Engineering,* Prentice-Hall of India Private Ltd, New Delhi-110001.

Semester	Course Title	Course Code	Credit-L-T-P
8th Semester	Uncertainty Analysis in Engineering	CVT470	2-2-0-0
Evaluation Policy	**Mid-Term**	**Internal Assessment**	**End-Term**
	26 Marks	24 Marks	50 Marks

Course objective: Engineering design and analysis require decisions with quantification of uncertainty to determine the reliability and risk of a system and system components. This course aims to develop an understanding of basic statistical approaches for uncertainty analysis applied to engineering problems.

Pre-requisites: None

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

CO No.	Course Outcomes	BTL
CO1	Comprehend and analyze different types of uncertainty associated with civil engineering problems.	4
CO2	Evaluate and represent engineering-problem data using statistical geometric distributions and quantify their parameters.	5
CO3	Articulate hypothesis testing for statistical significance of the random variable relationships defined for the engineering problems.	3
CO4	Perform linear regression analysis between random variables of an engineering problem and establish their statistical relationships and correlations.	5

Course articulation matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	2	1	3	2	2	2	-	2	1	1	1	3	3	1
CO2	3	2	3	3	2	2	2	-	1	3	1	1	3	3	2
CO3	3	3	3	3	3	1	1	-	1	2	1	2	3	3	2
CO4	3	3	3	3	3	2	1	-	2	2	1	1	3	3	1

1-Slightly; 2-Moderately; 3-Substantially.

Detailed Syllabus:

Module No.	Contents	Hours
Module 1	**Data:** Display, summary, quantiles; elements of probability; conditional probability, total probability, Bayes theorem; independence, counting; discrete random variables, CDF, PMF; expectation, mean, variance.	**10**
Module 2	**Geometric Distributions:** Bernoulli & binomial distributions and continuous random variables; moments, normal distribution; gamma and exponential distribution; derived distributions, joint and conditional distributions; joint moments, independence; Poisson distribution and Poisson process; distribution of sample mean; reliability example. Central Limit Theorem (CLT); lognormal distribution; Gumbel and Weibull distributions; examples:	**18**

	material strength, drought, floods, windspeed. Bias, variance, mean square error, estimators of binomial p; method of moments, sampling properties of MOM; maximum likelihood principle & estimators sample mean & variance; comparison of MM & MLE; confidence intervals for normal mean. Large/Small results for normal mean + Chi-Squared.	
Module 3	**Hypothesis testing:** introduction, normal test, type I and II errors, student t-test, P-values, comments, choice hypothesis, two-sample tests, two-sample test's type II error, paired t-test. **Regression- Linear model analysis:** regression precision; model choice; etc. R2 and correlation & model selection; sign, Wilcoxon sign rank, rank-sum tests.	**14**
Total		**42**

Books Recommended:

1. Nowak, A.S., Collins, C.R., 2012. *Reliability of Structures,* 2nd Ed. CRC Press.
2. Ang, A., Tang, W., 2018. *Probability Concepts in Engineering Planning and Design: Basic Principles (Volume 1)*. John Wiley & Sons.
3. Ang, A., Tang, W., 2018. *Probability Concepts in Engineering Planning and Design: Decision, Risk, and Reliability (Volume II)*. John Wiley & Sons.
4. Haldar, A., Mahadevan, S., 2000. *Probability, Reliability, and Statistical Methods in Engineering Design*. John Wiley & Sons.
5. Ang, A., Tang, W., 2007. *Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering*. Wiley