Course Curriculum

Third Year

B. Tech. Civil Engineering (Structural Engineering) (Integrated)

In line with National Education Policy 2020

(Effective from AY 2026-27 for Affiliated Institutes)

Dr. Babasaheb Ambedkar Technological University

Lonere 402 103, Dist- Raigad, Maharashtra, INDIA

Established vide Maharashtra Act No. XXII of 1989 and Act. No. XXIX of 2014
"Vidyavihar", P.O. Lonere, Dist. Raigad, Pin 402 103, Maharashtra, India
Telephone and Fax.: 02140 - 275142
www.dbatu.ac.in

Dr. Babasaheb Ambedkar Technological University, Lonere

Teaching & Evaluation Scheme for Third Year of
B. Tech. Civil Engineering (Structural Engineering) (Integrated)

Sr. No.	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				Credits
			L	T	P	ISE	MSE	ESE	Total	
Semester-V										
1	26AF1906PC501	Structural Mechanics-II	3	0	0	20	20	60	100	3
2	26AF1906PC502	Design of Steel Structures	3	0	0	20	20	60	100	3
3	26AF1906PC503	Open Channel Flow & Hydraulic Machines	3	0	0	20	20	60	100	3
4	26AF1906PC504	Geotechnical Engineering	3	0	0	20	20	60	100	3
5	26AF1ARPOE505	OPEN ELECTIVE-III	3	0	0	20	20	60	100	3
6	Refer Bucket	Multi-Disciplinary Minor-III	3	0	0	20	20	60	100	3
7	26AF1906PCL507	Design of Steel Structures Lab	0	0	2	50	-	50	100	1
8	26AF1906PCL508	OCF & HM Lab	0	0	2	25	-	25	50	1
9	26AF1906PCL509	Geotechnical Engineering Lab	0	0	2	50	-	50	100	1
10	26AF1906HM510	Soft Skills Development	0	2	0	-	-	-	AU	GR
11	26AF1906VS511	Construction Equipment and Site Safety Management	0	2	0	50	-	50	100	2
		TOTAL	**18**	**4**	**6**	**295**	**120**	**535**	**950**	**23**
Semester-VI										
1	26AF1906PC601	Design of Concrete Structures	3	0	0	20	20	60	100	3
2	26AF1906PE602	Program Elective-I	3	0	0	20	20	60	100	3
3	26AF1906PE603	Program Elective -II	3	0	0	20	20	60	100	3
4	26AF1906PE604	Program Elective-III	3	0	0	20	20	60	100	3
5	26AF1906PC605	Foundation Engineering	3	0	0	20	20	60	100	3
6	Refer Bucket	Multi-Disciplinary Minor-IV	3	0	0	20	20	60	100	3
7	26AF1906PCL607	Concrete Structures Lab	0	0	2	50	-	50	100	1
8	26AF1906PEL608	Program Elective-II- Lab	0	0	2	25	-	25	50	1
9	26AF1906PEL609	Program Elective-III- Lab	0	0	2	25	-	25	50	1
10	26AF1906EL610	Seminar	0	2	2	25	-	25	50	1
11	26AF1906VS611	Academic Research Writing	1	0	0	50	-	-	50	1
		TOTAL	**19**	**2**	**8**	**295**	**120**	**485**	**900**	**23**

Course Type	Course Code	Course Name
Program Elective-I	26AF1906PE602A	Hydraulics Structures
	26AF1906PE602B	Irrigation Engineering
Program Elective-II	26AF1906PE603A	Water Quality Engineering
	26AF1906PE603B	Environment Health and Safety
Program Elective-III	26AF1906PE604A	Highway & Railway Engineering
	26AF1906PE604B	Intelligent Transportation Systems
	26AF1906PE604C	Urban Transportation Planning

Course Type	Course Code	Course Name
Open elective-III	26AF1ARPOEM05H	Geomatics Engineering
	26AF1ARPOEM05I	Ground Improvement Techniques
	26AF1ARPOEM05J	Sustainable Construction Methods
Multi-Disciplinary Minor-III	Refer Bucket	Refer Bucket
Multi-Disciplinary Minor-IV	Refer Bucket	Refer Bucket

Type of course:

Basic Science: **BS**	Engineering Science: **ES**
Program Elective: **PE**	Program Core: **PC**
Modern Indian Language: **MIL**	Indian Knowledge System: **IK**
Value Education Course: **VEC**	Ability Enhancement Course: **AE**
Vocational and Skill Enhancement: **VS**	Audit Course: **AU**
Open Elective: **OE** (Other than particular program)	Co-curricular & Extracurricular Activities: **CC**
Humanities, Management, language and Commerce: **HM**	Multidisciplinary Courses: **MD**

ELECTIVE / OPEN ELECTIVE/ MULTIDISCIPLINARY MINOR COURSES

Below listed courses will be offered as per student's requirement and availability of subject expert with the approval of the head of the department.

OPEN ELECTIVE OTHER THAN PARTICULAR PROGRAM

Sr.No.	Course Offered	Teaching Scheme (Hrs)				Credits
		L	T	P	TOTAL	
1	Construction Techniques	02	00	00	02	02
2	Design of Masonry Structures	02	00	00	02	02
3	Energy Efficient Buildings	02	00	00	02	02
4	Advanced Surveying	03	00	00	03	03
5	Modern Surveying	03	00	00	03	03
6	Application of remote sensing & GIS	03	00	00	03	03
7	Geomatics Engineering	03	00	00	03	03
8	Ground Improvement Techniques	03	00	00	03	03
9	Sustainable Construction Methods	03	00	00	03	03

HONORS- CIVIL ENGINEERING

Sr.No.	Course Offered	Teaching Scheme (Hrs)				Credits
		L	T	P	TOTAL	
1	Finite Element Method	03	00	00	03	03
2	Limit State Design of Steel Structures	03	00	00	03	03
3	Elements of Remote Sensing	03	00	00	03	03
4	Building Planning and Design	03	00	00	03	03
5	Advanced Structural Design	03	00	00	03	03
6	Theory of Plates and Shells	03	00	00	03	03

RESEARCH - CIVIL ENGINEERING

Sr.No.	Course Offered	Teaching Scheme (Hrs)				Credits
		L	T	P	TOTAL	
1	Problem Identification and Definition	03	01	00	04	04
2	Experimental Work/Analytical Tools and Prototype Development	03	01	00	04	04
3	Research Project Phase-I	00	00	12	12	06
4	Research Project Phase-II	03	01	12	12	06

PROGRAM ELECTIVE COURSE

Sr.No.	Course Offered	Teaching Scheme (Hrs)				Credits
		L	T	P	TOTAL	
1	Hydraulics Structures	03	00	00	03	03
2	Irrigation Engineering	03	00	00	03	03
3	Water Quality Engineering	03	00	00	03	03
4	Environment Health and Safety	03	00	00	03	03
5	Highway & Railway Engineering	03	00	00	03	03
6	Intelligent Transportation Systems	03	00	00	03	03
7	Urban Transportation Planning	03	00	00	03	03
8	Pollution Control & Treatment	03	00	00	03	03
9	Industrial Waste water Management	03	00	00	03	03
10	Professional Practices	03	00	00	03	03
11	Construction Cost Analysis	03	00	00	03	03
12	Estimation and Costing	03	00	00	03	03
13	Design of Bridges	03	00	00	03	03
14	Rehabilitation of Structures	03	00	00	03	03
15	Smart Materials and Structural Health Monitoring	03	00	00	03	03
16	Pollution Control & Treatment	03	00	00	03	03
17	Waste Water Engineering	03	00	00	03	03
18	Industrial Waste water Management	03	00	00	03	03
19	Advanced Prestressed Concrete	03	00	00	03	03
20	Disaster Resistant Structures	03	00	00	03	03
21	Structural Fire Engineering	03	00	00	03	03

Note: The elective courses listed in the Course Contents structure are indicative. Students shall ensure availability of Course Contents prior to registration.

MULTIDISCIPLINARY MINOR BUCKET
for AFFILIATED INSTITUTES
MINOR DEGREE IN CIVIL STRUCTURAL ENINGEERING
(for other than B.Tech. in Civil Structural Engineering program students)

Semester	Subject Code	Subject Name	Total Credit
SEM-III	25AF1906MD306A	Building Construction	3
SEM-III	25AF1906MD306	Introduction to Engineering Geology	3
SEM-IV	25AF1906MD406	Concrete Technology	3
SEM-V	25AF1906MD506	Geomatics Engineering	3
SEM-VI	25AF1906MD606	Project Management	3
SEM-VII	25AF1906MD706	Construction Equipment and Site Safety Management	2
MINIMUM CREDITS REQUIRED TO COMPLETE A MINOR DEGREE IN CIVIL ENGINEERING			**14**

MINOR DEGREE IN PLANNING ENINGEERING
(only for B.Tech. in Civil Structural Engineering students)

Semester	Subject Code	Subject Name	Total Credit
SEM-III	25AFMDPLAN306A	Site Planning	3
SEM-III	25AF1906MD306	Introduction to Engineering Geology	3
SEM-IV	25AFMDPLAN406A	Fundamentals of Urban Design	2
SEM-IV	25AFMDPLAN406B	Town and Urban Planning	2
SEM-V	25AFMDPLAN506A	Real Estate Development and Management	3
SEM-V	25AFMDPLAN506B	Planning Legislation	3
SEM-VI	25AFMDPLAN606A	Disaster Mitigation and Management	3
SEM- VI	25AFMDPLAN606B	Project Management	3
SEM-VII	25AFMDPLAN706A	Sustainable Building Planning	3
SEM-VII	25AFMDPLAN706B	Appropriate Building Technologies	3
MINIMUM CREDITS REQUIRED TO COMPLETE A MINOR DEGREE IN PLANNING ENGINEERING			**14**

Dr. Babasaheb Ambedkar Technological University, Lonere

Teaching & Evaluation Scheme for Third Year of
B. Tech. Civil Engineering (Structural Engineering) (Integrated)

Sr. No.	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				Credits
			L	T	P	ISE	MSE	ESE	Total	
Semester-V										
1	26AF1906PC501	Structural Mechanics-II	3	0	0	20	20	60	100	3
2	26AF1906PC502	Design of Steel Structures	3	0	0	20	20	60	100	3
3	26AF1906PC503	Open Channel Flow & Hydraulic Machines	3	0	0	20	20	60	100	3
4	26AF1906PC504	Geotechnical Engineering	3	0	0	20	20	60	100	3
5	26AF1ARPOE505	OPEN ELECTIVE-III	3	0	0	20	20	60	100	3
6	Refer Bucket	Multi-Disciplinary Minor-III	3	0	0	20	20	60	100	3
7	26AF1906PCL507	Design of Steel Structures Lab	0	0	2	50	-	50	100	1
8	26AF1906PCL508	OCF & HM Lab	0	0	2	25	-	25	50	1
9	26AF1906PCL509	Geotechnical Engineering Lab	0	0	2	50	-	50	100	1
10	26AF1906HM510	Soft Skills Development	0	2	0	-	-	-	AU	GR
11	26AF1906VS511	Construction Equipment and Site Safety Management	0	2	0	50	-	50	100	2
		TOTAL	**18**	**4**	**6**	**295**	**120**	**535**	**950**	**23**

Course Type	Course Code	Course Name
Program Elective-I	26AF1906PE602A	Hydraulics Structures
	26AF1906PE602B	Irrigation Engineering
Program Elective-II	26AF1906PE603A	Water Quality Engineering
	26AF1906PE603B	Environment Health and Safety
Program Elective-III	26AF1906PE604A	Highway & Railway Engineering
	26AF1906PE604B	Intelligent Transportation Systems
	26AF1906PE604C	Urban Transportation Planning

Course Type	Course Code	Course Name
Open elective-III	26AF1ARPOEM05H	Geomatics Engineering
	26AF1ARPOEM05I	Ground Improvement Techniques
	26AF1ARPOEM05J	Sustainable Construction Methods
Multi-Disciplinary Minor-III	Refer Bucket	Refer Bucket
Multi-Disciplinary Minor-IV	Refer Bucket	Refer Bucket

Type of course:

Basic Science: **BS**	Engineering Science: **ES**
Program Elective: **PE**	Program Core: **PC**
Modern Indian Language: **MIL**	Indian Knowledge System: **IK**
Value Education Course: **VEC**	Ability Enhancement Course: **AE**
Vocational and Skill Enhancement: **VS**	Audit Course: **AU**
Open Elective: **OE** (Other than particular program)	Co-curricular & Extracurricular Activities: **CC**
Multidisciplinary Courses: **MD**	Humanities, Management, language and Commerce: **HM**

Detailed Course Contents

SUBJECT CODE	Structural Mechanics-II					CREDITS
26AF1906PC501						3
Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
3	0	0	3	20	20	60	100

Course Outcomes: Students will be able to	
COBJ1	To learn concept of influence line and moving load analysis
COBJ2	To learn structural response behavior of bridges and arches
COBJ3	To understand forced based method of structural analysis
COBJ4	To understand displacement-based method of structural analysis
COBJ5	To understand concepts related to finite difference and finite element methods

Course Outcomes: On completion of course, students will be able to	
CO1	Have a basic understanding of concept of influence line and moving load analysis
CO2	Have a basic understanding of structural response behavior of bridges and arches
CO3	Have a detailed understanding of forced based method of structural analysis
CO4	Have a detailed understanding of displacement-based method of structural analysis
CO5	Have a basic understanding of the principles and concepts related to finite difference and finite element methods

Course Contents

Application of all methods shall be restricted to beams, Frames and /or pin jointed frames or trusses of Degree of Indeterminacy up to three.

Module 1	**Analysis of trusses**	**Hrs. 6**

Analysis of determinate and indeterminate pin jointed trusses by energy method, effects of settlement and pre-strains.

Moving Loads and Influence Lines- Introduction to moving loads, concept of equivalent UDL, absolute maximum bending moment and shear force, concept of influence lines, influence lines for reaction, shear force, bending and deflection of determinate beams, influence line diagram (ILD) for forces in determinate frames and trusses, analysis for different types of moving loads, single concentrated load, several concentrated loads, uniformly distributed load shorter and longer than span, application of Muller Breslau principle for determinate structures to construct ILD.

Module 2	**Cables, Suspension Bridges and Arches**	**Hrs. 8**

Analysis of forces in cables, suspension bridges with three hinged and two hinged stiffening girders, theory of arches, Eddy's theorem, circular, parabolic and geometric arches, concept of radial shear force and axial thrust, analysis of three hinged and two hinged arches, effect of yielding of supports, rib shortening and temperature changes. ILD for 3 hinged arches and suspension bridges.

Module 3	Analysis of Indeterminate Structures by direct Flexibility Method	Hrs. 8
Fundamental concepts of flexibility method of analysis, flexibility coefficients and their use in formulation of compatibility equations, application of above methods to propped cantilevers, fixed beams, continuous beams, simple pin jointed frames including effect of lack of members, rigid jointed frames.		
Module 4	**Analysis of Indeterminate Structures by direct Stiffness Method**	**Hrs. 9**
Fundamental concepts of stiffness method of analysis, stiffness coefficients for prismatic members and their use for formulation of equilibrium equation, applications of the above methods to indeterminate beams and simple rigid jointed frames, rigid jointed frames with inclined member but having only one translational DoF in addition to rotational DoF's, including the effect of settlement of supports, pin jointed frames.		
Module 5	**Finite Element Method (Contents to conceptual level)**	**Hrs. 9**
Introduction to analysis by discretization such as finite difference method, Finite element method: types of elements-1D, 2D, 3D, Plane Strain and Plane Stress Problem, isoperimetric and axisymmetric, convergence criteria, Pascal's triangle, direct stiffness method, principle of minimum potential energy. Shape functions, concept of local and global stiffness matrix		

Text Books:	
1	Reddy C. S., "Basic Structural Analysis", Tata McGraw Hill
2	Pandit G. S. and Gupta S. P., "Structural Analysis - a Matrix Approach", Tata McGraw Hill, N.Delhi,
3	Chandrupatla T. R., Belegundu A. D., "Introduction to Finite Elements in Engineering, Prentice Hall
4	Thadani B. N. and Desai J. P., "Structural Analysis"
5	Punmia B.C., "Structural Analysis", Laxmi Publications
6	Vazirani V.N., Ratwani M.M and Duggal S.K., "Analysis of Structures - Vol. II" Khanna Publishers, N. Dehli, Sadhu Singh, "Theory and Solved Problems in Adv. Strength of Materials", Khanna Publishers, N. Dehli,
7	Ramamrutham S. and Narayanan R., "Theory of Structures" Dhanpat Rai Publishers, Delhi
Reference Books:	
1	Norris C. H. and Wilbur J. B., "Elementary Structural Analysis", McGraw Hill
2	Beaufait F.W., "Basic Concepts of Structural Analysis", Prentice Hall, N.J. Kinney J. S., "Indeterminate Structural Analysis", Oxford and IBH
3	Krishnamurthy, C.S., "Finite Element Analysis – Theory and Programing", Tata McGraw Hill
4	Hibbler R. C., "Structural Analysis", Pearson Publications
5	Kanchi M. B., "Matrix Methods of Structural Analysis", Wiley Eastern Ltd., N. Delhi
6	Wang C. K., "Matrix Methods of Structural Analysis", International Text-book, Scranton, Pennsylvania,
7	Gere J.M., Weaver W., "Analysis of Framed Structures", D. Van Nostrand Company, Inc.

SUBJECT CODE	Design of Steel Structures	CREDITS
26AF1906PC502		3

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
3	0	0	3	20	20	60	100

Course Objectives: Students will be able to	
COBJ1	To impart knowledge of steel structural systems, material properties, loading conditions, and design philosophies.
COBJ2	To introduce the principles of Working Stress Method and Limit State Method for steel structure design.
COBJ3	To familiarize students with the analysis and design of riveted, bolted, and welded connections.
COBJ4	To develop the ability to design tension members, compression members, columns, and flexural members as per codal provisions.
COBJ5	To enable students to apply plastic analysis concepts and modern steel design practices for structural engineering applications.

Course Outcomes: On completion of course, students will be able to	
CO1	Explain the fundamentals of steel structures, design philosophies, and codal provisions for structural design.
CO2	Design riveted, bolted, and welded connections using Working Stress and Limit State approaches.
CO3	Design axially loaded tension and compression members, including built-up columns and their components.
CO4	Analyze and design laterally supported and unsupported steel beams subjected to bending and shear.
CO5	Apply Limit State Method and basic plastic analysis concepts in the design of steel structural elements.

Course Contents

Module 1	**Introduction of Working Stress Method and Design of Connections**	**Hrs. 8**

Introduction, types of steel structures, grades of structural steel, various types of loads acting on steel structures, advantages/disadvantages of steel structures, working stress and limit state design philosophy.

Introduction to Working State Method to design of steel structures, relevance to other materials such as timber, masonry, soil, fluid, concrete, modern materials stainless steel, aluminum, composites etc. permissible stresses, concept of factor of safety.

Riveted and bolted connections, Welded connections-assumptions, types, design of fillet welds, intermittent fillet weld, failure of welded joints, welded joints vs bolted and riveted joints.

Module 2	**Working Stress Design of Axially Loaded Members and Compression Members**	**Hrs. 6**

Tension members: Common sections, net effective area, load capacity, connection using weld / bolts.

Compression members: Common sections used, effective length and slenderness ratio, permissible stresses, load carrying capacity,

Design of columns subjected to axial and eccentric loading, design of built-up columns, design of lacing, battening

Module 3	**Working Stress Design of Flexural Members and Introduction to Plastic**	**Hrs. 6**

	Analysis	
Types of c/s, lateral stability of beams, lateral torsional buckling, bending and shear strength design procedure for laterally supported and unsupported beams, design of basic cross-section for plate girders Introduction to Plastic Analysis: Hinge Formation, Collapse Mechanism, Approaches in Steel Structure design based on Plastic Analysis Method		
Module 4	**Introduction to Limit State Method and Design of Connections**	**Hrs.8**
Introduction to Limit state design method, limit states of strength and serviceability, probabilistic basis for design, the partial safety factor for load and resistance, various design load combinations, Provisions in IS 800:2007 for Design of Welded and bolted connections, design of fillet welds, failure of welded joints, design of bolted joints, treatment for axially loaded and eccentric connections		
Module 5	**Limit State Approach to design of axially loaded members & Flexural Members**	**Hrs. 8**
Design of axially loaded tension members, axially loaded compression members, Design of columns subjected to axial and eccentric loading, bending and shear strength design procedure for laterally supported beams		
Notes: 1) Contents in Module 1 to part of 3 shall be taught with help of relevant text or reference books based on elastic design concept, IS 800: 1984. Contents in Module 4 & 5 shall be taught with help of relevant text or reference books based on limit state design concept as per IS 800: 2007. 2) Use of IS 800: 1984 and 2007, IS 875 (All Parts), IS: Handbook No.1 for Steel Section & Steel Table is permitted for theory examination.		

Text Books:	
1	Duggal S. K., "Design of Steel Structures", Tata McGraw Hill Pub. Co. Ltd., New Delhi
2	Gambhir, "Fundamentals of Structural Steel Design", Tata McGraw Hill Pub. Co. Ltd., New Delhi
3	Negi L. S., "Design of Steel Structures", Tata McGraw Hill Pub. Co. Ltd., New Delhi
4	Chandra Ram, "Design of Steel Structures", Vol. I & Vol. II, Standard Book House, New Delhi
5	Dayaratnam P., "Design of Steel Structures", Wheeler Publishing, New Delhi
6	Subramanian N., "Steel Structures: Design and Practice" Oxford Univ. Press, Delhi
7	Vazirani V.N. and Ratwani M.M., "Design and Analysis of Steel Structures"
8	Sai Ram K. S., "Design of Steel Structures", Pearson Education, 2nd Edition
Reference Books:	
1	Arya A. S. and Ajamani J.L., "Design of Steel Structures", Nemchand and Brothers, Roorkee
2	Vazirani&Ratwani, "Design of Steel Structures", Standard Book House, New Delhi
3	Duggal S. K., "Limit State Design of Steel Structures", Tata McGraw Hill Pub. Co. Ltd., New Delhi
4	Publications of Bureau of Indian Standards, New Delhi, IS 800:1984, IS 800:2007, IS 875 (Part I to V)
5	Gaylord E.H. and Gaylord C.N., "Design of Steel Structures" McGraw Hill, New York
6	Lothers J.E., "Design in Structural Steel" Vol.-I, Prentice Hall New Jersy
7	Salmon and Johnson, "Steel Structures: Design and Behaviour", Harper and Row, New York
8	Steel Designers Manual.

SUBJECT CODE	Open Channel Flow & Hydraulic Machines						CREDITS
26AF1906PC503							3
Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
3	0	0	3	20	20	60	100

Course Objectives	
COBJ1	To understand the fundamentals of flow in open channels and discharge measurement.
COBJ2	To study uniform flow and design of efficient channel sections.
COBJ3	To learn the concepts and analysis of non-uniform flow in open channels.
COBJ4	To understand the impact of jets and working of hydraulic turbines.
COBJ5	To study the classification, working, and performance of pumps.

Course Outcomes: Students will be able to	
CO1	Explain different types of open channel flow and discharge measurement methods.
CO2	Apply Chezy's and Manning's equations for uniform flow analysis.
CO3	Analyze gradually varied flow and channel surface profiles.
CO4	Understand the impact of jets and velocity relationships in hydraulic machines.
CO5	Describe the working, performance, and selection of different types of pumps.

Course Contents

Module 1	**Flow in Open Channel**	**Hrs.8**
Introduction, Types of channels, Types of flow in open channels, Geometric properties of open channel, Velocity distribution, Measurement of velocity-pitot tube and current meter, Weirs and notches- Flow over sharp, broad, round crested weir or notch, Calibration of weir, Ogee and Siphon spillway, Empirical formulae for discharge over weir, Time required to empty a reservoir.		
Module 2	**Uniform Flow and Specific Energy**	**Hrs.6**
Uniform Flow- Chezy's and Manning's equation, Most efficient channel section-design and consideration, computation of uniform flow. Specific Energy- Specific energy and critical depth, Specific energy curve, Concept of critical, sub-critical and super-critical flows, Criteria for critical state of flow, Critical flow and its computation, specific force, specific discharge.		
Module 3	**Non-uniform Flow in Open Channel**	**Hrs.6**
Gradually Varied Flow- Dynamic equation of gradually varied flow and conditions, Classification of channel bottom slopes, Classification and characteristics of surface profiles with practical examples, Step method of integration of varied flow equation.		

Rapidly Varied Flow- Concept of rapidly varied flow-examples, Hydraulic jump- equation, computation of energy losses, relation between initial and sequent depths, Location of hydraulic jump, Classification of hydraulic jump, Uses, Surges in open channels.

Module 4	**Impact of Jet and Hydraulic Turbines**	**Hrs.6**

Impact of Jet- Impulse momentum principle, Impact of jet on flat and curved vanes (Stationary and Moving), Inlet and outlet velocity triangles under various conditions, Series of Flat and Curved vanes mounted on wheel.

Hydraulic Turbines- Elements of hydroelectric power plants, Classification of turbines, Working principle and basic design of Pelton wheel, Francis and Kaplan turbines, Performance of turbines, Selection of turbines, Cavitation in turbines, Draft tube.

Module 5	**Pumps**	**Hrs.6**

Classification of pumps, Components and working of reciprocating and centrifugal pump, Performance of pumps, Selection of pumps under various conditions, Condition of self-priming, Introduction to different types of pumps- Multi-stage, Jet, Air lift, Submersible pump.

Text Books:	
1	Hydraulics and Fluid Mechanics including Hydraulics Machines by Dr. P. N. Modi and Dr. S. M. Seth.
2	A Textbook of Fluid Mechanics and Hydraulic Machines by Dr. R. K. Bansal, Laxmi Publications.
3	Flow in open channels by K. Subramanya, McGraw-Hill Higher Education.
4	Open channel hydraulics by Ven Te Chow, McGraw-Hill Book Company.
5	Fluid Mechanics by K. L. Kumar, S. Chand publication. ISBN: 81-219-0100-6
6	A Textbook of Hydraulics Engineering by N.H. Kulkarni, TECHSAR Publications.
Reference Books:	
1	Fluid Mechanics including Hydraulic Machines by A. K. Jain, Khanna Publishers.
2	Introduction To Fluid Mechanics by Philip J. Pritchard, John Wiley & Sons, INC.
3	Introduction to Fluid Mechanics & Fluid Machines by S. K. Som & G. Biswas, Tata McGraw-Hill.
4	Fluid Dynamics by V. L. Streeter, K. W. Bedford and E. B. Wylie, New York, McGraw-Hill.

SUBJECT CODE	Geotechnical Engineering	CREDITS
26AF1906PC504		3

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
3	0	0	3	20	20	60	100

Course Objectives	
COBJ1	To understand the index properties of soil and its classification.
COBJ2	To study the mechanics of compaction and clay mineralogy.
COBJ3	To learn the concept of permeability and dewatering.
COBJ4	To know how to evaluate the quantity of seepage discharge.
COBJ5	To study the shear strength of soil
COBJ6	To understand the stress distribution & consolidation of soil

Course Outcomes: Students will be able to	
CO1	Classify soil based on index properties of soil.
CO2	Explain the principal of compaction and demonstrate quality control in field.
CO3	Determine the permeability of soil and explain methods of dewatering.
CO4	Evaluate the quantity of seepage discharge and design criteria of graded filter.
CO5	Measure the shear strength of different types of soil using various methods.

Course Contents

Module 1	**Introduction**	**Hrs. 10**

History of development of soil mechanics, formation of soil, its significance to the field problems. Soil properties and its classification, Definition of soil, soil as a three-phase system, weight volume relationship, Index properties of course and fine-grained soil, BIS classification of fine grained and coarse-grained soil.

Module 2	**Compaction of Soil**	**Hrs. 7**

Mechanics of compaction, factors affecting compaction, standard and modified Proctor test, their field Determination, zero air void line, concept of wet of optimum and dry of optimum, different structures of soil, field compaction and their control, CBR test and CBR values for soaked and unsoaked conditions.

Module 3	**Permeability of Soil**	**Hrs. 7**

Darcy's law and its validity, discharge and seepage velocity, factors affecting permeability, determination of coefficient of permeability in laboratory and field, permeability for stratified soil deposits, drainage and dewatering of soil and its various methods.

Module 4	**Shear Strength and Seepage Analysis**	**Hrs. 10**

A physical concept of shear strength, introduction of Mohr's stress diagram, Mohr's failure criteria, Mohr-Coulomb's theory and development of failure envelopes, unconfined compression test, laboratory measurement of shear

strength for different drainage conditions by direct shear test, triaxial test, merits and demerits of various shear strength tests. Laplace equation and its derivation in Cartesian coordinate system, its application for the computation of discharge seepage, seepage pressure, quick sand condition, concept of flow net, characteristics and uses of flow net, preliminary problem of discharge, estimation of discharge through homogenous earthen embankment, Terzaghi's design criteria for graded filter, concept of piping and criteria of stability against piping

Module 5	**Stresses in soils**	**Hrs. 7**

State of stress at a point, stress distribution in soil mass, Boussinesq's theory and its applications, point load and uniformly loaded area, Newmark's Influence Chart, its preparation and use. Consolidation of Soil: Definition, Spring analogy, Terzaghi's theory of one-dimensional consolidation, Consolidometer test,

	Text Books:
1	Kasamalkar B. J., "Geotechnical Engineering", Pune Vidyarthi Griha Prakashan Pune
2	Murthy V.N.S., "Soil Mechanics & Foundation Engineering", U.B.S. Publishers and Distributors N. Delhi
3	Punmia B.S., "Soil Mechanics & Foundation Engineering", Laxmi Publications
4	Arora K. R., "Soil Mechanics" Standard Publishers, N. Delhi
5	Dr. B.C.Punmia A.K.Jain, "Soil Mechanics and Foundations" Laxmi Publications(P)Ltd
6	Gopal R Rao "Basic Soil Mechanics "
Reference Books:	
1	Alam Singh, "Text book of soil mechanics in theory and practice", Asian Pub. House, Mumbai
2	Taylor D.W., "Fundamentals of Soil mechanics"
3	Terzaghi and Peak "Soil mechanics" John Willey and Sons, New-York
4	Scott R. F., "Principal of soil mechanics"
5	Lambe T.W, "Soil Testing" by Willey Eastern Ltd., New Delhi

SUBJECT CODE	OPEN ELECTIVE-III	CREDITS
26AF1ARPOEM05H	Geomatics Engineering	3

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
3	0	0	3	20	20	60	100

Course Objectives	
COBJ1	To introduce the fundamentals and principles of remote sensing.
COBJ2	To understand image interpretation and digital image processing techniques.
COBJ3	To learn the concepts and implementation of spatial databases and spatial analysis.
COBJ4	To comprehend the components, functions, and applications of GIS.
COBJ5	To explore the implementation steps and real-life applications of GIS in civil engineering and related domains.

Course Outcomes: On completion of course, students will be able to	
CO1	Explain the principles and components of remote sensing systems and satellite platforms.
CO2	Perform visual and digital interpretation of remotely sensed data for terrain analysis.
CO3	Apply spatial database concepts and analysis techniques for data management and decision-making.
CO4	Understand the fundamentals and operational principles of GIS, including data models and projections.
CO5	Analyze and implement GIS applications in civil engineering, planning, hazard assessment, and business.

Course Contents

Module 1	**Concepts of Remote Sensing**	**Hrs. 8**
Basics of remote sensing, elements involved, electromagnetic spectrum Terminology & units, energy resources, energy interactions with Earth surface & atmosphere Atmospheric effects, Remote sensing platforms and sensors, satellite orbits, sensor resolutions, types of sensors, IRS, and Landsat satellites series.		
Module 2	**Remote Sensing Data Interpretation & Digital Image Processing**	**Hrs. 8**
Visual interpretation techniques, elements, converging evidence, Spectral signature, Spectral properties of soil, water, vegetation, Digital image and properties, Concepts of digital image processing, image enhancement, Pattern recognition, classification techniques, and accuracy estimation.		
Module 3	**Spatial DBMS & Analysis**	**Hrs. 8**
Spatial DBMS: data storage, DBMS structure models, Entity Relationship model, normalization. Spatial Analysis: topology, vector & raster data analysis, network analysis, Data interpolation techniques, data		

input: keyboard, digitization, scanning, remotely sensed data.		
Module 4	**Introduction to GIS**	**Hrs. 8**
History and components of GIS, applications and integration of remote sensing, Nature of geographic data, types of maps and scales, Map projections, coordinate systems, geo-referencing, map transformation, Thematic mapping for various applications.		
Module 5	**Implementing a GIS and Applications**	**Hrs. 8**
Implementing a GIS: Awareness, developing system requirements, evaluation of alternative systems, decision making using GIS. Applications of GIS: GIS-based road network planning, Mineral mapping using GIS, Shortest path detection using GIS, Hazard Zonation using remote sensing and GIS, GIS for solving multi-criteria problems, GIS for business applications.		

Text Books:	
1	Remote Sensing and GIS by Basudeb Bhatta, Oxford University Press, 2nd Edition, 2011.
2	Introduction to Geographic Information Systems by Kang-Tsung Chang, McGraw-Hill Education (Indian Edition), 7th Edition, 2015.
3	Fundamentals of Geographic Information Systems by Michael N. Demers, 4th Edition, Wiley Publishers, 2012.
4	Textbook of Remote Sensing and Geographical Information Systems by M. Anji Reddy.
Reference Books:	
1	Remote Sensing and Image Interpretation by Thomas M. Lillesand and Ralph W. Kiefer, Wiley Publishers, 7th Edition, 2015.
2	Geographic Information systems – An Introduction by Tor Bernhardsen, Wiley India Publication, 3rd Edition, 2010.
3	Advanced Surveying: Total Station, GIS and Remote Sensing by Satheesh Gopi, R. Sathi Kumar, N. Madhu, Pearson Education, 1st Edition, 2007.

SUBJECT CODE	OPEN ELECTIVE-III	CREDITS
26AF1ARPOEM05I	Ground Improvement Techniques	3

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
3	0	0	3	20	20	60	100

Course Objectives	
COBJ1	Understand the Need for Ground Improvement: Recognize the necessity and scope of ground improvement in geotechnical engineering projects.
COBJ2	Explore Dewatering Techniques: Learn various methods for lowering groundwater and their applications in soil stabilization.
COBJ3	Analyze Compaction Methods: Investigate in-situ compaction techniques for both granular and cohesive soils, and assess factors influencing compaction.
COBJ4	Evaluate Drainage and Consolidation Aids: Study the function and design of sand drains, wick drains, and related methods for soil strengthening and settlement reduction.
COBJ5	Understand Reinforcement Techniques: Learn the principles of earth reinforcement, geotextiles, and their practical applications in filtration, drainage, and erosion control.

Course Outcomes: Students will be able to	
CO1	Explain the principles and methods of dewatering and groundwater control in soil stabilization
CO2	Identify and apply various compaction techniques and evaluate their effectiveness for different soil types.
CO3	Design stone columns, lime piles, root piles, and understand soil nailing techniques for slope stability and liquefaction mitigation.
CO4	Apply the principles of reinforced earth design and select appropriate geosynthetics for engineering applications.
CO5	Distinguish between types of grout and grouting methods; design grouting systems for specific geotechnical issues including expansive soil stabilization.

Course Contents

Module 1	**Dewatering: Introduction**	**Hrs. 8**
Scope and necessity of ground improvement in Geotechnical engineering basic concepts. Drainage – Ground Water lowering by well points, deep wells, vacuum and electroosmotic methods. Stabilization by thermal and freezing techniques - Applications.		
Module 2	**Compaction and Sand Drains**	**Hrs. 6**
Insitu compaction of granular and cohesive soils, Shallow and Deep compaction methods – Sand piles – Concept, design, factors influencing compaction. Blasting and dynamic consolidation – Preloading with sand drains, fabric drains, wick drains etc. – Theories of sand drain – design and relative merits of various methods – Case studies.		

Module 3	Stone Column, Lime Piles and Soil Nailing	Hrs. 5
Stone column, lime piles – Functions – Methods of installation– design, estimation of load carrying capacity and settlement. Root piles and soil nailing – methods of installation – Design and Applications - Soil liquefaction mitigation methods - case studies.		
Module 4	**Earth Reinforcement**	**Hrs. 4**
Earth reinforcement – Principles and basic mechanism of reinforced earth, simple design: Synthetic and natural fiber-based Geotextiles and their applications. Filtration, drainage, separation, erosion control – case studies.		
Module 5	**Grouting**	**Hrs. 4**
Grouting – Types of grouts – Suspension and solution grouts – Basic requirements of grout. Grouting equipment – injection methods – jet grouting – grout monitoring – Electro – Chemical stabilization – Stabilization with cement, lime - Stabilization of expansive clays – case studies.		

Text Books:	
1	Pappala, A.J., Huang,J., Han, J., and Hoyos, L.R., "Ground Improvement and Geosynthetics; Geotechnical special publication No.207, Geo Institute, ASCE, 2010
2	Cox, B.R., and Grifiths S.C., "Practical Recommendation for Evaluation and mitigation of Soil Liquefaction" in Arkansas, (Project Report), 2010.
3	Day, R.W., "Foundation Engineering Handbook, McGraw – Hill Companies, Inc. 2006.
4	Rowe, R.K., "Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publishers, 2001.
5	Das, B.M., "Principles of Foundation Engineering, Fourth Edition, PWS Publishing, 1999.
Reference Books:	
1	Moseley, M.P., "Ground Treatment, Blackie Academic and Professionals, 1998.
2	Koerner, R.M., "Designing with Geosynthetics, Third Edition, Prentice Hall 1997.
3	Hehn, R.W., "Practical Guide to Grouting of Underground Structures, ASCE, 1996
4	Jewell, R.A., "Soil Reinforcement with Geotextiles, CIRIA, London, 1996.
5	Koerner, R.M. and Welsh, J.P., "Construction and Geotechnical Engineering using Synthetic Fabrics"

SUBJECT CODE	OPEN ELECTIVE-III	CREDITS
26AF1ARPOEM05J	Sustainable Construction Methods	3

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
3	0	0	3	20	20	60	100

Course Objectives	
COBJ1	To introduce the concepts of sustainability in the built environment.
COBJ2	To familiarize students with sustainable and alternative building materials.
COBJ3	To explore eco-friendly and cost-effective construction methods and technologies.
COBJ4	To understand green building standards and regulations.
COBJ5	To introduce digital and smart technologies for sustainable construction.

Course Outcomes: Students will be able to	
CO1	Explain the fundamental concepts of sustainability.
CO2	Describe the properties and uses of sustainable building materials.
CO3	Identify suitable construction techniques and practices for sustainable buildings.
CO4	Discuss the standards and guidelines for sustainable buildings.
CO5	Comment on the role of BIM and automation in sustainable construction.

Course Contents

Module 1	**Introduction to Sustainability**	**Hrs. 8**

Impacts of global warming, sustainability indicators - Carbon foot print, Embodied energy and carbon, sustainability analysis - Lifecycle Analysis, EIA - Concept of Green Buildings.

Module 2	**Sustainable building materials**	**Hrs. 8**

Introduction to sustainable building materials, qualities, use, examples - Natural building materials, locally available and locally manufactured materials – wood, earth, stone and lime-based materials.

Alternative Building Materials - Overview and definition of alternative or appropriate building materials - Alternative materials developed and promoted by government organisations like CSIR labs: CBRI and SERC, GRIHA, ASTRA (IISc), BMTPC, HUDCO and its building centers - Alternative materials developed and promoted by non-government organisations DA, Auroville, TERI.

Module 3	**Sustainable methods & technologies**	**Hrs. 5**

Eco friendly and low-cost techniques - Different substitute, for wall construction - Flemish Bond - Rat Trap Bond – Arches – Panels - Cavity Wall – Ferro, Cement and Ferro Concrete constructions – different pre cast members using these materials -Alternate roofing systems - Filler Slab - Composite Beam and Panel Roof -Pre-engineered and ready to use building elements - wood products -steel and plastic –Mivan technique -Contributions of agencies - Costford - Nirmithi Kendra – Habitat

Module 4	Green building rating systems	Hrs. 4
Green building rating systems – Guidelines from IGBC – LEED rating system, TERI-GRIHA rating system. Codes - Energy Conservation Building Code (BEE), National Building Code. Green Building Case studies – Residential, Institutional, and Commercial. Concept of Net Zero buildings – Use of BIPV and other renewable energy in buildings		
Module 5	**ICT for Sustainable Construction**	**Hrs. 4**
Building Information modeling – Introduction to BIM, concepts and benefits, BIM for construction scheduling, cost estimation and construction management. Building Automation – Concepts, components of BA, applications of BA for functional efficiency of buildings.		

Text Books:	
1	Sustainable Building - Design Manual Pt 1 & 2, The Energy and Resources Institute, TERI, 2004
2	Automation Systems in Smart and Green Buildings (Modern Building Technology), Er. V K Jain, Khanna Publishers.
3	Jagadish. K.S. Alternative Building Materials and Technologies, New age International Pvt Ltd Publishers, 2008
4	Energy Conservation Building Code of India, User manual, 2007
5	P.K. Singh, Rainwater Harvesting: Low cost indigenous and innovative technologies, Macmillan Publishers India, 2008
Reference Books:	
1	Ross Spiegel.G, Green Building Materials A Guide to Product Selection and Specification,
2	Traci Rose Rider, Stacy Glass, Jessica McNaughton, Understanding Green Building Materials, W.W.Norton and Company, 2011
3	BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors- Chuck Eastman, et al.
4	Jagadish. K.S. Building with stabilised mud, I.K. International Publishing House Pvt. Limited, 2007

SUBJECT CODE	Design of Steel Structures Lab	CREDITS
26AF1906PCL507		1

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
0	0	2	2	50	-	50	100

Course Outcomes: On completion of course, students will be able to	
CO1	Illustrate the geometric and dimensional characteristics of various structural steel sections, types of trusses, and types of structural connections through detailed engineering drawings.
CO2	Analyze and design industrial shed structures using portal or gable frame systems with appropriate bracing, purlins, columns, and base plates, considering practical loading conditions.
CO3	Evaluate the structural behavior of trussed roof systems with bracing and perform detailed design of purlins, columns, and column bases for industrial applications.
CO4	Design gantry girders along with supporting columns, bracings, and associated structural elements for industrial sheds subjected to moving loads from cranes.
CO5	Analyze and design structural systems involving composite steel–RCC construction with emphasis on load-sharing behavior, member design, and detailing.

Course Contents

Term work shall consist of detailed analytical report for structural design and drawing of any one of the following from Group A/B/C as per IS 800-2007.

Group A
1) Drawing of structural steel sections, types of trusses, types of connections 2) Industrial Shed: Roof Truss with Necessary Bracing System, Purlins, Column and Column Bases
Group B
1) Drawing of structural steel sections, types of trusses, types of connections 2) Industrial Shed: Plate Girder, Purlins, Column and Column Bases
Group C
1) Drawing of structural steel sections, types of trusses, types of connections 2) Analysis and design of any structural steel building with Portal or Gable Frames of Solid or Open Web Sections with Necessary. Bracing System, Purlins, Column and Column Bases

SUBJECT CODE	OCF & HM Lab	CREDITS
26AF1906PCL508		1

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
0	0	2	2	25	-	25	50

Course Outcomes: On completion of course, students will be able to	
CO1	Calculate coefficient of discharge for flow measuring equipment in open channels and closed conduits.
CO2	Study mechanism of hydraulic jump.
CO3	Understand mechanism of pumps and turbines.
CO4	Understand the impact of jets on various surfaces.
CO5	Evaluate the performance characteristics of Pelton, Kaplan, and Francis turbines

Course Contents

Practical Work consists of at least six performances from list below and detailed reporting in form of journal.

Experiment No 1	Calibration of V notch / Rectangular notch.
Experiment No 2	Calibration of Ogee Weir.
Experiment No 3	Velocity distribution in open channel in transverse direction of flow.
Experiment No 4	Study of hydraulic jump
Experiment No 5	Impact of jet
Experiment No 6	Study of Turbines
Experiment No 7	Tests on Centrifugal Pump
Experiment No 8	Performance Characteristics of Pelton/ Kaplan/ Francis Turbine
Use of computer programs such as MS Excel is desirable for post-processing of results.	

SUBJECT CODE	Geotechnical Engineering Lab					CREDITS	
26AF1906PCL509						1	
2 hours / week				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
0	0	2	2	25	-	25	50

Course Outcomes: On completion of course, students will be able to	
CO1	Determine basic physical properties of soils for classification.
CO2	Evaluate soil compaction characteristics using Proctor tests.
CO3	Measure in-situ density and bearing capacity of soils.
CO4	Assess soil permeability and consolidation for drainage and settlement.
CO5	Analyze soil shear strength parameters for stability analysis.

Course Contents

Practical Work consists of at least eight performances from list below and detailed reporting in form of journal.

Experiment No 1	To find out specific gravity of soil solids by Pycnometer Method
Experiment No 2	Determination of moisture content by oven drying method
Experiment No 3	To detect field density of the soil by core cutter method
Experiment No 4	To ensure grain size distribution by mechanical sieve analysis.
Experiment No 5	To work out Atterberg's limits (LL, PL and SL)
Experiment No 6	To determine compaction properties by Standard Proctor Test
Experiment No 7	To figure out of permeability of soil by using falling head test
Experiment No 8	To decide shear strength parameters by direct shear test.
Experiment No 9	To find out shear strength by unconfined compressive strength test.
Experiment No 10	To determine of shear strength parameters by Triaxial shear test.
Experiment No 11	Determination of C.B.R. value by conducting laboratory CBR test. (soaked/unsoaked)
Experiment No 12	To decide Coefficient of consolidation by conducting consolidation test
Experiment No 13	To work out Compaction properties of soil by modified proctor test
Experiment No 14	To determine permeability of soil by using constant head method
Experiment No 15	To analyze the stability of an earth slope using GEO5's Slope Stability module, determine the Factor of Safety (FOS) using Bishop's Simplified Method, and study the influence of soil shear strength parameters (cohesion c and angle of internal friction φ) on slope stability.
Use of computer programs such as MS Excel is desirable for post-processing of results.	

SUBJECT CODE	Soft Skills Development	CREDITS
26AF1906HM510		AU

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
0	2	0	2	-	-	-	GR

Course Objectives	
COBJ1	To inculcate soft skills so that students can work efficiently in the corporate sector and government organisations.
COBJ2	To provide knowledge of conflict management while working in large organisations
COBJ3	To develop management skills required in routine work environment
COBJ4	To polish the personality of the learners in order to make them good leaders and employees
COBJ5	To imbibe qualities like manners and etiquettes, coordination, mutual understanding for their colleagues while working in a group.

Course Outcomes: On completion of course, students will be able to	
CO1	Learners will acquire interpersonal communication skills
CO2	Learners will develop the ability to work independently
CO3	Learners will develop the qualities like self-discipline, self-criticism and self-management
CO4	Learners will have the qualities of time management and discipline
CO5	Learners would be able to present themselves as an inspiration for others

Course Contents

Module 1	**Introduction to Soft Skills and Personality Development**	**Hrs. 8**

Introduction to Soft Skills, Need of Soft Skills, New Approach to Learning, Human Perceptions: Understanding People, Types of Soft Skills: Self-Management Skills, Interpersonal Skills, What is Personality, Personality Development.

Module 2	**Self-Management & Self-Management Techniques**	**Hrs. 8**

Self Management, Stress Management: Types of Stress: Self-Awareness about Stress, Regulating Stress: Making The Best out of Stress, Self-Evaluation, Self- discipline, Self-criticism, Recognition of one's own limits and deficiencies, dependency, etc. Self-Awareness, Self-Management, identifying one's strengths and weaknesses, Planning & Goal setting, Managing self-emotions, ego, pride

Module 3	**Interpersonal Skills Development**	**Hrs. 5**

Positive Relationship, Positive Attitudes, Empathise: comprehending others' opinions, points of views, and face them with understanding, Mutuality, Trust, Emotional Bonding, Handling Situations (Interview), Importance of interpersonal skills, Creative Thinking, Critical Thinking.

Module 4	**Problem Solving Techniques**	**Hrs. 5**

Conflict Resolution Skills: Seeking Win-Win Solution (Negotiation Skills), Inter-Personal Conflicts: Two Examples, Inter-Personal Conflicts: Two Solutions, Types of Conflicts: Becoming a Conflict Resolution Expert

Module 5	Motivation/ Inspiration and Motivation Techniques	Hrs. 5
Ability to shape and direct working methods according to self-defined criteria, Ability to think for oneself, apply oneself to a task independently with self-motivation, Motivation techniques based on needs and field situations, Leadership and Team Dynamics.		

Text Books:	
1	Mitra, Barun. Personality Development and Soft Skills. Oxford University Press, 2016.
2	Ramesh, Gopalswamy. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success. Pearson Education, 2013.
3	Covey, Stephen R. Seven Habits of Highly Effective People: Powerful Lessons in Personal Change. Simon & Schuster Ltd., 2013.
4	Rosenberg, Marshall B. Nonviolent Communication: A Language of Life. Puddle Dancer Press, 2015.

SUBJECT CODE	Construction Equipment and Site Safety Management	CREDITS
26AF1906VS511		2

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
0	2	0	2	25	-	25	50

Course Objectives	
1	To understand the classification, selection, and cost analysis of construction equipment.
2	To study earthmoving and material handling equipment used in construction projects.
3	To learn road construction and concreting equipment and their applications.
4	To understand construction site safety practices and hazard control measures.
5	To study safety laws, regulations, and safety management systems in construction.

Course Outcomes: On completion of course, students will be able to	
CO1	Explain the types, selection criteria, and cost aspects of construction equipment.
CO2	Describe the operation and applications of earthmoving and material handling equipment.
CO3	Understand the use of road construction and concreting equipment in projects.
CO4	Apply construction safety measures and emergency response procedures.
CO5	Understand safety regulations, risk assessment, and safety management systems.

Course Contents

Module 1	**Introduction to Construction Equipment**	**Hrs. 8**

The classification of construction equipment, the fundamental criteria for selecting appropriate machinery based on productivity, cost-effectiveness, project suitability, The estimation of ownership and operating costs, understanding equipment depreciation, replacement policies, introduction to automation trends in construction equipment.

Module 2	**Earthmoving and Material Handling Equipment**	**Hrs. 8**

Types of earthmoving machinery such as excavators, bulldozers, backhoe loaders, and scrapers, along with compacting equipment like rollers and rammers, material handling tools including different types of cranes, hoists, conveyors, forklifts. Emphasis is placed on equipment used for foundation works, the importance of safety protocols and inspection routines for all these machines.

Module 3	**Road Construction and Concreting Equipment**	**Hrs. 8**

The equipment used in road construction including pavers, graders, and milling machines. Equipment for concrete-related operations such as batching plants, transit mixers, concrete pumps, and slip-forming machines, advanced techniques such as shotcreting, the use of asphalt mixing and laying equipment, practical case studies to illustrate the effective deployment of such equipment in real-world projects.

Module 4	Construction Site Safety Management	Hrs. 8
The concept of construction safety, common hazards, and accident trends in the industry, safety measures such as proper signage, the use of personal protective equipment (PPE), the role of site layout in enhancing safety, risks associated with working at heights, excavation, trenching, fire hazards, and electrical safety, emergency planning and basic first aid procedures.		
Module 5	**Safety Laws, Regulations, and Management Systems**	**Hrs. 8**
The legal and regulatory framework governing construction safety, relevant national standards and international benchmarks such as OSHA and ISO 45001. Statutory compliance, conducting safety audits and inspections, preparation of safety reports, risk assessment methods, job hazard analysis (JHA), the implementation of comprehensive Safety Management Systems (SMS), behavior-based safety approaches.		

Guidelines for Assignments/Assessment:	
1	The candidate shall perform minimum five assignments consisting aspects of the Course.
2	Faculty member can do the (internal & external) assessment through Quiz/ Exam. (MCQ/descriptive) /PPT/ Poster/Drawing/small project activity and must maintain the record of the same.

Text Books:	
1	Sharma, S.C., Construction Equipment and Management, Khanna Publishers.
2	Hinze, J., Construction Safety, Prentice Hall.
3	Peurifoy, R.L., Construction Planning, Equipment, and Methods, McGraw-Hill.
4	Goetsch, D.L., Construction Safety and Health, Pearson
5	Mahesh Varma, Construction Equipment and Its Planning and Application, Metropolitan Book Co. Pvt. Ltd.
Reference Books:	
1	IS Codes and OSHA Construction Safety Manuals.
2	CPWD Safety Code and Manuals.

Dr. Babasaheb Ambedkar Technological University, Lonere

Teaching & Evaluation Scheme for Third Year of
B. Tech. Civil Engineering (Structural Engineering) (Integrated)

Sr. No.	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				Credits
			L	T	P	ISE	MSE	ESE	Total	
Semester-VI										
1	26AF1906PC601	Design of Concrete Structures	3	0	0	20	20	60	100	3
2	26AF1906PE602	Program Elective-I	3	0	0	20	20	60	100	3
3	26AF1906PE603	Program Elective -II	3	0	0	20	20	60	100	3
4	26AF1906PE604	Program Elective-III	3	0	0	20	20	60	100	3
5	26AF1906PC605	Foundation Engineering	3	0	0	20	20	60	100	3
6	Refer Bucket	Multi-Disciplinary Minor-IV	3	0	0	20	20	60	100	3
7	26AF1906PCL607	Concrete Structures Lab	0	0	2	50	-	50	100	1
8	26AF1906PEL608	Program Elective-II- Lab	0	0	2	25	-	25	50	1
9	26AF1906PEL609	Program Elective-III- Lab	0	0	2	25	-	25	50	1
10	26AF1906EL610	Seminar	0	2	2	25	-	25	50	1
11	26AF1906VS611	Academic Research Writing	1	0	0	50	-	-	50	1
		TOTAL	**19**	**2**	**8**	**295**	**120**	**485**	**900**	**23**

Course Type	Course Code	Course Name
Program Elective-I	26AF1906PE602A	Hydraulics Structures
	26AF1906PE602B	Irrigation Engineering
Program Elective-II	26AF1906PE603A	Water Quality Engineering
	26AF1906PE603B	Environment Health and Safety
Program Elective-III	26AF1906PE604A	Highway & Railway Engineering
	26AF1906PE604B	Intelligent Transportation Systems
	26AF1906PE604C	Urban Transportation Planning

Course Type	Course Code	Course Name
Open elective-III	26AF1ARPOEM05H	Geomatics Engineering
	26AF1ARPOEM05I	Ground Improvement Techniques
	26AF1ARPOEM05J	Sustainable Construction Methods
Multi-Disciplinary Minor-III	Refer Bucket	Refer Bucket
Multi-Disciplinary Minor-IV	Refer Bucket	Refer Bucket

Type of course:

Basic Science: **BS**	Engineering Science: **ES**
Program Elective: **PE**	Program Core: **PC**
Modern Indian Language: **MIL**	Indian Knowledge System: **IK**
Value Education Course: **VEC**	Ability Enhancement Course: **AE**
Vocational and Skill Enhancement: **VS**	Audit Course: **AU**
Open Elective: **OE** (Other than particular program)	Co-curricular & Extracurricular Activities: **CC**
Multidisciplinary Courses: **MD**	Humanities, Management, language and Commerce: **HM**

SUBJECT CODE	Design of Concrete Structures						CREDITS
26AF1906PC601							3
Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
3	0	0	3	20	20	60	100

Pre-requisite: Engineering Mechanic, Mechanics of Solids, Structural Mechanics

Course Objectives	
COBJ1	To understand the fundamentals and philosophies of reinforced concrete design.
COBJ2	To study analysis and design of RC structural elements using Working Stress Method.
COBJ3	To learn limit state design concepts for shear, bond, and flexure.
COBJ4	To understand the design and detailing of beams, slabs, and staircases using LSM.
COBJ5	To study the design of columns and footings under different loading conditions.

Course Outcomes: On completion of course, students will be able to	
CO1	Explain the behavior and design philosophies of reinforced concrete structures.
CO2	Design RC beams, columns, and footings using Working Stress Method.
CO3	Apply limit state concepts for shear, bond, and flexural design.
CO4	Design and detail beams, slabs, and staircases using Limit State Method.
CO5	Analyze and design compression members and isolated footings using LSM principles.

Course Contents

Module 1	**Fundamentals and Working Stress Method**	**Hrs. 6**
Basic aspects of structural design, design philosophies (WSM, ULM, LSM), Stress-strain behavior of concrete and steel, Comparison of WSM, ULM, and LSM, factor of safety, load estimation, Introduction to Working Stress Method, permissible stresses, assumptions, Basic design of RC sections using WSM principles.		
Module 2	**Structural Design Using WSM**	**Hrs. 10**
Stress block parameters and section classification (under/over-reinforced, balanced), Flexural design of singly and doubly reinforced beams, Shear design principles and detailing of reinforcement, Design of axially and uniaxially eccentrically loaded short columns, Design of isolated column footings, WSM as per IS:456-2000 Annexure B.		
Module 3	**Limit State Method - Philosophy, Shear, and Bond**	**Hrs. 8**
Limit State approach: definition, types, and classifications of limit states, Characteristic loads and strengths, partial safety factors, Strain variation and stress distribution diagrams, serviceability requirements, Design for shear: types of shear failure, reinforcement types, minimum shear steel, Design for bond: development length, anchorage, detailing as per IS code.		

Module 4	Limit State Design in Flexure - Beams, Slabs, and Staircases	Hrs. 8
Design of singly and doubly reinforced beams using LSM, Design of flanged beams (L and T sections),Design and detailing of one-way and two-way slabs under various loading/supports, Deflection and crack control criteria, Design of staircases: dog-legged and open-well, effective span, and load distribution.		
Module 5	**Compression Members and Footings - Limit State Design**	**Hrs. 8**
Design of axially and eccentrically loaded short columns (rectangular and circular), Construction of interaction diagrams for uni-axial bending, Concept of bi-axial bending and interaction surface (theoretical introduction), Design and detailing of isolated footings for axial and uniaxial loads, Practical considerations in reinforcement layout and anchorage.		

Text Books:	
1	Varghese, P. C. Limit State Design of Reinforced Concrete, PHI Learning.
2	Pillai, S. U., & Menon, D. Reinforced Concrete Design, McGraw-Hill.
3	Jain, A. K. Limit State Design of RCC, Nem Chand & Bros.
4	Subramanian, N. Design of Reinforced Concrete Structures, Oxford University Press.
5	Punmia, B. C. Reinforced Concrete Structures, Laxmi Publications.
Reference Books:	
1	IS:456-2000 – Code of Practice for Plain and Reinforced Concrete, BIS.
2	Handoo, B. L. Concrete Structures, Satya Prakashan.

SUBJECT CODE	PROGRAM ELECTIVE-I	CREDITS
26AF1906PE602A	Hydraulic Structures	3

Teaching Work Load/week (3 Hrs.)				Examination Scheme (100 Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
3	0	0	3	20	20	60	100

Pre-requisite: Knowledge of Applied Mechanics, Fluid Mechanics and Irrigation Engineering.

Course Objectives	
COBJ1	To understand the fundamentals, classification, and design considerations of hydraulic structures and dams.
COBJ2	To study the design and stability aspects of dams, reservoirs, and diversion headworks.
COBJ3	To learn the functions and design concepts of spillways and energy dissipators.
COBJ4	To understand the design principles of weirs, barrages, and canal structures.
COBJ5	To study dam safety and instrumentation techniques used in hydraulic structures.

Course Outcomes: On completion of course, students will be able to	
CO1	Explain the classification, site selection, and design aspects of hydraulic structures and dams.
CO2	Analyze stability, seepage, and reservoir-related aspects of dams and diversion headworks.
CO3	Describe spillway types, gates, and energy dissipation arrangements.
CO4	Apply design concepts of weirs, barrages, and lined and unlined canals.
CO5	Understand dam safety measures and the working of instrumentation systems.

Course Contents

Module 1	**Fundamentals of Hydraulic Structures**	**Hrs. 8**

Introduction and classification of hydraulic structures, Site selection and design parameters, Factors governing selection of type of dam, Classification of dams, Classification based on purpose, Classification based on materials, Classification based on size of project, Classification based on hydraulic action, Classification based on structural action, Dams and earthquakes, Dams and social issues, Large dams verses small dams, Displacement and rehabilitation, Dams and climate change ,Overview of hydrological and geological considerations, Introduction to IS code practices.

Module 2	**Dams and Reservoirs**	**Hrs. 8**

Types and classification of dams: Gravity, Arch, Earth-fill, Rock-fill, Design of gravity dams: Stability, stress analysis, practical profiles, Seepage and slope stability in earth dams, Reservoir planning, sedimentation, and control. Introduction, Function of diversion headworks, Selection of site for diversion headworks, Layout of diversion headworks, Components of diversion headworks, Design of weir on permeable foundation,

Module 3	Spillways and Energy Dissipators	Hrs. 8

Spillway: Necessity and function, components of spillway, different types, Energy dissipation arrangements, gates for spillway, Elementary design of an ogee spillway Outlets in Dams: Outlets through concrete and earth dams, different types, Trash racks.

Spillway Gates -Introduction of Spillway gates , Classification of spillway crest gates, Classification based on function, Classification based on movement of gates, Classification based on special features, Introduction to automatic gates, Maintenance of gates, Inspection of gates.

Module 4	Canal and River Structures	Hrs. 08

Design of weirs and barrages on permeable foundations: Introduction, causes of failure of weirs, creep theory, Khosla's theory.

Design of canal sections: Design of unlined canals- introduction, design formulae. Kennedy's theory and Lacey's theory, drawbacks and comparison. Design of lined canals, design parameters, design procedures, types of lining

Module 5	Dam Safety and Instrumentation	Hrs. 08

Significance of Instrumentation: introduction, objectives of dam safety and instrumentation. Working principles and functions of instruments: piezometer, porous tube piezometer, pneumatic piezometer, vibrating wire piezometer, vibrating wire settlement cell, inclinometer, joint meter, pendulums, inverted pendulum, hanging pendulum, automatic pendulum coordinator, vibrating wire pressure cell, extensometer, embedment strain gauge, temperature gauge, distributed fiber optics temperature tool, seismograph

Text Books:

1	Arora, K.R., "Irrigation, Water Power and Water Resources Engineering", Standard Publishers Distributors, Delhi.
2	Modi, P.N.," Introduction to Water Resources and Waterpower Engineering", Standard Publication, Delhi
3	Garg, S.K., "Irrigation Engineering and Hydraulic Structures" Khanna Publishers
4	Asawa, G, L "Irrigation and Water Resources Engineering", New Age Int. Ltd.
5	"Hydraulic Engineering", J. A. Roberson, J. J. Cassidy, M. N. Chaudhry, John Wiley & Sons, New York, 1998.

Reference Books:

1	Water Resources Engineering by R.K. Linsley & J.L.H. Paulhus, McGraw Hill.
2	Open channel hydraulics by Ven Te Chow Mc Graw Hill Book Co. International Students Edition

SUBJECT CODE	Dams and Reservoirs						CREDITS
26AF1906PE602B							3
Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
3	0	0	3	20	20	60	100

Course Objectives	
COBJ1	To understand the fundamentals and classification of dams and hydraulic structures.
COBJ2	To study different canal structures and their functions in irrigation systems.
COBJ3	To learn river behavior and river training methods.
COBJ4	To understand the principles and components of diversion head works.
COBJ5	To study the types and design considerations of cross drainage works.

Course Outcomes: On completion of course, students will be able to	
CO1	Explain the classification, selection, and features of dams and hydraulic structures.
CO2	Describe different canal structures, falls, outlets, and regulators.
CO3	Understand river training structures and their applications.
CO4	Apply basic design concepts of diversion head works and weirs.
CO5	Describe the types, functions, and design considerations of cross drainage works.

Course Contents

Module 1	**Fundamentals of Hydraulic Structures**	**Hrs. 6**

Introduction, historical development of dams, different terms related to dams, selection of site of dam, factors governing selection of type of dam, classifications of dam, classification based on purpose, classification based on material, classification based on size of project, classification based on hydraulic action, classification based on structural action, introduction of arch dam and buttress dam including classification, advantages and limitations.

Module 2	**Canal Structures**	**Hrs. 6**

Canal falls Introduction, Necessity of canal fall, Selection of site for canal fall, Classification of canal fall, Types of falls, Free fall or open fall, Notch fall, Ogee Fall, Rapid Stepped fall, Straight glacis fall, Sarda fall, Semi pressure fall, Baffle or Englis Fall, Montague fall Siphon well or cylinder fall, Pressure or closed conduit fall, Shaft or Pipe fall, Selection of type of fall, Canal outlets- Introduction of Canal outlet or module, Canal escapes- Introduction of Escapes, Significance of canal escape, Canal regulators—Canal regulators.

Module 3	**River Training Structures**	**Hrs. 6**

Introduction, Classification of rivers, Classification based on topography, regime, alignment, source, Behaviour of rivers, River training, Objectives of river training, Classification of river training, purpose, orientation, River training structures, Embankment or Levee, Guide banks, Groynes or spurs, Artificial cut off, Pitched Island, Submerged sill or dykes, Closing dykes

Module 4	Diversion head works	Hrs. 6
Introduction, function of diversion head works, selection of sites for diversion head works, components of diversion head works, design of weir on permeable foundation, criteria for safe design of weir floor, brief introduction to Bligh and Lane's theory, Khosla's theory based on potential theory approach, Khosla's theory on independent variables, design of weirs on permeable foundations.		
Module 5	**Cross Drainage Works**	**Hrs. 6**
Introduction, Necessity of Cross Drainage works, Selection of site for Cross Drainage work, Selection of suitable type of C. D. works, data required for design of cross drainage work, classification of cross drainage works. Drain over canal: siphon, super passage. Canal over drain: aqueduct, siphon aqueduct. Canal and drain water meeting at same level: level crossing, inlet and outlet, design considerations for cross drainage works.		

Text Books:	
1	Irrigation and Water Resources Engineering, Asawa G. L., New Age International (P) Ltd.
2	Irrigation Engineering and Hydraulic Structures, Garg S. K, Khanna Publication.
3	Irrigation Water Power Engineering, Punmia B. C., Laxmi Publication.
4	Design Textbook in Civil Engineering: Volume Six: Dams- Leliavsky, Serge – Oxford and IBH Publishing Co. Pvt. Ltd., 1981.
Reference Books:	
1	Design of Small Dams, United States Department of the Interior, Bureau of Reclamation revised reprint 1974, Oxford and IBH Publishing Co.
2	Design Textbook in Civil Engineering, Volume Six, Leliavsky, Serge-Oxford and IBH Publishing Co.Pvt. Ltd.
3	Irrigation, Water Resources and Water Power Engineering, Modi P. N., Standard Book House, New Delhi.

SUBJECT	Program Elective -II	CREDITS
26AF1906PE603A	Water Quality Engineering	3

Teaching Workload/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
3	0	0	3	20	20	60	100

Course Objectives	
COBJ1	To understand the fundamentals of water quality and water pollution.
COBJ2	To study water quality parameters and analytical instruments.
COBJ3	To learn water and wastewater treatment technologies and processes.
COBJ4	To understand the design and operation of water and wastewater treatment systems.
COBJ5	To study water quality index, pollution impacts, and water quality modeling.

Course Outcomes: On completion of course, students will be able to	
CO1	Identify and classify different sources of water pollutants and explain the chemical and biological processes affecting water quality.
CO2	Perform laboratory analysis of key water quality parameters and interpret results using appropriate instrumentation and techniques.
CO3	Compare Indian and international water quality standards and assess the suitability of water for drinking, agricultural, industrial, and aquatic uses.
CO4	Design basic components of water treatment plants and evaluate the performance of conventional and advanced treatment systems.
CO5	Analyze the impact of pollution on surface and groundwater bodies.

Course Contents

Module 1	**Fundamentals of Water Quality and Pollution**	**Hrs. 8**

Terminology related to water quality and pollution, Sources of water pollutants, Natural and anthropogenic pollution, Pollution kinetics including zero-order, first-order and second-order reactions, Reaction mechanisms in aquatic environments, international water quality standards (WHO), Indian water quality standards (IS 10500) for drinking, irrigation, industrial and aquatic use.

Module 2	**Water Quality Analysis and Instrumentation**	**Hrs. 8**

Water quality parameters including pH, TDS, BOD, COD, DO, turbidity, alkalinity, hardness, nitrates, metals, Analytical methods such as titrimetric, gravimetric, spectrophotometric, electrometric, Instruments used in analysis including pH meter, turbidity meter, DO meter, spectrophotometer, flame photometer, Working principles and applications of each instrument

Module 3	**Water and Wastewater Treatment Technologies**	**Hrs. 8**

Water purification methods including mechanical filters, biological filters and membrane filters, Reverse osmosis principle and applications, RO membranes and related instruments, Water treatment processes such as aeration, nitrogen removal, pH control, removal of solids and gases, Disinfection methods using chlorine, bromine, iodine, potassium permanganate, Ion exchange process

Module 4	Water and Wastewater Treatment Systems	Hrs. 6
Components of water treatment plants, Design and working principles of treatment units, Wastewater treatment methods including primary, secondary and tertiary treatments, Activated sludge process, Trickling filters, UASB reactor, Membrane bioreactor (MBR), Instrumentation in wastewater treatment, Sludge management and disposal techniques.		
Module 5	**Water Quality Index, Pollution Impacts and Modeling.**	**Hrs. 06**
Water Quality Index (WQI) concept and principles, Parameters used in WQI calculation, Indian and international WQI standards, Water pollution due to pesticides and toxic metals, Sources and control of arsenic, lead, cadmium and mercury, Water quality modeling concepts, Introduction to QUAL2K and WASP models, Model inputs, calibration and result interpretation.		

Text Books:	
1	Groundwater Hydrology by David Keith Todd- John Wiley & Sons.
2	Water quality assessments by Chapman- D.- (Ed.)- 2nd Ed.- E&FNSPON (Imprint of Chapman & Hall-USA)-Pub. on behalf of UNESCO- WHO- UNEP- 1992.
3	Metcalf & Eddy (Wastewater Engineering: Treatment and Resource Recovery McGraw-Hill Education
4	Water Supply Engineering. By Dr. B.C. Punmia, Ashok Kr. Jain, Arun Kr. Jain
5	Surface Water-Quality Modeling - Steven C. Chapra
Reference Books:	
1	Water Supply Engineering By SK Garg.
2	Environmental Pollution Control Engineering - C. S. Rao

SUBJECT CODE	Program Elective -II	CREDITS
26AF1906PE603B	Environment Health and Safety	3

Teaching Workload/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
3	0	0	3	20	20	60	100

Course Objectives	
COBJ1	To introduce the necessity and framework of Environment, Health, and Safety (EHS) systems.
COBJ2	To impart knowledge of occupational health and hygiene.
COBJ3	To develop understanding of workplace safety systems.
COBJ4	To equip students with risk assessment and hazard control skills.
COBJ5	To familiarize learners with Environmental Health and Safety Management Systems.

Course Outcomes: On completion of course, students will be able to	
CO1	Need for EHS in industries and related Indian regulations.
CO2	Various types of Health hazards, effect, assessment and control methods.
CO3	Various safety systems in working environments.
CO4	The methodology for preparation of Emergency Plans and Accident investigation.
CO5	EHS Management System and its elements

Course Contents

Module 1	**Introduction**	**Hrs. 6**

Need for developing Environment, Health and Safety systems in work places- International initiatives, National Policy and Legislations on EHS in India – Regulations and Codes of Practice -Role of trade union safety representatives – Ergonomics.

Module 2	**Occupational Health & Hygiene**	**Hrs. 8**

Definition of occupational health and hygiene – Categories of health hazards – Exposure pathways and human responses–Exposure Assessment-occupational exposure limits Hierarchy of control measures – Role of personal protective equipment and the selection criteria.

Module 3	**Workplace Safety & Safety Systems**	**Hrs.8**

Features of Satisfactory and Safe design of work premises – good housekeeping – lighting and color, Ventilation and Heat Control, Noise, Chemical and Radiation Safety – Electrical Safety – Fire Safety – Safety at Construction sites, ETP – Machine guarding – Process Safety, Working at different levels.

Module 4	**Hazards & Risk Management**	**Hrs. 6**

Safety appraisal – Job Safety Analysis-Control techniques – plant safety inspection – Accident investigation – Analysis and Reporting – Hazard and Risk Management Techniques –Onsite and Offsite emergency Plans. Employee Participation- Education and Training- Case Studies.

Module 5	Environmental Health & Safety Management	Hrs. 6
Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and implementation and review – ISO 45001-Strucure and Clauses-Case Studies.		

Text Books:	
1	The Beginner's Guide to the Environmental, Health and Safety Profession, Chance Roberts.
2	Environmental Safety and Health Regulations, Joel M. Haight, Feb 4, 2013.
3	Safety, Health and Environmental Auditing, Simon Watson Pain, May 31, 2023.
4	Industrial Health and Safety Acts and Amendments, by Ministry of Labour and Employment, Government of India.
5	The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.
Reference Books:	
1	Fundamentals of Industrial Safety and Health by Dr.K.U.Mistry, Siddharth Prakashan, 2012.
2	Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services, 2005

SUBJECT CODE	Program Elective -III	CREDITS
26AF1906PE604A	Highway & Railway Engineering	3

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
3	0	0	3	20	20	60	100

Course Objectives	
COBJ1	To understand the classification of highways and the institutional frameworks.
COBJ2	To impart knowledge on the design principles of various highway geometric elements.
COBJ3	To introduce students to the selection and testing of highway construction materials.
COBJ4	To provide an overview of railway infrastructure components.
COBJ5	To educate students on the design, construction, and maintenance of railway track systems.

Course Outcomes: On completion of course, students will be able to	
CO1	Classify different types of highways and explain their functions, identify the institutions involved in highway development.
CO2	Describe the various cross-sectional and geometric elements of highways.
CO3	Suitable materials for highway construction and evaluate their properties.
CO4	Identify and explain the components of railway.
CO5	Explain the layout and working principles of railway operations.

Course Contents

Module 1	**Highway Engineering**	**Hrs. 8**

Classification of highways – Institutions for Highway planning, design and construction at different levels – factors influencing highway alignment -Typical cross sections of Urban and Rural roads – Engineering surveys for alignment- Conventional and Modern method.

Module 2	**Design of Highway Elements**	**Hrs. 8**

Cross sectional elements – Horizontal curves, super elevation, transition curves, widening of curves – Sight distances – Vertical curves, gradients- pavement components and their role – Design practice for flexible and rigid pavements (IRC methods only).

Module 3	**Highway Construction & Maintenance**	**Hrs. 8**

Highway construction materials, properties, testing methods – Construction practice of flexible and concrete pavement- Highway drainage – Evaluation and Maintenance of pavements.

Module 4	**Railway Planning & Construction**	**Hrs. 8**

Elements of permanent way – Rails, Sleepers, Ballast, rail fixtures and fastenings, Selection of gauges – Track Stress, coning of wheels, creep in rails, defects in rails – Route alignment surveys, conventional and modern methods-Geometric design of railway, gradient, super elevation, widening of gauge on curves (Problems)-Railway drainage- Level Crossings-Signalling.

Module 5	Railway Track Construction Maintenance & Operation	Hrs. 8
Railway Track Construction Maintenance and Operation Points and Crossings – Design of Turnouts, Working Principle-Track Circuiting – Construction & Maintenance – Conventional, Modern methods and Materials, Layouts of Railway Stations and Yards, Rolling Stock, Tractive Power, Track Resistance – Role of Indian Railways in National Development – Railways for Urban Transportation – LRT & MRTS Feasibility study, Planning and construction		

Text Books:	
1	Khanna.S. K., Justo. C.E.G and Veeraragavan A. "Highway Engineering", Nemchand Publishers.
2	Subramanian K.P., "Highways, Railways, Airport and Harbour Engineering", Scitech Publications (India.
3	Kadiyali.L.R. "Principles and Practice of Highway Engineering", Khanna Technical Publications.
4	C. Venkatramaiah., Transportation Engineering-Vol. 2 Railways, Airports, Docks and Harbours, Bridges and Tunnels., Universities Press (India) Private Limited, Hyderabad, 2015.
5	Indian Road Congress (IRC), Guidelines for the Design of Flexible Pavements, (Third Revision), IRC:37-2012.
Reference Books:	
1	Indian Road Congress (IRC), Guidelines for the Design of Plain Jointed Rigid Pavements for Highways, (Third Revision), IRC:58-2012
2	Yang H. Huang, "Pavement Analysis and Design", Pearson Education Inc, Nineth Impression, South Asia, 2012.

SUBJECT CODE	Program Elective -III	CREDITS
26AF1906PE604B	Intelligent Transportation Systems	3

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
3	0	0	3	20	20	60	100

Course Objectives	
COBJ1	To introduce the concept and scope of Intelligent Transportation Systems (ITS).
COBJ2	To provide knowledge of various ITS data collection and communication technologies.
COBJ3	To explore the functional areas of ITS.
COBJ4	To analyze user needs and service requirements.
COBJ5	To understand the role of information management in ITS.

Course Outcomes: Students will be able to	
CO1	Explain ITS & ATIS.
CO2	Explain about Advanced Transportation Management System.
CO3	Explain about APTS, CVO, new technology and ETC.
CO4	Discuss about regional architecture, integration of infrastructure and operational planning.
CO5	Summarizes about ITS issues in terms of various factors and emerging issues.

Course Contents

Module 1	**Introduction to Intelligent Transportation Systems (ITS)**	**Hrs. 8**

Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS- safety, mobility, environmental sustainability, efficiency, Overview of ITS components and architecture, ITS stakeholders: Government, public, private sector, enforcement authorities

ITS Data collection techniques –Roadside sensors and detectors (loop, video, infrared, microwave), Automatic Vehicle Location (AVL) systems, Automatic Vehicle Identification (AVI) systems, Role of Geographic Information Systems (GIS) and Remote Sensing, Data quality, integrity, and fusion techniques, vehicle Positioning System.

Module 2	**Telecommunications in ITS**	**Hrs. 6**

Types of communications: wired vs wireless, analog vs digital, vehicle-to-Infrastructure (V2I),vehicle-to-Vehicle (V2V), and vehicle to everything (V2X) communications, role of highspeed internet, DSRC (Dedicated Short-Range Communications), and satellite-based communications, video-based data collection and analytics, role and architecture of Traffic Management Centres (TMCs),Information dissemination technologies: Variable Message Signs (VMS), web-based and mobile systems, Data storage and retrieval systems for ITS, road side communication.

Module 3	ITS functional areas	Hrs. 8
Advanced Traffic Management Systems (ATMS)-Real-time traffic monitoring and control, Adaptive signal control and ramp metering, Advanced Traveler Information Systems (ATIS)-Route guidance and navigation systems, Real-time traffic and transit information for users, Advanced Vehicle Control Systems (AVCS):Collision avoidance, adaptive cruise control, lane keeping systems, Advanced Public Transportation Systems (APTS):Smart fare collection, passenger information systems, real-time fleet management, Commercial Vehicle Operations (CVO):Electronic clearance, weigh-in-motion systems, freight tracking, Advanced Rural Transportation Systems (ARTS):ITS solutions in low-density, remote areas.		
Module 4	**ITS User Needs and Services**	**Hrs. 6**
Framework of user needs: safety, efficiency, equity, convenience, Incident detection, congestion management, dynamic rerouting, Transit Signal Priority (TSP), scheduling, predictive arrival systems, Electronic Payment Systems: Toll collection (ETC), smart card systems, digital wallets for transit, Commercial Vehicle Operations (CVO):Fleet monitoring, route optimization, driver behaviour analysis, Emergency Management Systems: Dispatch optimization, crash notification systems (eCall), emergency vehicle signal pre-emption, Advanced Vehicle Safety Systems, Blind spot detection, driver alertness monitoring, autonomous braking, Accessibility and equity in ITS design		
Module 5	**Information Management**	**Hrs. 8**
Automated Highway Systems - Vehicles in Platoons, autonomous vehicle convoys – Integration of Automated Highway Systems, ITS in developing countries, institutional and organizational issues in ITS deployment, ITS architecture and standards (e.g., ISO, IEEE, NTCIP), evaluation and performance measurement of ITS, ITS in Developed Countries: ITS Programs in the World – Overview of ITS implementations in developed countries-Case studies from USA (ITS America), Japan (VICS), Europe (ERTICO), South Korea ITS in Developing Countries: Challenges and opportunities, Indian ITS policies and initiatives (e.g., MoRTH, NHAI projects, Smart Cities,Delhi Integrated Multi-Modal Transit System (DIMTS),FASTag, BRTS systems)		

Text Books:	
1	Ghosh, S., Lee, T.S.,"Intelligent Transportation Systems: New Principles and Architectures", CRC Press, 2000.
2	Mashrur A. Chowdhury, and Adel Sadek, "Fundamentals of Intelligent Transportation Systems Planning", Artech
3	Urban Transportation: Planning, Operation and Management" – G.R. Rajasekhar
4	"Intelligent Transport Systems" – M.G. Lay & Indian adaptations
Reference Books:	
1	Sussman, J.M.,"Perspectives on Intelligent Transportation Systems", Springer, Berlin, 2010.
2	R.P Roess, E.S. Prassas, W.R. McShane.,"Traffic Engineering", Pearson Educational International, 3rdEdition, 2004.

SUBJECT CODE	Program Elective -III	CREDITS
26AF1906PE604C	Urban Transportation Planning	3

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
3	0	0	3	20	20	60	100

Course Objectives	
COBJ1	To understand travel demand characteristics and transportation planning processes.
COBJ2	To study transportation data collection methods and survey techniques.
COBJ3	To learn trip generation and trip distribution modeling methods.
COBJ4	To understand traffic assignment and mode split analysis techniques.
COBJ5	To study environmental and economic aspects of transportation planning.

Course Outcomes: Students will be able to	
CO1	Explain the concepts and stages of transportation planning.
CO2	Conduct transportation surveys and analyze collected traffic data.
CO3	Apply trip generation and trip distribution models in transport planning.
CO4	Understand traffic assignment and mode split analysis methods.
CO5	Evaluate environmental impacts and economic feasibility of transportation projects.

Course Contents

Module 1	**Travel Demand & Transportation Planning Process**	**Hrs.10**

Travel Demand -Travel characteristics – Origin. Destination, Route mode, Purpose – Travel demand as a function of independent variables – Assumptions in demand estimation, relation between land use and travel – Four step process of Transportation planning.

Transportation Planning Process -General concept of Trip – Trip Generation – Trip Distribution –Traffic assignment and mode split, Aggregate and disaggregate Models– Direct Demand Models, Sequential and Sequential Recursive models.

Module 2	**Data Collection and Inventories**	**Hrs. 8**

Definition of study area – Zoning principles; Types and sources of Data, Home Interview surveys; Roadside interview surveys; Goods, Taxi, IPT surveys; Sampling techniques; Expansion factors and Accuracy check: Desire line diagram and use.

Module 3	**Trip Generation & Trip Distribution Models**	**Hrs. 8**

Trip Generation Models: Factors governing Trip Generation and Attraction: Multiple linear Regression Models – Category analysis.

Trip Distribution Models Methods of Trip Distribution: Growth Factor Models – Uniform Growth Factor Method; Average Growth Factor Method; Fratar Method; Furness Method; limitation of Growth Factor Models; Concept of Gravity Model.

Module 4	Traffic Assignment and Mode Split	Hrs. 8
Purpose of assignment and general principles - Assignment Techniques – All-or-nothing assignment: Multiple route assignment: Capacity resistant method, Minimum path trees; Diversion curves. Factors affecting mode split – Probit, logit and Discriminant Analysis, dynamic assignment.		
Module 5	**Transportation and Environment**	**Hrs. 8**
Transportation and Environment: Detrimental effect of Traffic on Environment: Noise Pollution: Air pollution: Vibrations: Visual Intrusion – Effects and remedial measures. Economic Evaluation of Transportation Plans: Costs and benefits of transportation projects; vehicle operating cost; time saving, accident costs; methods of economic evaluation – benefit Cost ratio method – Net Present Value method; Internal Rate of Return method.		

Text Books:	
1	Kadiyali, L. R., "Traffic engineering and transport planning". Khanna publishers,2013.
2	Papa Costas C.S., "Fundamentals of Transportation Engineering", 2nd Edition, Prentice
3	Williumsen and Ortuzar, Modelling Transport
4	Urban Transportation Challenges and Way Forward, A Report by INAE Forum on Civil Infrastructure
5	Marvin L. Manheim, Fundamentals of Transportation Systems Analysis, Volume 1
Reference Books:	
1	Bruton M.J., "Introduction to Transportation Planning", Hutchinson of London, 4thEdition, 2009.
2	Khisty C.J., "Transportation Engineering- An Introduction", 3rd Edition, Prentice Hall, 2008.
3	B.G. Hutchinson, Principles of Urban Transport System Planning

SUBJECT CODE	Foundation Engineering	CREDITS
26AF1906PC605		3

3 Lectures hours/week				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
3	0	0	3	20	20	60	100

Course Objectives	
COBJ1	To introduce soil exploration techniques and their importance in foundation engineering.
COBJ2	To understand and apply bearing capacity and settlement analysis theories.
COBJ3	To address challenges in designing foundations for problematic soils.
COBJ4	To study the design and analysis of shallow and deep foundations.
COBJ5	To examine slope stability and methods for its analysis and improvement.

Course Outcomes: On completion of course, students will be able to	
CO1	To identify and apply appropriate soil exploration and sampling methods.
CO2	Analyze the stability of slope by theoretical and graphical methods.
CO3	To compute bearing capacity and settlements using standard methods.
CO4	To design foundations for expansive, collapsible, and compressible soils.
CO5	To evaluate and design various foundation systems per IS codes.

Course Contents

Module 1	**Introduction**	**Hrs. 8**

General requirements to be satisfied for satisfactory performance of foundations, Soil exploration: Necessity, Planning, Exploration Methods, Soil Sampling Disturbed and undisturbed, Rock Drilling and Sampling, Core Barrels, Core Boxes, Core Recovery, Field Tests for Bearing Capacity evaluation, Test Procedure & Limitations

Module 2	**Bearing Capacity Analysis**	**Hrs. 10**

Failure Modes, Terzaghi's Analysis, Specialization of Terzaghi's Equations, Skempton Values for Nc, Meyerhof's Analysis, I.S. Code Method of Bearing Capacity Evaluation, Effect of Water Table, Eccentricity of load, Safe Bearing Capacity and Allowable Bearing Pressure, Settlement Analysis: Immediate Settlement - Consolidation Settlement, Differential Settlement, Tolerable Settlement, Angular distortion

Module 3	**Foundations for Difficult Soils**	**Hrs. 10**

Guidelines for Weak and Compressible Soils, Expansive soil, Parameters of Expansive Soils, Collapsible Soils and Corrosive Soils, Causes of Moisture changes in Soils, Effects of Swelling on Buildings, Preventative measures for Expansive Soils, Design of Foundation on Swelling Soils, Ground Improvement Methods: for general considerations, for Cohesive Soils, for Cohesionless Soils,

Shallow Foundations: Assumptions & Limitations of Rigid Design Analysis, Safe Bearing Pressure, Settlement of Footings, Design of isolated, Combined, Strap Footing (Rigid analysis), Raft Foundation (Elastic Analysis), I. S. Code of Practice for Design of Raft Foundation

Module 4	Deep foundations	Hrs. 8
Pile Foundation: Classification, Pile Driving, Load Carrying Capacity of Piles, Single Pile Capacity, Dynamic Formulae, Static Formulae, Pile Load Tests, Penetration Tests, Negative skin Friction, Under Reamed Piles, Group Action of Piles, Caissons Foundations: Box, Pneumatic, Open Caissons, Forces, Grip Length, Well Sinking, Practical Difficulties and Remedial Measures Sheet Piles: Classification, Design of Cantilever Sheet Pile in Cohesionless and Cohesive soils. Design of Anchored Sheet Pile by Free Earth Support Method, Cellular Cofferdams: Types, Cell Fill Stability Considerations		
Module 5	**Slope Stability**	**Hrs. 8**
Different Definitions of Factors of Safety, Types of Slope Failures, Stability of an Infinite Slope of Cohesionless Soils, Stability Analysis of an Infinite Slope of Cohesive Soils, Stability of Finite Slopes- Slip Circle Method, Semi Graphical and Graphical Methods, Friction Circle Method, Stability Number: Concept and its use		

Text Books:	
1	Kasamalkar, B.J., "Foundation Engineering", Pittsburgh vintage Grand Prix
2	Murthy V.N.S., "Soil Mechanics and Foundation Engineering", CRC Press 2002
3	Arora K.R., "Soil Mechanics and Foundation Engineering", Standard publication 2009
4	Punmia B. C., "Soil Mechanics and Foundation Engineering", Laxmi publication 16th 2017
5	Nayak N.V., "Foundation Design Manual", Dhanpat Rai and Son
6	Brahma S.P., "Foundation Engineering", Tata McGraw-Hill 5th Edition
7	Bowles J.E., "Foundation analysis & Design", McGraw-Hill Higher Education 5th edition
Reference Books:	
1	Teng W.C., "Foundation Design", Prentice-Hall Inc
2	Tomlinson M.J., "Foundation Design & Construction", Prentice-Hall; 7th edition
3	Lee, "Sheet Piles" Concrete Publication,1961
4	Relevant Publications by Bureau of Indian Standards, New Delhi
5	IS 6403:1981, IS 1904:1986, IS 4091:1979

SUBJECT CODE	Design of Concrete Structures Lab						CREDITS
26AF1906PCL607							1
Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
0	0	2	2	50	-	50	50

Course Outcomes: On completion of course, students will be able to	
CO1	Identify and interpret design requirements of RCC structural elements. (Remembering/Understanding)
CO2	Analyze structural behavior under various loading conditions. (Analyzing)
CO3	Design RCC components as per IS 456 provisions. (Applying/Creating)
CO4	Create detailed structural drawings using manual and CAD tools. (Creating)
CO5	Justify design choices and evaluate structural safety and serviceability. (Evaluating)

Course Contents

Term work shall consist of detailed analytical report for structural design and drawing of the following RC structures:

A (Compulsory)	Design and detailing of G+1 RCC framed structure.
B (Any one of the listed)	The introduction, analysis and design of these topics shall be studied in self-study mode. If required the subject teacher should address the student's queries during tutorials). 1) Retaining wall 2) Elevated water tank: analysis and design of staging and tank body. 3) Staircase of special form such as helicoidal stair 4) Shell roofs: simple cylindrical, conical shells 5) Special foundation type such as combined footing, raft, pile foundation
Use of computer programs such as MS Excel is desirable for post-processing of results.	

SUBJECT CODE	Program Elective -II Lab	CREDITS
26AF1906PEL608A	Water Quality Engineering Lab	1

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
0	0	2	2	25	-	25	50

Course Outcomes: On completion of course, students will be able to	
CO1	Determine key physical and chemical water quality parameters such as pH, turbidity, and TDS using standard instruments.
CO2	Analyze alkalinity and hardness of water samples to evaluate buffering capacity and scaling potential.
CO3	Perform BOD and COD tests to assess organic pollution levels in water and wastewater.
CO4	Interpret the working of a reverse osmosis (RO) unit.

Course Contents

Practical Work consists of at least eight performances from list below and detailed reporting in form of journal.

Experiment No 1	Determination of pH of Water Sample
Experiment No 2	Determination of Turbidity
Experiment No 3	Estimation of Total Dissolved Solids (TDS)
Experiment No 4	Determination of Alkalinity of Water.
Experiment No 5	Determination of Total Hardness and Calcium Hardness.
Experiment No 6	Estimation of Chlorides.
Experiment No 7	Estimation of Dissolved Oxygen (DO)
Experiment No 8	Determination of Biochemical Oxygen Demand (BOD)
Experiment No 9	Determination of Chemical Oxygen Demand (COD)
Experiment No 10	Demonstration of Reverse Osmosis (RO) Unit
Experiment No 11	Visit to a Water or Wastewater Treatment Plant.
Use of computer programs such as MS Excel is desirable for post-processing of results.	

SUBJECT CODE	Program Elective -II Lab	CREDITS
26AF1906PEL608B	Environment Health and Safety Lab	1

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
0	0	2	2	25	-	25	50

Course Outcomes: On completion of course, students will be able to	
CO1	Determine key physical and chemical water quality parameters such as pH, turbidity, and TDS using standard instruments.
CO2	Analyze alkalinity and hardness of water samples to evaluate buffering capacity and scaling potential.
CO3	Perform BOD and COD tests to assess organic pollution levels in water and wastewater.
CO4	Interpret the working of a reverse osmosis (RO) unit.

Course Contents

Practical Work consists of at least eight performances from list below and detailed reporting in form of journal.

Experiment No 1	Determination of pH of Water Sample
Experiment No 2	Determination of Turbidity
Experiment No 3	Estimation of Total Dissolved Solids (TDS)
Experiment No 4	Determination of Alkalinity of Water.
Experiment No 5	Determination of Total Hardness and Calcium Hardness.
Experiment No 6	Estimation of Chlorides.
Experiment No 7	Estimation of Dissolved Oxygen (DO)
Experiment No 8	Determination of Biochemical Oxygen Demand (BOD)
Experiment No 9	Determination of Chemical Oxygen Demand (COD)
Experiment No 10	Demonstration of Reverse Osmosis (RO) Unit
Experiment No 11	Visit to a Water or Wastewater Treatment Plant.
Use of computer programs such as MS Excel is desirable for post-processing of results.	

SUBJECT CODE	Program Elective-III Lab	CREDITS
26AF1906PEL609A	Highway & Railway Engineering Lab	1

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
0	0	2	2	25	-	25	50

Course Outcomes: On completion of course, students will be able to	
CO1	Conduct and interpret results from aggregate crushing, impact, abrasion, and shape tests to assess their suitability for use in road construction.
CO2	Perform penetration, softening point, ductility, flash & fire point, and viscosity tests to determine the performance characteristics of bituminous materials.
CO3	Assess binder content and stripping value to evaluate mix stability and moisture susceptibility in bituminous mixtures.
CO4	Conduct and analyze Marshall stability tests to evaluate the strength and deformation characteristics of bituminous mixes.
CO5	Gain hands-on experience in executing laboratory tests on aggregates and bitumen, and interpreting results as per relevant IS/ASTM standards.

Course Contents

Practical Work consists of at least eight performances from list below and detailed reporting in form of journal.

Experiment No 1	Aggregate crushing value test
Experiment No 2	Aggregate impact value test
Experiment No 3	Los Angeles abrasion test
Experiment No 4	Aggregate shape test
Experiment No 5	Penetration test of bitumen
Experiment No 6	Softening point test of bituminous material
Experiment No 7	(a) Flash and fire point test of bituminous material (b) Viscosity test of bituminous material
Experiment No 8	Ductility test of bitumen
Experiment No 9	(a) Determination of binder content of asphalt mix (b) Determination of stripping value of aggregate
Experiment No 10	Marshall stability test of bituminous mix
Use of computer programs such as MS Excel is desirable for post-processing of results.	

SUBJECT CODE	Program Elective-III Lab	CREDITS
26AF1906PEL609B	Intelligent Transportation Systems Lab	1

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
0	0	2	2	25	-	25	50

Course Outcomes: On completion of course, students will be able to	
CO1	Explain the principles, objectives, and historical development of urban and town planning.
CO2	Interpret land use classifications, zoning regulations, and apply development control rules in planning exercises.
CO3	Analyze the components of Master Plans and evaluate the legal and institutional framework of planning in India
CO4	Apply basic concepts to plan urban infrastructure such as roads, water supply, sewerage, and drainage.
CO5	Assess planning strategies for sustainable development and smart cities with a focus on environmental considerations.

Course Contents

Practical Work consists of at least six performances from list below and detailed reporting in form of journal.

Experiment No 1	Introduction to Urban Base Maps & Survey Tools- a) Understanding toposheets, satellite imagery, and municipal base maps b) Introduction to GIS/AutoCAD/Google Earth for basic mapping
Experiment No 2	Land Use Mapping of a Locality- a) Field visit or remote mapping of a ward or neighborhood b) Categorize plots into residential, commercial, public/semi-public, green, etc. c) Prepare a land use map (manual or using GIS)
Experiment No 3	Plot Layout and Subdivision Planning- a) Design a residential layout with proper plot sizes, roads, and amenities b) Apply development control norms: FAR, setbacks, open space, etc.
Experiment No 4	Zoning Map Preparation- a) Create a basic zoning plan for a small urban area based on surveyed data b) Apply compatible zoning: residential, commercial, institutional, recreational
Experiment No 5	Master Plan Case Study- a) Review an existing Master Plan of a city (e.g., Delhi, Pune, Indore, etc.) b) Identify key land use proposals, transport networks, and growth areas c) Submit a summary report with maps and observations
Experiment No 6	Development Control Rules (DCR) Exercise- a) Analyze local building bye-laws and DCR (e.g., height limits, plot coverage) b) Prepare a report on compliance of a building with DCR norms
Experiment No 7	Urban Transportation Planning Exercise- a) Map a road network hierarchy (arterial, collector, local roads) b) Suggest basic traffic control measures, intersection design or BRT corridor.
Experiment No 8	Infrastructure Planning Mini-Project- a) Plan water supply/sewerage for a residential block (20–30 plots). b) Basic pipe sizing, layout sketching as per CPHEEO guidelines.
Experiment	Smart City Component Mapping-

No 9	a) Identify and mark ICT-based services (e-governance, smart lighting, surveillance) b) Case study of a smart city implementation in India.
Experiment No 10	Slum Redevelopment Plan a) Create a simple layout showing redevelopment of a slum area b) Include resettlement housing, basic amenities, and green space
Project Title: Preparation of a Land Use Plan for a Small Urban Area / Neighborhood (2–5 sq.km) Components: Site analysis and land use survey, Base map preparation, Proposed zoning plan, Infrastructure layout (roads, water, sewage), Development control norms, Sustainability or smart city elements, Presentation and Report	

SUBJECT CODE	Program Elective-III Lab	CREDITS
26AF1906PEL609C	Urban Transportation Planning Lab	1

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
0	0	2	2	25	-	25	50

Course Outcomes: On completion of course, students will be able to	
CO1	Identify and analyze urban transportation and infrastructure problems.
CO2	Conduct transportation surveys and prepare technical reports.
CO3	Apply trip generation, trip distribution, and modal split concepts.
CO4	Understand development control rules and building compliance requirements.
CO5	Prepare basic transportation and infrastructure planning layouts and proposals.

Course Contents

Practical Work consists of at least six performances from list below and detailed reporting in form of journal.

Exp.No.1	Identifying problems in urban areas like parking, delay at intersection, pollution and students will make a brief report regarding problems
Exp.No.2	Make any two-transport survey and prepare a report of outcome
Exp.No.3	Prepare write up on transportation planning process
Exp.No.4	Problems based on trip generation and trip distribution
Exp.No.5	Problems based on modal split
Exp.No.6	Prepare write up about Urban mass rapid transit system
Exp.No.7	Development Control Rules (DCR) Exercise- a) Analyze local building bye-laws and DCR (e.g., height limits, plot coverage) b) Prepare a report on compliance of a building with DCR norms
Exp.No.8	Urban Transportation Planning Exercise- a) Map a road network hierarchy (arterial, collector, local roads) b) Suggest basic traffic control measures, intersection design or BRT corridor.
Exp.No.9	Infrastructure Planning Mini-Project- a) Plan water supply/sewerage for a residential block (20–30 plots). b) Basic pipe sizing, layout sketching as per CPHEEO guidelines.
Project – Propose traffic improvement measures for a selected junction/area.	

SUBJECT CODE	Seminar	CREDITS
26AF1906EL610		1

Teaching Work Load/week (Hrs.)				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
0	0	2	2	25	-	25	50

Course Objectives	
COBJ1	Identify technical and practical challenges within the field of civil engineering.
COBJ2	Develop the ability to interpret, analyze, and communicate technical information effectively.
COBJ3	Strengthen skills in technical report writing and presentation through critical thinking and structured documentation
COBJ4	Learn referencing and plagiarism avoidance techniques.

Course Outcomes: On completion of course, students will be able to	
CO1	Understand and evaluate ongoing research, advancements, and interdisciplinary applications in civil engineering.
CO2	Conduct and organize a comprehensive literature survey using scholarly resources such as journals, books, and technical documents.
CO3	Analyze and derive conclusions from the selected technical topic.
CO4	Prepare and present a structured technical report demonstrating critical analysis.
CO5	Enhance their technical writing and oral communication skills

Guidelines for seminar work

1	*The seminar report should include the following elements. Internal guides may use a continuous evaluation sheet for each student, which will contribute to the term work assessment.*
2	**Introduction:** Background of the selected topic, its relevance to civil engineering, the need for the study, objectives, and scope along with any limitations.
3	**Literature Review:** Summary and analysis of literature from books, journals, conference papers, technical reports, and other scholarly documents—preferably from the last five years.
4	**Theoretical Content:** Core subject matter related to the topic, including models, equations, methods, or relevant case studies.
5	**Conclusion:** Final observations, outcomes of the study, and potential future scope.
6	**References:** Properly cited sources used throughout the seminar report.

Guidelines for Assessment

Panel of staff members along with a guide will assess the seminar work based on these parameters- Topic, Contents and Presentation, regularity, Punctuality and Timely Completion, Question and Answers, Report, Paper presentation/Publication, Attendance and Active Participation.

SUBJECT CODE	Academic Research Writing	CREDITS
26AF1906VS611		1

Lectures hours/week				Examination Scheme (Marks)			
Theory	Tutorial	Laboratory	Total	ISE	MSE	ESE	Total
1	0	0	1	25	--	25	50

Course Objectives	
COBJ1	To introduce students to the fundamentals of academic writing
COBJ2	To develop critical reading and literature review skills.
COBJ3	To strengthen students' ability to plan, draft, and revise structured academic content.
COBJ4	To enhance students' command of academic style, language, and referencing.
COBJ5	To prepare students for academic publishing and professional communication.

Course Outcomes: On completion of course, students will be able to	
CO1	Identify (Remember) types and characteristics of academic writing.
CO2	Analyze (Analyze) and synthesize scholarly literature for review.
CO3	Construct (Create) well-structured academic and technical documents.
CO4	Apply (Apply) appropriate citation styles and referencing techniques.
CO5	Evaluate (Evaluate) content for plagiarism and ethical compliance.

Course Contents

Module 1	**Introduction to Academic Research**	**Hrs. 8**
Definition, purpose, and types of academic writing, Differences between academic and non-academic writing, Research ethics and integrity in writing, Structure of a research paper, report, and thesis, Common errors in academic writing		
Module 2	**Literature Review and Critical Reading**	**Hrs. 8**
Importance and purpose of literature review, Finding and selecting credible sources, Techniques for reading and analyzing research papers, Synthesizing literature: thematic and chronological review, Tools for managing references (Zotero/ Mendeley/EndNote)		
Module 3	**Writing Process and Structure**	**Hrs. 8**
Drafting abstracts, introductions, and conclusions, Writing coherent body paragraphs and sections, Data presentation: Tables, figures, and charts, Argumentation and logical flow in writing, Writing summaries, paraphrasing, and quoting		
Module 4	**Style, Language, and Referencing Techniques**	**Hrs. 8**
Formal tone, academic vocabulary, and sentence structure, Common language issues: passive vs. active voice, conciseness, Citation styles: APA, IEEE, MLA – rules and examples, In-text citations and bibliography preparation, Avoiding plagiarism: definition, consequences, and tools (Turnitin)		

Module 5	Writing for Publication and Technical Communication	Hrs. 8
Selecting journals and understanding author guidelines, writing research proposals and conference abstracts, Peer review process and publication ethics, technical reports, project documentation, and grant writing, Presenting research findings: posters and oral presentations		

Guidelines for Assignments/Assessment:	
1	The students have to submit minimum five assignments consisting aspects of the Course.
2	Faculty can do the assessment (internal & external) through Quiz/ Exam. (MCQ/descriptive) /PPT/ Poster/Drawing/small project activity and must maintain the record of the same.
3	Faculty can encourage students for Swayam/NPTEL course.

Text Books:	
1	Day, R. A., & Gastel, B. How to Write and Publish a Scientific Paper, Cambridge University Press.
2	Greetham, B. How to Write Better Essays, Palgrave Macmillan.
3	Bailey, S. Academic Writing: A Handbook for International Students, Routledge.
4	Booth, W. C., Colomb, G. G., & Williams, J. M. The Craft of Research, University of Chicago Press.
5	Glasman-Deal, H. Science Research Writing for Non-Native Speakers of English, Imperial College Press.
Reference Books:	
1	Swales, J. M., & Feak, C. B. Academic Writing for Graduate Students, University of Michigan Press.
2	Murray, R. How to Write a Thesis, Open University Press.