COURSE CURRICULUM

(DRAFT SYLLABUS)

for

B.TECH. DEGREE

in

CIVIL ENGINEERING

(Applicable from the academic session 2024-2025)

Dr. B. C. Roy Engineering College

An Autonomous Institution

Approved by: All India Council for Technical Education (AICTE)

Affiliated to: Maulana Abul Kalam Azad University of Technology, West Bengal (Formerly Known as -WBUT)

Jemua Road, Durgapur, West Bengal, India,713206

The BoS of CE (Civil Engineering) in its second meeting on 2nd April, 2025 has unanimously accepted and approved the sixth semester draft syllabus of CE (Civil Engineering).

Sanjay Sengupta
H.O.D. I C.E.
Dr. B. C. Roy Engg. College, Durgapur

Signature of the BoS Chairman

Course Name: DESIGN OF STEEL STRUCTURES
Course Code: CE(PC)601
(Semester VI)
Category: Major
Course Broad Category: CORE ENGG (Professional Core Courses)

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1. **Course Prerequisite:**
   Class-XII level knowledge of Mathematics and Geometry; Strength of Materials; Solid Mechanics; Structural Analysis; Design of RC Structure

2. **Course Learning Objectives:**
   i. Students will be able to learn the fundamental concepts, design philosophies (Limit State Design, Working Stress Design), and codal provisions related to the design of steel structures as per relevant standards.
   ii. Students will be able to develop the ability to analyze and design structural elements such as beams, columns, tension members, connections, and frames, ensuring stability, strength, and serviceability under different loading conditions.

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies and Field Visits.
   Evaluation System –
   Attendance
   Internal Assessment (40 Marks)
   Continuous Internal Assessment 1 (30 Marks) – 20% of CIA1
   Continuous Internal Assessment 2 (20 Marks) [Assignment/Mini-Project/Group Discussions/Presentations/Open Book test/Quiz- 20 Marks]
   End-Semester Examination (70 Marks)- 60% of ESE.

4. **Course Content:**
   Course Name: Design of Steel Structures
   Course Code: CE(PC)601
   Hours per Week: 2L:1T:0P
   Credits: 3

Module	Topics	28L+14T
1.	**Materials and Specification:** Rolled steel sections, mechanical properties of steel and their specifications for structural use. Codes of practices. Design of Steel structures using tubular, rectangular and square section.	2L+1T
2.	**Structural connections:** Riveted, welded and bolted including High strength friction grip bolted joints. – types of riveted & bolted joints, assumptions, failure of joints,efficiency of joints, design of bolted,riveted & welded joints for axial load. Eccentric connection: - Riveted & bolted joints subjected to torsion & shear, tension & shear, design of riveted, bolted & welded connection.	4L+2T

Module	Topics	28L+14T
3.	**Design of Tension members:** Design of tension members, I.S code provisions.Permissible stresses, Design rules, Examples.	6L+3T
4.	**Design of Compression members:** Effective lengths about major & minor principal axes, I.S code provisions. Permissible stresses, Design rules, Design of one component, two components and built-up compression members under axial load. Examples. Built up columns under eccentric loading: Design of lacing and batten plates, Different types of Column Bases- Slab Base, Gusseted Base, Connection details.	6L+3T
5.	**Design of Beams:** Permissible stresses in bending, compression and tension. Design of rolled steel sections, plated beams. simple Beam end connections, beam -Column connections. I.S code provisions.	4L+2T
6.	**Design of Girders:** Design of Plate girders, Design of webs & flanges, Concepts of curtailment of flanges – Riveted & welded web stiffeners, web flange splices - Riveted, welded& bolted. Design gantry girder considering lateral buckling – I.S code provisions.	6L+3T

5. References:

IS Codes:

- IS 800 – 2007(Latest Revised code)
- IS 875 – I (1987), II (1987), -III (2015), -IV(1987), V (1987
- S.P.: 6(1) – 1964 Structural Steel Sections

Reference Books:

- S.K. Duggal, Limit State Design of Steel Structures, Tata McGraw Hill Education Private Limited, 2017. (ISBN: 9789351343493/9351343499).
- V.L. Shah and V. Gore, Limit State Design of Steel Structures IS:800-2007, Structures Publication, 2012. (ISBN: 8190371754).

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CE(PC)601.1	Identify the material properties of structural steel.	Identify	Remember
CE(PC)601.2	Describe different bolted and welded connections, analyze and design them for axial and eccentric loads.	Describe	Understand
CE(PC)601.3	Design different steel sections subjected to axial tension following Indian codes of practices.	Design	Create
CE(PC)601.4	Design rolled and built-up compression members along with base connection subjected to axial compression, bending and tension.	Design	Create
CE(PC)601.5	Design of Beams and various connections related to beam.	Design	Create
CE(PC)601.6	Assess different components of girder system, calculate lateral and vertical loads acting on the system	Assess	Evaluate

7. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	-	3	-	-	-	-
3	-	-	3	-	-	-
4	-	-	-	3	-	-
5	-	-	-	-	3	-
6	-	-	-	-	-	3

8. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	1	1	1	0	0	0	1	2
CO2	3	3	3	2	1	2	2	0	0	0	2	2
CO3	3	3	3	3	1	1	1	0	1	1	1	3
CO4	3	3	3	3	1	1	1	0	1	1	1	3
CO5	3	3	3	3	1	1	1	0	1	1	1	3
CO6	3	3	3	3	1	1	1	0	1	1	1	3

9. Mapping to PSO

	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1
CO2	2	2	1	1
CO3	3	3	3	2
CO4	3	3	3	2
CO5	3	3	3	2
CO6	3	3	3	2

Course Name: INTELLIGENTTRANSPORTATIONSYSTEMS
Course Code: CE(PC)602
(Semester VI)
Category: Minor
Course Broad Category: CORE ENGG (Professional Core Courses)

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1. **Course Prerequisite:**
   Class-XII level knowledge of Physics, MathematicsandGeography;Undergraduate level introductory knowledgeofTransportation Engineering.

2. **Course Learning Objectives:**
   i. This course will enable students to have an awareness and scope of transport issues, such as, traffic safety, public transport, advanced vehicle management and control.
   ii. Students will also learn how Intelligent transport systems (ITS) involve the application of information technology and telecommunications to control traffic, inform travellers and drivers, operate public transport, automating payments, handle emergencies and incidents, operate commercial fleets and freight exchange, and automate driving and safety.
3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology –Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures and Field Visits.
   Evaluation System –
   Attendance
   Internal Assessment (40 Marks)
   Continuous Internal Assessment 1 (30 Marks) – 20% of CIA1
   Continuous Internal Assessment 2 (20 Marks) [Assignment/Mini-Project/Group Discussions/Presentations/Open Book test/Quiz- 20 Marks]
   End-Semester Examination (70 Marks)- 60% of ESE.

4. **Course Content:**
   Course Name: Intelligent Transportation Systems
   Course Code: CE(PC)602
   Hours per Week: 3L:0T:0P
   Credits: 3

Module	Topics	42L
1.	Basic elements of intelligent transportation systems (ITS): focusing on technological, systems and institutional aspects. Benefits of ITS -ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), process of video data collection	8L
2.	Telecommunications in ITS – The importance of telecommunications in the ITS system, information management, and traffic management centres (TMC). Vehicle – Road side communication – Vehicle Positioning System.	7L

Module	Topics	42L
3.	ITS functional areas – Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS)	7L
4.	ITS User Needs and Services – Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, and Information Management.	8L
5.	Automated Highway Systems - Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.	6L
6.	ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS and sustainable mobility, Travel demand management: electronic toll collection, and ITS and road-pricing.	6L

5. References:

Text Book:

- Choudury M A and Sadek A, "Fundamentals of Intelligent Transportation Systems Planning" Artech House.
- Pradip Kumar Sarkar, Amit Kumar Jain, "Intelligent Transport Systems", PHI Learning Publishers
- Kan Paul Chen, John Miles, "Recommendations for World Road Association (PIARC)" ITS Hand Book 2000.
- Sussman, J. M., "Perspective on ITS", Artech House Publishers, 2005.

Reference Books:

- US Department of Transportation, "National ITS Architecture Documentation", 2007 (CDROM).
- Turban. E and Aronson. J. E, "Decision Support Systems and Intelligent Systems"

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CE(PC)602.1	To discuss the historical background and evolution of intelligent transportation systems (ITS).	Discuss	Understand
CE(PC)602.2	To describe the role of ITS and its benefits and challenges in improving the transportation experiences of users and system managers.	Describe	Understand
CE(PC)602.3	To use the engineering applications of ITS and ITS architecture.	Use	Apply
CE(PC)602.4	To appraise the technological requirements and suggest the appropriate systems in various functional areas of ITS	Appraise	Examine
CE(PC)602.5	Toexecute the knowledge of ITS standards and specifications.	Execute	Apply
CE(PC)602.6	To implementthe ITS applications in various transportation modes to improve their safety and efficiency.	Implement	Apply

7. Mapping of course outcomes to module/course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	-	3	-	-	-	-
3	-	-	3	2	-	-
4	-	-	2	3	-	-
5	-	-	2	2	3	-
6	-	-	2	2	-	3

8. Mapping of the Course outcomes to Program Outcomes

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

9. Mapping to PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1
CO2	3	1	1	2
CO3	3	1	1	1
CO4	3	2	1	1
CO5	2	2	1	2
CO6	3	1	1	2

Course Name: CONSTRUCTION ENGINEERING & MANAGEMENT
Course Code: CE(PC)603
(Semester VI)
Category: Major
Course Broad Category: CORE ENGG (Professional Core Courses)

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1. **Course Prerequisite:**
   - Civil Engineering Materials
2. **Course Learning Objectives:**
   a. Understand the principles and processes involved in construction engineering and project management.
   b. Learn about different types of construction methods, equipment, and materials.
   c. Develop skills in planning, scheduling, and controlling construction projects.
   d. Analyze the cost estimation, budgeting, and financial management aspects of construction projects.
   e. Explore safety, quality control, and risk management in construction projects.
   f. Gain insights into modern construction management techniques, including Building Information Modeling (BIM).
3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology –Lectures and Presentations, Interactive Discussions and Case Studies, Problem-solving sessions and tutorials, Use of software for project Management, Guest Lectures, and Group Projects.
   Evaluation System –
   Attendance
   Internal Assessment (40 Marks)
   Continuous Internal Assessment 1 (30 Marks) – 20% of CIA1
   Continuous Internal Assessment 2 (20 Marks) [Assignment/Mini-Project/Group Discussions/Presentations/Open Book test/Quiz- 20 Marks]
   End-Semester Examination (70 Marks)- 60% of ESE.

4. **Course Content:**
   Course Name: Construction Engineering & Management
   Course Code: CE(PC)603
   Hours per Week: 3L:0T:0P
   Credits: 3

Module	Topics	Lecture (42L)
1.	**Introduction to Construction Engineering & Management** 1.1 Objective of Project 1.2 Methods of Project Management 1.3 Phases of a Construction Project 1.4 Role of a Construction Engineer and Manager 1.5 Building Bye laws	4L
2.	**Construction Methods and Equipment** 2.1 Selection of construction methods 2.2 Earthmoving, excavation, and tunneling techniques 2.3 Earthwork Equipments 2.4 Hosting Equipments	7L

Module	Topics	Lecture (42L)
	2.5 Automation in construction	
3.	**Project Planning and Scheduling** 3.1 Work Breakdown Structure and Network Fundamentals 3.2 Program Evaluation and Review Technique (PERT) 3.3 Critical Path Method (CPM) 3.4 Crashing 3.5 Updating and Resource Allocation	8L
4.	**Cost Estimation and Budgeting** 4.1 Types of cost estimates 4.2 Rate analysis and quantity surveying 4.3 Budgeting techniques and financial control	5L
5.	**Quality Control and Safety in Construction** 5.1 Construction quality standards and specifications 5.2 Inspection and testing methods 5.3 Safety management and accident prevention	5L
6.	**Risk Management in Construction** 6.1 Identification and assessment of risks 6.2 Risk mitigation strategies 6.3 Contractual and legal risk management	5L
7.	**Modern Trends in Construction Management** 7.1 Building Information Modeling (BIM) 7.2 Lean construction and sustainability in construction 7.3 Use of AI, IoT, and automation in construction management	4L
8.	**Case Studies and Project Management Tools** 8.1 Real-world case studies of successful and failed projects 8.2 Software tools such as Primavera and MS Project. 8.3 Practical applications of project management principles	4L

5. References:

Text Book:

A. Chitkara, K. K., *Construction Project Management: Planning, Scheduling, and Controlling*, McGraw-Hill.
B. Peurifoy, R. L., Schexnayder, C. J., *Construction Planning, Equipment, and Methods*, McGraw-Hill.
C. Halpin, D. W., *Construction Management*, Wiley.

Reference Books:

A. Kerzner, H., *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*, Wiley.
B. Jha, K. N., *Construction Project Management: Theory and Practice*, Pearson.
C. Hendrickson, C., *Project Management for Construction*, Prentice Hall.
D. Eastman, C. M., *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors*, Wiley.

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CE(PC)603.1	Explain the fundamentals of construction engineering and project management.	Explain	Understand
CE(PC)603.2	Identify various construction methods, equipment and its purpose.	Identify	Understand
CE(PC)603.3	Develop project planning and scheduling using software tools like MS Project and Primavera.	Develop	Create
CE(PC)603.4	Execute cost estimation and financial management for construction projects.	Execute	Apply
CE(PC)603.5	Examine construction quality, safety, and risk management strategies.	Examine	Analyze
CE(PC)603.6	Appraise modern trends and emerging technologies like BIM in construction management.	Appraise	Evaluate

7. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
Module 1	3	2	1	1	-	-
Module 2	2	3	2	1	-	-
Module 3	-	2	3	2	-	-
Module 4	-	1	2	3	-	-
Module 5	-	-	2	2	3	2
Module 6	-	-	1	3	2	2
Module 7	2	-	-	2	2	3
Module 8	2	2	2	2	3	3

8. Mapping of the Course outcomes to Program Outcomes

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

9. Mapping to PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	3	2	1	2
CO3	3	3	1	2
CO4	2	3	2	2
CO5	1	3	2	2
CO6	2	3	3	2

Course Name: HYDROLOGY & WATER RESOURCES ENGINEERING
Course Code: CE(PC)604
(Semester VI)
Category: Major
Course Broad Category: CORE ENGG (Professional Core Courses)

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1. **Course Prerequisite:**
   Fluid Mechanics andHydraulicEngineering.

2. **Course Learning Objectives:**
   i. Students will understand precipitation, evapotranspiration, infiltration, runoff, and streamflow measurement in hydrology.
   ii. They will apply hydrological methods for flood estimation, groundwater flow, and flood routing.

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology –Lectures and Presentations, Interactive Discussions and Case Studies.
   Evaluation System –
   Attendance
   Internal Assessment (40 Marks)
   Continuous Internal Assessment 1 (30 Marks) – 20% of CIA1
   Continuous Internal Assessment 2 (20 Marks) [Assignment/Mini-Project/Group Discussions/Presentations/Open Book test/Quiz- 20 Marks]
   End-Semester Examination (70 Marks)- 60% of ESE.

4. **Course Content:**
   Course Name: Hydrology & Water Resources Engineering
   Course Code: CE(PC)604
   Hours per Week: 3L:0T:0P
   Credits: 3

Module	Topics	42L
1.	**Introduction Precipitation:** Definition of hydrology; Importance of hydrology; Global water availability; India's water availability; Practical applications of hydrology; Hydrologic cycle;Concept of catchment; Water budget equation; Definition of precipitation; Forms and types of precipitation; Measurement of rain fall; Optimum number of rain gauge stations; Consistency of rainfall data; Computation of mean rainfall; Estimation of missing rainfall data; Presentation of precipitation data (moving average curve, mass curve, rainfall hyetographs, intensity – duration - frequency curves); Probability Analysis of Rainfall Data.	9L
2.	**Losses from Precipitation:** Introduction; Evaporation: Definition, Process, factors affecting, measurement using IS Class A Pan; Estimation using empirical formulae;Evapotranspiration	7L

Module	Topics	42L
	(ET); Infiltration: Definition, factors affecting infiltration capacity, measurement (double ring infiltrometer). Horton's infiltration equation, infiltration indices.	
3.	**Runoff Hydrographs:** Runoff: Definition; Components. Factors affecting. Rainfall - runoff relationship using simple regression analysis;Hydrographs: Definition; Components of Hydrograph; Unit hydrograph and its derivation from simple storm hydrographs; Base flow separation. S -curve and its uses.	7L
4.	**Stream Flow Measurement:** Introduction; Measurement of stage; Measurement of discharge by Area-Velocity Method, Moving Boat Method, Dilution Technique, Electromagnetic Method, Ultrasonic Method; Indirect Methods: Flow Measuring Structures, Slope Area Method; Simple stage discharge relation.	6L
5.	**Ground Water Hydrology and Well Hydraulics:** Scope and importance of ground water hydrology; Aquifer Parameters: Specific Yield, Specific Retention, Storage Coefficient, Transmissivity; Steady radial flow into wells in unconfined and confined aquifers; Types of wells, Methods of construction.	6L
6.	**Floods:** Concept of flood as a natural hazard; Estimation of flood discharge in ariver – rational method, empirical formulae, unit hydrograph method; flood frequency studies – return period; Flood Control Measures.	2L
7.	**Flood Routing:** Concept of flood routing in channels and through a reservoir, Hydrologic vs Hydraulic Routing: Differences, Applications, and Methods; Basic routing equations; reservoir routing – Modified Pul's method; channel routing – Muskingum method.	5L

5. References:

Text Book:

- Engineering Hydrology, K. Subramanya,McGraw Hill Education(India) Private Limited.
- Hydrology for Engineers, Ray Linsley, Max Kohler, Joseph L. Paulhus, McGraw-Hill Education.
- Water-Resources Engineering, David Chin, Pearson.

Reference Books:

- Engineering Hydrology, R. Srivastava andA. Jain, McGraw HillEducation(India) Private Limited
- Ground Water, H.M. Raghunath, New Age International Pvt Ltd Publishers.

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CE(PC)604.1	Describe hydrology, precipitation, rainfall measurement, and probability analysis of rainfall data.	Describe	Understand

CE(PC)604.2	Explain losses from precipitation, including evaporation, evapotranspiration, and infiltration.	Explain	Understand
CE(PC)604.3	Differentiate runoff components, rainfall-runoff relationships, and hydrograph types.	Differentiate	Analyse
CE(PC)604.4	Use various streamflow measurement techniques, including velocity-area and indirect methods.	Use	Apply
CE(PC)604.5	Judge groundwater hydrology parameters, well hydraulics, and types of wells.	Judge	Evaluate
CE(PC)604.6	Appraise flood estimation, flood control, and flood routing methods.	Appraise	Evaluate

7. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	-	3	-	-	-	-
3	-	-	3	-	-	-
4	-	-	-	3	-	-
5	-	-	-	-	3	-
6	-	-	-	-	-	3
7	-	-	-	-	-	3

8. Mapping of the Course outcomes to Program Outcomes

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

9. Mapping to PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	-
CO2	3	3	2	1
CO3	3	3	2	2
CO4	3	3	3	3
CO5	3	3	3	2
CO6	3	3	3	3

Course Name: INTRODUCTION TO FINITE ELEMENT ANALYSIS
Course Code: CE(PE)601A
(Semester VI)
Category: Minor
Course Broad Category: CORE ENGG (Program Elective Courses)

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1. **Course Prerequisite:**
   Solid Mechanics, Structural Analysis – I , Structural Analysis –II, Problem Solving Using Python and MATLAB

2. **Course Learning Objectives:**
   This is an introductory course in the finite element method. The course learning objectives are:
   (a) To provide the fundamental concepts of the theory of the finite element method
   (b) To expose aspects of the application of the method to realistic civil engineering problems
   (c)Introduce to general purpose finite element software codes and software

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures and Computer Laboratory
   Evaluation System –
   Attendance
   Internal Assessment (40 Marks)
   Continuous Internal Assessment 1 (30 Marks) – 20% of CIA1
   Continuous Internal Assessment 2 (20 Marks) [Assignment/Mini-Project/Group Discussions/Presentations/Open Book test/Quiz- 20 Marks]
   End-Semester Examination (70 Marks)- 60% of ESE.

4. **Course Content:**
   Course Name: Introduction to Finite Element Analysis
   Course Code: CE(PE)601A
   Hours per Week: 3L:0T:0P
   Credits: 3

Module	Topics	42L
1.	**Introduction To FEM**:Introduction - Limitations of methods of structural analysis -Mathematical modelling of physical Problem - Concept of FEM through perimeter of circle – History, merit and demerits and applications of FEM – FEM based software – Steps involved in FEM as applicable to Structural mechanics problems.	4L
2.	**Choice Of Displacement Models:**Introduction –Discretization - Choice of Elements shapes - Choice of displacement model - Requirements Ideal displacement model - Factors affecting nature and degree of polynomial for displacement models. FORMULATION OF SHAPE FUNCTION AND STRAIN DISPLACEMENT	8L

Module	Topics	42L
	MATRIX:Introduction – Properties of Shape Functions - Methods of Determination – Shape functions for 1D bar and beam element, 2D CST element.	
3.	**Element Stiffness Matrix And Assembly**: Introduction - Element Stiffness Matrix based on minimization of total potential Energyand Principle of virtual work, Strong and weak forms, Essential vs. natural boundary conditions Stiffness Matrix for 2 noded truss element, 2 noded Beam element, 3 noded CST - Assemblage of Element Stiffness Matrices and load matrix- Static Condensation	8L
4.	**1D Bar And Truss Using FEM:**Introduction - Analysis of stepped bars and tapered bars- Analysis of plane Truss - Truss with initial Strain/Rise in Temperature	4L
5.	**Beams And Plates Using FEM:**Introduction - Analysis of simply supported beam – Analysis of propped cantilevers, fixed beams, and continuous beams for various loadings,Generalization to two dimensions - Membrane, plane strain and plane stress problems Triangular and quadrilateral elements -Isoparametric elements - Axisymmetric problems, Introduction to analysis of plates for in-plane loading.	8L
6.	**Introduction to General purpose finite element codes and software**: Codes for beams and truss through MATLAB and Python, Familiarization with software e.g. ANSYS, ABACUS, Free Open Source FEM software	8L

5. References:

Text Book:

- Reddy, J.N., "Introduction to Finite Element Method", Mc Graw Hill, 4th Edition, 2020.
- Bhavikatti, S.S. "Finite Element Analysis" New Age international, 3rd Edition, 2015.

Reference Books:

- Chandrapatula, T.R, Belegundu, A.D, "Introduction to Finite Elements in Engineering", 4th Edition, 2015
- Klaus-Jurgen Bathe, "Finite Element Methods", Prentice Hall 1st Edition 2003
- Hutton, D, "Fundamentals of Finite Element Analysis", McGraw Hill, 2017

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CE(PE)601A.1	Explain the basics of FEM	Explain	Understand
CE(PE)601A.2	Explain the shape functions and strain displacement matrix	Explain	Understand
CE(PE)601A.3	Prepare element stiffness matrix and assemble them.	Prepare	Apply
CE(PE)601A.4	Solve problems of bars and trusses using FEM	Solve	Apply
CE(PE)601A.5	Solve problems of beams and plates using FEM	Solve	Apply
CE(PE)601A.6	Examine different problems using FEM codes and software	Examine	Analyse

7. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	-	3	-	-	-	-
3	-	-	3	-	-	-
4	-	-	-	3	-	-
5	-	-	-	-	3	-
6	-	-	-	-	-	3

8. Mapping of the Course outcomes to Program Outcomes

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

9. Mapping to PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1
CO2	3	3	2	1
CO3	3	3	2	1
CO4	3	3	3	1
CO5	3	3	3	1
CO6	2	2	3	3

Course Name: EATHQUAKE ENGINEERING

Course Code: CE(PE)601B

(Semester VI)

Category: Minor

Course Broad Category: CORE ENGG (Program Elective Courses)

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1. **Course Prerequisite:**

   Structural Analysis – I, Structural Analysis –II, Design of Reinforced Concrete Structures, Design of Steel Structure

2. **Course Learning Objectives:**

   This is an introductory course in the domain of earthquake engineering. The course learning objectives are:

   (a) Toimparttheknowledge ofbehavior ofcivilengineeringstructuresduring earthquakes.

   (b) Toexplainseismicanalysisoffframed andmasonrystructures.

   (c) Tointroducetheconcepts ofductile detailing.

   Teaching methodology and evaluation system for the course:

   Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures and Computer Laboratory

   Evaluation System –

   Attendance

   Internal Assessment (40 Marks)

   Continuous Internal Assessment 1 (30 Marks) – 20% of CIA1

   Continuous Internal Assessment 2 (20 Marks) [Assignment/Mini-Project/Group Discussions/Presentations/Open Book test/Quiz- 20 Marks]

   End-Semester Examination (70 Marks)- 60% of ESE.

3. **Course Content:**

   Course Name: Earthquake Engineering

   Course Code: CE(PE)601A

   Hours per Week: 3L:0T:0P

   Credits: 3

Module	Topics	42L
1.	**Introduction to seismology** Fundamentals of earthquake engineering, plate tectonics, Causes of earthquakes, types of earthquakes, important earthquake parameters such as magnitude and intensity, Philosophy of earthquake resistant design	4L
2.	**Concept of single degree of freedom Systems** Concept of natural frequency and degree of freedom, Equation of motion for single degree of freedom (SDOF) system, Concepts of response of SDOF systems (free, forced, undamped and damped), concept of resonance.	8L

Module	Topics	42L
3.	**Response of multi degree of freedom Systems** Concept of response spectrum, Equations of motion for multi degree of freedom (MDOF) systems, Natural frequencies and mode shape for MDOF systems, Normalization of modes, Dynamic analysis and calculation of base shear of MDOF systems by response spectrum method as per IS 1893, Modal combinations.	8L
4.	**Seismic analysis of buildings** Concepts of floor diaphragms and lateral load resisting systems, Importance of strength, stiffness, ductility and configuration, various structural irregularities, calculation of centre of mass, centre of stiffness and eccentricity, lateral- torsional analysis of building as per seismic coefficient Method, Calculation for base shear and its distribution along height.	8L
5.	**Ductile Design and detailing** Importance of ductile detailing, capacity design concept, strong column weak beam theory, Concepts of ductile detailing and design of beams and columns as per IS: 13920.	6L
6.	**Seismic analysis & design of masonry buildings** Seismic detailing of masonry buildings as per IS: 4326, Provision of various types of bands and vertical reinforcements, Calculation for rigidity of masonry wall, Concept of lateral load analysis of masonry building. Structural controls, Introduction to base isolation and dampers, Introduction to reinforced masonry structures.	8L

5. References:

Text Book:

- MarioPaz,"*Structural Dynamics -Theoryand Computations*",Pearson Education
- Pankaj Agarwal & Manish Shrikhande, "*Earthquake Resistant Design of Structures*", Prentice Hall of India, New Delhi
- S.K.Duggal,"*EarthquakeResistantDesign ofStructures*",OxforduniversityPress

Reference Books:

- ChopraA.K.,"*DynamicsofStructures"*,PearsonEducation,New Delhi
- RayW. Clough&Joseph Penzien,"*Dynamics ofStructures*", McGrawHill
- IS:1893-IndianStandardCriteriaforEarthquake ResistantDesignofStructures
- IS: 4326 - Indian Standard Code of Practice for Earthquake Resistant Design & Construction of Buildings
- IS:13920-IndianStandardCodeofPracticeforDuctileDetailingofReinforcedConcrete Structures Subjected to Seismic Forces
- IS:13827-IndianStandardGuidelinesforImprovingEarthquakeResistance ofEarthenBuildings
- IS:13828 - Indian Standard Guidelines for Improving Earthquake Resistance of Low StrengthMasonry Buildings
- IS:13935- IndianStandardGuidelinesforRepair andSeismicStrengtheningof Buildings

- SP22-ExplanatoryHandbookon CodesforEarthquakeEngineering

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CE(PE)601B.1	Comprehend the Basics of Seismology and Earthquake Engineering	Comprehend	Understand
CE(PE)601B.2	Illustrate the Single Degree of Freedom (SDOF) Systems	Illustrate	Analyze
CE(PE)601B.3	Assess the Behavior of Multi-Degree of Freedom (MDOF) Systems	Assess	Evaluate
CE(PE)601B.4	Perform Seismic Analysis of Buildings	Perform	Apply
CE(PE)601B.5	Design Earthquake-Resistant Structures with Ductile Detailing:	Design	Create
CE(PE)601B.6	Design Seismic-Resilient Masonry Buildings	Design	Create

7. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	-	3	-	-	-	-
3	-	-	3	-	-	-
4	-	-	-	3	-	-
5	-	-	-	-	3	-
6	-	-	-	-	-	3

8. Mapping of the Course outcomes to Program Outcomes

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

9. Mapping to PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2
CO2	3	3	3	1
CO3	3	3	3	1
CO4	3	3	3	2
CO5	3	2	2	2
CO6	3	2	2	3

Course Name: IndustrialWaste WaterManagement
Course Code: CE(PE)602A
(Semester VI)
Category: Major
Course Broad Category: CORE ENGG (Program Elective Course-4 PE)

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1. Course Prerequisite(s):

Students are expected to know the fundamentals of Mathematics, Chemistry,Environmental Engineering, Fluid Mechanics, and Biology for Engineers.

2. Course Learning Objectives:

The objectives of the course are to enable the student

- Differentiate between the quality standards for domestic and industrial water needs, as well as the quantity of wastewater generated.
- Comprehend industrial processes, water consumption patterns, and wastewater production.
- Develop an understanding of appropriate treatment methods for industrial wastewater.
- Learn about the operational challenges associated with common effluent treatment plants.
- Acquire knowledge of various techniques and strategies to minimize wastewater generation, along with the application of physico-chemical and biological treatment methods for the recovery, reuse, and disposal of industrial wastewater.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies and Field Visits.

Evaluation System –
Attendance
Continuous Internal Assessment (CIA) - 40 Marks [CIA 1 (Mid-Semester Evaluation- 20 Marks); CIA 2 (Assignment/Mini-Project/Group Discussions/Presentations/Open Book test/Quiz- 20 Marks)].
End-Semester Examination (ESE) - 100 Marks [60% of (ESE)]

4. Course Content :

Course Name: Industrial Waste Water Management
Course Code: CE(PE)602A
Hours per Week: 3L:0T:0P
Credits: 3

Module	Topics	42L
1.	**Introduction** General Characteristics of Industrial effluents, Effects on Environment – ISI tolerance limits for discharging industrial effluents into surfacewater, into public sewers and on to land for irrigation.	**4L**
2.	**Sources of Pollution** Physical, Chemical, Organic & Biological properties of Industrial Wastes, Difference between industrial & municipal waste waters, Effects of industrial effluents onsewers and Natural water Bodies.	**6L**
3.	**Pre & Primary Treatment** Equalization, Proportioning, Neutralization, Oil separation byFloating-Waste Reduction-Volume Reduction-Strength Reduction.	**8L**
4.	**Waste Treatment Methods** Nitrification and De-nitrification, Phosphorous removal, Heavy metal removal, Membrane Separation Process, Air Stripping and Absorption Processes, Special Treatment Methods, Disposal of Treated Waste Water.	**8L**
5.	**Industrial Effluents: Composition, Sources, and Treatment** Characteristics and Composition of waste water and Manufacturing Processes of Industries likeSugar, Characteristics and Composition of Industries like Food processing Industries, Steel, andPetroleum Refineries.	**10L**
6.	**Wastewater Management in Textile, Tannery, and Mineral Processing Industries** Characteristics and Composition of Industries like Textiles, Tanneries, Atomic Energy Plants and other Mineral Processing Industries, Joint Treatment of Raw Industries waste water and Domestic Sewage, Common Effluent Treatment Plants(CETP), Location, Design, Operation and Maintenance Problems – Economical aspects.	**6L**

5. References :

Text Books:

1. Rao, M.N. &Dutta, A.K. “Waste Water Treatment”, 3rdEdition, IBH Publishers, 1982.
2. Patwardhan-” Industrial Waste Water Treatment”- PHI learning Pvt. Ltd, 2009.
3. Mark J. Hammer, Mark J. Hammer Jr., “Water & Wastewater Technology”, Prentice Hall ofIndia.
4. N.L. Nemerrow –Theories and practices of Industrial Waste Engineering.

Reference Books :

1. Metcalf & Eddy, “Wastewater engineering Treatment disposal reuse”, Tata McGraw Hill.
2. Eckenfelder, W.W., “Industrial Water Pollution Control”, McGraw-Hill.
3. C. Fred Gurnham” Industrial Waste Water Control”, (Revisedfor publication January 28, 1977) 31 May, 2007.

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CE(PE)602A.1	Examine the characteristics of industrial effluents and theireffects on environment including their tolerance limits.	Examine	Analyse
CE(PE)602A.2	Describe the basic principles of industrial waste watertreatment by physical methods.	Describe	Understand
CE(PE)602A.3	Discuss the sources, characteristics and treatment of industrial wastes.	Discuss	Understand
CE(PE)602A.4	Identify the sources, characteristics and treatment of majorindustrial waste of Thermal Power Plants, Oil Refineries, Steelmills and Cement industries.	Identify	Understand
CE(PE)602A.5	Examine the sources, characteristics and treatment of Chemicalindustrial wastes.	Examine	Analyse
CE(PE)602A.6	Appraise the economic aspects of joint treatment of industrial and domestic wastewater.	Appraise	Evaluate

7. Mapping of Course Outcomes (CO) to Module :

Module	CE(PE)602A.1	CE(PE)602A.2	CE(PE)602A.3	CE(PE)602A.4	CE(PE)602A.5	CE(PE)602A.6
1	3	-	-	-	-	-
2	3	-	-	-	-	-
3	-	3	-	-	1	-
4	-	3	1	-	-	-
5	-	-	3	3	3	-
6	-	-	-	-	-	3

8. Mapping of the Course Outcomes (CO) to Program Outcomes (PO) :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE(PE)602A.1	3	3	-	-	-	3	3	-	-	-	-	2
CE(PE)602A.2	3	3	1	-	-	1	3	-	-	-	-	1
CE(PE)602A.3	3	2	1	3	-	2	3	-	-	-	-	1
CE(PE)602A.4	3	2	2	2	-	3	3	-	-	-	-	2
CE(PE)602A.5	3	3	2	3	2	3	3	-	-	-	1	2
CE(PE)602A.6	1	2	3	2	2	3	3	-	-	-	1	3
Average	2.67	2.5	1.50	1.67	0.67	2.50	3	0	0	0	0.33	1.83

9. Mapping of the Course Outcomes (CO) to Program Specific Outcomes (PSO) :

CO	PSO1	PSO2	PSO3	PSO4
CE(PE)602A.1	3	3	2	1
CE(PE)602A.2	3	3	2	2
CE(PE)602A.3	3	2	2	1
CE(PE)602A.4	3	3	3	2
CE(PE)602A.5	3	3	3	2
CE(PE)602A.6	3	3	3	3

Course Name:CONSTRUCTION EQUIPMENTS AND AUTOMATION
Course Code: CE(PE)602B
(Semester VI)
Category: MAJOR
Course Broad Category: ELECTIVE (PE)

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1. **Course Prerequisite:**
   Concrete TechnologySustainable and Green Construction.
2. **Course Learning Objectives:**
   i. Identify various types of construction equipment and recognize emerging trends and innovations in automation within the industry.
   ii. Select and analyze appropriate construction equipment, including drones, based on site conditions, project requirements, capabilities, and limitations.
3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology –Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.
   Evaluation System –
   Total Marks: 100 [40(CIA) + 60% of (ESE)]
   Attendance
   Internal Assessment (40 Marks)
   Continuous Internal Assessment 1 (30 Marks) – 20% of CIA1
   Continuous Internal Assessment 2 (20 Marks) [Assignment/Mini-Project/Group Discussions/Presentations/Open Book test/Quiz- 20 Marks]
   End-Semester Examination (70 Marks)- 60% of ESE.

4. **Course Content:**
   Course Name: CONSTRUCTION EQUIPMENTS AND AUTOMATION
   Course Code: CE(PE)602B
   Hours per Week: 3L-0T-0P
   Credits: 3

Module	Topics	42L
1.	Introduction: Distinctive features, necessity, and significance of construction equipment in projects; emerging trends and innovations in construction technology.	4L
2.	Construction Equipment: Excavating equipment, pavers, rollers, plastering machines, cranes and hoists, concrete batching plants, hauling and conveying equipment; analysis of capacity, feasibility, safety, and owning and operating costs of various construction equipment.	7L
3.	Emerging trends in construction automation: necessity, challenges, and benefits; automated equipment and machinery for construction; automation in canal lining, highway construction, and concrete technology.	8L
4.	Drones in construction: Photogrammetry, real-time project monitoring, aerial mapping, land surveying, quantity and quality assessment, structural health monitoring, and underwater surveying.	7L
5.	Robotics: Introduction to robotics in construction; benefits in terms of time, cost, quality, and safety; applications in bricklaying, demolition, material handling, structural steel cutting, rebar tying and bending, formwork production, and 3D printing of building and infrastructure components.	9L

Module	Topics	42L
6.	Application of advanced technologies in construction automation: Building Information Modeling (BIM), Virtual Reality (VR), Augmented Reality.	7 L

5. References:

- Construction Equipment and Management, S. C. Sharma, Khanna Book Publishing Company.
- Construction Equipment and Machinery, Dr. S. Judes Sujatha, Mrs. P.V. Reshma Raj and Mr. V. Ruban Daniel, Sanpublication.
- Automation in Construction Industry, Dr. J. R. Pitroda, Prof. J. M. Rathod, Iipbook store.
- Construction Planning, Methods and Equipment, R.L Peurifoy, McGraw Hill, 2011.
- Construction Project management, Theory & Practice, Kumar Neeraj Jha, Pearson Education India.
- BIM and Construction Management: Proven Tools, Methods, and Workflows by Brad Hardin, Dave McCool, John Wiley & Sons.
- Construction equipment and its planning and application Mahesh Varma Metropolitan Book Co.
- Robotics and Automation in Construction, Open access peer- reviewed edited volume.
- Automation in Construction Management: Automated management of Construction Materials using RFID Technology, Javad Majrouhi Sardroud, Scholars' Press.
- Enhancing BIM Methodology with VR Technology, Open access peer.

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CE(PE)602B.1	Basic understanding of construction equipment's in construction projects	Recognize	Understand
CE(PE)602B.2	Derive feasibility of specific equipment in different project conditions.	Relate	Understand
CE(PE)602B.3	Selection of Automation techniques in construction industry and applicability in engineering solutions.	Execute	Apply
CE(PE)602B.4	Select suitable drone technology for surveying, project management and structural health monitoring.	Calculate	Analyze
CE(PE)602B.5	Analyze benefits of robotics versus conventional construction equipment.	Relate	Analyze
CE(PE)602B.6	Classify application of Virtual Reality, Augmented Reality, BIM in construction industry.	Formulate	Create

7. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	-	3	-	-	-	-
3	-	-	3	-	-	-
4	-	-	-	3	-	-

5	-	-	-	-	3	-
6	-	-	-	-	-	3

8. Mapping of the Course outcomes to Program Outcomes

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

9. Mapping to PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	3	3	2	2
CO3	3	3	2	2
CO4	3	3	3	2
CO5	3	3	3	3
CO6	3	3	3	3

Course Name: STRUCTURAL HEALTH MONITORING AND REHABILITATION
Course Code: CE(PE)602C
(Semester VI)
Category: Major
Course Broad Category: PROGRAM ELECTIVE COURSE

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1. **Course Prerequisite:**
   Class-XII knowledge of Physics and mathematics;Undergraduate level knowledgeofStructural Engineering.

2. **Course Learning Objectives:**
   i. This course will enable students toassess the health of structures using different techniques of SHMand identify suitable SHM techniques for the in-service performanceof structures.
   ii. Students will also learn todecide the appropriate strengthening & retrofitting techniques to regain structuralstrength.
3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology –Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures and Field Visits.
   Evaluation System –
   Attendance
   Internal Assessment (40 Marks)
   Continuous Internal Assessment 1 (30 Marks) – 20% of CIA1
   Continuous Internal Assessment 2 (20 Marks) [Assignment/Mini-Project/Group Discussions/Presentations/Open Book test/Quiz- 20 Marks]
   End-Semester Examination (70 Marks)- 60% of ESE.

4. **Course Content:**
   Course Name: Intelligent Transportation Systems
   Course Code: CE(PE)602C
   Hours per Week: 3L:0T:0P
   Credits: 3

Module	Topics	42L
1.	Need of Structural Health Monitoring, Definition & Concept of SHM,SHM & Biomimetic Comparison of SHM with NDT, Factors affecting the health of structures, SHM scheme, various steps in SHM, damagediagnostic methods, challenges in SHM.	6L
2.	Methodologies and Monitoring Principles, Local & Global Techniquesfor SHM, Static & Dynamic Field Testing, Short & Long-TermMonitoring, Active & Passive Monitoring.,Concrete strength assessment –Rebound hammer test –Ultrasonic pulse velocity tests, penetration resistance, pullout tests, core sampling and testing,chemical tests – carbonation, chloride, content and corrosion problem.	8L
3.	Instruments for SHM, Data Acquisition Systems-Types, Hardware &It's Components.Basics of Sensors, Transducers & Actuators, Classification of Sensors,and Characteristics & Working Principles of Various Types of	6L

Module	Topics	42L
	Sensors	
4.	Vibration Control & SHM Damage Diagnostic methods based on vibration response, AmbientVibration Test, Methodbased on modal frequency/shape/damping, Curvature and flexibility method, Modal strainenergy method, Sensitivity method, Baseline-free method,Experimental modal analysis, operational modalanalysis and combined methods.	8L
5.	Numerical Methods& Demonstration of DynamicProperties of Structures for Damage Detection & SHM, Acoustic Emission Technique, ElectromechanicalImpedance Technique, Wave Propagation Based Techniques, FibreOptics Based Techniques, Remote & Wireless SHM Techniques, IoTApplication in SHM, Artificial Intelligence & Machine Learning inSHM.	8L
6.	Introduction to deterioration of structures, Case studies of structuraldamages & failures, Need of Retrofitting, Current scenario ofinfrastructure through case studies. ***Concept of Repair & Retrofitting of Structures:*** Case studies ofstructural & foundation failure, performance problems, causes ofdistress in structural members, design and material deficiencies, and factorscausing extensive Deterioration in buildings and bridges ***Structural Assessment:*** Conditional Evaluation, Damage AssessmentProcedure, Principles of Structural Assessment, Classification & levelsof assessment.	6L

5. References:

Text Book:

- Daniel Balageas, Peter Fritzen, Alfredo Guemes, "Structural Health Monitoring", JohnWiley & Sons,2006.
- Bhattacharjee, J, "Concrete Structures Repair Rehabilitation And Retrofitting",CBS Publishers & Distributors, New Delhi
- Charles R Farrar, and Keith Worden, Structural Health Monitoring: A Machine LearningPerspective, John Wiley &Sons, first edition, 2012-2013.
- Nagayama, T. and Spencer Jr, B.F., 2007, Structural health monitoring using smartsensors,Newmark Structural Engineering Laboratory.University of Illinois at Urbana-Champaign

Reference Books:

- Malhotra, V.M. and Carino, N.J., "Handbook on Non-destructive Testing of Concrete", CRC Press.
- IS 15988: 2013 Seismic Evaluation and Strengthening of Existing Reinforced Concrete Buildings -Guidelines"

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CE(PE)602C.1	To Discuss the fundamentals of structural dynamic	Discuss	Understand
CE(PE)602C.2	To Explain the needs and challenges of Structural Health Monitoring (SHM).	Explain	Understand
CE(PE)602C.3	To Examine various methods of damage detection.	Examine	Analyze

CE(PE)602C.4	ToSolve the conditional assessment & techniques for strengthening andretrofitting of structures	Solve	Apply
CE(PE)602C.5	ToUse the Structural Health Monitoring technique for building.	Use	Apply
CE(PE)602C.6	ToUse the Structural Health Monitoring techniques for bridge	Use	Apply

7. Mapping of course outcomes to module/course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	3	2	-	-	-
2	3	3	3	-	-	-
3	2	3	3	-	-	-
4	2	3	2	3	2	2
5	2	2	2	3	2	2
6	2	2	2	3	3	3

8. Mapping of the Course outcomes to Program Outcomes

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

9. Mapping to PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2
CO2	2	3	3	2
CO3	2	3	3	2
CO4	2	2	3	3
CO5	2	2	3	3
CO6	2	2	3	3

Course Name: CAREER PLANNING AND SKILL DEVELOPMENT
Course Code: CE(MNC)601
(Semester VI)
Category: Knowledge Enhancement
Course Broad Category: Multidisciplinary Non-Credit Course- 4 (MNC)

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1. **Course Prerequisite:**
   - Basic communication skills (verbal and written)
   - Awareness of career opportunities in civil engineering and allied fields
   - Willingness to develop soft skills, technical skills, and employability skills.
2. **Course Learning Objectives:**
   a. Understand career opportunities in civil engineering and interdisciplinary domains.
   b. Develop effective communication, leadership, and teamwork skills.
   c. Enhance technical proficiency and digital literacy for career growth.
   d. Learn resume writing, interview preparation, and job application strategies.
   e. Explore entrepreneurship, higher studies, and research opportunities.
   f. Build networking skills and industry connections for career advancement.

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology –
   Interactive lectures with guest speakers from industry and academia, Workshops on resume building, Mock interviews and group discussions, Case studies on career success stories, Industry visits and networking sessions.
   Evaluation System –
   Attendance
   Internal Assessment (40 Marks)
   Continuous Internal Assessment 1 (30 Marks) – 20% of CIA1
   Continuous Internal Assessment 2 (20 Marks) [Assignment/Mini-Project/Group Discussions/Presentations/Open Book test/Quiz- 20 Marks]
   End-Semester Examination (70 Marks)- 60% of ESE.

4. **Course Content:**
   Course Name: Career Planning And Skill Development
   Course Code: CE(MNC)601
   Hours per Week: 3L:0T:0P
   Credits: 0

Module	Topics	Lecture (42L)
1.	**Career Exploration and Goal Setting** 1.1 Introduction to career planning 1.2 Career opportunities in civil engineering, public sector, private sector, and research 1.3 Role of interdisciplinary skills in career growth 1.4 Setting SMART career goals	6L
2.	**Communication and Presentation Skills** 2.1 Verbal and non-verbal communication 2.2 Public speaking and presentation skills 2.3 Writing emails, reports, and professional correspondence 2.4 Effective storytelling and elevator pitch	6L

Module	Topics	Lecture (42L)
3.	**Resume Building and Personal Branding** 3.1 Resume formats and content optimization 3.2 Cover letter writing and job application techniques 3.3 LinkedIn profile creation and networking strategies 3.4 Personal branding and online presence management	5L
4.	**Interview Skills and Group Discussions** 4.1 Types of interviews (technical, HR, behavioral) 4.2 Common interview questions and answers 4.3 Case study-based group discussions 4.4 Mock interviews and feedback sessions	5L
5.	**Technical Skill Development** 5.1 Digital tools and software proficiency (MS Excel, AutoCAD, STAAD Pro/SAP200, Primavera, BIM etc.) 5.2 Importance of data analytics and AI in civil engineering 5.3 Certifications and online learning platforms (Coursera, edX, Udemy etc.)	5L
6.	**Entrepreneurship, Higher Studies, and Research Opportunities** 6.1 Pathways for entrepreneurship and startup ecosystem 6.2 Higher education and scholarship opportunities in India and abroad 6.3 Research methodologies and technical paper writing 6.4 Funding agencies and grants for research and innovation	5L
7.	**Leadership, Teamwork, and Workplace Ethics** 7.1 Leadership styles and decision-making skills 7.2 Importance of teamwork and conflict resolution 7.3 Time management and productivity hacks 7.4 Professional ethics and workplace culture	5L
8.	**Industry Exposure and Networking** 8.1 Industry trends and future skill requirements 8.2 Alumni interaction and mentoring sessions 8.3 Site visits and hands-on workshops 8.4 Career planning roadmap and final reflections	5L

5. References:

Text Book:

a. Shiv Khera, *You Can Win*, Macmillan India.
b. Dale Carnegie, *How to Win Friends and Influence People*, Simon & Schuster.
c. Jeffrey Gitomer, *The Sales Bible: The Ultimate Sales Resource*, HarperCollins.

Reference Books:

a. Richard N. Bolles, *What Color is Your Parachute?*
b. Stephen R. Covey, *The 7 Habits of Highly Effective People*.
c. Thomas H. Davenport, *Big Data at Work: Dispelling the Myths, Uncovering the Opportunities*.
d. Industry reports on emerging civil engineering careers.

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Identify various career opportunities in civil engineering and interdisciplinary domains.	Identify	Understand
CO2	Develop effective communication and presentation skills for professional growth.	Develop	Create
CO3	Design a strong resume, cover letter, and online professional presence.	Design	Create
CO4	Demonstrate interview skills, group discussion techniques, and networking abilities.	Demonstrate	Apply
CO5	Demonstrate technical proficiency in relevant digital tools and software.	Demonstrate	Apply
CO6	Explain leadership, teamwork, ethics, and entrepreneurship for career success.	Explain	Understand

7. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
Module 1	3	-	1	1	-	-
Module 2	-	3	2	2	-	2
Module 3	2	2	3	2	2	-
Module 4	-	3	2	3	-	-
Module 5	-	-	-	1	3	-
Module 6	3	-	-	1	3	3
Module 7	1	2	-	2	-	3
Module 8	3	2	2	3	2	3

8. Mapping of the Course outcomes to Program Outcomes

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

9. Mapping to PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	3	2	1	2
CO3	3	3	1	2
CO4	2	3	2	2
CO5	1	3	2	2
CO6	2	3	3	2

Course Name: BIOLOGY FOR ENGINEERS

Course Code: CE(PE)692

(Semester- 6th)

Course Broad Category: CORE ENGG (Program Elective Course)

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1. **Course Prerequisite:**
   - Class-X-XII level knowledge of Biology and Bio-Environmental Science.
   - Undergraduate level introductory knowledge of Bio- Engineering.

2. **Course Learning Objectives:**
   i. This course imparts basic knowledge of biology, evolution, general awareness of environmental pollution effects and bio-engineering's aspects that provides the basic ideas among the engineering students for a better foundation of technical education.
   ii. To provide fundamentals among the upcoming young engineers and to carry out advanced technical and machinery research projects in biology and allied domains.

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology – Lectures , Practical's and Presentations, Interactive Discussions and Case Studies and d Field Visits.
   Evaluation System –
   Total Marks : 100 [60(PCIA) + 40(PESE)]
   PCIA : 60 Marks (Includes practical performance, reports, and viva voce after each experiment.)
   PESE : 40 Marks (Final comprehensive practical examination covering the entire syllabus.)

4. **Course Content:**
   Course Name: Biology For Engineers
   Course Code: CE(PE)692
   Hours per Week: 0L:0T:2P
   Credits:1

Module	**Topics**	14 P
1	INTRODUCTION OF SOIL Study of some physicals and chemicals criteria of the soil. Physical properties – temperature, humidity.	1P

Module	Topics	14 P
2	Chemical properties – electric method, measuring pH, colorimetric method	1P
3	SOIL MICROORGANISMS Isolations and enumerations of soil microorganisms.	1P
4	**FRUITING GLIDING BACTERIA FROM SOIL** Isolation of Fruiting Gliding Bacteria	1P
5	**MICROORGANISMS DECOMPOSES CRUDE OIL** Microbial decomposition (bacterial effects) of crude oil	1P
6	Microbial decomposition (fungal effects) of crude oil	1P
7	Microbial decomposition (algal effects) of crude oil	1P
8	**Environmental Management** Principles: Perspectives, concerns and management strategies; Policies and legal aspects.	1P
9	Environment Protection Acts and modification, International Treaties; Environmental Impact Assessment-Case studies (International Airport, thermal power plant)	1P
10	**Biostatistics** Introduction to Biostatistics:-Terms used, types of data ;Measures of Central Tendencies-Mean, Median, Mode, Normal and Skewed distributions; Analysis of Data-Hypothesis testing and ANNOVA(single factor)	1P
11	**Ecology** Ecosystems-Components, types, flow of matter and energy in an ecosystem; Community ecology-	1P
12	Characteristics, frequency, life forms, and biological spectrum Ecosystem structure-Biotic and a- biotic factors, food chain, food web, ecological pyramids;	1P
13	**BOD OF WATER / WASTE WATER SAMPLE** Determination of BOD[Biological Oxygen Demand] of water or waste	1P

Module	Topics	14 P
	water sample.	
14	Isolation of microorganism from waste water sample.	1P

5. Reference Books:

1. Biology: A global approach: Campbell, N.A. ;Reece, J.B.; Urry, Lisa; Cain, M,L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R.B. Pearson Education Ltd
2. OutlinesofBiochemistry,Conn,E.E;Stumpf,P.K;Bruening,G;Doi,R.H.JohnWileyandSons
3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company.
4. Molecular Genetics (Second edition), Stent, G. S.; and Calender , R. W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher
5. Microbiology, Prescott, L.MJ.P. Harley and C.A.Klein 1995 .2nd edition Wm, C.Brown Publishers LifeSciences ,Vol.I &II,PathfinderPublications

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
1	Define the physical properties and chemical properties individually of soil.	Define	Remember
2	Discuss the laws to control the environmental pollution and ecology of the bio-environments.	Discuss	Understand
3	Examine the microbial enzymatic decomposes ability.	Examine	Analyse
4	Explain about the Biostatistics Calculations	Explain	Understand
5	Justify BOD calculation from water sample from different areas.	Justify	Evaluate
6	Investigate the microorganisms of waste water sample.	Investigate	Create

7. Mapping of course outcomes to module / course content

Module	*CO1*	*CO2*	*CO3*	*CO4*	*CO5*	*CO6*
1	3	-	-	-	-	2
2	3	-	-	-	-	2

3	3	-	-	-	-	2
4	2	-	-	-	-	3
5	3	-	-	-	-	2
6	-	3	-	-	-	2
7	-	3	-	-	-	2
8	-	-	3	-	-	2
9	-	-	3	-	-	2
10	-	-	2	-	3	2
11	-	-	-	3	-	-
12	-	-	-	3	-	-
13	-	-	2	2	-	-
14	-	-	2	-	-	3

8. Mapping of the Course outcomes to Program Outcomes

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

9. Mapping to PSO

	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2
CO2	2	2	1	2
CO3	1	1	2	3
CO4	2	1	1	2
CO5	1	2	3	3
CO6	1	2	2	3

Course Name: BUILDING INFORMATION MODELING
Course Code: CE(PC)691
(Semester VI)
Category: Major
Course Broad Category: CORE ENGG (PC)

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1. **Course Prerequisite:**
   Undergraduate level knowledge of Building Planning and Computer-Aided Civil Engineering Drawing, Construction Engineering & Management, Design of RC Structures & Design of Steel Structures,and basic knowledge of isometric structures and engineering graphics fundamentals.

2. **Course Learning Objectives:**
   i. To understand the Fundamentals of BIM and Software Applications.
   ii. To develop Architectural and Structural Models Using BIM Tools.
   iii. To integrate MEP (Mechanical, Electrical, and Plumbing) Components into BIM Models.
   iv. To perform quantity estimation and generate construction documentation.
   v. To visualize the designs in real timewithin the 3D modeling environment.

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology – Lectures & Demonstrations, Hands-on Lab Sessions, Project-Based Learning and Collaborative & Self-Learning.
   Evaluation System –
   Total Marks : 100 [60(PCIA) + 40(PESE)]
   PCIA : 60 Marks (Includes practical performance, reports, and viva voce after each experiment.)
   PESE : 40 Marks (Final comprehensive practical examination covering the entire syllabus.)

4. **Course Content:**
   Course Name: Building Information Modeling
   Course Code: CE(PC)691
   Hours per Week: 0L:0T:2P
   Credits: 1

Module/ Experiments	Topics	14P	100%
1.	Introduction to BIM and Revit Software Setup: Overview of BIM and Revit: Evolution, Features, Model Visualization, and System Requirements	1	07
2.	Fundamentals of Revit and 3D Model Creation: Basic Concepts in Revit, Exploring Architectural, Structural, and Components Tabs, Importing CAD Files, Creating a 3D Model	2	14

Module/ Experiments	Topics	14P	100%
3.	Architectural Modeling and Level of Development (LoD) Implementation: Level of Development (LoD) and its Types, Developing Architectural Models from Lower LoD to Higher LoD	3	21
4.	Structural Modeling and Reinforcement Detailing in BIM: Creating Structural Models (RCC & Steel), Preparation of Bar Bending Schedule (BBS)	3	21
5.	MEP (Mechanical, Electrical, and Plumbing) Modeling and Integration in BIM: Creating Plumbing Models and Integrating Them into Architectural Models	2	14
6.	Quantity Estimation, Costing, and GFC Documentation in BIM	2	14
7.	Interference/Clash Check Using Revit and Navisworks, BIM Coordination, and Digital Twin Applications	1	09

5. References:

- BIM Handbook by Chuck Eastman ET. AL., WILEY Publisher.
- An introduction to Building Information Modeling (BIM) by "The Institution of Structural Engineers BIM Panel".
- Building Information Modeling by Construction Manager's Library - ERASMUS.

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CE(PC)691.1	Describe BIM fundamentals, evolution, and Revit software features.	Describe	Understand
CE(PC)691.2	Sketch 3D architectural and structural models with LoD concepts.	Sketch	Apply
CE(PC)691.3	Demonstrate RCC and steel models with reinforcement detailing and BBS.	Demonstrate	Apply
CE(PC)691.4	Integrate MEP systems into BIM for coordinated design.	Integrate	Analyze
CE(PC)691.5	Appraise quantity estimation, costing, and Good for-construction (GFC) drawings for project execution.	Appraise	Evaluate
CE(PC)691.6	Perform clash detection using Revit/Navisworks and explore Digital Twin.	Perform	Evaluate

7. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	2	3	2	-	-	-
3	-	3	-	-	-	-
4	-	3	3	-	-	-
5	-	-	-	3	-	-
6	-	-	-	-	3	-
7	-	-	-	-	-	3

8. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE(PC)691.1	-	-	-	-	2	-	-	-	1	-	-	1
CE(PC)691.2	2	-	2	-	3	2	-	-	1	-	-	2
CE(PC)691.3	2	-	2	-	3	-	-	-	1	-	-	2
CE(PC)691.4	2	2	3	-	3	2	-	-	1	2	2	2
CE(PC)691.5	-	-	2	-	2	2	-	-	1	2	3	2
CE(PC)691.6	-	2	2	2	3	1	-	-	1	2	2	3

9. Mapping to PSO

	PSO1	PSO2	PSO3	PSO4
CE(PC)691.1	1	-	1	1
CE(PC)691.2	2	1	2	2
CE(PC)691.3	2	1	2	3
CE(PC)691.4	2	2	3	3
CE(PC)691.5	1	1	2	3
CE(PC)691.6	1	2	3	3

Course Name: HYDROLOGY & WATER RESOURCES ENGINEERING LABORATORY
Course Code: CE(PC)692
(Semester VI)
Category: Major
Course Broad Category: CORE ENGG (PC)

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1. **Course Prerequisite:**
   Water Resources Engineering Laboratory CE(PC)693
2. **Course Learning Objectives:**

i. Learn the principles and techniques for measuring rainfall, stream flow, infiltration, and groundwater levels.
ii. Gain hands-on experience with instruments such as rain gauges, current meters.
iii. Conduct experiments to understand flow characteristics in open channels.
iv. Measure flow velocity, discharge, and energy losses using hydraulic models.
v. Study Darcy's law and its applications in ground water movement.
vi. Perform experiments on well drawdown and aquifer properties.
vii. Conduct laboratory tests to determine physical, chemical, and biological parameters of water.
viii. Understand the significance of water quality standards in engineering applications.
ix. Study the working principles of weirs, orifices, notches, and flumes.
x. Perform discharge measurements and analyze flow characteristics.

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology – Hands-on Laboratory Sessions**,** Pre-lab Theoretical Lectures and Discussions, Problem-solving Sessions, Group Projects and Presentations and Lab Reports and Data Interpretation.
   Evaluation System –
   Total Marks : 100 [60(PCIA) + 40(PESE)]
   PCIA : 60 Marks (Includes practical performance, reports, and viva voce after each experiment.)
   PESE : 40 Marks (Final comprehensive practical examination covering the entire syllabus.)

4. **Course Content:**
   Course Name: HYDROLOGY & WATER RESOURCES ENGINEERING LABORATORY
   Course Code: CE(PC)692
   Hours per Week: 2P
   Credits: 1

Experiment 1	Catchment Area delineation (Manually and using DEM).
Experiment 2	Calculation of average rainfall over a catchment area with arithmetic mean method, Thiessen Polygon Method and Isohyetal Method.

Experiment 3	Use of different types of Rain gauges.
Experiment 4	Use of Infiltration rate using Double ring Infiltrometer.
Experiment 5	Measurement of evaporation using evaporimeter.
Experiment 6	Measurement of bright sunshine hours using sunshine recorder.

5. References:

a. Chow, V. T. (1964). Handbook of Applied Hydrology. McGraw-Hill.
b. Gupta, H. V., Sorooshian, S., & Yapo, P. O. (1999). Hydrologic Modeling. American Geophysical Union.
c. Linsley, R. K., Franzini, J. B., Freyberg, D. L., & Tchobanoglous, G. (1992). Water Resources Engineering. McGraw-Hill.Course Outcomes:

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CE(PC)692.**1**	Develop a diagram of the catchment area for any water Body from given information.	Develop	Create
CE(PC)692.2	Calculate the average rainfall over a catchment.	Calculate	Analyse
CE(PC)692.3	Measure the rainfall data using Different types of rain-gauges.	Measure	Evaluate
CE(PC)692.4	Measure the rate of infiltration Of water through the soil.	Measure	Evaluate
CE(PC)692.5	Measure the evaporation using evaporimeter.	Measure	Evaluate
CE(PC)692.6	Measure the sunshine hours in A particular day.	Measure	Evaluate

7. Mapping of course outcomes to module / course content

	CO1	CO2	CO3	CO4	CO5	CO6
Experiment 1	3	-	-	-	-	-
Experiment 2	3	-	-	-	-	-
Experiment 3	3	-	-	-	-	-
Experiment 4	3	-	-	3	-	-
Experiment 5	-	3	-	-	3	-
Experiment 6	-	3	-	-	-	3

8. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE(PC)493.1	3	1	1	0	3	0	1	0	1	2	1	3
CE(PC)493.2	3	3	2	1	0	2	2	0	2	2	1	1
CE(PC)493.3	3	2	0	1	3	0	2	0	3	2	1	2
CE(PC)493.4	3	2	0	0	3	0	2	0	3	2	1	2
CE(PC)493.5	3	2	0	0	3	0	2	0	3	2	1	2
CE(PC)493.6	3	1	0	1	3	1	2	0	3	2	1	3

9. Mapping to PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	0	2	0
CO2	3	3	1	0
CO3	3	0	1	0
CO4	3	2	1	0
CO5	3	1	1	0
CO6	3	0	3	0

Course Name: Computational Tools and Software Laboratory in Civil Engineering
Course Code: CE(PE)691
(Semester 6th)
Category: Major
Course Broad Category: Program Elective Course- 3 (PE)

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1. Course Prerequisite:

Undergraduate level knowledge of Computer-Aided Civil Engineering Drawing_CE(PC)391 and basic knowledge of computer and civil engineering principles.

2. Course Learning Objectives:

By the end of the course, students will be able to:

1. Prepare various models of buildings and different structures.
2. Analyze and design various structures so that they will be structurally safe and economic.

3. Teaching methodology and evaluation system for the course:

Teaching methodology -

- Provide a theoretical knowledge and familiarize with different tools and menus.
- Hands-on practice in lab, on various structures.
- Real-life model preparation and design of small structural projects, integration with other projects.

Evaluation System -

Total Marks : 100 [60(PCIA) + 40(PESE)]

PCIA : 60 Marks (Includes practical performance, reports, and viva voce after each experiment.)

PESE : 40 Marks (Final comprehensive practical examination covering the entire syllabus.)

4. Course Content:

Course Name: Computational Tools and Software Laboratory in Civil Engineering
Course Code: CE(PE)691
Hours per Week: 0L:0T:2P
Credits: 1

Modules	Topics	14P
Module 1	Introduction to Computational Tools and Software, overview of computational tools in civil engineering, types of software used in different areas of civil engineering (structural, geotechnical, hydraulic, transportation, environmental etc.), Software installation, configuration, and interface overview.	1P
Module 2	Hands-on Practice using STAAD.Pro, Basic structural model creation, Structural analysis and interpretation of results, Design of simple structures.	2P
Module 3	By using ETABS different types of multistoried building model creation, analysis and design of steel and concrete structures.	2P
Module 4	Critical model creation in SAP2000, hands-on practice on RCC tanks, silos etc.	2P
Module 5	Slope stability and Foundation settlement analysis using PLAXIS	2P
Module 6	Hands-on practice using computational tools and software like HEC-RAS for hydraulic and hydrological analysis.	2P
Module 7	Wind analysis, Seismic analysis, different load combinations as per Indian Standards, complete design of multistoried buildings by using Staad.Pro and SAP 2000.	3P

5. Text/References Books:

- **Online resources, SAWAM/NPTEL.**

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CE(PE)691_1	Understand the Fundamentals of Computational Tools	Define, Explain, Describe	Remembering and Understanding
CE(PE)691_2	Perform Data Analysis and Visualization	Analyze, Interpret, Visualize	Analyzing and Evaluating
CE(PE)691_3	Enhance Problem-Solving and Decision-Making Skills and Gain Experience with Multi-Disciplinary Software Applications.	Evaluate, Decide, Formulate	Evaluating and Creating
CE(PE)691_4	Apply Computational Techniques to Real-World Problems	Apply, Solve, Analyze	Applying and Evaluating
CE(PE)691_5	Develop Proficiency in Civil Engineering Software	Use, Apply, Operate	Applying and Analyzing
CE(PE)691_6	Develop Simulation Models for Engineering Systems, Stay Updated with Technological Advancements in Software Tools and improve Collaboration Skills.	Predict, Adapt	Applying and Creating

7. Mapping of course outcomes to module / course content

Modules	CO1	CO2	CO3	CO4	CO5	CO6
Module 1	3	-	-	-	-	-
Module 2	-	3	-	-	-	-
Module 3	-	-	3	2	-	-
Module 4	-	-	2	3	-	-
Module 5	-	-	-	-	3	-
Module 6	-	-	-	-	-	3
Module 7	3	-	-	-	-	-

8. Mapping of the Course outcomes to Program Outcomes

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

9. Mapping to PSO

	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	3	3	1	2
CO3	3	2	1	2
CO4	3	2	1	3
CO5	2	2	1	2
CO6	3	1	1	2

Course Name: Advanced Technologies and Monitoring Systems Laboratory
Course Code: CE(PE)692
(Semester VI)
Category: Major
Course Broad Category: PROGRAM ELECTIVE COURSE- 4 (PE)

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1. **Course Prerequisite:**
   Fundamentals of Structural and Geotechnical Engineering, Proficiency in statistical analysis, MATLAB, or Python, Basic understanding of Non-Destructive Testing (NDT) Techniques, Basic understanding of Material Testing and Pavement Analysis.

2. **Course Learning Objectives:**
   i. To develop proficiency in non-destructive testing (NDT) methods.
   ii. To apply advanced monitoring techniques for structural and geotechnical evaluation.
   iii. To integrate smart technologies for real-time infrastructure monitoring.
   iv. To analyze pavement and bituminous material performance.
   v. To evaluate material behavior under accelerated conditions.

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology – Lab-based experiment demonstrations, discussions on testing procedures, hands-on practice with testing equipment, and real-life case studies.
   Evaluation System –
   Total Marks : 100 [60(PCIA) + 40(PESE)]
   PCIA : 60 Marks (Includes practical performance, reports, and viva voce after each experiment.)
   PESE : 40 Marks (Final comprehensive practical examination covering the entire syllabus.)

4. **Course Content:**
   Course Name: Advanced Technologies and Monitoring Systems Laboratory
   Course Code: CE(PE)692
   Hours per Week: 0L:0T:2P
   Credits: 1

Experiment	Topics	14P	100%
1.	Non-Destructive Testing (NDT) of Concrete: Rebound Hammer Test for Surface Hardness	1P	07
2.	Ultrasonic Pulse Velocity (UPV) Test for Concrete Quality and Homogeneity Assessment	1P	07
3.	Combined Rebound Hammer and UPV Testing for Structural Integrity Evaluation of Buildings	1P	07
4.	Accelerated Curing Tank: Evaluating Early Strength Gain in Concrete Specimens	1P	07

Experiment	Topics	14P	100%
5.	Ultrasonic Pulse Velocity (UPV) Test on Concrete under Accelerated Curing Conditions	1P	07
6.	Dynamic Cone Penetration Test (DCPT) for Soil Layer Strength and Stiffness Evaluation	1P	07
7.	Soil Moisture and Pressure Sensor Interface with Raspberry Pifor Geotechnical Stability Analysis	1P	07
8.	Calibration and Testing of Strain Gauges and Accelerometers for Structural Monitoring	1P	07
9.	Real-Time Data Logging and Analysis Using DAQ Systems	1P	07
10.	Aerial surveying in civil engineering usingIZI Fly Drone	1P	07
11.	Modified Roughness Evaluation Using MERLIN for Pavement Surface Profiling	1P	07
12.	Indirect Tensile Strength Test of Bituminous Mix for Tensile and Cracking Resistance Analysis	1P	07
13.	Real-Time Pavement Health Monitoring: Integration of Temperature and Strain Sensors with Raspberry Pi	1P	07
14.	Centrifuge Extractor Test: Separation of Liquid and Solid Particles in Bituminous Materials	1P	09

5. References:NA

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CE(PE)692.1	Implement NDT techniques (Rebound Hammer, UPV) for concrete quality assessment.	Implement	Apply
CE(PE)692.2	Examine soil properties using DCPT and sensor-based geotechnical monitoring.	Examine	Analyze
CE(PE)692.3	Demonstrate real-time data acquisition using DAQ systems and sensors.	Demonstrate	Apply
CE(PE)692.4	Appraise pavement roughness, bituminous mix performance, and tensile strength.	Appraise	Evaluate
CE(PE)692.5	Formulate aerial surveying techniques using drones and smart monitoring technologies to enhance civil infrastructure assessment and analysis.	Formulate	Create
CE(PE)692.6	Develop skills in calibration, data interpretation, and decision-making for civil engineering applications.	Develop	Create

7. Mapping of course outcomes to module / course content

Experiment	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	2
2	3	-	-	-	-	2
3	3	-	-	-	-	2

4	2	-	-	-	-	3
5	3	-	-	-	-	2
6	-	3	-	-	-	2
7	-	3	-	-	-	2
8	-	-	3	-	-	2
9	-	-	3	-	-	2
10	-	-	2	-	3	2
11	-	-	-	3	-	-
12	-	-	-	3	-	-
13	-	-	2	2	-	-
14	-	-	2	-	-	3

8. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE(PE)692.1	2	1	-	2	2	-	-	-	-	-	-	1
CE(PE)692.2	2	2	-	2	2	-	-	-	-	-	-	1
CE(PE)692.3	1	1	1	2	3	-	-	-	-	1	-	2
CE(PE)692.4	2	1	1	2	1	-	-	-	-	-	-	1
CE(PE)692.5	1	2	2	3	3	1	1	-	1	2	1	2
CE(PE)692.6	1	2	1	2	2	1	-	-	1	2	1	3

9. Mapping to PSO

	PSO1	PSO2	PSO3	PSO4
CE(PE)692.1	2	1	1	2
CE(PE)692.2	2	2	1	2
CE(PE)692.3	1	1	2	3
CE(PE)692.4	2	1	1	2
CE(PE)692.5	1	2	3	3
CE(PE)692.6	1	2	2	3