

**NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR**  
**CURRICULUM AND SYLLABUS OF BTECH DEGREE IN CIVIL ENGINEERING PROGRAM**  
**2023 ONWARD ADMISSION BATCH**



**V0:**

First Year Curriculum Recommended by members of UGAC	19.08.2023
First Year Curriculum Approved by the Chairman, Senate	19.08.2023
First Year Curriculum & Syllabus ratified in the 71st Senate meeting (Item No. 71.5(b))	18.12.2023
Entire Curriculum and Syllabus Recommended by UGAC	09.12.2024
Entire Curriculum and Syllabus Approved by the 73 <sup>rd</sup> Senate (Item No. 73.8)	23.03.2025

**GROUP – 1**  
**FIRST SEMESTER**

<b>Semester - I</b>							
<b>Sl. No</b>	<b>Code</b>	<b>Subject</b>	<b>L</b>	<b>T</b>	<b>S</b>	<b>C</b>	<b>H</b>
1	MAC01	Mathematics - I	3	1	0	4	4
2	CSC01	Computer Programming	2	1	0	3	3
3	XEC01	Engineering Mechanics	2	1	0	3	3
4	XEC02*	Basic Electrical and Electronics Engineering	3	0	0	3	3
5	ESC01	Ecology and Environment	2	0	0	2	2
6	CYC01	Engineering Chemistry	3	0	0	3	3
7	CSS51	Computer Programming Laboratory	0	0	3	2	3
8	XES52	Basic Electrical and Electronics Engineering Laboratory	0	0	3	2	3
9	CYS51	Engineering Chemistry Laboratory	0	0	2	1	2
		<b>TOTAL</b>	<b>15</b>	<b>3</b>	<b>8</b>	<b>23</b>	<b>26</b>

\*From the AY2025-26, L-T-P of XEC02 is 3-1-0, Credit = 4

**SECOND SEMESTER**

<b>Semester - II</b>							
<b>Sl. No</b>	<b>Code</b>	<b>Subject</b>	<b>L</b>	<b>T</b>	<b>S</b>	<b>C</b>	<b>H</b>
1	MAC02	Mathematics - II	3	1	0	4	4
2	CSC02	Data Structure and Algorithms	2	1	0	3	3
3	PHC01	Engineering Physics	2	1	0	3	3
4	HSC01	Professional Communication	2	0	2	3	4
5	CSS52	Data Structure and Algorithms Laboratory	0	0	3	2	3
6	XES51	Engineering Graphics	0	1	3	3	4
7	PHS51	Engineering Physics Laboratory	0	0	2	1	2
8	XXS51	Extra Academic Activities	0	0	2	1	2
		<b>TOTAL</b>	<b>9</b>	<b>4</b>	<b>12</b>	<b>20</b>	<b>25</b>

## **GROUP – 2**

### **FIRST SEMESTER**

<b>Semester - I</b>							
<b>Sl. No</b>	<b>Code</b>	<b>Subject</b>	<b>L</b>	<b>T</b>	<b>S</b>	<b>C</b>	<b>H</b>
1	MAC01	Mathematics - I	3	1	0	4	4
2	CSC01	Computer Programming	2	1	0	3	3
3	XEC01	Engineering Mechanics	2	1	0	3	3
4	PHC01	Engineering Physics	2	1	0	3	3
5	HSC01	Professional Communication	2	0	2	3	4
6	CSS51	Computer Programming Laboratory	0	0	3	2	3
7	XES51	Engineering Graphics	0	1	3	3	4
8	PHS51	Engineering Physics Laboratory	0	0	2	1	2
9	XXS51	Extra Academic Activities	0	0	2	1	2
<b>TOTAL</b>			<b>11</b>	<b>5</b>	<b>12</b>	<b>23</b>	<b>28</b>

### **SECOND SEMESTER**

<b>Semester - II</b>							
<b>Sl. No</b>	<b>Code</b>	<b>Subject</b>	<b>L</b>	<b>T</b>	<b>S</b>	<b>C</b>	<b>H</b>
1	MAC02	Mathematics - II	3	1	0	4	4
2	CSC02	Data Structure and Algorithms	2	1	0	3	3
3	XEC02	Basic Electrical and Electronics Engineering	3	0	0	3	3
4	ESC01	Ecology and Environment	2	0	0	2	2
5	CYC01	Engineering Chemistry	3	0	0	3	3
6	CYS51	Engineering Chemistry Laboratory	0	0	2	1	2
7	CSS52	Data Structure and Algorithms Laboratory	0	0	3	2	3
8	XES52	Basic Electrical and Electronics Engineering Laboratory	0	0	3	2	3
<b>TOTAL</b>			<b>13</b>	<b>2</b>	<b>8</b>	<b>20</b>	<b>23</b>

\*From the AY2025-26, L-T-P of XEC02 is 3-1-0, Credit = 4

SEMESTER III							
Sl No.	Course Code	Name of the course	L	T	S	C	H
1	MAC331	Mathematics – III	3	1	0	4	4
2	ESC331	Geology for Civil Engineering	3	0	0	3	3
3	CEC301	Solid Mechanics	3	1	0	4	4
4	CEC302	Construction, Material and Concrete Technology	3	1	0	4	4
5	CEC303	Fluid Mechanics	3	0	0	3	3
6	CES351	Mechanics Laboratory	0	0	3	2	3
7	CES352	Civil Engineering Drawing	0	0	3	2	3
8	CES353	Estimation and Costing Sessional	0	0	3	2	3
9	XXS381	Co-Curricular Activities – III (Optional)	0	0	0	0	0
			<b>15</b>	<b>3</b>	<b>9</b>	<b>24</b>	<b>27</b>

*N.B.: Although XXS381 is non-credit, participation will enrich individual grade cards.*

SEMESTER IV							
Sl No.	Course Code	Name of the course	L	T	S	C	H
1	CEC401	Structural Analysis – I	3	1	0	4	4
2	CEC402	Design of Concrete Structures	3	1	0	4	4
3	CEC403	Water Resources Engineering	3	1	0	4	4
4	CEC404	Environmental Engineering	3	1	0	4	4
5	CEC405	Surveying	3	0	0	3	3
6	CES451	Structural Mechanics Laboratory	0	0	3	2	3
7	CES452	Design of Concrete Structures Sessional	0	0	3	2	3
8	CES553	Surveying Laboratory	0	0	3	2	3
9	XXS481	Co-Curricular Activities – IV (Optional)	0	0	0	0	0
			<b>15</b>	<b>4</b>	<b>9</b>	<b>25</b>	<b>28</b>

*N.B.: Although XXS481 is non-credit, participation will enrich individual grade cards.*

SEMESTER V							
Sl No.	Course Code	Name of the course	L	T	S	C	H
1	CEC501	Structural Analysis – II	3	1	0	4	4
2	CEC502	Design of Steel Structures	3	1	0	4	4
3	CEC503	Transportation Engineering	3	1	0	4	4
4	CEC504	Soil Mechanics	3	0	0	3	3
5	CEE510 to 519	Depth Elective – 1	3	0	0	3	3
6	CES551	Structural Analysis Sessional	0	0	3	2	3
7	CES552	Design of Steel Structures Sessional	0	0	3	2	3
8	CES553	Environmental and Water Resource Engineering Laboratory	0	0	3	2	3
9	XXS581	Co-curricular Activities - V (Optional)	0	0	0	0	0
			<b>15</b>	<b>3</b>	<b>9</b>	<b>24</b>	<b>27</b>

*N.B.: Although XXS581 is non-credit, participation will enrich individual grade cards.*

SEMESTER VI							
Sl No.	Course Code	Name of the course	L	T	S	C	H
1	HSC631	Economics and Accountancy	3	0	0	3	3
2	CEC601	Foundation Engineering	3	0	0	3	3
3	CSC631	AI & ML	3	0	2	4	5
4	CEE610 to 619	Depth Elective – 2	3	0	0	3	3
5	CEE620 to 629	Depth Elective – 3	3	0	0	3	3
6	CES651	Structural Engineering Laboratory	0	0	3	2	3
7	CES652	Civil Engineering Computation & Software Laboratory	0	0	3	2	3
8	CES653	Soil Mechanics and Foundation Engineering Laboratory	0	0	3	2	3
9	XX681	Co-curricular Activities - VI (Optional)	0	0	0	0	0
			<b>15</b>	<b>0</b>	<b>9</b>	<b>22</b>	<b>26</b>

*N.B.: Although XXS681 is non-credit, participation will enrich individual grade cards.*

SEMESTER VII							
Sl No.	Course Code	Name of the course	L	T	S	C	H
1	MSC731	Principles of Management	3	0	0	3	3
2	CEC701	Disaster Mitigation and Management	3	1	0	4	4
3	CEE710 to 719	Depth Elective – 4	3	0	0	3	3
4	CEE720 to 729	Depth Elective – 5	3	0	0	3	3
5	CEO***	Open Elective	3	0	0	3	3
6	CES751	Project - I	0	0	6	1	6
7	CES752	Summer Internship	0	0	2	1	2
8	CES753	Transportation Engineering Laboratory	0	0	3	2	3
			<b>15</b>	<b>1</b>	<b>11</b>	<b>20</b>	<b>27</b>

SEMESTER VIII							
Sl No.	Course Code	Name of the course	L	T	S	C	H
1	CES851	Project – II	0	0	15	6	15
2	CES852	Comprehensive Viva	0	0	0	1	0
			<b>0</b>	<b>0</b>	<b>15</b>	<b>7</b>	<b>15</b>

Semester	I+II	III	IV	V	VI	VII	VIII	TOTAL
Credit Unit	43	24	25	24	22	20	7	165

### OPEN ELECTIVES

The students can opt from elective subject(s) that are offered in a particular semester, except the subjects with his /her own department code.

OPEN ELECTIVE – 1 : SEMESTER-VII							
S/N	Code	Subject	L	T	S	C	H
1	CEO740	Introduction to Earthquake Engineering	3	0	0	3	3
2	CEO741	Elementary Civil Engineering					
3	CEO742	Finite Element Analysis and Applications	3	0	0	3	3
4	CEO743	Elementary Structural Design	3	0	0	3	3
5	CEO744	Reliability Engineering	3	0	0	3	3
6	CEO745	Numerical Methods in Engineering	3	0	0	3	3
7	CEO746	Watershed Planning and management	3	0	0	3	3
8	CEO747	Road Safety Awareness Program					

### DEPTH ELECTIVES

The students primarily will opt from elective subject(s) that are offered in a particular semester by his /her own department. However, a student can opt for elective subject(s) that are offered by other department in a particular semester, with the permission/ consent from his/her Head of the Department and the concerned teacher of that subject.

DEPTH ELECTIVE – 1 : SEMESTER-V							
S/N	Code	Subject	L	T	S	C	H
1	CEE510	Advanced Concrete Technology	3	0	0	3	3
2	CEE511	Advanced Structural Mechanics	3	0	0	3	3
3	CEE512	Principles of Reliability	3	0	0	3	3
4	CEE513	Applied Probability and Statistics in Civil Engineering	3	0	0	3	3
5	CEE514	Experimental Method and Analysis	3	0	0	3	3
6	CEE515	Transportation Infrastructure Design	3	0	0	3	3
7	CEE516	Transportation Planning and Management	3	0	0	3	3
8	CEE517	Remote sensing and GIS	3	0	0	3	3
9	CEE518	Hydrology & Irrigation Engineering	3	0	0	3	3
10	CEE519	Ground Water	3	0	0	3	3

DEPTH ELECTIVE – 2 : SEMESTER-VI							
S/N	Code	Subject	L	T	S	C	H
1	CEE610	Advanced Structural Analysis	3	0	0	3	3
2	CEE611	Introduction to Finite Element Method	3	0	0	3	3
3	CEE612	Bridge Engineering	3	0	0	3	3
4	CEE613	Experimental Stress Analysis, Instrumentation & Sensor Technology	3	0	0	3	3
5	CEE614	Repair and Rehabilitation of Structures	3	0	0	3	3
6	CEE615	Pavement Analysis and Design	3	0	0	3	3
7	CEE616	Applied Numerical Methods	3	0	0	3	3
8	CEE617	Road Safety Analysis	3	0	0	3	3
9	CEE618	Intelligent Transportation System (ITS)	3	0	0	3	3
10	CEE619	Remote Sensing and its applications for Disaster Management	3	0	0	3	3

DEPTH ELECTIVE – 3 : SEMESTER-VI							
S/N	Code	Subject	L	T	S	C	H
1	CEE620	Advanced Design of Concrete Structures	3	0	0	3	3
2	CEE621	Construction Planning and Management	3	0	0	3	3
3	CEE622	Introduction to Random Vibration	3	0	0	3	3
4	CEE623	Mechanics of Composite Structures	3	0	0	3	3
5	CEE624	Theory of Plates and Shells	3	0	0	3	3
6	CEE625	Environmental Pollution and control	3	0	0	3	3
7	CEE626	Geotechnical Physical Modelling	3	0	0	3	3
8	CEE627	System Approach to Civil Engineering	3	0	0	3	3
9	CEE628	Artificial Intelligence in Civil Engineering	3	0	0	3	3
10	CEE629	Open Channel Hydraulics	3	0	0	3	3

**DEPTH ELECTIVE – 4 : SEMESTER-VII**

S/N	Code	Subject	L	T	S	C	H
1	CEE710	Structural Dynamics	3	0	0	3	3
2	CEE711	Advanced Design of Steel Structures	3	0	0	3	3
3	CEE712	Earthquake resistant design of structure	3	0	0	3	3
4	CEE713	Green Building and Sustainable Materials	3	0	0	3	3
5	CEE714	Structural Health Monitoring	3	0	0	3	3
6	CEE715	Railways, Airports and Harbour Engineering	3	0	0	3	3
7	CEE716	Industrial Waste	3	0	0	3	3
8	CEE717	Ground Improvement	3	0	0	3	3
9	CEE718	Soil Dynamics	3	0	0	3	3
10	CEE719	Slope Stability and Reinforced Earth	3	0	0	3	3

**DEPTH ELECTIVE – 5 : SEMESTER-VII**

S/N	Code	Subject	L	T	S	C	H
1	CEE720	Material Technology	3	0	0	3	3
2	CEE721	Offshore Structural Dynamics	3	0	0	3	3
3	CEE722	Pre-stressed Concrete	3	0	0	3	3
4	CEE723	Piping Engineering	3	0	0	3	3
5	CEE724	Theory of Elasticity and Plasticity	3	0	0	3	3
6	CEE725	Traffic Engineering and Management	3	0	0	3	3
7	CEE726	Soil Structure Interaction	3	0	0	3	3
8	CEE727	Machine Foundation	3	0	0	3	3
9	CEE728	Water Resources System Planning & Management	3	0	0	3	3
10	CEE729	Sediment Transport	3	0	0	3	3

Course Code	Title of the course	Program core (PCR) /Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MAC331	Mathematics-III	PCR	3	1	0	4	4
Pre-requisite(s)		Course Assessment methods					
		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes	<ul style="list-style-type: none"> <li>CO1: Acquire the idea about mathematical formulations of phenomena in physics and engineering.</li> <li>CO2: To understand the common numerical methods to obtain the approximate solutions for the intractable mathematical problems.</li> <li>CO3: To understand the basics of complex analysis and its role in modern mathematics and applied contexts.</li> <li>CO4: To understand the optimization methods and algorithms developed for solving various types of optimization problems.</li> </ul>						
Topics Covered	<p><b>Partial Differential Equations (PDE):</b> Formation of PDEs; Lagrange method for solution of first order quasilinear PDE; Charpit method for first order nonlinear PDE; Homogenous and Nonhomogeneous linear PDE with constant coefficients: Complimentary Function, Particular integral; Classification of second order linear PDE and canonical forms; Initial &amp; Boundary Value Problems involving one dimensional wave equation, one dimensional heat equation and two dimensional Laplace equation. [14]</p> <p><b>Numerical Methods:</b> Significant digits, Errors; Difference operators; Newton's Forward, Backward and Lagrange's interpolation formulae; Numerical solutions of nonlinear algebraic/transcendental equations by Bisection and Newton-Raphson methods; Trapezoidal and Simpson's 1/3 rule for numerical integration; Euler's method and modified Euler's methods for solving first order differential equations. [14]</p> <p><b>Complex Analysis:</b> Functions of complex variable, Limit, Continuity and Derivative; Analytic function; Harmonic function; Conformal transformation and Bilinear transformation; Complex integration; Cauchy's integral theorem; Cauchy's integral formula; Taylor's theorem, Laurent's theorem (Statement only); Singular points and residues; Cauchy's residue theorem. [17]</p> <p><b>Optimization:</b></p> <p><b>Mathematical Preliminaries:</b> Hyperplanes and Linear Varieties; Convex Sets, Polytopes and Polyhedra. [2]</p> <p><b>Linear Programming Problem (LPP):</b> Introduction; Formulation of linear programming problem (LPP); Graphical method for its solution; Standard form of LPP; Basic feasible solutions; Simplex Method for solving LPP. [9]</p>						
Text Books, and/or reference material	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>An Elementary Course in Partial Differential Equations-T. Amarnath</li> <li>Numerical Methods for scientific &amp; Engineering Computation- M.K.Jain, S.R.K. Iyengar &amp; R.K. Jain.</li> <li>Foundations of Complex Analysis- S. Ponnuswami</li> <li>Operations Research Principles and Practices- Ravindran, Phillips, Solberg</li> <li>Advanced Engineering Mathematics- E. Kreyszig</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Complex Analysis-L. V. Ahlfors</li> <li>Elements of partial differential equations- I. N. Sneddon</li> <li>Operations Research- H. A. Taha</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	Code/provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	1	2	-	-	-	-	2			
CO2	3	3	2	2	2	1	2	-	-	-	1	2			
CO3	3	3	2	2	3	-	1	-	-	1	-	2			
CO4	3	2	2	3	2	1	1	-	1	-	-	2			



Course Code	Title of the course	Program Core (PCR)/Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEC301	Solid Mechanics	PCR	3	1	0	4	4
Pre-requisite(s)		Course Assessment methods					
Knowledge of Engineering Mechanics and Mathematics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs):	<ul style="list-style-type: none"> <li>CO1: Development of skills for predicting structural behavior of solids under different loads</li> <li>CO2: Knowledge of basics of analysis and design of structural components made of variety of materials</li> <li>CO3: Developing the requisite skill that helps in studying the advanced courses</li> </ul>						
Topics Covered (Hrs)	<p><b>Concept of stress and strain:</b> Normal and shear stresses and strains in axially loaded members, Elastic moduli and their inter-relationships, strain energy due to direct stresses, impact loads. (6)</p> <p><b>Beam Statics:</b> Definitions, support types and support reactions, concepts of redundancy, shear force and bending moment diagrams for beams. (10)</p> <p><b>Symmetric Beam Bending:</b> Basic kinematical assumptions, moment of inertia, elastic flexure formulae and its application, moment carrying capacity. (4)</p> <p><b>Bending stress and Shear stress:</b> Concepts of bending stress and shear stress, their distributions in beam sections, combined effect of bending, shear and direct stresses. (8)</p> <p><b>Strain energy:</b> Due to pure bending and shearing stress. (3)</p> <p><b>Deflection of beams:</b> Moment-curvature relationship, determination of deflection by double integration method and Macaulay's principle (4)</p> <p><b>Torsion:</b> Pure torsion, Torsion of circular solid shaft, closed coil helical spring. Combined bending and torsion. (4)</p> <p><b>Two-dimensional stress problems:</b> Principal stresses, maximum shear stresses, Mohr's circle of stresses, construction of Mohr's circle. (5)</p> <p><b>Thin pressure vessels:</b> Hoop stress and meridional stress, volumetric changes (4)</p> <p><b>Columns:</b> Fundamentals, different types of equilibrium, column buckling theory, Euler's load for columns, limitations of Euler's theory – problems, eccentric load and secant formulae, empirical column formulae &amp; IS code formulae. (4)</p>						
Text Books, and/or reference material (s)	<p><b>Text Books:</b></p> <p>6. Elements of Strength of Material by S. P. Timoshenko &amp; D.H. Young, 4<sup>th</sup> Ed. East West Press Publisher Pvt. Ltd</p> <p>7. Strength of Materials by S. S. Bhavikatti, 5<sup>th</sup> Ed. Vikas Publishing</p> <p>8. Engineering Mechanics of Solids by E. P. Popov, 2<sup>nd</sup> Ed. Pearson Education India</p> <p><b>Reference Books:</b></p> <p>9. Strength of Material by Singer &amp; Pytel, 4<sup>th</sup> Ed. Addison Wesley</p> <p>10. A Text Book of Strength of Materials by Ghosh &amp; Datta, 1<sup>st</sup> Ed. New Age International Publication Pvt. Ltd, New Delhi</p>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	-	2
CO2	-	3	2	-	-	-	-	-	-	-	-	-	3	-	3
CO3	-	3	-	2	-	-	-	-	-	-	-	-	3	2	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEC302	Construction, Materials & Concrete Technology	PCR	3	1	0	4	4
Pre-requisite(s)		Course Assessment methods					
No pre-requisites		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>• CO1: Apply the knowledge about building materials for construction practices.</li> <li>• CO2: Understand the building components and planning</li> <li>• CO3: Learn the basic principles of construction</li> </ul>						
Topics Covered (Hrs)	<p><b>A). Construction (16):</b> Introduction to anthropometrics and ergonomics; Occupancy classification of Buildings; Essentials of National Building Code; Essentials of Building and development rules; Introduction to green building; Planning and orientation of buildings (6) Introduction to different components and functions of a building in details: Foundation, Wall, Beam, Floor, Roof, Stair &amp; Staircase, Door, Window, and etc. (10)</p> <p><b>B). Building Materials (20):</b> <b>Aggregates:</b> Classification, sampling, properties of fine and coarse aggregates, standard tests, deleterious substances, Alkali-aggregate reaction, thermal properties, grading of aggregate. (4) <b>Cement:</b> Introduction, chemical composition, major compounds, hydration, physical properties, testing, fineness, consistency, setting time, soundness, strength, heat of hydration, specific gravity, types of cement (8) <b>Water:</b> Source, quality, impurities and effect of on concrete, sea water (2) <b>Admixture:</b> Introduction, classification, specifications and functions of admixtures. (2) <b>Other materials:</b> Brick, Timber, Lime, Cement mortar, Timber, Steel and Paint. (4)</p> <p><b>C). Concrete Technology (16):</b> <b>Introduction:</b> classification, properties, grades, advantage, disadvantages and quality control. (1) <b>Fresh concrete:</b> Introduction, workability, factors, measurement, segregation, bleeding and manufacture of concrete – batching, mixing, transporting, placing, compaction, finishing and curing. (5) <b>Hardened concrete:</b> Introduction, strength, stress–strain characteristics, destructive and non-destructive test, shrinkage, creep, permeability, durability, attack of sulphates, acid, efflorescence, thermal properties and fire resistance. (4) <b>Concrete mix design:</b> Factors and mix design using Indian Standard code. (4) <b>Special concrete:</b> Introduction of Light weight, High density, High strength, Fibre reinforced, Polymer concrete and Ferro cement. (2)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Engineering Materials by S.C.Rangwala, K.S.Rangwala and P.S.Rangwala, Charotar Publishing House, Anand</li> <li>2. Building Construction by S.C.Rangwala, Charotar Publishing House, Anand</li> <li>3. Concrete Technology by M.S.Shetty, S.Chand Publisher, New Delhi</li> <li>4. IS10262:2009, Concrete Mix Proportioning – Guidelines (1<sup>st</sup> Revision), BIS, New Delhi.</li> <li>5. IS383:1970, Specification for Coarse and Fine aggregates from natural sources for concrete (2<sup>nd</sup> Revision) BIS, New Delhi.</li> <li>6. SP 7:2016, National Building Code of India 2016 (NBC 2016) Volume-1 and Volume-2</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>7. Concrete Technology by M. L.Gambhir, Tata McGraw Hill and www.nptel.ac.in</li> </ol>						

Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and	Computer aided skill and tools	Code provisions / guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	2	1	-	-	-	-	-	2	-	1
CO2	3	-	-	-	-	2	1	-	-	-	-	-	3	3	1
CO3	3	-	3	-	-	2	1	-	-	-	-	-	-	1	2

Course Code	Title of the course	Program Core (PCR)/Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CEC303</b>	<b>Fluid Mechanics</b>	<b>PCR</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>
Pre-requisite(s)		Course Assessment methods					
Mechanics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>• CO1: Development of skills for predicting fluid behaviour</li> <li>• CO2: Knowledge of basics of fluid flow measurement and model development</li> <li>• CO3: Developing the requisite skill that helps in studying the advanced courses</li> </ul>						
Topics Covered (Hrs)	<p><b>Fluid Properties:</b> Equations of State, Units and Dimensions, Fluid Pressure, Pressure Gauges, Resultant Pressure on Plane and Curved Immersed Surfaces, Centre of Pressure, Equilibrium of Floating Bodies, Buoyancy and Meta Centre. <b>(9)</b></p> <p><b>Types of Flow:</b> Definitions, Continuity Equation, Equation of Flow along a Stream Line, Energy Equation, Momentum Equation, Fluid Acceleration, Flow in a Curved Path, Forced and Free Vortex. <b>(7)</b></p> <p><b>Dimensional Analysis:</b> Similitude of fluid flow, non-dimensional numbers. <b>(3)</b></p> <p><b>Incompressible flow in closed conduits:</b> Laminar and Turbulent Flow, Critical Reynold's Number, Pipe Friction Law, Laminar Flow in Pipes, Friction Loss in Smooth and Rough Pipes, Minor Losses in Pipes, HGL and EGL, Empirical Formula for Pipe flow. <b>(6)</b></p> <p><b>Flow measurement:</b> Orifice coefficient, External and Reentrant Mouth pieces, Measurement of Velocity and Discharge in Closed Conduits, Venturimeter, Orificemeter and Pitot Tube, Flow through Rectangular Weirs and V-Notch, Time of Emptying Tanks and Reservoirs. <b>(7)</b></p> <p><b>Open Channels:</b> Equation of Uniform Flow, Chezy and Manning Formulae, Velocity Distribution and Economic Cross Section. <b>(4)</b></p>						
Text Books, and/or reference material (s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Fluid Mechanics by Frank M White, Tata McGraw-Hill</li> <li>2. Introduction to Fluid Mechanics by Robert W Fox &amp; Alan T McDonald, WILEY</li> <li>3. Fluid Mechanics by V. L. Streeter &amp; E B Wylie, McGraw-Hill</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>4. Fluid Mechanics and Hydraulics by Jack B Evett &amp; Cheng Liu, Tata McGraw-Hill</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	code/provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	1	1
CO2	-	2	3	1	-	-	-	-	-	-	-	-	-	2	1
CO3	-	3	-	2	-	-	-	-	-	-	-	-	-	3	2

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CES351</b>	<b>Mechanics Laboratory</b>	<b>PS</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>	<b>2</b>
Pre-requisite(s)		Course Assessment methods					
NIL		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>• CO1: Development of skills to perform relevant laboratory experiments related to fluid mechanics and its applications in civil engineering.</li> <li>• CO2: Development of skills to conduct laboratory tests on different materials related to civil engineering</li> <li>• CO3: Development of understanding to interpret the results from experiments/testings, realise their limitations and correlate with theoretical knowledge.</li> <li>• CO4: Realisation of the importance of results from laboratory testing/experimentation in the analysis and design of civil engineering systems/structures for realistically predicting their behaviour.</li> <li>• CO5: Development of skills to work in a group to perform tests/experiments as well as produce laboratory reports in an appropriate way.</li> </ul>						
Topics Covered (Hrs)	<p><b>A). Fluid Mechanics</b></p> <ol style="list-style-type: none"> <li>1. Determination of coefficient of bend losing flow through pipes.</li> <li>2. Experiment on friction loss in flow through pipes.</li> <li>3. Calibration of Venturimeter.</li> <li>4. Calibration of V-notch.</li> <li>5. Calibration of Orificemeter.</li> <li>6. Experiment on the impact of jet.</li> </ol> <p><b>B). Strength of Materials</b></p> <ol style="list-style-type: none"> <li>1. Determination of tensile strength of metals using Universal Testing Machine</li> <li>2. Determination of hardness of a given specimen using Rockwell Hardness Test Machine</li> <li>3. Determination of the strain energy of a given specimen using Charpy Impact Test Machine</li> <li>4. Determination of torsional strength of a given specimen using Torsional Testing machine</li> <li>5. Assessment of the compressive strength of concrete using Rebound Hammer</li> <li>6. Determination of Poisson's Ratio of concrete using Ultrasonic Pulse velocity Meter (UPVM)</li> </ol>						

Text Books, and/or reference material (s)	<b>ReferenceBooks:</b> 1. Fluid Mechanics by M White Frank, Tata McGraw-Hill 2. Introduction to Fluid Mechanics by W Fox Robert & T Alan McDonald, WILEY 3. Fluid Mechanics by V. L. Streeter, & E B, Wylie, McGraw-Hill. 4. Elements of Strength of Material by S. P. Timoshenko & D.H. Young, East West Press Publisher Pvt. Ltd., New Delhi
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**Mapping of Course Outcomes COs □ POs □ PSOs**

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	Code provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	3	1	-	-	-	-	-	-	-	1	2	-
CO2	2	-	-	3	1	-	-	-	-	-	-	-	3	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	3	-	2
CO4	2	-	3	-	-	-	-	-	-	-	-	-	3	-	3
CO5	-	-	-	-	-	-	-	-	3	2	-	-	1	-	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CES352</b>	<b>Civil Engineering Drawing</b>	<b>PS</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>	<b>2</b>
Pre-requisite(s)		Course Assessment methods					
NIL		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>• CO1: To learn the basic concepts of Civil Engineering drawings</li> <li>• CO2: To draw plan, elevation and section of load bearing and framed structures.</li> <li>• CO3: To prepare plan, elevation and section for Residential and Public Buildings from given requirements.</li> <li>• CO4: To prepare detailed drawings for Plumbing, water supply and drainage for buildings.</li> </ul>						
Topics Covered (Hrs)	<p>Symbols, signs, and lines for different materials used in Civil Engineering.</p> <p>Detailed working drawings of</p> <ul style="list-style-type: none"> <li>• Panelled Doors, glazed windows and ventilators.</li> <li>• Trusses</li> <li>• RC Staircase</li> </ul> <p>Preparation of site plans and service plans as per national building code</p> <p>Preparation of building plan using the planning principles from given requirements of areas &amp; Specifications.</p> <p>Preparation of sketch design and working drawings for:</p> <ul style="list-style-type: none"> <li>• Residential buildings - Flat and pitched roof, load bearing and non-load bearing structures</li> <li>• Public buildings – small public utility shelters, dispensaries, banks, schools, offices, libraries, hostels, restaurants, commercial complexes, factories etc.</li> </ul>						

Text Books, and/or reference material (s)	<b>Text Books:</b>
	1. B.T.S. Prabhu, Building Drawing and Detailing, Spades Publishers, 2007.
	2. J. De Chiara, Time Saver Standards for Site Planning, McGraw Hill, 1999.
	3. IS 4963:1987, Recommendation for Buildings and Facilities for the Physically Handicapped.
	4. IS 962:1989, Code of Practice for Architectural and Building Drawings.
	5. M.G. Shah, M. Kalec, & S.Y. Patki, Building Drawing, New Delhi: Tata McGraw Hill, 2000.
	6. SP 41: 1987, Handbook on Functional Requirements of Buildings.
	7. SP 7: 2016, National Building Code of India 2016 (Vol I and II).
8. A.M.S. Tessie, The House, Its Plan & Use, Oxford and IBH Publishing Co., 2000.	

**Mapping of Course Outcomes COs □ POs □ PSOs**

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	Code/provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	3	-	-	-	3	-	3	3	3	3
CO2	3	-	-	-	-	3	-	-	-	3	-	3	3	3	3
CO3	3	-	-	-	-	3	-	-	-	3	-	3	3	3	3
CO4	3	-	-	-	-	3	-	-	-	3	-	3	3	3	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CES353</b>	<b>Estimation and Costing sessional</b>	<b>PCR</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>	<b>2</b>
Pre-requisites:		Course Assessment methods:					
CEC 303 & CEC403		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes	<ul style="list-style-type: none"> <li>CO1: Learn the art of quantity estimation, preparation of Bill of Quantities, and writing specification.</li> <li>CO2: Learn rate analysis</li> <li>CO3: Acquire knowledge about specifications and software applications for estimation.</li> </ul>						
Topics Covered	<ol style="list-style-type: none"> <li>Preparation of bill of quantities of a simple residential building including sanitary works</li> <li>Analysis of rate and preparation of cost estimate of a simple residential building</li> <li>Computation of volume of earthwork, Preparation of mass haul diagram</li> <li>Estimation of roadway, culverts, bridges etc.</li> <li>Software application in estimation</li> <li>Specifications of different items of work.</li> </ol>						
Text Books, and/or reference material	<b>Text Books:</b> <ol style="list-style-type: none"> <li>Building Construction by S.C. Rangwala, Charotar Pub. House, Anand,</li> <li>Estimating and costing in civil engineering – theory and practice, 23<sup>rd</sup> edition by B.N. Dutta, UBPSD, New Delhi, 1991.</li> <li>Estimating, costing and specification in civil engineering, 6<sup>th</sup> edition by M. Chakraborty, Kolkata, 1979.</li> </ol> <b>Reference Books:</b> <ol style="list-style-type: none"> <li>Text book of estimating and costing (civil engineering) by G.S. Birdie, Dhanpat Rai &amp; Sons, Delhi, 1986.</li> <li>Civil Engineering Contracts and Estimates by B.S. Patil, Orient Longman, New Delhi, 1981.</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigation of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	3	-	-	-	-	3	-	3	-	-
CO2	3	3	-	-	-	3	-	-	-	-	3	-	3	-	-
CO3	3	3	-	-	-	3	-	-	-	-	3	-	3	3	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CEC-401</b>	<b>Structural Analysis-I</b>	<b>PCR</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>	<b>4</b>
Pre-requisite(s)		Course Assessment methods					
Engineering & Solid Mechanics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>• CO1: Acquire the knowledge of structural systems, elements, joints, loads, stability, equilibrium, compatibility and indeterminacy</li> <li>• CO2: To apply geometric methods to obtain slope and deflections</li> <li>• CO3: To apply Energy methods to obtain slope and deflections</li> <li>• CO4: Evaluate &amp; draw the influence lines for internal and external reactions in beams &amp; girders due to moving load.</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction:</b> Structural system, support condition and loads <b>(2)</b></p> <p><b>Shear force and bending moment:</b> Recapitulation of bending moment, shear force, torsion of determinate structures. <b>(4)</b></p> <p><b>Slopes and deflections:</b> Slopes and deflections in beams and frames, elastic curve, application of elastic beam theory with moment area method, conjugate beam method. <b>(14)</b></p> <p><b>Energy methods:</b> Strain energy, complementary energy, real work, virtual work, application of Castigliano's Theorems &amp; virtual work methods to beams, frames, trusses, Maxwell's Reciprocal theorem, Betti's Law <b>(14)</b></p> <p><b>Static and kinematic indeterminacy:</b> Application on different type of structures <b>(6)</b></p> <p><b>Influence Lines:</b> Application of influence lines &amp; rolling loads for determinate beams and arches <b>(12)</b></p>						
Text Books, and/or reference material (s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Basic Structural Analysis by C. S. Reddy (Tata McGraw Hill)</li> <li>2. Elementary Structural Analysis by Wilbur &amp; Norris (Mcgraw-Hill College)</li> <li>3. Structural Analysis by R. C. Hibbeler (Pearson Edu.)</li> <li>4. Structural Analysis by Devdas Menon, (Narosa)</li> </ol> <p><b>Reference Books:</b></p> <p>Structural Analysis by G. S. Pandit &amp; S. P. Gupta (Tata McGraw Hill)</p> <p>Theory of structures by S. P. Timoshenko and D. H. Young Mc. Graw Hill book Co</p>						

### Mapping of Course Outcomes COs □ POs

	Engineering knowledge	Problemanalysis	Design/development of solutions	Conduct investigations of complex problems	Moderntool usage	Theengineerand society	Environment& sustainability	Ethics	Individual& team work	Communication	Projectmanagement & finance	Life-long learning
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	-	-	-	-	-	1	-	-	-	-	-
CO3	3	-	-	-	2	-	-	-	-	-	-	-
CO4	3	-	-	-	2	-	-	-	-	-	-	-

Course Code	Titleofthe course	ProgramCore (PCR) / Electives(PEL)	TotalNumberofcontacthours				Credit
			Lecture (L)	Tutoria 1 (T)	Practica 1 (P)	Total Hours	
<b>CEC402</b>	<b>Designof Concrete Structures</b>	<b>PCR</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>4</b>
Pre-requisite(s)		CourseAssessmentmethods					
Solid Mechanics		Continuous(CT)andendassessment(EA).CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>• CO1:Applyknowledgeofsolidmechanicsfordesignsolutions.</li> <li>• CO2:Understandbasicdesignphilosophiesapplicabletoconcretestructures.</li> <li>• CO3:Formulate,analyse,anddesignbasiccomponentsofCivilEngineeringReinforcedConcrete structures.</li> </ul>						
Topics Covered (Hrs)	<p><b>Properties</b>ofconcreteandreinforcingsteel,Characteristicstrengths,Stressstraincurves, Shrinkage and creep phenomenon, I.S. specification <b>(4)</b></p> <p><b>Design philosophies</b> – working stress method and limit state method of design. <b>(8)</b></p> <p><b>Analysisanddesign</b> ofsectionsinflexurebyworkingstressandlimitstatemethod,Single and doubly reinforced sections, T and L sections <b>(10)</b></p> <p><b>Behaviourofbeams</b>inshearandbond,Designforshear,Anchorageandcurtailmentof reinforcement, Detailing of reinforcement. <b>(4)</b></p> <p><b>Serviceability</b>,Limitstatesofdeflectionandcracking,Calculationofdeflections. <b>(4)</b></p> <p><b>Design of columns:</b> Short and long columns, Eccentrically loaded columns <b>(8)</b></p> <p><b>Design of one-way and two-way slabs, Staircases.</b> <b>(6)</b></p> <p><b>Isolatedandcombinedfootings(6)</b></p> <p><b>Designof cantilevertyperetainingwalls(6)</b></p>						

Text Books, and/or reference material (s)	<b>Text Books:</b>
	<ol style="list-style-type: none"> <li>1. Reinforced Concrete Design, 2nd Edition, by S. Unnikrishna Pillai and Devdas Menon, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.</li> <li>2. IS 456:2000, Indian Standard Plain and Reinforced Concrete – Code of Practice (4th Revision), BIS, New Delhi.</li> <li>3. SP-16, Design Aids for Reinforced Concrete to IS:456 – 1978, BIS, New Delhi</li> <li>4. www.nptel.iitm.ac.in/courses/</li> </ol>
	<b>Reference Books:</b>
	<ol style="list-style-type: none"> <li>5. Reinforced Concrete, 6th Edition, by S.K. Mallick and A.P. Gupta, Oxford &amp; IBH Publishing Co. Pvt. Ltd. New Delhi, 1996.</li> <li>6. Reinforced Concrete Design, 1st Revised Edition, by S.N. Sinha, Tata McGraw-Hill Publishing Company. New Delhi, 1990.</li> </ol>

**Mapping of Course Outcomes COs □ POs □ PSOs**

	Engineering knowledge	Problem analysis Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions/ guidelines	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	2	-	-	-	3	-	2
CO2	3	-	3	-	-	-	1	-	-	2	-	2	-	2	-
CO3	-	-	3	-	-	-	-	2	-	2	1	3	2	1	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CEC403</b>	<b>Water Resource Engineering</b>	<b>PCR</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>	<b>4</b>
Pre-requisite(s)		Course Assessment methods					
Fluid mechanics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs):	<ul style="list-style-type: none"> <li>• CO1: Understanding of occurrence, distribution, storage &amp; transmission of water in different form in the space, on the surface and below the surface of the earth.</li> <li>• CO2: Understanding of tempo-spatial collection of data and preparation of hydro-meteorological information system.</li> <li>• CO3: learning importance, requirement, method &amp; infrastructure for imparting irrigation water to crop, development &amp; conservation of water for its economic &amp; efficient use</li> </ul>						

Topics Covered (Hrs)	<p><b>Hydrology:</b> Hydrologic cycle &amp; system model, Hydro-meteorological Information System and its Definition, need, generation, maintenance, validation, calibration of data sets, estimation of missing data, retrieval of data (5)</p> <p><b>Precipitation:</b> Forms, types &amp; measurement, Recording &amp; non-recording gauges, Network, Analysis &amp; Adjustment of data, Average depth, depth-area-duration analysis, Surface retention, Detention, Overland flow, Interception, Depression storage. (6)</p> <p><b>Evaporation&amp;Transpiration:</b>Factors,Measurement,formulaconsumptiveuse(2)</p> <p><b>Stream flow:</b> Stage, discharge &amp; relations, interpretation of stream flow records. Factors affecting the run off, yield, flow duration &amp; mass curve (4)</p> <p><b>Infiltration:</b>Process,Capacity,Measurement,Estimation(2)</p> <p><b>Run-off:</b>Factors, Yield, Flow-duration curve, Flow mass curve. (2)</p> <p><b>Hydrograph:</b>Baseflowseparation,Unithydrograph,Synthetichydrograph(2)</p> <p><b>Irrigation:</b> Necessity, Advantages, Disadvantages, Types, Water distribution techniques, Quality of water, Duty, Delta, Base period, Indian crop seasons, Irrigation efficiencies, Soil- moisture –irrigation relationships, Estimating depth and frequency of irrigation. (5)</p> <p><b>Canal irrigation system:</b> Capacities, losses, Design &amp; construction of unlined, lined &amp; stable channels, Sediment transport, Economics of canal lining, Cross drainage works (3)</p> <p><b>Water-logging and control:</b>Causes,Control,Reclamationofsalineand alkalinelands,Surface &amp; Sub-surface drainage (3)</p> <p><b>Diversion head-works:</b> Definition of weirs, barrages &amp; their classification, Layout of typical diversion head-works &amp; function of its components. (2)</p> <p><b>Reservoirs:</b>Types,selectionofsite,Storagezones,Fixationofcapacity,regulation. (2)</p> <p><b>Dam:</b> Earthen and concrete dam, selection criteria, design (4)</p> <p><b>Spillwaysandenergydissipaters:</b>Location,types,energydissipation,stillingbasin&amp; spillway gate (4)</p> <p><b>FloodForecasting:</b>Estimation,forecasting&amp;mitigation,floodlandmanagement(4)</p> <p><b>Flood routing:</b> Reservoir &amp; Channel routing (hydrological method only) (2)</p>
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. EngineeringHydrologybyK.Subramanya,FourthEdition,McGrawHillsEducation(India)</li> <li>2. IrrigationEngineeringandHydraulicStructuresbyS.K.Garg,KhannaPublishers,NewDelhi</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>3. IrrigationandWaterPowerEngineeringbyB.C.Punmia,B.B.Pande,A.K.Jain,A.Kumar,,16<sup>th</sup> Edition, Laxmi Publications (P) Limited, New Delhi</li> </ol>

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analysis, design and prepare	Computer aided skill and tools	code/provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO2	-	3		3		-	3	-	-	-	-	-	2	-	-
CO3	-	-	3	-	3	3	-	3	3	2	3	3	2	-	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEC404	Environmental Engineering	PCR	3	1	0	4	4
Pre-requisite(s)		Course Assessment methods					
None		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	CO1: Apply knowledge of water supply & wastewater engineering for design solutions. CO2: Understand basic design philosophies applicable to conveyance and treatment units of water & wastewater. CO3: Formulate, analyse, and design basic components of water supply & wastewater disposal.						
Topics Covered (Hrs)	<b>Water – uses &amp; requirement:</b> Sources, Quantity, Quality criteria, Intakes & transportation. (9) <b>Conventional water treatment methods:</b> Aeration, Sedimentation, Coagulation & flocculation, Filtration, Disinfection – including design of units. Other miscellaneous water treatment processes. (13) <b>Water storage &amp; distribution systems,</b> Design of pipe networks. (3) <b>Introduction to plumbing systems</b> in buildings. (2) <b>Estimation of quantities</b> of sanitary wastewater & storm water runoff. (3) <b>Sewerage system,</b> Design of sewers, Sewer appurtenances, Materials of sewer construction. (5) <b>Quality &amp; characterisation of domestic wastewater:</b> different parameters including oxygen demands, Standards of sewage disposal. (4) <b>Principles of wastewater treatment,</b> Physical, chemical & biological treatment methods, Primary & secondary treatment, Bio-filter, Activated sludge process, Stabilisation pond, Septic tank. (12) <b>Introduction to other treatment processes</b> including digestion & disposal of sludge. (3) <b>Principles of stream sanitation.</b> (2)						
Text Books, and/or reference material (s)	<b>Text Book(s):</b> 1. Environmental Engineering – I: S. K. Garg 2. Environmental Engineering – I: B. C. Punmia <b>Reference Books:</b> 1. G.M. Fair, J.C. Geyer, D.A. Okun, Elements of Water Supply and Wastewater Disposal, John Wiley and Sons Inc., 2. CPHEEO: Manual on water supply and treatment, Ministry of Urban Development.						

### Mapping of Course Outcomes COs □ POs □ POs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigation of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyses, design and prepare	Computer aided skills and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	2	-	-	-	2	-	-
CO2	3	-	3	-	-	-	1	-	-	2	-	2	2	-	-
CO3	-	-	3	-	-	-	-	2	-	2	1	3	2	-	3

Course Code	Title of the course	Program Core (PCR)/ Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEC405	Surveying	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods					
None		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes	<ul style="list-style-type: none"> <li>CO1: Learn basic principles of surveying and handling of various surveying instruments.</li> <li>CO2: Learn to conduct engineering surveys.</li> <li>CO3: Data entry in field books and level books.</li> <li>CO4: Make and interpret maps.</li> <li>CO5: Compute area and volumes.</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction:</b> Definition, primary division, classification and Principles of surveying, Basic measurements. (2)</p> <p><b>Linear measurements:</b> Instruments, Ranging, Chaining, Tape corrections. (3)</p> <p><b>Chain surveying:</b> Principles, Basic definitions, Equipment, Field work, Obstacles, Plotting &amp; accuracy. (2)</p> <p><b>Compass surveying:</b> Instruments, Traverse, Bearings and their designations, Magnetic declination, Magnetic &amp; true bearings, Field work, Plotting &amp; adjustment of a closed traverse. (3)</p> <p><b>Levelling:</b> Basic definitions, Instruments and their adjustments, Principles of levelling, Fieldwork and writing level books, Profile levelling &amp; cross-sectioning, Reciprocal levelling, Difficulties in levelling, Errors. (4)</p> <p><b>Contouring:</b> Basic definitions, Methods of locating contours, Characteristic of contours, Use of contour maps. (2)</p> <p><b>Plane Table surveying:</b> Introduction and basic definitions, Instruments and their uses, Principles of plane tabling, Methods of plane tabling, Three point problems and its solutions, Two-point problem and its solution, Errors in plane tabling, Advantages and disadvantages. (3)</p> <p><b>Theodolite:</b> Different parts, Temporary adjustments, Fundamental lines, Permanent adjustments, Measurement of horizontal and vertical angles. (4)</p> <p><b>Theodolite Traversing:</b> Introduction and basic definitions, Field work, Angular measurements, Traverse computations, Balancing of the traverse, Accuracy of traverse surveying. (4)</p> <p><b>Measurement of areas:</b> Area of a tract with irregular boundaries, Different methods, Planimeter and its uses. (4)</p> <p><b>Measurement of volumes:</b> Computation of area of cross sections for different sections, Computation of volumes by different methods, Volume from contour map, Capacity of reservoir, Volume from spot levels, Mass-Haul diagram – its characteristics and uses. (4)</p> <p><b>Electromagnetic distance measurements:</b> Working principle of EDM equipment, Uses, Range, Accuracy, Corrections to be applied to horizontal distances. (4)</p>						
Text Books, and/or reference material	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Surveying and Levelling Part I &amp; II by T.P. Kanetkar and S.V. Kulkarni, Pune Vidyarthi Griha Prakashan Pune – 30, 1979</li> <li>Surveying Vol. I &amp; II by B.C. Punmia, A.K. Jain and A.K. Jain A.K., Laxmi Publications (P) Ltd., 2005</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Surveying Vol. I &amp; II by K.R. Arora, Standard Book House, P.B.-1074, Delhi</li> <li>Surveying courses available in <a href="http://nptel.iitm.ac.in/">http://nptel.iitm.ac.in/</a></li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-
CO2	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-
CO3	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-
CO4	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-
CO5	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CES451</b>	<b>Structural Mechanics Laboratory</b>	<b>PS</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>	<b>2</b>
Pre-requisite(s)		Course Assessment methods					
Engineering & Solid Mechanics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Acquire the knowledge of behavior of different structural systems through experiments/simulations</li> <li>CO2: Able to compare the values of structural parameters obtained from theoretical with experimental/simulation results.</li> <li>CO3: Gain the idea to verify the energy theorems.</li> <li>CO4: Acquire the knowledge of drawing influence line through experiments.</li> </ul>						
Topics Covered (Hrs)	<ol style="list-style-type: none"> <li>Experiment/simulation on behavior (slopes, deflections etc.) of different types of structures (beams, columns, frames, arches etc.) with different loading conditions</li> <li>Experiment/simulation on shear force and bending moment of different types of structures (beams, columns, frames, arches etc.) and point of contra flexure.</li> <li>Experiments/simulation on Castigliano's Theorem and Maxwell's Reciprocal theorem for simple structures namely cantilever beam, frame etc.</li> <li>Experiments/Simulation on fixed end beams, continuous beam, portal frames with fixed base and validation in regard to static and kinematic indeterminacy.</li> <li>Experiments/simulation on continuous beam for moving unit loads to draw influence line diagram.</li> <li>Experiments/simulation/field visit on typical civil engineering structures for preparation of report</li> </ol>						
Text Books, and/or reference material (s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Basic Structural Analysis by C.S.Reddy, Tata McGraw Hill</li> <li>Elementary Structural Analysis by Wilbur &amp; Norris, McGraw-Hill College</li> <li>Elements of structural analysis by N. C. Sinha, New Central book agency Pvt.Ltd.</li> <li>Structural Analysis by R.C.Hibbeler, Pearson Education</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Structural Analysis by G. S.Pandit &amp; S.P.Gupta, Tata McGraw Hill</li> <li>Theory of structures by S. P. Timoshenko and D. H. Young, McGraw Hill book Co</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	Codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	3	3	3	-	-	2	3	-	3	-	3	-
CO2	3	3	-	3	3	3	-	-	2	3	-	3	-	3	-
CO3	3	3	-	3	3	3	-	-	2	3	-	3	-	3	-
CO4	3	3	-	3	3	3	-	-	2	3	-	3	-	3	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CE5452	Design of Concrete Structures	PS	0	0	3	3	2
Pre-requisite(s)		Course Assessment methods					
Solid Mechanics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Apply knowledge of solid mechanics for design solutions.</li> <li>CO2: Understand basic design philosophies applicable to concrete structures.</li> <li>CO3: Formulate, analyse, and design basic components of Civil Engineering Reinforced Concrete structures.</li> </ul>						
Topics Covered (Hrs)	<p><b>Properties</b> of concrete and reinforcing steel, Characteristic strengths, Stress-strain curves, Shrinkage and creep phenomenon, I.S. specification (4)</p> <p><b>Design philosophies</b> – working stress method and limit state method of design. (8)</p> <p><b>Analysis and design</b> of sections in flexure by working stress and limit state method, Single and doubly reinforced sections, T and L sections (8)</p> <p><b>Behaviour of beams</b> in shear and bond, Design for shear, Anchorage and curtailment of reinforcement, Detailing of reinforcement. (4)</p> <p><b>Serviceability</b>, Limit states of deflection and cracking, Calculation of deflections. (4) <b>Design of columns</b>: Short and long columns, eccentrically loaded columns (8) <b>Design of one-way and two-way slabs, Staircases.</b> (6)</p> <p><b>Isolated and combined footings</b> (6)</p> <p><b>Design of cantilever type retaining walls</b> (6)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Reinforced Concrete Design, 2nd Edition, by S. Unnikrishna Pillai and Devdas Menon, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.</li> <li>IS456:2000, Indian Standard Plain and Reinforced Concrete – Code of Practice (4th Revision), BIS, New Delhi.</li> <li>SP-16, Design Aids for Reinforced Concrete to IS:456 – 1978, BIS, New Delhi</li> <li><a href="http://www.nptel.iitm.ac.in/courses/">www.nptel.iitm.ac.in/courses/</a></li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Reinforced Concrete, 6th Edition, by S.K. Mallick and A.P. Gupta, Oxford &amp; IBH Publishing Co. Pvt. Ltd. New Delhi, 1996.</li> <li>Reinforced Concrete Design, 1st Revised Edition, by S.N. Sinha, Tata McGraw-Hill Publishing Company. New Delhi, 1990.</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	Code/provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	2	-	-	-	3	-	2
CO2	3	-	3	-	-	-	1	-	-	2	-	2	-	2	-
CO3	-	-	3	-	-	-	-	2	-	2	1	3	2	1	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CES453</b>	<b>Surveying laboratory</b>	<b>PCR</b>	<b>1</b>	<b>0</b>	<b>3</b>	<b>4</b>	<b>3</b>
Pre-requisites:		Course Assessment methods:					
CEC 303 & CEC403		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes	<ul style="list-style-type: none"> <li>• CO1: learn the basics surveying techniques and the use of basic surveying instruments.</li> <li>• CO2: Measurement of distance using tape or EDM and angle using compass and theodolite</li> <li>• CO3: Profile levelling and contouring using levelling instruments</li> <li>• CO4: Principles and practices used in triangulation, traversing and surveying through Total Station equipment</li> </ul>						
Topics Covered	<ol style="list-style-type: none"> <li>1). Chain Survey.</li> <li>2). Compass traverse work.</li> <li>3). Uses of dumpy level, Profile levelling and cross-sectioning.</li> <li>4). Plane table surveying work – using radiation and intersection methods.</li> <li>5). Contouring by any method (Optional subject to availability of time).</li> <li>6). Study of theodolite, function of its different parts, Measurement of horizontal and vertical angle</li> <li>7). Total Station for detailed surveying for any structure.</li> </ol>						
Text Books, and/or reference material	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Basak, N. N., Surveying &amp; Levelling, , 2nd Edition, McGraw Hill Publishing House.</li> <li>2. Ghosh, J. K., “Elementary Engineering Surveying”, Studium Press (India) Pvt Ltd.</li> <li>3. Duggal, S. K., “Surveying (Vol. 1, Vol 2)”, Tata McGraw-Hill Education India</li> <li>4. Subramanian, R., “Surveying and Leveling”, Oxford University Press</li> <li>5. Roy, S. K., “Fundamentals of Surveying”, Prentice Hall India Learning Private Limited</li> <li>6. Bossler, J.D , “Manual of Geospatial Science and Technology”, Taylor and Francis.</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	3	3	3	-	-
CO2	3	-	-	-	-	-	-	-	-	-	3	3	3	-	-
CO3	3	-	-	-	-	-	-	-	-	-	3	3	3	-	-
CO4	3	-	-	-	3	-	-	-	-	-	3	3	3	-	-



Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CEC502</b>	<b>Design of Steel Structures</b>	<b>PCR</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>	<b>4</b>
Pre-requisite(s)		Course Assessment methods					
Solid Mechanics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>• CO1: Apply knowledge of solid mechanics for design solutions.</li> <li>• CO2: Understand basic design philosophy applicable to steel structures.</li> <li>• CO3: Formulate, analyse, and design basic components of Civil Engineering Steel structures.</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction</b>, Properties of structural steel, I.S. rolled sections, I.S. specifications (2)</p> <p><b>Design philosophy</b> of Limit State method for Steel Structures (6)</p> <p><b>Design of Tension members</b>, Compression members in truss (6)</p> <p><b>Design of Beams</b> (laterally supported / unsupported) : Simple beam using rolled sections, Built up sections / compound beams (8)</p> <p><b>Design of Gantry girders</b> (4)</p> <p><b>Design of Plate girders</b>, Connections, Stiffeners and curtailment of flange plates, Splicing – riveted and welded. (6)</p> <p><b>Design of Simple Connections</b>: Riveted, Bolted and welded connections, moment resisting connections. (6)</p> <p><b>Design of Struts and columns</b> including built-up columns under axial and eccentric loadings, Lacing and battens, Column splicing. (8)</p> <p><b>Design of Column bases</b> – slab base, Gusseted base. (6)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Design of steel Structures by N. Subrahmanium (Oxford publications)</li> <li>2. IS 800-2007: General Construction in Steel- Code of Practice</li> <li>3. IS 808-1989: Dimensions of Hot Rolled Steel beam, column, channel and angle sections</li> <li>4. <a href="http://www.nptel.iitm.ac.in/courses/">www.nptel.iitm.ac.in/courses/</a></li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>5. Limit State Design of Steel Structures by S.K. Duggal (McGraw Hill publications)</li> <li>6. Limit State Design of Steel Structures by Virendra Gehlot &amp; Dr. Ram Chandra (Scientific publisher)</li> <li>7. Design of steel Structures by S.S. Bhavikatti (IK Int'l Publishing House, N Delhi)</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	2	-	-	-	3	-	2
CO2	3	-	3	-	-	-	1	-	-	2	-	2	-	2	-
CO3	-	-	3	-	-	-	-	2	-	2	1	3	2	1	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEC503	Transportation Engineering	PCR	3	1	0	4	4
Pre-requisite(s)		Course Assessment methods					
None		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1-To develop a basic understanding and knowledge of Transportation engineering, characteristics of various categories of road, and highway planning.</li> <li>CO2-To know the geometric design of the road and highway.</li> <li>CO3- To develop in-depth knowledge of Traffic Characteristics and the principle of intersections.</li> <li>CO4- To understand the influencing parameters of pavement and pavement materials</li> <li>CO5- To design the flexible, rigid pavement and understand its' construction, distresses, and maintenance</li> </ul>						
Topics Covered (Hrs)	<p><b>Module 1: (6 hours) Road Classification and Transportation Planning:</b> Introduction - Highway development in India - Classification of roads - Typical cross sections of roads in urban and rural areas, O-D Survey and introduction of the transportation planning</p> <p><b>Module 2: (12 hours) Road Alignment and Geometrical Design:</b> Requirements and factors controlling alignment of roads -Engineering surveys for highway location - Pavement surface characteristics - Camber and width requirements - Sight distances - stopping and overtaking sight distances, overtaking zone requirements - Design of horizontal alignment -speed, radius, superelevation, methods of providing superelevation, extra widening at curves, transition curves - Design of vertical alignment - gradient, grade compensation, summit curves, and valley curves - worked out problems on all the above topics.</p> <p><b>Module 3: (12 hours) Traffic engineering:</b> Introduction - Road user, vehicle, and traffic characteristics - Speed, volume, delay, parking studies - Simple worked-out problems - Principles of design of at-grade intersections - Simple layouts - Objectives, classification, and uses of traffic signs and markings - Design of isolated signals.</p> <p><b>Module 4: (12 hours) Pavement Materials and Design:</b> Desirable properties and testing of highway materials: road aggregates, bituminous materials, and subgrade soil - Design of flexible and rigid pavements- IRC guidelines – BBD method of flexible overlay design - worked out problems– Introduction to Mechanistic-Empirical Pavement Design.</p> <p><b>Module 5: (10 hours) Pavement Construction and Maintenance:</b> Construction of earth roads, WBM roads, stabilised roads, bituminous pavements, cement concrete roads, and joints in cement concrete roads - Types and causes of distresses in flexible &amp; rigid pavements – Remedial measures – Recycling of pavements.</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Khanna, S.K., and Justo, C.E.G., Highway Engineering, Nemchand and Bros, 2015, Roorkee.</li> <li>Kadiyali, L.R., and Lal, N.B., Principles and Practices of Highway Engineering, Khanna Publishers, 2013.</li> <li>O' Flaherty, C.A., Highway-Traffic Planning and Engineering, Edward Arnold., 1986</li> </ol> <p>Reference Book:</p> <ol style="list-style-type: none"> <li>Indo-HCM -2017</li> <li>IRC: 37, Guidelines for the Design of Flexible Pavements.</li> <li>IRC: 58, Guidelines for the Design of Rigid Pavements.</li> <li>IRC:15, Standard Specifications and Code of Practice for Construction of Concrete Roads</li> <li>Ministry of Road Transport and Highways Specifications for Roads and Bridges.</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual & team	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	-	-	-	2	-	-	3	2	-	2
CO2	2	3	3	1	-	-	1	-	-	2	-	3	2	-	3
CO3	3	3	3	1	-	1	-	2	-	2	1	1	3	1	3
CO4	3	3	3	1	-	1	1	2	-	-	1	2	3	1	3
CO5	2	-	-	-	-	-	1	1	-	-	-	1	-	-	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEC504	Soil Mechanics	PCR	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Engineering and Fluid Mechanics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Acquire knowledge of classifying the soil from Civil Engg. Aspect</li> <li>CO2: Ability to conduct Experiment and Analyse the data with interpretation</li> <li>CO3: Ability to analyse Soil for Soil-Structure like Dams (Earthen/Rigid)</li> <li>CO4: Ability to Design Soil related Civil Engg. Structure</li> <li>CO5: Understanding need of the Professional Ethics &amp; future studies</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction:</b> Type of soil, Mineralogical composition, Basic definitions of soil parameters, Inter-phase relationships, Problems (4)</p> <p><b>Index properties:</b> Index properties of soils and their determination, classification based on index properties. Problems (4)</p> <p><b>Classification:</b> Various classification systems, IS, MIT, US bureau and soil classification, PRA, Plasticity chart. Group Index. Problems. (3)</p> <p><b>Soil-Water Pressure:</b> Total, effective, and pore pressure in soil. Capillary rise, effect of seepage on pore pressure, Quick condition. Problems. (3)</p> <p><b>Permeability:</b> Permeability and seepage through soil, Darcy's law, Determination of permeability by laboratory methods and field methods. Factors affecting permeability. Flow through stratified soil. Problems. (4)</p> <p><b>Seepage analysis:</b> Laplace's equation for Isotropic &amp; an-isotropic soils, Flow-nets, Seepage through sub-soil, earthen embankment &amp; piping failure, Problems (5)</p> <p><b>Stress distribution:</b> Stress distribution in soils, point loads, line loads, strip loads, rectangular footings, circular footings, arbitrary footings. Boussineq's equation, Westergaard's equation, Newmark's equation. Significant depth, pressure bulb, Newmark's influence coefficients, stress due to linearly varying loads. Problems. (6)</p> <p><b>Consolidation:</b> One-dimensional Consolidation theory, Oedometer test, e-log<sub>10</sub>P curve, settlement &amp; its time required, determination of C<sub>v</sub>, m<sub>v</sub>, C<sub>c</sub>. Definition of Normally &amp; Over consolidated soils. Problems. (7)</p> <p><b>Compaction:</b> Compaction, Standard Proctor Test, Modified Proctor Test, <math>\rho_{dvs}</math> <math>\rho_w</math> curve. Field compaction tests and Field compaction. Problems. (3)</p>						
Text Books, and/or reference material (s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Soil Mechanics and Foundation Engineering by VNS Murthy, CBS publisher and Distributor</li> <li>Soil Mechanics and Foundation Engineering by S.K. Garg, Khanna Publishers</li> <li>Basic and Applied Soil Mechanics by Gopal Ranjan &amp; A.S.R. Rao, New Age International</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Advanced Soil Mechanics by B.M. Das, McGrawHills Publishers</li> </ol>						

### Mapping of Course Outcomes COs $\square$ POs $\square$ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	-	-	-	-	-	-	-	-	-	-	1	2	-
CO2	-	3	-	3	-	-	-	-	-	-	-	-	3	-	2
CO3	1	3	3	-	-	-	-	-	-	-	1	-	2	-	2
CO4	-	2	3	2	-	-	-	-	-	-	-	-	-	2	2
CO5	-	-	-	-	-	-	-	-	3	-	-	2	-	2	2

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CES551	Structural Analysis Sessional	PS	0	0	3	3	2
Pre-requisite(s)		Course Assessment methods					
Solid Mechanics & Structural Analysis-I		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>• CO1: To analyze indeterminate beams and frames by force methods</li> <li>• CO2: To analyse indeterminate beams and frames by displacement methods</li> <li>• CO3: To evaluate and draw the influence lines for internal and external forces in indeterminate beams and girders.</li> <li>• CO4: To study dynamic characteristics and dynamic analysis of mathematical model of a vibrating system</li> <li>• CO5: To apply approximate numerical method to analyze structural analysis problems</li> </ul>						
Topics Covered (Hrs)	Manual and computerised analysis of various building frames using different methods related to Structural Analysis –I and II.						
Text Books, and/or reference material (s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Basic Structural Analysis by C. S. Reddy (Tata McGraw Hill)</li> <li>2. Elementary Structural Analysis by Wilbur &amp; Norris (Mcgraw-Hill College)</li> <li>3. Structural Analysis by Devdas Menon, (Narosa)</li> <li>4. Structural Analysis by R. C. Hibbeler (Pearson Edu.)</li> <li>5. Structural Dynamics: Theory and Computation by Mario Paz, Young Hoon Kim (Springer)</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>6. Structural Analysis by G. S. Pandit &amp; S. P. Gupta (Tata McGraw Hill)</li> </ol>						

Mapping of Course Outcomes COs □ POs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	2	-	-	-	-	-	-	-
CO2	3	-	-	-	2	-	-	-	-	-	-	-
CO3	3	-	-	-	2	-	-	-	-	1	-	-
CO4	3	2	-	-	2	-	-	-	-	-	-	-
CO5	3	-	1	-	-	-	-	-	-	-	-	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CES552</b>	<b>Design of Steel Structures Sessional</b>	<b>PS</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>	<b>2</b>
Pre-requisite(s)		Course Assessment methods					
Solid Mechanics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Apply knowledge of solid mechanics for design solutions.</li> <li>CO2: Understand basic design philosophy applicable to steel structures.</li> <li>CO3: Formulate, analyse, and design basic components of Civil Engineering Steel structures.</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction</b>, Properties of structural steel, I.S. rolled sections, I.S. specifications (2) <b>Design philosophy</b> of Limit State method for Steel Structures (6)</p> <p><b>Design of Tension members</b>, Compression members in truss (6)</p> <p><b>Design of Beams</b> (laterally supported/unsupported): Simple beam using rolled sections, Built up sections / compound beams (6)</p> <p><b>Design of Gantry girders</b> (4)</p> <p><b>Design of Plate girders</b>, Connections, Stiffeners and curtailment of flange plates, Splicing – riveted and welded. (2)</p> <p><b>Design of Simple Connections</b>: Riveted, Bolted and welded connections, moment resisting connections. (6)</p> <p><b>Design of Struts and columns</b> including built-up columns under axial and eccentric loadings, Lacing and battens, Column splicing. (6)</p> <p><b>Design of Column bases</b> – slab base, Gusseted base. (4)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Design of steel Structures by N. Subrahmanium, Oxford publications</li> <li>IS 800-2007: General Construction in Steel – Code of Practice</li> <li>IS 808-1989: Dimensions of Hot Rolled Steel beam, column, channel and angle sections</li> <li>www.nptel.iitm.ac.in/courses/</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Limit State Design of Steel Structures by S.K. Duggal, McGraw Hill publications</li> <li>Limit State Design of Steel structures by Virendra Gehlot &amp; Dr. Ram Chandra, Scientific publisher</li> <li>Design of steel Structures by S.S. Bhavikatti, IK Intl Publishing House, N Delhi</li> </ol>						

Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	code/provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	2	-	-	-	3	-	2
CO2	3	-	3	-	-	-	1	-	-	2	-	2	-	2	-
CO3	-	-	3	-	-	-	-	2	-	2	1	3	2	1	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CES553</b>	<b>Environmental and Water Resource Engineering Laboratory</b>	<b>PS</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>	<b>3</b>
Pre-requisite(s)		Course Assessment methods					
A first course in physics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>• CO1: Understand the principles of design of experiments in Environmental Engineering and Water Resources Engineering</li> <li>• CO2: Understand the principles and development of experimental skills for estimating yield (run-off) from a basin</li> <li>• CO3: Achieve hands-on experience in dealing with basic laboratory equipment in a group work environment and learn to prepare professional laboratory report</li> </ul>						
Topics Covered (Hrs)	<p><b>A). Environmental Engineering:</b> pH and temperature, Turbidity, Conductivity, Total solids, Settleable solids and suspended solids, Chloride, Acidity, Alkalinity, Residual chlorine, Dissolved oxygen and Colony count of bacteria.</p> <p><b>B). Water Resource Engineering:</b> Identification of a drainage basin from a topographic map. Identification of major stream in the identified drainage basin. Measurement of discharge in the identified stream by field approximation method. Maintaining and presenting time series of discharge.</p> <p>Collecting time series of concurrent precipitation and other meteorological data during the period over the identified drainage basin from IMD Network.</p> <p>Correlating discharge data with the precipitation data and presenting correlation coefficient.</p> <p>Measurement of velocity in a Channel/Flume by Acoustic Doppler Velocity Meter, Measurement of discharge in a Channel by using Electromagnetic Flow Meter, Verification of mass balance through Channels of different sizes: <math>A_1V_1 = A_2V_2</math>, Verification of Discharge in the channel by V-Notch, Identification of land-use in the mobile bed channel, Visualizations of land-form development in the mobile bed, Measurement of 3-D plan form of mobile bed after stabilization of flow in the channel for a particular land use, Measurement of 3-D plan form of mobile bed after stabilization of flow in the channel for barren land in the channel.</p>						
Text Books, and/or reference material(s)	<p>Text Books:</p> <ul style="list-style-type: none"> <li>• Subramanya, K, "Engineering Hydrology", Fourth Edition, McGraw Hills Education (India) Private Limited, New Delhi</li> </ul> <p>Reference Materials:</p> <ul style="list-style-type: none"> <li>• Instruction sheets prepared by the faculty members of Water Resources Engineering Group</li> </ul>						

**Mapping of Course Outcomes COs→POs (mentioning Correlation Level)**

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	3	-	-	-	-	-	-
CO2	-	3	3	-	-	-	-	-	-	-	-	-
CO3	-	-	-	3	3	-	3	3	3	3	3	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>HSC631</b>	<b>Economics and Accountancy</b>	<b>PCR</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>
Pre-requisite(s)		Course Assessment methods					
NIL		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Learners will be able to review basic economic principles.</li> <li>CO2: Learners will be introduced to the basic capital appraisal methods used for carrying out economic analysis of different alternatives of engineering projects or works.</li> <li>CO3: Learners will gain a good knowledge of financial accounting, enabling them prepare, analyse and interpret financial statements for taking informed decisions.</li> </ul>						
Topics Covered (Hrs)	<b>Part 1: Economics</b>		<b>Group A: Microeconomics</b>				
	<b>Sl no.</b>	<b>Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>	<b>H</b>
	Unit 1	Economics: Basic Concepts	2	0	0	2	2
	Unit 2	Theory of Consumer Behaviour	3	0	0	3	3
	Unit 3	Theory of Production, Cost and Firms	3	0	0	3	3
	Unit 4	Analyses of Market Structures: Perfect Competition	3	0	0	3	3
	Unit 5	Monopoly Market	2	0	0	2	2
	Unit 6	General Equilibrium & Welfare Economics	2	0	0	2	2
	<b>Total</b>		<b>15</b>	<b>0</b>	<b>0</b>	<b>15</b>	<b>15</b>
			<b>Group B: Macroeconomics</b>				
	<b>Sl no.</b>	<b>Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>	<b>H</b>
	Unit 1	Introduction to Macroeconomic Theory	2	0	0	2	2
	Unit 2	National Income Accounting	3	0	0	3	3
	Unit 3	Determination of Equilibrium Level of Income	4	0	0	4	4
	Unit 4	Money, Interest and Income	2	0	0	2	2
Unit 5	Inflation and Unemployment	2	0	0	2	2	
Unit 6	Output, Price and Employment	2	0	0	2	2	
<b>Total</b>		<b>15</b>	<b>0</b>	<b>0</b>	<b>15</b>	<b>15</b>	
<b>PART 2: Management Accountancy</b>							
<b>Sl no.</b>	<b>Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>	<b>H</b>	
Unit 1	Introduction to Accounting: Accounting Environment of Business; Objectives of Accounting; Accounting Equations for Financial Statements. Books of Accounting: Journal, Ledger, Cash book.	3	0	0	3	3	
Unit 2	Financial Statement Preparation and Analysis: Preparation of Trial Balance, Trading, Profit & Loss account and Balance Sheet. Case study discussion.	5	0	0	5	5	
Unit 3	Financial Ratio Analysis: Common Size Statements; Computation of Financial Ratios; Interpretation and analysis of Financial Ratios with the help of case studies.	4	0	0	4	4	
<b>Total</b>		<b>12</b>	<b>0</b>	<b>0</b>	<b>12</b>	<b>12</b>	

Text Books, and/or reference material(s)	<b>PART 1: Economics</b> <b>Group A: Microeconomics</b> 1. Koutsoyiannis: Modern Microeconomics 2. Maddala and Miller: Microeconomics 3. AnindyaSen: Microeconomics: Theory and Applications 4. Pindyck&Rubinfeld: Microeconomics <b>Group B: Microeconomics</b> 1. W. H. Branson: Macroeconomics – Theory and Policy (2nd ed) 2. N. G. Mankiw: Macroeconomics, Worth Publishers 3. Dornbush and Fisher: Macroeconomic Theory 4. Soumyen Sikder: Principles of Macroeconomics <b>PART 2: Management Accountancy</b> 1. Gupta, R. L. and Radhaswamy, M: Financial Accounting; S. Chand & Sons 2. Ashoke Banerjee: Financial Accounting; Excel Books 3. Maheshwari: Introduction to Accounting; Vikas Publishing 4. Shukla, MC, Grewal TS and Gupta, SC: Advanced Accounts; S. Chand & Co.
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**Mapping of Course Outcomes COs → POs (mentioning Correlation Level)**

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	2	1	-	1	3	-	-	-	-	-
CO2	-	1	-	1	-	-	-	-	-	2	1	-
CO3	-	-	-	1	-	-	-	-	-	2	3	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CEC601</b>	<b>Foundation Engineering</b>	<b>PCR</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>
Pre-requisite(s)		Course Assessment methods					
Soil Mechanics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Calculates shear strength of soil</li> <li>CO2: Determine the earth pressures on foundations and retaining structures</li> <li>CO3: Analyse stability of finite and infinite soil &amp; rock slopes</li> <li>CO4: Calculate the bearing capacity of soils and foundation settlements</li> </ul>						
Topics Covered (Hrs)	<p><b>Shear strength of soil:</b> Determination of shear strength in laboratory and in field, Mohr-Coulomb failure criterion, Failure envelopes and shear strength parameters for different test conditions, Problem. (6)</p> <p><b>Lateral earth pressure theories:</b> Analytical and graphical methods, Effect of surcharge, water table and stratification on earth pressure, Design of cantilever sheet pile, Problem. (8)</p> <p><b>Stability of slopes,</b> infinite slopes, Analysis of finite slopes by method of slices, modified method of slices, friction circle method, Taylor's stability number, Effect of pore water pressure, Problem (8)</p> <p><b>Bearing capacity of shallow foundations:</b> Selection of location and depth, Analytical method of using Terzaghi's equation, I.S. method, Skempton's equation, Field test method, Method based on SPT, Design of combined footings. (8)</p> <p><b>Bearing capacity of pile foundation:</b> Types of piles, Bearing capacity of single and group of piles, Problem. (7)</p> <p><b>Well foundation:</b> Elements of wells, Types. (2)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering by V N S Murthy.</li> <li>Basic and Applied Soil Mechanics by G. Ranjan and A. S. Rao</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Foundation analysis and Design by J.E. Bowles</li> <li>Soil Mechanics and Foundation Engineering by S.K. Garg, Khanna Publishers</li> <li>Advanced Soil Mechanics by B.M. Das, McGraw Hills Publishers</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	1	-	-	-	-	-	-	-	-	3	2	-
CO2	3	3	2	-	-	-	-	-	-	1	-	-	3	2	-
CO3	2	3	2	-	-	-	-	-	-	-	-	-	3	2	-
CO4	3	2	-	1	-	-	-	-	-	-	-	-	-	2	3

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CSC631</b>	<b>Artificial Intelligence and Machine Learning</b>	<b>PCR</b>	<b>3</b>	<b>0</b>	<b>2</b>	<b>5</b>	<b>4</b>
Pre-requisites		Course Assessment methods (Continuous evaluation (CE) and end assessment (EA))					
Basic Concepts of Probability and Statistics, Knowledge of Algorithm analysis		CE+EA					
Course Outcomes	<ul style="list-style-type: none"> <li>CO1: Identify problems where artificial intelligence (AI) techniques are applicable</li> <li>CO2: Understand to apply search strategies to solve the problems.</li> <li>CO3: Principal models used in machine learning and Apply them in machine learning to appropriate problems</li> <li>CO4: Formulate valid solutions for problems involving uncertain inputs or outcomes by using decision making techniques.</li> <li>CO5: Understanding different supervised and unsupervised learning methods.</li> </ul>						
Topics Covered	<p><b>Introduction to Artificial Intelligence (AI):</b> What is Intelligence, Reasoning and Planning, Learning and Adaptation, and interaction with the real world, A brief history of AI, Application areas of AI, State of the art. (2)</p> <p><b>Problem solving by search:</b> Problem types, Illustrative search problems; Search Space, Search tree; BFS, DFS, UCS; Local search; Hill climbing; Heuristics; A* search (6)</p> <p><b>Knowledge Representation:</b> Propositional, predicate logic, first order logic, resolution and unification (5)</p> <p><b>Reasoning under Uncertainty:</b> Conditional independence representation, exact inference through variable elimination, and approximate inference through sampling. (5)</p> <p><b>Introduction to Machine Learning:</b> Basic concepts, bias-variance trade off, evaluation metrics etc. (2)</p> <p><b>Supervised Learning:</b> Simple linear regression, multiple linear regression, logistic regression, support vector machine, decision trees, Introduction to artificial neural network. (14)</p> <p><b>Unsupervised Learning:</b> Clustering algorithms, k-means/k-medoid, hierarchical clustering (6)</p> <p><b>Dimensionality reduction:</b> Principal component analysis. (2)</p> <p><b>Sessional experiments:</b> Study of PROLOG programming language to implement different search techniques, Implementation of different machine learning techniques (linear and logistic regression; Decision Trees; Support Vector Machine; artificial neural network; Clustering</p>						



Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CES651	Structural Engineering Laboratory	PCR	0	0	3	3	2
Pre-requisite(s)		Course Assessment methods					
Building Materials and Concrete Technology		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Learn to determine the properties of different engineering materials like cement, fine &amp; coarse aggregates, concrete etc.</li> <li>CO2: Design concrete mix proportion based on the properties of concrete ingredients.</li> <li>CO3: Acquiring knowledge about detailing of reinforced concrete beam under given conditions</li> </ul>						
Topics Covered (Hrs)	<p>To observe the behavior of a mild steel specimen while being tested and to determine (i) upper and lower yield points, (ii) ultimate strength, (iii) breaking strength, (iv) percentage elongation of length, (v) percentage reduction of cross-section.</p> <p>To determine the properties of bricks.</p> <p>To determine the (a) fineness of cement by sieving, (b) standard consistency of cement and (c) setting time of cement. (6)</p> <p>To determine the (a) specific gravity of cement (b) compressive strength of cement and (c) soundness of cement. (6)</p> <p>To determine the (a) particle size distribution, (b) specific gravity and water absorption and (c) bulk density and voids in coarse aggregate. (6)</p> <p>To determine the (a) particle size distribution, (b) specific gravity and water absorption and (c) bulk density and voids in fine aggregate. (6)</p> <p>Concrete mix design by I.S Method. (6)</p> <p>(a) Preparation of concrete specimen to determine the compressive strength, flexural strength and split tensile strength of concrete of a given mix proportions. (6)</p> <p>(i) Compressive strength at 7 days - 3 nos cube + 3 nos cylinder</p> <p>(ii) Compressive strength at 28 days - 3 nos cube + 3 nos cylinder</p> <p>(iii) Split tensile strength at 28 days - 3 nos cylinder</p> <p>(iv) Flexural strength at 28 days - 3 nos prism</p> <p>(b) Test above specimen according to the proper testing day (7 days and 28 days) (3)</p> <p>(c) To determine the consistency and workability of freshly mixed concrete by (i) Slump test and (ii) Compacting factor test</p> <p>Design, detailing and bar bending schedule for R.C. beam under given conditions.</p> <p>Castings and study on the strength and deflection behavior of R.C. beams.</p>						
Text Books, and/or reference material (s)	<p><b>Text Book:</b></p> <ol style="list-style-type: none"> <li>Concrete Technology by M. S. Shetty, S. Chand &amp; Co</li> <li>Concrete Technology by M. L. Gambhir, Tata McGraw Hill</li> <li>IS code of practice: 383-2016, 10262-2019, 456-2000 etc</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code/provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	3	-	3	-	-	-	-	-	3	-	-	3
CO2	3	-	-	3	-	3	-	-	-	-	-	3	-	-	3
CO3	3	3	3	3	-	3	-	-	-	-	-	3	-	-	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CES652</b>	<b>Civil Engineering Computation &amp; Software Laboratory</b>	<b>PS</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>	<b>2</b>
Pre-requisite(s)		Course Assessment methods					
Construction, Materials & Concrete Technology		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs)	<ul style="list-style-type: none"> <li>CO1: Acquiring knowledge on computer aided analysis, design with different commercially available software</li> <li>CO2: Hands-on experience on industrial practices of different types of design problems in the field of civil engineering.</li> <li>CO3: Develop computational skills for inter-disciplinary nature of jobs</li> </ul>						
Topics Covered (Hrs)	<ol style="list-style-type: none"> <li>Practices on coding for the solution of different types of structural/geotechnical/environmental problems using C++/Python/MatLAB</li> <li>Modelling and computer aided solution of civil engineering problems using StaadPRO</li> <li>Analysis and design of complex civil engineering structural problems using ANSYS</li> <li>Computer-aided design of typical civil engineering structures using ANSYS, ABACUS, COMSOL, ETABS/SAP/LS DYNA/PLAXIS, Geomedia etc</li> <li>Computer-aided estimation of typical civil engineering structures and validation using commercially available software, coding</li> </ol>						
Text Books, and/or reference material(s)	<p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Manuals of Commercial /Open source software related to Civil Engineering Applications (Eg. SAP, STAAD, ABAQUS, ETABS, LS DYNA, Plaxis, Geomedia etc.)</li> <li>Applied Numerical Methods for Engineers Using Matlab and C by Robert J. Schilling, Sandra L. Harris, Nelson Engineering; Har/Cdr edition</li> <li>Numerical Methods for Scientists and Engineers by R. W. Hamming, Dover Publications</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	-	-	3	-	-	3	3	3	3
CO2	3	3	3	3	3	3	-	-	3	-	-	3	3	3	3
CO3	3	3	3	3	3	3	-	-	3	-	2	3	3	3	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CE5653	Soil Mechanics and Foundation Engineering Laboratory	PS	0	0	3	3	2
Pre-requisite(s)		Course Assessment methods					
Soil Mechanics and Foundation Engineering		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Understand the principles of design of experiments in Soil Mechanics</li> <li>CO2: Understand the principles and development of experimental skills for estimating index and engineering properties of soil</li> <li>CO3: Achieve hands-on experience in dealing with basic laboratory equipment in a group work environment and learn to prepare professional laboratory report</li> </ul>						
Topics Covered (Hrs)	<ol style="list-style-type: none"> <li>Determination of the specific gravity of soil</li> <li>Mechanical analysis of soil (Fine fraction- Hydrometer method)</li> <li>Mechanical analysis of soil (Coarse fraction- Sieve analysis)</li> <li>Determination of consistency properties of soil</li> <li>Relative Density or Density Index test</li> <li>Light/Heavy compaction test (Standard/Modified Proctor test)</li> <li>California Bearing Ratio (CBR) Test</li> <li>Consolidation test</li> <li>Direct shear test</li> <li>Unconfined Compressive Strength (UCS) test</li> <li>Triaxial tests</li> <li>Permeability test</li> </ol>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Engineering Soil Testing by Shamsher Prakash, (1979), Nemichand, New Delhi</li> <li>Soil Testing for Engineers by William Lambe, (2003), MIT.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Relevant IRC/IS codes.</li> <li>Engineering Properties of soil and their measurements by Joseph E Bowles, McGraw Hill</li> <li>Geotechnical Laboratory Measurements by John T. Germaine, Amy V. Germaine, (2009), John Wiley</li> </ol>						

### Mapping of Course Outcomes Cos to Pos to PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyses, design and prepare	Computer aided skill and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	1	-	-	-	1	-	-	-	2	-	3
CO2	-	-	-	1	1	-	-	-	2	-	-	-	2	1	3
CO3	-	-	-	-	1	-	-	-	2	1	-	1	1	1	3

Course Code	Title of the course	Program Core (PCR) /Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MSC731	Principles Of Management	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous assessment (CA) and End Assessment (EA))					
		CA+EA					
Course Outcomes	<ul style="list-style-type: none"> <li>CO1: To make budding engineers aware of various management functions required for any organization</li> <li>CO2: To impart knowledge on various tools and techniques applied by the executives of an organization</li> <li>CO3: To make potential engineers aware of managerial function so that it would help for their professional career</li> <li>CO4: To impart knowledge on organizational activities operational and strategic both in nature</li> <li>CO5: To impart knowledge on each functional area of management like Marketing, Finance, Behavioral Science, Quantitative Techniques and Decision Science</li> </ul>						
Topics Covered	<p><b>UNIT I:</b> Management Functions and Business Environment: Business environment - macro, Business environment - micro; Porter's five forces, Management functions – overview, Different levels and roles of management, Planning- Steps, Planning and environmental analysis with SWOT, Application of BCG matrix in organization <b>(12)</b></p> <p><b>UNIT II:</b> Quantitative tools and techniques used in management: Forecasting techniques, Decision analysis <b>(6)</b></p> <p><b>UNIT III:</b> Creating and delivering superior customer value: Basic understanding of marketing, Consumer behavior-fundamentals, Segmentation, Targeting &amp; Positioning, Product Life cycle. <b>(8)</b></p> <p><b>UNIT IV:</b> Behavioral management of individual: Motivation, Leadership, Perception, Learning. <b>(8)</b></p> <p><b>UNIT V:</b> Professional ethics: Introduction to Professional ethics, Morals, values and Ethics, Ethics in Business. <b>(2)</b></p>						
Text Books, and/or reference material	<p>Text Books:</p> <ol style="list-style-type: none"> <li>Marketing Management 15th Edition, Philip Kotler and Kelvin Keller, Pearson India</li> <li>Management Principles, Processes and practice, first edition, Anil Bhat and Arya Kumar, Oxford Higher education</li> <li>Organizational Behavior, 13th edition, Stephen P Robbins, Pearson Prentice hall India</li> <li>Operations Management, 7th edition (Quality control, Forecasting), Buffa &amp; Sarin, Wiley</li> <li>A.C. Fernando: Business Ethics &amp; Corporate Governance, Pearson Education 2nd edition</li> </ol>						

### Mapping of Course Outcomes Cos □ Pos □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	Code provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	2		2	1	1	3			
CO2	-	-	-	-	-	-	1		1			3			
CO3	-	-	-	-	-	-	1	2	2	2	2	3			
CO4	-	-	-	-	-	-	1	2	2	1	1	3			
CO5	-	-	-	-	-	-	2	2	2	2	1	3			
CO6	-	-	-	-	-	-	2		2	1	1	3			







Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CE5753	Transportation Engineering Laboratory	PS	0	0	3	3	2
Pre-requisite(s)		Course Assessment methods					
Transportation Engineering		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Understand the principles of design of experiments in Transportation and Soil Mechanics</li> <li>CO2: Understand the principles and development of experimental skills for estimating material properties for roadways</li> <li>CO3: Understand the principles and development of experimental skills for estimating some index and engineering properties of soil</li> <li>CO4: Achieve hands-on experience in dealing with basic laboratory equipment in a group work environment and learn to prepare professional laboratory report</li> </ul>						
Topics Covered (Hrs)	<p><b>A. Pavement Material Testing</b></p> <p>1. Aggregate grading analysis; 2. Determination of flakiness index.; 3. Determination of aggregate impact value; 4. Los Angeles abrasion test; 5. Aggregate crushing value test; 6. Determination of softening point for the bitumen sample; 7. Determination of penetration value for bitumen sample; 8. Ductility test for the bitumen sample; 9. Viscosity test for the bitumen sample</p> <p><b>B. Flexible Pavement Design lab</b></p> <p>10. Marshall Mix Design for flexible pavement; 11. Marshall flow and stability test</p> <p><b>C. Traffic Engineering Lab</b></p> <p>12. Manual method for traffic volume study; 13. Heterogeneous Traffic Flow Data Collection; 14. Speed Data Collection by videography technique; 15. Speed Data Collection by Radar gun; 16. Frequency of speeds obtained from a sample survey and estimation of design speed of the road; 17. Parking Studies: off-street and on-street parking; 18. Parking In-Out Survey: Calculation of accumulation, occupancy and parking load; 19. Parking study by license plate method; 20. Volume study and design at signalised intersections by IRC Methods; 21. Determine the safe stopping sight distance of signalised intersections; 22. Identify, classify, and record various traffic control devices such as signs, marking and signals installed along a street/ corridor; 23. Intersection delay study; 24. Travel time delay study; 25. Driver characteristics study</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Highway Engineering by S. K. Khanna, C.E.G. Justo and A. Veeraraghavan, Nemchand &amp; Bros.</li> <li>ITE Manual of Transportation Engineering Studies, 2nd edition</li> <li>Kadiyali, L. R. "Traffic Engineering and Transportation Planning", Khanna Publishers, New Delhi, 1987</li> <li>Papacostas, C.S. and Prevedouros, P.D. "Transportation Engineering &amp; Planning (third edition)", PHI Learning Private Limited, Delhi, 2014</li> <li>Papacostas, C.S. "Fundamentals of Transportation Engineering", Prentice-Hall, New Delhi, 1987</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Relevant IRC/IS codes.</li> </ol>						

### Mapping of Course Outcomes (COs) to Pos and PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	1	-	-	-	1	-	-	-	2	-	3
CO2	-	-	-	1	1	-	-	-	2	-	-	-	2	1	3
CO3	-	-	-	1	1	-	-	-	2	-	-	-	2	1	3
CO4	-	-	-	-	1	-	-	-	2	1	-	1	1	1	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CES851</b>	<b>Project II</b>	<b>PS</b>	<b>0</b>	<b>0</b>	<b>15</b>	<b>5</b>	<b>15</b>
Pre-requisite(s)		Course Assessment methods					
Design of Concrete Structures along with Concrete Technology Laboratory		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>• CO1: Demonstrate a sound technical knowledge of their selected project topic.</li> <li>• CO2: Undertake problem identification, formulation and solution.</li> <li>• CO3: Design engineering solutions to complex problems utilising a systems approach.</li> <li>• CO4: Conduct an engineering project.</li> </ul>						
Topics Covered (Hrs)	Any type of Civil Engineering problem either experimentally, analytically, and Numerically.						
Text Books, and/or reference material(s)	<b>Text Books:</b> <b>Reference Books:</b>						

Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3



Course Code	Title of the course	Program Core (PCR)/Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEO740	Introduction to Earthquake Engineering	PEL	3	0	0	3	3
Pre-requisites:		Course Assessment methods					
No pre-requisites		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes	<ul style="list-style-type: none"> <li>CO1: Applying Engineering mathematics in solving vibration problem</li> <li>CO2: Ability to design a building earthquake resistant</li> <li>CO3: Learn basic of Earthquake engineering</li> <li>CO4: Ability to manage disaster</li> </ul>						
Topics Covered	<p><b>Seismology:</b> Engineering geology of earthquakes, plate tectonics, Seismicity of the world, Seismic waves, faults, plate boundaries, Intensity, Strong ground motion, Measuring of Earthquake, Earthquake Magnitude-Local (Richter) magnitude, surface wave magnitude, Moment magnitude. Spectral Parameters: Peak Acceleration, Peak Velocity, Peak Displacement, Frequency Content and duration. (12)</p> <p><b>Elementary Vibration:</b> Vibration of elementary system, Single degree and two-degree freedom systems, Earthquake analysis, Response spectrum concept (10)</p> <p><b>Earthquake Resistant Design:</b> Philosophy, Code based methods for seismic design for RC buildings. Behaviour of masonry structure during earthquake, bands &amp; reinforcement in masonry (10)</p> <p><b>General Guidelines:</b> Efficient seismic resistant planning, selection of sites, importance of architectural features in earthquake resistant buildings, continuity of construction, projection special construction features like pounding, floating column, soft storey, staircase etc., role of engineers in the earthquake mitigations &amp; disaster management (10)</p>						
Text Books, and/or reference material	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Earthquake resistant design of structures by Pankaj Agarwal and Manish Shrikhande</li> <li>Basics of Structural dynamics and seismic Design by S.R. Damodarasamy and S. Kavitha</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Elements of Earthquake Engineering by Jai Krishna, A.R. Chandrasekharan, Brijesh Chandra</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	code provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	1	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	1	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-

Course Code	Title of the course	Program Core (PCR)/Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEO741	Elementary Civil Engineering	PEL	3	0	0	3	3
Pre-requisites:		Course Assessment methods					
No pre-requisites		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes	<ul style="list-style-type: none"> <li>CO1: Gain knowledge about elementary level civil engineering</li> <li>CO2: To learn the use of surveying instruments</li> <li>CO3: To learn about construction materials and technology</li> </ul>						
Topics Covered	<p><b>Measurement:</b> Measurement of lengths, heights, and angles using surveying equipment, chain, tape, Dumpy level, staffs, Theodolites. <b>(10)</b></p> <p><b>Survey:</b> Different mapping methods, elements of chain surveying, compass surveying, plane table surveying, theodolite surveying, leveling and contouring. <b>(10)</b></p> <p><b>Building Materials:</b> Common building materials, stone, brick, timbers, cement, concrete, lime concrete, their strength, characteristics and different types of each material. <b>(10)</b></p> <p><b>Construction:</b> Elements of residential buildings, method of construction, miscellaneous temporary constructions, form work, timbering etc. <b>(12)</b></p>						
Text Books, and/or reference material	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Surveying and Levelling Part I by T. P. Kanetkar, and S. V. Kulkarni, Pune Vidyarthi Griha Prakashan Pune – 30, 1979</li> <li>2. Engineering Materials by S.C. Rangwala, Charotar Pub. House, Anand</li> <li>3. Building Construction by S.C. Rangwala, Charotar Pub. House, Anand</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>4. Building Construction by B.C. Punmia, A.K. Jain and A.K. Jain, Laxmi Publications (P) Ltd.</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigation of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-
CO2	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-
CO3	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEO742	Finite Element Analysis and Applications	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Mechanics, Mathematics, Engineering problems in various fields		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Knowledge of importance of FEA over classical methods and use it for modelling and analysis of real life engineering systems.</li> <li>CO2: Learning to simulate physical systems related to various engineering fields through FE modelling &amp; interpret analysis data for prediction of system response.</li> <li>CO3: Skill to use computational tools for solving engineering problems.</li> <li>CO4: Foundation for using advanced FEA software packages for modelling and analysis of problems related to relevant field of studies in both industry and research.</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction:</b> Recapitulation of Matrix Manipulation Techniques, Solution of Simultaneous Linear Equations, Inverse of Matrix, Eigen Values and Eigen Vectors, Computer Implementation. (5)</p> <p><b>Engineering Problems:</b> Different numerical methods, History of Finite Element Method (FEM), Steps in FEM, Areas of Application, Verification problems, implementation of Engineering Problems in FEA. (10)</p> <p><b>Spring Element:</b> General, Implementation in FEA, Applications, Problems. (5)</p> <p><b>Bar Elements:</b> Definition, Property Matrix using Direct and Energy Approach, Engineering Implementation in FEA, Problems and Validation. (6)</p> <p><b>Application of FEA:</b> General Conduction Problems, Mechanical systems, Electrical systems etc. Validation, convergence study and error analysis in solution of real life engineering problems. (10)</p> <p><b>Computer Programs/SOFTWARES in FEA.</b> (6)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Finite element analysis: theory and programming by CS Krishnamurthy (2001). Publisher: Tata McGraw Hill Education</li> <li>Finite Element Analysis Theory and Application with ANSYS by Moaveni. Publisher: Pearson (2008)</li> <li>Fundamentals of Finite Element Analysis by David V. Hutton. Publisher: Tata McGraw Hill Education Private Limited (2005)</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Finite Element Procedures by Klaus-Jürgen Bathe. Publisher: Prentice-Hall (2009)</li> </ol>						

### Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO2	-	3	-	2	-	-	-	-	-	-	-	-	3	-	-
CO3	-	-	-	-	3	-	-	-	-	-	-	-	-	3	-
CO4	-	2	-	3	-	-	-	-	-	-	-	-	2	3	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEO743	Elementary Structural Design	PEL	3	0	0	3	3
Pre-requisite(s) Engineering/Solid Mechanics		Course Assessment methods Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Apply knowledge of solid mechanics for design solutions.</li> <li>CO2: Understand basic design philosophy applicable to steel structures.</li> <li>CO3: Formulate, analyze, and design basic components of Civil Engineering Steel structures.</li> </ul>						
Topics Covered (Hrs)	<p><b>Properties</b> of Reinforced Concrete and Structural Steel, Loads &amp; load combinations, Design Philosophies-Working Stress Method, Limit State Method (4)</p> <p><b>Limit State Method (LSM) of design for RC Structures:</b> Limit State of Flexure: Stress-strain characteristics of concrete &amp; reinforcing steel, Moment of Resistance for singly reinforced, doubly reinforced sections. Limit State of Shear, Bond &amp; Anchorage, Development length, Design of Beams, slab, Short Columns under axial load, Design of isolated Footing. (19)</p> <p><b>Limit State Method (LSM) of design for Steel Structures:</b> Limit state of collapse &amp; serviceability, partial safety factor for material and loading, Connections: truss joint connections, Design of Tension member, Compression member, Design for Beams, Gusseted Column base foundation (19)</p>						
Text Books, and/or reference material (s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Reinforced Concrete Design by S. UPillai and Devdas Menon, Tata McGraw-Hill.</li> <li>IS456:2000, Indian Standard Plain and Reinforced Concrete – Code of Practice (4th Revision), BIS, New Delhi.</li> <li>Design of steel Structures by N. Subrahmanium (Oxford publications)</li> <li>IS800-2007: General Construction in Steel- Code of Practice</li> <li>IS808-1989: Dimension of Hot Rolled Steel beam, column, channel and angle sections</li> <li>www.nptel.iitm.ac.in/courses/</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Reinforced Concrete Design by S.N.Sinha, Tata McGraw-Hill Publishing:</li> <li>Limit State Design of Steel Structures by S.K.Duggal, McGraw Hill publications</li> </ol>						

### Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigation of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	Professional provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	2	-	-	-	3	2	3
CO2	3	-	3	-	-	-	1	-	-	2	-	2	3	1	3
CO3	-	2	3	-	-	-	-	2	-	2	2	2	3	3	3





Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEO746	Watershed planning & Management	PEL	3	0	0	3	3
Pre-requisite(s)			Course Assessment methods				
Fluid Mechanics, Irrigation & Water Resources Engineering, Economics and Computer Applications			Continuous (CT) and end assessment (EA). CT+EA				
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: A clear understanding of different aspects of watershed</li> <li>CO2: Development of capabilities for optimization techniques, linear and dynamic programming for watershed management</li> <li>CO3: Development of ability to formulate model for watershed planning with deterministic as well as stochastic inputs,</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction:</b> Concept, Definition &amp; Scope, Indian &amp; Global Perspective, Timeline in India, Problems &amp; Prospects, Problems &amp; Constraints (4)</p> <p><b>Land Capability &amp; Planning:</b> Definition, Classification, Planning, Use, Restoration, Policy Analysis &amp; Decision Support (3)</p> <p><b>Watershed Characteristics:</b> Physical &amp; Geomorphologic Factors, Classification &amp; Measurement, Physical, Geomorphologic &amp; Quantitative Characteristics (4)</p> <p><b>Importance of Watershed Properties:</b> Watershed Management, Effect of Physical Properties, Effect of Geomorphologic Factors &amp; Associated Processes (4)</p> <p><b>Hydrologic Data:</b> Definition, Scope, Hydro-meteorological &amp; Physiographical Data (3)</p> <p><b>Delineation and Prioritization:</b> Concept of Topographic or Contour Map, Boundary Delineation, GIS for Delineation, Accuracy in Delineation, Concept of Priority, Factors, Basics &amp; Methods, Purpose &amp; Benefits (4)</p> <p><b>Water Yield Assessment &amp; Measurement:</b> Concept of Water Yield &amp; its assessment, benefits, Perspectives, Measurement, Modelling &amp; Assessment (3)</p> <p><b>Hydrologic and Hydraulic Design:</b> Hydrologic design, recharge structures, Earthen Embankments &amp; Diversion Structures, Hydrology &amp; Hydrologic design (5)</p> <p><b>Soil Erosion and its Control Measures:</b> Types, Problem &amp; Control (4)</p> <p><b>Sediment Yield Estimation:</b> Generation &amp; Transport Mechanism, Types Methods Estimation &amp; Modelling, Estimation of Different Load (4)</p> <p><b>Rainwater Conservation &amp; Harvesting:</b> Need, Techniques, Design (4)</p>						
Text Books, and/or reference material (s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Watershed management challenges: Introduction and overview by E. R. Sharma &amp; C. A. Scott, (2005), Watershed Management Challenges: Improving</li> <li>2. Land and Water Management Engineering by V. V. N. Murthy &amp; M. K. Jha, (2011), Kalyani Publishers, Ludhiana, India.</li> <li>3. Watershed Management - Guidelines for Indian Conditions by E. M. Tideman, (1999), Omega Scientific Publishers, New Delhi.</li> <li>4. Integrated Watershed Management in Rainfed Agriculture by S. P. Wani, J. Rockström &amp; K. L. Sahrawat, (2011). CRC Press.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>5. <a href="http://www.ussi.co.uk/Weirs_and_Flumes.html">http://www.ussi.co.uk/Weirs_and_Flumes.html</a>. Last seen: 29th September 2013</li> </ol>						

### Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Investigation of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions / guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	3	3	3	3	3	-	-	-	-	-	-	-	-
CO3	-	-	3	-	-	-	-	3	3	3	3	3	-	2	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEO747	Road safety awareness program	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Transportation Engineering		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	CO1: Identify the factors contributing to accidents. CO2: Collect data pertaining to road crashes and prepare a comprehensive crash database CO3: Perform statistical analysis of crash data. CO4: Formulate traffic management measures for accident prevention and perform road safety audit and prepare an audit report.						
Topics Covered (Hrs)	Module 1: (10 hours) <b>Introduction to road safety engineering</b> - Overview of road safety - Global road safety scenario and pattern - global trends and projections - national and state road safety level - problems in road safety in developing countries- magnitude, socioeconomic and health effects.  Module 2: (10 hours) <b>Road user's prospects</b> - Characteristics of Road user, Motor vehicle, Roadway- the relationship between elements- human factors governing road user behavior- risk factors for traffic accidents- exposure to risk- crash involvement- crash severity- post-crash injury outcomes  Module 3: (10 hours) <b>Analysis and prevention-</b> Collection of accident data strategies to Improve Highway Safety--Format of the accident data- Sample Accident Report-Statistical methods for the analysis of accident data  Module 4: (10 hours) <b>Analysis and report preparation</b> – Statistical Comparison, Proportionality Test, T-testing, Empirical Bayes Method, ML modeling for accident data- Road Safety Audit- Blackspot Identification						
Text Books and/or reference material(s)	<b>Reference Books:</b> 1. David L. Geotsc. Occupational Safety and Health for Technologists, Engineers and Managers. 5th Edition, 2004. 2. World Health Organization, Road Traffic Injury Prevention Training Manual, 2006. 3. Matson, M.T., Smith, S.W., Hurd, W.F. Traffic Engineering, McGraw-Hill Book Company Inc., London, 1955. 4. Fuller, R., Santos, J.A. Human Factors for Highway Engineers, Pergamon, 2002. 5. Khisty, C.J., Lall, B.K. Transportation Engineering- An Introduction, Third Edition, Prentice Hall of India, New Delhi, 2006. 6. Jason C.YU, Transportation Engineering- Introduction to Planning, Design, and Operations, Elsevier, 1982. 7. Kadiyali, L.R. Traffic Engineering and Transportation Planning, Khanna Publishers, New Delhi, 2009. 8. IRC: 103-1988, Guidelines for Pedestrian Facilities, Indian Roads Congress, New Delhi. 9. IRC: SP: 32-1988, Road Safety for Children (5-12 Years old), Indian Roads Congress, New Delhi. 10. IRC: SP: 44-1996, Highway Safety Code, Indian Roads Congress, New Delhi. 11. IRC: SP: 88-2010, Road Safety Audit Manual, Indian Roads Congress, New Delhi.						

### Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	Professional provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	3	4	-	-	-	-	-	-	-	-	3	3	3
CO3	-	3	3	-	3	-	-	-	2	-	-	3	2	1	1
CO4	3	3	3	-	-	-	2	-	2	-	-	3	3	3	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE510	Advanced Concrete Technology	PCL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Solid mechanics and Concrete Technology		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs)	<ul style="list-style-type: none"> <li>CO1: Identify and suggest suitable materials for cement concrete construction.</li> <li>CO2: Design a concrete mix proportion based on the requirements and make a proper concrete for construction purposes.</li> <li>CO3: Determine the hardened properties of concrete and make a durable concrete</li> <li>CO4: Explore special concretes for construction</li> </ul>						
Topics Covered (Hrs)	<p><b>Concrete and its properties: (8)</b> Brief Introduction to Concrete Making Materials: Cement, Aggregates, Water, Admixture; <i>Mix Design</i>: Factors influencing design of mix, IS method of mix design; <i>Fresh Concrete</i>: Rheology of concentrated suspensions, pastes, mortars and concretes; workability, segregation and bleeding.</p> <p><b>Strength of Concrete: (8)</b> Strength-porosity relationship, failure modes in concrete, factors affecting strength, behaviour of concrete under various stress states</p> <p><b>Dimensional Stability: (6)</b> Types of deformations and their significance, Elastic behaviour, Drying shrinkage and creep, Thermal shrinkage</p> <p><b>Durability: (6)</b> Significance, crystallization in pores, deterioration mechanism of concrete upon frost action, fire, chemical reactions, corrosion etc.</p> <p><b>Advances in concrete: (6)</b> Structural lightweight concrete, high-strength concrete, high performance concrete, fiber-reinforced concrete, Heavyweight Concrete for Radiation Shielding, Mass concrete etc.</p> <p><b>Microstructure of concrete: (5)</b> Significance of microstructure of concrete, microstructure of aggregate phase, microstructure of hydrated cement paste, interfacial transition zone</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Engineering Materials by S. C. Rangwala, K. S. Rangwala and P. S. Rangwala, Charotar Publishing House, Anand</li> <li>Concrete Technology by M. S. Shetty, S. Chand Publisher, New Delhi</li> <li>IS 10262:2009, Concrete Mix Proportioning - Guidelines (1st Revision), BIS, New Delhi.</li> <li>IS 383:1970, Specification for Coarse and Fine aggregates from natural sources for concrete (2nd Revision) BIS, New Delhi.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Concrete Technology by M.L. Gambhir, Tata McGraw Hill and www.nptel.ac.in</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	3	-	3	3	-	-	-	-	3	3	-	3
CO2	3	3	3	3	2	3	3	-	-	-	-	3	3	2	3
CO3	3	-	-	3	-	3	3	-	-	-	-	3	3	-	3
CO4	3	3	3	3	-	3	3	-	-	-	-	3	3	-	3



Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE512	Principles of Reliability	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Engineering Mathematics and Design of Concrete Structures		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes ((COs) :	<ul style="list-style-type: none"> <li>CO1: Understand of reliability theory based on knowledge of fundamentals of probability and statistics.</li> <li>CO2: Apply Monte Carlo simulation technique to solve different civil engineering problems.</li> <li>CO3: Understand the different reliability analysis methods.</li> <li>CO4: To design the elements of civil engineering structures by using reliability methods.</li> </ul>						
Topics Covered (Hrs)	<p><b>Basic statistics and probability:</b> Definition of probability, Axioms of probability, Conditional probability, Total probability theorem, Bayes' theorem, Basics of statistics, Definition of random variable, Different functions of random variable, Discrete and continuous random variables, Multiplerandom variables, probability distribution of random variables (Bernoulli and Binomial distribution, Poisson, geometric, hypergeometric, uniform, normal, lognormal, gamma). (10)</p> <p><b>Simulation technique:</b> Monte Carlo method, theory and applications. (5)</p> <p><b>Reliability analysis:</b> Definition of reliability, Limit state function, Reliability Index, Different classical reliability analysis methods, First order reliability method, Hasofer-Lind reliability method, Rackwitz-Fiessler reliability method, Introduction to second order reliability method. (15)</p> <p><b>Reliability-based design:</b> Load and resistance parameter model, reliability based code format, Calibration of partial safety factors for level I code, Application to solve design problems. (9)</p>						
Text Books, and/or reference material (s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Structural Reliability Analysis and Design by Ranganathan, Jaico Publishing House</li> <li>Probability, Reliability and Statistical Methods in Engineering Design by A. Halder and S. Mahadevan, John Wiley and Sons. New York.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Probability Concepts in Engineering and Design by Ang and Tang, John Wiley.</li> <li>Structural Reliability Analysis and Prediction by R. E. Melchers and A. T. Beck, John Wiley.</li> </ol>						

### PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code/provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	1	1	-	3	-	-	-	-	-	-	-	-	-	3	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	1	-	3	-	-	-	-	-	-	-	-	-	3	-	-

Course Code	Title of the course	Program Core (PCR)/ Electives (PEL)	Total number of contact hours				Credits
			Lecture (L)	Tutorial (T)	Practical (P)	Total hours	
CEE513	Applied Probability and Statistics in Civil Engineering	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs)	<ul style="list-style-type: none"> <li>CO1: understand the basic of probability and statistics</li> <li>CO2: understand the random variables, different distributions of random variables, functions of random variable, joint distribution, sampling distributions, estimation theory, testing of hypothesis and goodness of fit tests.</li> <li>CO3: solve different engineering problems applying the theory of probability and statistics.</li> <li>CO4: apply the theories of probability and statistics to analyse data which is important for design of civil engineering problems.</li> </ul>						
Topics Covered (Hrs)	<p>Probability: Axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, civil engineering problems. (4)</p> <p>Random Variables: Discrete, continuous random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, probability and moment generating function, Markov inequality, Chebyshev's inequality problems. (6)</p> <p>Special Distributions: Discrete uniform, binomial, geometric, negative binomial, hypergeometric, Poisson, continuous uniform, exponential, gamma, Weibull, beta, normal, lognormal, civil engineering problems. (8)</p> <p>Function of a random variable: Different functions of a random variable. (2)</p> <p>Joint Distributions: Joint, marginal and conditional distributions, product moments, correlation and regression, independence of random variables, bivariate normal distribution. (4)</p> <p>Sampling Distributions: The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F distributions, problems (2)</p> <p>Estimation: Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions. (5)</p> <p>Testing of Hypotheses: Null and alternative hypotheses, the critical and acceptance regions, tests for one sample and two sample problems for normal populations, tests for proportion. (6)</p> <p>Goodness of fit tests: Chi-square goodness of fit test and its applications, civil engineering problems. (2)</p>						
Text Books, and/or reference material (s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Ang, A. H. S. and Tang, W. H. 1975. Probability Concepts in Engineering Planning and Design: Volume 1, Basic Principles, Wiley.</li> <li>Ang, A. H.-S. and Tang, W. H. 1984. Probability Concepts in Engineering Planning and Design: Volume 2 Decision, Risk and Reliability, Wiley, New York.</li> <li>Ross, S, 1998. A First Course in Probability, Prentice Hall, NJ.</li> <li>Montgomery, D.C. and Runger, G.C. 1998. Applied Statistics and Probability for Engineers, Wiley, New York.</li> </ol> <p><b>REFERENCE BOOKS:</b></p> <ol style="list-style-type: none"> <li>Spiegel M. R., Schiller, J.J. and Srinivasan, R. A. 2010. Probability and Statistics, Tata-McGraw-Hill, New Delhi.</li> <li>Papoulis, A. 1991. Probability. Random variable and Stochastic process, McGraw-Hill, New York.</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	Code provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	-	-	-	-	-	-	-			
CO2	3	1	-	-	-	-	-	-	-	-	-	-			
CO3	2	3	2	1	2	-	-	-	2	-	-	-			
CO4	2	3	3	2	3	-	-	-	2	-	-	-			

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE514	Experimental methods and Analysis	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Basic Engineering, statistics & probability		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs):	<ul style="list-style-type: none"> <li>• CO1: Development of skills for predicting engineering system behaviour</li> <li>• CO2: Knowledge of basics of data analysis for further applications.</li> <li>• CO3: Developing the requisite skill that helps in the advanced courses related to experimental study</li> </ul>						
Topics Covered (Hrs)	<p><b>Types of measurements and errors:</b> Internal &amp; external estimates of errors, Relative frequency distribution, Histogram, True value, Precision of measurement, Best estimate of true value &amp; precision, Methods of calculating best estimate of true value &amp; standard deviation (7)</p> <p><b>Combination of measurements:</b> Accuracy of mean, Significant digits. Method of least squares &amp; its application for calculation of best estimate of true value, curve fitting, (8)</p> <p><b>General linear regression:</b> Comparison &amp; combination of measurements. Extensions of least square method. Theory of errors, Binomial &amp; Gaussian distribution, Confidence limits, Significance test, principle of maximum likelihood &amp; goodness of fit, Chi-square test. (9)</p> <p><b>Displacement measurement:</b> Dial Gauge, Microcator, Optical Method, Pneumatic Transducer, Strain Gauges, Variable Inductance &amp; Capacitance Transducer, Piezo-Electric, Electro-Kinetic, Photo-Electric, Ionization, Vibrating Wire &amp; Vacuum Tube Transducer.</p> <p><b>Force &amp; Torque:</b> Elastic Type, Fluid Load Cell, Dynamometers.</p> <p><b>Temperature:</b> Bi-Materials, Pressure &amp; Resistance Thermometers, Thermocouples &amp; Pyrometers.</p> <p><b>Pressure:</b> McLeod Gauge, Pirani Gauge, Ionization Gauge, Manometers, Bourdon Tube, Resistance Gauges.</p> <p><b>Fluid Velocity:</b> Pitot tube &amp; Hot Wire Anemometer, LDA. Flow Measurement in Confined Passages &amp; Open Channels. Miscellaneous measurements (10)</p> <p><b>Dynamic Response</b> of a Measuring Instrument, Response to Transient &amp; Periodic Signals, First &amp; Second order systems as well as their Dynamic Response Characteristics. (8)</p>						
Text Books, and/or reference material (s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Instrumentation, Measurement and Analysis by B C Nakra and K K Chaudhary, Tata McGraw Hill, 1985.</li> <li>2. Principles of Measurement, Precision, Error and Truth by N C Barford, Addison Wesley, 1967.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>3. Physical Measurement and Analysis by N N Cook and E Rabinowicz, Addison Wesley, 1963</li> <li>4. Experimental Methods for Engineers by J P Holman and W J Gajda, McGraw Hill Co., 1978</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions / guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	-	-	-	-	-	-	2	-	-	-	2	-	-
CO2	3	-	3	-	-	-	-	-	1	2	-	2	3	-	-

CO3	-	-	3	-	-	-	-	2	-	2	1	3	1	-	-
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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE515	Transportation Infrastructure Design	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Transportation Engineering		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	CO1: Design the geometrical elements of midblocks and intersections. CO2: Perform safety evaluation of design of existing and proposed geometric designs. CO3: Plan and design the pedestrian, bicycle and parking facilities.						
Topics Covered (Hrs)	<p><b>Module 1: (10 hours) Design of Urban and rural road:</b> Hierarchy of Highway System, Functions, Geometric Design Standards, Design Controls and Criteria – Vehicle, Driver and Traffic; Cross-Section Elements, Typical Sections, urban and rural road geometries and its standards – Cross-Sectional Elements, Urban Street Planning Measures, Urban Road Classification, Planning Considerations, Street Design for Regulating Mixed Traffic, Design Speed, Segregation of Lanes, and Traffic Calming Measures.</p> <p><b>Module 2: (6 hours) Public Transport:</b> Bus Stops, Bus Bays, Bus Rapid Transit, Multi-modal Integration. Intermediate Public Transport <b>Commercial Traffic:</b> Planning and Design Measures,</p> <p><b>Module 3: (6 hours) Cycle Traffic-</b> Types of Cycle Tracks, Location and Width of Cycle Track, Riding Surface and Lighting, Bicycle Parking Infrastructure, Parking and Storage</p> <p><b>Module 4: (8 hours) Design of Intersections:</b> Types of Intersections and Controls, Principles of Intersection Design; Design of At-Grade Intersections – Design Elements, Channelisation, Design using Templates; Rotary and Roundabout – Design, Capacity; Signalised Intersections – Benefits and Drawbacks, Warrants, Design; Signal Coordination – Methods, Design; Grade separated intersections – Warrants, Types, Geometric Standards, Spacing and Space controls, Ramps and Gore area design,</p> <p><b>Module 5: (5 hours) On-street Parking Facilities. Road Signs and Marking</b></p> <p><b>Module 6: (4 hours) Pedestrian Facilities:</b> Characteristics of Pedestrians and Bicycles, Issues Shared by Pedestrians and Bicycles, Pedestrian Facility Design - Walkways, Sidewalks, and Public Spaces, Pedestrian Facility Capacity and LOS, Signs and Pavement Markings, Intersections, Midblock Crossings, Flyovers and Subways; Bicycle Facility Design - Shared Roadways</p>						
Text Books and/or reference material(s)	<p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna publishers, 1987.</li> <li>IRC-SP41: Guidelines for the Design of At-Grade Intersections in Rural and Urban Areas</li> <li>IRC-70-2017 guidelines on regulation and control of mixed traffic in urban areas</li> <li>Salter, R. J., Highway Traffic Analysis and Design, ELBS, 1996. 4. Edward K. Morlock, Introduction to Transportation Engineering and Planning, International Student Edition, McGraw-Hill Book Company, New York, 1992.</li> <li>Guide for the Planning, Design, and Operation of Pedestrian Facilities, AASHTO, 2004</li> <li>Guide for the Development of Bicycle Facilities, AASHTO, 1999</li> <li>Manual on Uniform Traffic Control Devices (MUTCD), 2009</li> <li>Urban Intersection Design Guide, Texas Department of Transportation, 2005</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	3	4	-	-	-	-	-	-	-	-	3	3	3
CO3	-	3	3	-	3	-	-	-	2	-	-	3	2	1	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			L	T	P	H	
CEE516	Transportation Planning and Management	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Engineering & Solids Mechanics with Structural Analysis		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	CO1- Develop an understanding of transportation planning to measure transportation demand. CO2- Design various travel behavior surveys to collect transportation planning related data and analyze the data for calibration and validation of various types of models involved in traditional four-step travel demand forecasting process. CO3-Develop in-depth knowledge on the classic four stage demand models including: 1) trip generation, 2) trip distribution, 3) mode choice, and 4) trip assignment. CO4- Able to understand econometric models and use statistical packages for sustainable transportation planning and land-use transport						
Topics Covered (Hrs)	<b>Introduction to Transportation Systems Planning (5 hrs)</b> Basics of Transportation Planning process; Characteristics of transportation problem: Transportation ; transportation demand and supply problem; concept of equilibrium, Introduction to transportation modelling: Revealed and stated-preference models; Aggregate and disaggregate models; Cross-section and time-series models, Overview of Traditional Four-Step Travel Demand Forecasting Process; Information needs for travel demand forecasting; Zoning and O-D matrix estimation from traffic surveys <b>Transportation Data Collection (4 hrs)</b> Type of data collection methods; Survey instrument design; Sampling procedures <b>Trip Generation (8 hrs)</b> Introduction to trip-generation concepts; Factors affecting trip generation; Types of trips; Regression analysis; Linear regression technique and related statistical parameters; Development of regression models from field datasets; Category analysis; Temporal and geographical stability <b>Trip Distribution (8 hrs)</b> Trip distribution models: Growth factor models including Uniform factor method, Average factor method, Fratar method and Furness method; Synthetic methods including Gravity model, Intervening opportunities model and Competing opportunities model <b>Modal Split (8 hrs)</b> Basic modal split models: Trip end and Trip interchange type modal split models: Random Utility theory; Discrete choice modelling framework: Estimation, assumption and specifications of binary, multinomial, mixed and nested Logit and Probit models; Modelling with RP and SP data; Model aggregation and transferability; Introduction and application of N-logit econometric package <b>Traffic Assignment (4 hrs)</b> Basic concepts of assignment; Speed-flow and cost-flow curves; All-or-Nothing assignment; Incremental assignment; Capacity restraint assignment; Stochastic assignment; Stochastic user equilibrium assignment; System optimum assignment and introduction to Dynamic assignment; Shortest path tree building algorithms; Public transport assignments <b>Smart City planning (2 hrs)</b> Smart City Transportation Planning: Transit-Oriented Development (TOD), Pedestrian-Oriented Development, Liveable Street Planning						
Text Books, and/or reference material(s)	<b>Text Books:</b> 1. De Dios Ortuzar, J., and Willumsen, L. G. Modelling transport. John Wiley & Sons., 2011 2. Hutchinson B.G; Principles of Urban Transport Systems Planning; McGraw-Hill Book Company, 1974. <b>Reference Books:</b> 1. Papacosta, C.S., and Prevedouros Transportation Engineering and Planning, PHI Pvt. Ltd.,2004 2. Chakroborty, P. and Das, A. Principles of Transportation Engineering, PHI Pvt. Ltd., 2012 3. Train, K. E. Discrete choice methods with simulation. Cambridge university press, 2009 4. Kadiyali, L. R. Traffic Engineering and Transport Planning, Khanna Publishers, 2015						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	Code provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	-	-	-	2	-	-	3	2	-	2
CO2	3	3	3	1	-	-	1	-	-	2	-	3	2	-	3
CO3	2	3	3	1	-	1	-	2	-	2	1	1	3	1	3
CO4	3	3	3	1	-	1	1	2	-	-	1	2	3	1	3

Course Code	Title of the course	Program Core (PCR)/Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEC517	Remote Sensing & GIS	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
None		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs):	CO1: Learn about basic items, parameters & concepts related with remote sensing. CO2: Apply techniques of visual image interpretation and digital image processing. CO3: Use GIS and its components for basic applications in civil engineering.						
Topics Covered (Hrs)	<b>Remote Sensing:</b> History, Physical basis, Electromagnetic spectrum, Spectral reflectance curves, Spectral signatures, Resolutions, Passive & active remote sensing, Remote sensing platforms. (12) <b>Sensors:</b> Different types, Satellite band designations & principal applications, FCC, Aerial photography & its interpretation. (9) <b>Digital image processing:</b> Pixels & DN values, Digital image formats, Image processing functions – Image enhancement, Image transformation, Image classification & analysis. (9) <b>Geographic Information System:</b> Introduction, GIS components – hardware, software & infrastructure, GIS data types, Data input & processing, DEM generation, Preparation of thematic map from RS data. (6) <b>Integration of RS &amp; GIS techniques</b> and its applications in the field of Civil Engineering. (3)						
Text Books, and/or reference material (s)	<b>Text Books:</b> 1. Remote Sensing & GIS (2nd Ed.) by B. Bhatta (Oxford University Press, New Delhi) 2. Textbook of Remote Sensing & Geographical Information Systems (3rd Ed.) by M. Anji Reddy (BS Publications, Hyderabad) <b>Reference Books:</b> 3. Remote sensing & Image Interpretation (6th Ed.) by T.M. Lillesand, R.W. Kiefer & J.W. Chipman (Wiley India (P) Ltd., New Delhi) 4. Geographical Information Systems (2nd Ed.) by P.A. Longley, M.F. Goodchild, D.J. Maguire & D.W. Rhind (John Wiley & Sons, Inc.)						

Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	1	-	-	-	-	-	-
CO2	3	2	-	2	2	-	1	-	1	1	-	3	-	-	-
CO3	3	2	3	-	2	-	1	-	1	1	-	3	-	-	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE518	Hydrology and Irrigation Engineering	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Physics and Fluid Mechanics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Understanding of occurrence, distribution, storage &amp; transmission of water in different form in space, over &amp; below surface of earth, data collection &amp; processing</li> <li>CO2: Understanding flow generation, occurrence of flood, drought, environmental flow requirement.</li> <li>CO3: Realizing need for food sufficiency, crop water, irrigation requirement, method &amp; design of infrastructures for irrigation requirement.</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction:</b> Brief introduction to Hydrology and Irrigation system (6)</p> <p><b>Diversion head-works:</b> Definition of weirs and barrages and their classification, Layout of typical diversion head-works and function of its components. (3)</p> <p><b>Concrete gravity dams:</b> Forces acting, Elementary profile, Design of gravity dams (3) <b>Earthen dams:</b> Types, Causes of failure, Seepage control, Slope protection (3) <b>Hydraulic power:</b> Thermal-water power, systems, arrangement, equipment, operation (2)</p> <p><b>River navigation:</b> Requirements of navigable waterways, Methods of achieving navigability, Open channel methods, Navigation dams, Navigation locks, Financing river navigation projects. (4)</p> <p><b>Ground water:</b> Occurrence, Well hydraulics, Regional aquifer hydraulics, Ground water quality. (4)</p> <p><b>Flood damage mitigation:</b> Design flood, Flood mitigation, Improvement, Evacuation and flood proofing, Land management and flood mitigation, Flood forecasting, Flood plain management, Economics of flood mitigation (5)</p> <p><b>Planning for water resources development:</b> Level, Phases, objectives, formulation, evaluation, Environmental issues, Systems analysis, multiply purpose projects. (2)</p> <p><b>Engineering economy in water resources planning:</b> Social importance, Annual cost comparisons, Interest and taxes, Frequency and economy, Economy studies for public works, Cost allocation. (4)</p> <p><b>Planning for water resources development:</b> Level of planning, Phases, Objectives, Data requirements, Project formulation and evaluation, Environmental considerations, Systems analysis, Multiple purpose projects. (3)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Engineering Hydrology by K. Subramanya, Fourth Edition, McGraw Hills Education (India) Private Limited, New Delhi</li> <li>Irrigation and Water Power Engineering by B. C. Punmia, B. B. Pande, A. K. Jain &amp; A. Kumar, 16<sup>th</sup> Edition, Laxmi Publications (P) Limited, New Delhi.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Hydrology by V. T. Chow, McGraw-Hill Book Company, Inc., New York</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	3	3	3	-	-	-	-	-	-	-	-	1	-	1
CO3	-	-	-	-	3	3	3	3	3	3	3	3	1	-	2

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE519	Ground Water	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Fluid Mechanics and Water Resources Engineering		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Understanding of occurrence, distribution, storage and transmission of water below the ground level.</li> <li>CO2: Understanding of mechanics of flow of water under the ground</li> <li>CO3: Techniques for exploitation of groundwater on sustainable basis.</li> <li>CO4: Ability to develop models for storage and transmission of groundwater.</li> <li>CO5: Development of capabilities in recharging, management &amp; conjunctive use of ground water</li> </ul>						
Topics Covered (Hrs)	<p><b>Fundamentals of groundwater:</b> Introduction – Characteristic of Groundwater – Distribution of water - ground water column – Permeability - Darcy's Law - Types of aquifers - Hydrogeological Cycle – water level fluctuations. (6)</p> <p><b>Hydraulic flow:</b> Storage coefficient - Specific field - Heterogeneity and Anisotropy - Transmissivity – Governing equations of groundwater flow - Steady state flow – Dupuit Forchheimer assumptions – Velocity potential - Flow nets (8)</p> <p><b>Estimation of parameters:</b> Transmissivity and Storativity – Pumping test - Unsteady state flow - Thies method – Jacob method - Image well theory – Effect of partial penetrations of wells - Collectors wells. (6)</p> <p><b>Groundwater development:</b> Infiltration gallery - Conjunctive use - Artificial recharge - Rainwater harvesting - Safe yield – Yield test – Geophysical methods – Selection of pumps. (6)</p> <p><b>Water quality:</b> Groundwater chemistry - Origin, movement and quality - Water quality standards – Salt water intrusion – Environmental concern (6)</p> <p><b>Artificial recharge:</b> Artificial recharge of groundwater; concept of artificial recharge – recharge methods, relative merits, Application of GIS and Remote Sensing in Artificial Recharge of Ground Water (3)</p> <p><b>Groundwater management:</b> Groundwater basin management; concept of conjunctive use (4)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Ground Water Hydrology by H.M. Raghunath, Wiley Eastern Ltd., 2000.</li> <li>Ground Water Hydrology by D.K. Todd, John Wiley and Sons, 2000.</li> <li>Ground Water by Bawvwr, John Wiley &amp; Sons</li> <li>Groundwater System Planning &amp; Management by R. Willes &amp; W.W.G. Yeh, Printice Hall.</li> <li>Applied Hydrogeology by C. W. Fetta, CBS Publishers &amp; Distributers.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Principles of Pavement Engineering by Nick Tom</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	3	3	3	3	-	-	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE610	Advanced Structural Analysis	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Engineering & Solids Mechanics with Structural Analysis		Continuous (CT) and end assessment (EA). CT+EA					

Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Develop basic understanding of the fundamental concepts and theorems of the advanced topics in analysis of structures.</li> <li>CO2: Model and analyze different structural systems by matrix method of analysis using element approach of force/ flexibility method.</li> <li>CO3: Model and analyze different structural systems by matrix method of analysis using element approach of displacement/ stiffness method.</li> <li>CO4: Understand the basic methodology adopted in developing computer programmes for structural analysis and thus, develop an overall understanding of the available structural analysis softwares.</li> <li>CO5: Ability to write the governing equations for stability &amp; analysis of structures.</li> </ul>
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Topics Covered (Hrs)	<p><b>Recapitulation</b> of basic concepts of structural analysis, force &amp; displacement methods, static &amp; kinematic indeterminacies of pure truss, pure frame &amp; generalized structures <b>(4)</b></p> <p><b>Stiffness / Displacement Method:</b> System approach of solution, global and local coordinate systems, element stiffness matrices for truss and frame elements, displacement and force transformation matrices, connectivity arrays, global stiffness matrix, global load vector, assembling of stiffness matrix and load vector, solution of stiffness equation, output of global displacements and local member end forces, introduction to warping torsion and shear deformation, three dimensional element stiffness matrix and transformation matrix, analysis of grids, different types of example problems. <b>(15)</b></p> <p><b>Flexibility/ Force Method:</b> System approach of solution, global and local coordinate systems, element flexibility matrices for truss and frame elements, force transformation matrices, global flexibility matrix, global load vector, assembling of flexibility matrix, solution of flexibility equation, output of displacements and member end forces, different types of example problems. <b>(10)</b></p> <p><b>Elastic Stability Analysis</b> of beam, column and frames. <b>(10)</b></p>
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Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Structural Analysis by L.S.Negi &amp; R.S.Jangid, Tata McGraw-Hill Publishing Company Limited</li> <li>Structural Analysis: A Unified Classical and Matrix Approach, Amin Ghali, Adam M.Neville by E&amp; FN SPON 4<sup>th</sup> Ed.</li> <li>Stability Analysis and Design of Structure by M.L.Gambhir, Springer 2004 edition</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Structural Analysis: A Matrix Approach by G.S.Pandit &amp; S.P.Gupta, Tata McGraw-Hill Publishing Company Limited</li> </ol>
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Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	-	-	-	-	-	-	-	-	-	2	-	-
CO2	3	3	3	-	1	-	-	-	-	-	-	-	2	-	-
CO3	3	3	3	1	1	-	-	-	-	-	-	1	2	-	-
CO4	-	-	-	-	2	-	-	-	-	-	1	2	-	-	-
CO5	3	3	2	1	-	-	-	-	-	-	-	1	-	-	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE611	<b>Introduction to Finite Element Method</b>	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Solid Mechanics, Structural Engineering & Engg. Mathematics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Understanding the advantage of FEM over classical methods and use it for modelling and analysis of real life engineering structures.</li> <li>CO2: Skill to simulate simple engineering structures through FE modelling and interpret data from the FE analysis to ascertain their reliability and applicability in light of physical constraints of the system and common engineering sense.</li> <li>CO3: Ability to use computational tools for solving Civil Engineering problems.</li> <li>CO4: Skill of using advanced FEA software packages and development of FE codes for modelling, analysis and investigation of problems related to industry and research.</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction:</b> Engineering Problems, Different numerical methods, History of Finite Element Method (FEM), Steps in FEM, Areas of Application, Verification problems, implementation of Engineering Problems in FEM. (9)</p> <p><b>Solution of Engineering Problems using Matrix operation:</b> Importance, Matrix Manipulation Techniques, Solution of Simultaneous Linear Equations, Inverse of Matrix, Computer Implementation. (6)</p> <p><b>Spring Element:</b> General, Implementation in FEM, Applications in civil engineering, Problems. (6)</p> <p><b>Bar Elements:</b> Definition, Stiffness Matrix, Load vector and displacement vector, Implementation in FEM, Problems and Validation. (6)</p> <p><b>FEM Modelling of Engineering Problems:</b> Trusses, beams, Frames etc. (10)</p> <p><b>Computer Programs / SOFTWARES based on FEM:</b> Use in solution of Engineering Problems. (2)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Finite element analysis: theory and programming by C S Krishnamurthy (2001): Tata McGraw Hill Education</li> <li>An Introduction to the Finite Element Method by Reddy, J.N., 2005.</li> <li>Fundamentals of Finite Element Analysis by David V. Hutton Publisher: Tata McGraw Hill Education Private Limited (2005)</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Finite Element Procedures by Klaus-Jurgen Bathe Publisher: Prentice-Hall (2009)</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigation of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO2	-	3	-	2	-	-	-	-	-	-	-	-	3	-	-
CO3	-	-	-	-	3	-	-	-	-	-	-	-	-	3	-
CO4	-	2	-	3	-	-	-	-	-	-	-	-	2	3	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE612	Bridge Engineering	PCL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Survey, Water Resource Engineering, analysis and design of structures		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs)	<ul style="list-style-type: none"> <li>CO1: Acquire knowledge to select different type bridges by assessing their material, capacity, quality &amp; suitability</li> <li>CO2: Ability to make a bridge plan and design following requisite criteria</li> <li>CO3: Supervise the construction procedure of different components of a bridge</li> <li>CO4: Assess the quality and roles of various components of bridge</li> </ul>						
Topics Covered (Hrs)	<p><b>Hydraulic design:</b> Survey, Catchment, Site selection, Hydraulic geometry, Linear waterways, Economic span, Afflux and Scour. (4)</p> <p><b>Load on bridge:</b> Different types of load acting on bridge along with numerical (6)</p> <p><b>Slab and box culvert:</b> Analysis of deck slab-effective width &amp; length method and numerical example with different type of live load. (4)</p> <p><b>R.C. beam-slab and steel composite bridges:</b> R.C.T-beam bridge and steel composite bridge design using Pigeaud's method and Courbon's method (6)</p> <p><b>Dynamic response of bridge deck:</b> General features, factor affecting vibration, practical approach for vibration analysis and numerical examples. (2)</p> <p><b>Prestressed concrete bridge:</b> General features, advantage of P.S.C. Bridge, design details of pre-tensioned and post-tensioned bridge and numerical (6)</p> <p><b>Bridge bearing:</b> Introduction, types of bearing, design principles of different bearing and numerical examples (4)</p> <p><b>Substructure:</b> Introduction, type of piers, forces acting on piers, stability analysis of abutment, types of wing wall and numerical examples of Pier and Abutment. (4)</p> <p><b>Bridge foundation:</b> General aspect, types of foundations, design aspect of pile and well foundations and numerical examples of pile and well foundations. (3)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Bridge Engineering by S. Ponnuswamy, Tata McGraw-Hill Publishing Company Limited, New Delhi.</li> <li>IRC:6-2017 Standard Specifications and Code of Practice for Road Bridges</li> <li>www.nptel.ac.in</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Design and construction of Highway Bridges by K.S. Rakshit, New Central Book Agency (P) Ltd</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	3	3
CO2	-	3	2	-	3	-	1	-	-	-	-	-	3	3	3
CO3	-	-	-	-	-	-	-	-	3	2	-	1	-	-	1
CO4	-	-	-	-	-	-	-	-	-	-	-	3	1	-	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE613	Experimental Stress Analysis, Instrumentation & Sensor Technology	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Engineering Mechanics, Solids Mechanics and Structural Analysis		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Understand experimental approach, use strain gauges</li> <li>CO2: Analyze the errors during measurement, instrumentation of electrical variables</li> <li>CO3: understand the requirements during the transmission of measured signals, Construct Instrumentation/Computer Networks using proper sensor technologies</li> </ul>						
Topics Covered (Hrs)	<p>Principles of Experimental Approach: Merit of Experimental Analysis introduction, uses of experimental stress analysis-Advantages of experimental stress analysis, Different methods, Simplification of problems.[10]</p> <p>Strain Measurement using Strain Gauges: Definition of strain and its relation to Experimental Determinations, properties of strain-gauge systems, Types of strain gauges, Mechanical and Optical strain gauges. Electrical Strain Gauges - Introduction, LVDT - resistance strain gauge - various types - gauge factor, Materials for adhesion base, etc. Strain Rosettes: Introduction, The three elements rectangular Rosette - The delta rosette - Corrections for Transverse strain effects.[8]</p> <p>Fundamentals of Measurement, Sensing. Instrumentation and data acquisition, common types of sensors; function of these sensors; interpretation of signals from sensor. Sensor Installation and Operation to i) Predict the response of sensors, methodology for sensor installation; Sensor selection, Sensor siting, Sensor Installation &amp; Configuration, Measurement uncertainty.[10]</p> <p>Data Analysis and Interpretation, Fundamental statistical concepts, Data reduction and interpretation, Time domain signal processing, noise.[8]</p> <p>Frequency Domain Signal Processing and Analysis, its principles; to draw conclusions about physical processes based on analysis of sensor data; Combine signals in a meaningful way to gain deeper insight into physical phenomena, Basic concepts in frequency domain signal processing and analysis, Fourier Transform FFT, Noise reduction with filters, Leakage.[3]</p>						
Text Books, and/or reference material(s)	<p>Text Books:</p> <ol style="list-style-type: none"> <li>Alan S Morris (2001), Measurement and Instrumentation Principles, 3rd/e, Butterworth Hienemann</li> <li>David A. Bell (2007), Electronic Instrumentation and Measurements 2nd/e, Oxford Press</li> <li>S. Tumanski (2006), Principle of Electrical Measurement, Taylor &amp; Francis</li> <li>Ilya Gertsbakh (2010), Measurement Theory for Engineers, Springer</li> <li>Experimental Stress Analysis by J.W.Dally and W.F.Riley</li> <li>Experimental Stress Analysis by Dr. Sadhu Singh</li> </ol> <p>Reference Books:</p> <ol style="list-style-type: none"> <li>Experimental Stress Analysis by Dove and Adams</li> </ol>						

**Mapping of Course Outcomes COs → POs → PSOs**

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1															
CO2															
CO3															

Course	Title of the	Program	Total number of contact hours	Credits
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Code	course	Core (PCR)/ Electives (PEL)	Lecture (L)	Tutorial (T)	Practical (P)	Total hours	
CEE614	Repair and Rehabilitation of Structures	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Building Science and Technology/Concrete Technology		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs)	<ul style="list-style-type: none"> <li>• CO1: Identify and understand the factors leads to the deterioration of structures.</li> <li>• CO2: Examine the distress in structural members and identify the causes for the failures.</li> <li>• CO3: Apply the modern techniques to repair and strengthen the structural members.</li> </ul>						
Topics Covered (Hrs)	<p><b>Deterioration of Concrete Structures: (10)</b> Introduction, Requirement of repair and rehabilitation of structures, Major causes and signs of deterioration, Cracks – types, causes and characteristics</p> <p><b>Condition assessment of structures: (10)</b> Preliminary and detailed investigations, damage classifications, In-situ and laboratory testing: non-destructive tests, semi-destructive tests, durability tests on concrete.</p> <p><b>Repair Materials and Techniques: (12)</b> Selection of the repair material and method, compatibility of repair materials, various materials for repair: cement based repair materials, polymer modified repair materials, Resin-based products, composites etc., Various repair techniques: surface repairs, pre-placed aggregate techniques, grouting, stitching, gunite, gravity filling, drilling and plugging.</p> <p><b>Strengthening of structures: (7)</b> Strengthening techniques, strengthening of different structural members (beam, slab, column, footing etc.)</p>						
Text Books, and/or reference material (s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Peter H. Emmons, Concrete Repair and Maintenance Illustrated: Problem Analysis; Repair Strategy; Techniques, Galgotia Publications Pvt. Ltd., 2002.</li> <li>2. R. Dodge Woodson, Concrete Structures: Protection, Repair and Rehabilitation, Elsevier, 2009.</li> <li>3. Jacob Feld and Kenneth L Carper, Construction Failures, Wiley Europe, 1997.</li> <li>4. CPWD Handbook on Repair and Rehabilitation of RCC Buildings, Jain Book Agency, 2011.</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	Code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	3	-	2	-	-	-	-	-	3	3	-	3
CO2	3	3	3	3	2	-	-	-	-	-	-	3	3	-	3
CO3	3	2	3	3	3	2	2	-	-	-	-	3	3	-	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE615	Pavement Analysis and Design	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Transportation Engineering		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Identify the pavement types based on their behavior under traffic</li> <li>CO2: Analyze the pavement components with respect to their material composition.</li> <li>CO3: Estimate the stresses induced due to wheel load and temperature.</li> <li>CO4: Design the pavement, flexible or rigid, for the conditions prevailing at the site.</li> </ul>						
Topics Covered (Hrs)	<p>Module 1: (12 hours) <b>Introduction:</b> Types and Component parts of Pavements, Factors affecting Design and Performance of Pavements, Comparison between Highway and Airport pavements, Superpave. Stresses in Flexible Pavements: Stresses and Deflections in Homogeneous Masses, Burmister's 2- layer, 3- layer Theories, Wheel Load Stresses, ESWL of Multiple Wheels, Repeated Loads and EWL factors, Sustained Loads and Pavement behaviour under Traffic Loads.</p> <p>Module 2: (10 hours) <b>Methods of Flexible Pavement Design:</b> Empirical, Semi-empirical and Theoretical Approaches; Development, Principle, Design steps, Applications of different Pavement Design Methods.</p> <p>Module 3: (10 hours) <b>Stresses in Rigid Pavements:</b> Types of Stresses and Causes, Factors influencing the Stresses; General Conditions in Rigid Pavement Analysis, Wheel Load Stresses, Warping Stresses, Friction Stresses, Combined Stresses.</p> <p>Module 4: (7 hours) <b>Methods of Rigid Pavement Design:</b> Types of Joints in Cement Concrete Pavements and their Functions, Joint Spacings, Design of Slab Thickness, Design of Joint Details for Longitudinal Joints, Contraction Joints and Expansion Joints, IRC Method of Design – Continuously Reinforced Concrete Pavement Design - Rigid Overlay Design.</p>						
Text Books and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Yang H. Huang, Pavement Analysis and Design, Prentice Hall, 2003</li> <li>Yoder and Witzak, Principles of Pavement Design, John Wiley and sons, Second Edition, 1975.</li> <li>David Croney, The Design and Performance of Road Pavements, McGraw Hill, 1997</li> <li>Harold N. Atkins, Highway Materials, Soils, and Concrete, Prentice Hall, 2002.</li> <li>Lavin, P. G., Asphalt Pavements, Spon Press, 2003. 9. Mechanistic Empirical Pavement Design Guide, NCHRP, TRB, 2008.</li> <li>RRL, DSIR, Concrete Roads, HMSO, IRC Publications</li> <li>Nai C. Yang, Design of functional pavements, McGraw-Hill, 1973</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>IRC: 37, 'Guidelines for the Design of Flexible Pavements'</li> <li>IRC: 58 'Guidelines for the Design of Rigid Pavements'</li> <li>IRC: 81, 'Strengthening of Flexible Road Pavements using Benkelman Beam Deflection Technique'</li> <li>IRC: 101, Guidelines for Design of Continuously Reinforced Concrete Pavement with Elastic Joints'</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of	Conduct investigations of complex	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual &	Communication	Project management & finance	Life-long learning	Plan, analysis, design and prepare	Computer aided skill and tools	Code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	3	4	-	-	-	-	-	-	-	-	3	3	3
CO3	-	3	3	-	3	-	-	-	2	-	-	3	2	1	1
CO4	3	3	3	-	-	-	2	-	2	-	-	3	3	3	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE616	Applied Numerical Methods	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Engineering Mathematics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Assess the error involved in a numerical method</li> <li>CO2: Solve problems in engineering and science with a required accuracy using appropriate numerical methods</li> <li>CO3: Write an algorithm for the numerical methods for efficient coding of program</li> <li>CO4: Understand the mathematics concepts underlying the numerical methods</li> </ul>						
Topics Covered (Hrs)	<p><b>Fundamentals of numerical methods:</b> Need for Numerical methods in Civil Engineering, Sources of Errors, Absolute, Relative and Percentage, round off error, and stability of algorithms. <b>(04)</b></p> <p><b>Linear system of algebraic equations:</b> Gauss elimination method, LU decomposition method; iterative methods, ill conditioned systems. Jacobi, Gauss Seidel method, Relaxation method. <b>(08)</b></p> <p><b>Nonlinear equations:</b> Bisection method, Regula Falsi method, Newton Raphson method, Modified Newton-Raphson method, Higher order Newton's method Bairstow method, system of non-linear equations. <b>(8)</b></p> <p><b>Interpolation and approximation:</b> Newton's, Lagrange and Hermite interpolating polynomials, cubic splines; least square and minimax approximations. <b>(06)</b></p> <p><b>Numerical differentiation and integration:</b> Newton-Cotes and Gaussian type quadrature methods. <b>(06)</b></p> <p><b>Ordinary differential equations:</b> Initial value problems: single step and multistep methods, stability and their convergence. Boundary value problems: functional approximation, finite difference method. <b>(07)</b></p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Numerical Methods for Scientists and Engineers by R. W. Hamming, Dover Publications; 2 edition</li> <li>Numerical Methods: Problems and Solutions by Mahinder Kumar Jain (Author), S.R.K. Iyengar (Author), R. K. Jain, New age publishers</li> <li>Numerical Methods for Engineers by Chapra, S. C., and Canale, R. P., McGraw Hill, Inc., 2007.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Applied Numerical Methods for Engineers Using Matlab and C by Robert J. Schilling (Author), Sandra L. Harris, Nelson Engineering; Har/Cdr edition</li> <li>Numerical Analysis for Scientists and Engineers: Theory and C Programs by Madhumangal Pal, Alpha Science Intl Ltd; 1 edition</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	code/provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	-	3	-	3	-	-	-	-	-	-	-	-	3	-
CO3	3	-	3	-	3	-	-	-	-	1	-	-	-	3	-
CO4	2	-	-	-	3	-	1	-	-	-	-	-	-	3	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE617	Road Safety Analysis	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Transportation Engineering		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	CO1: Identify the factors contributing to accidents. CO2: Collect data pertaining to road crashes and prepare a comprehensive crash database CO3: Perform statistical analysis of crash data. CO4: Formulate traffic management measures for accident prevention and perform road safety audit and prepare an audit report.						
Topics Covered (Hrs)	Module 1: (10 hours) <b>Introduction to road safety engineering</b> - Overview of road safety - Global road safety scenario and pattern - global trends and projections - national and state road safety level - problems in road safety in developing countries- magnitude, socioeconomic and health effects. Module 2: (10 hours) <b>Traffic Elements</b> - Characteristics of Road user, Motor vehicle, Roadway- relationship between elements- human factors governing road user behavior- risk factors for traffic accidents- exposure to risk- crash involvement- crash severity- post-crash injury outcomes Module 3: (10 hours) <b>Analysis and prevention</b> - Collection of accident data- Statistical methods for analysis of accident data, Speed in relation of safety- Weather and its effects on accidents- Vulnerable road users safety, parking influence on accidents- Traffic management measures for accident prevention- Legislation, Enforcement, Education and Propaganda- Formulating and implementing road safety policy. Module 4: (9 hours) <b>Road safety improvement program</b> - Road safety audit (RSA) - Procedure in road safety audit- design standards- audit tasks- stages of road safety audit- key legal aspects. Road design issues in RSA's – structuring and preparation of audit report.						
Text Books and/or reference material(s)	<b>Reference Books:</b> 1. David L. Geotsc. Occupational Safety and Health for Technologists, Engineers and Managers. 5th Edition, 2004. 2. World Health Organization, Road Traffic Injury Prevention Training Manual, 2006. 3. Matson, M.T., Smith, S.W., Hurd, W.F. Traffic Engineering, McGraw-Hill Book Company Inc., London, 1955. 4. Fuller, R., Santos, J.A. Human Factors for Highway Engineers, Pergamon, 2002. 5. Khisty, C.J., Lall, B.K. Transportation Engineering- An Introduction, Third Edition, Prentice Hall of India, New Delhi, 2006. 6. Jason C.YU, Transportation Engineering- Introduction to Planning, Design, and Operations, Elsevier, 1982. 7. Kadiyali, L.R. Traffic Engineering and Transportation Planning, Khanna Publishers, New Delhi, 2009. 8. IRC: 103-1988, Guidelines for Pedestrian Facilities, Indian Roads Congress, New Delhi. 9. IRC: SP: 32-1988, Road Safety for Children (5-12 Years old), Indian Roads Congress, New Delhi. 10. IRC: SP: 44-1996, Highway Safety Code, Indian Roads Congress, New Delhi. 11. IRC: SP: 88-2010, Road Safety Audit Manual, Indian Roads Congress, New Delhi.						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Professional team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	Code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	3	4	-	-	-	-	-	-	-	-	3	3	3
CO3	-	3	3	-	3	-	-	-	2	-	-	3	2	1	1
CO4	3	3	3	-	-	-	2	-	2	-	-	3	3	3	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE618	Intelligent Transportation Systems	PEL	3	0	0	3	3

Pre-requisite(s)	Course Assessment methods
Transportation Engineering	Continuous (CT) and end assessment (EA). CT+EA

Course Outcomes (COs):	<ul style="list-style-type: none"> <li>CO1: Understand ITS &amp; ATIS</li> <li>CO2: Explain the Advanced Transportation Management System.</li> <li>CO3: Know about APTS, CVO, new technology and ETC.</li> <li>CO4: Details about regional architecture, integration of infrastructure and operational planning.</li> </ul>
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Topics Covered (Hrs)	<p>Introduction to ITS, including where ITS fits; roles and responsibilities Advanced Traveller Information Systems (ATIS), including functionality; business models; field trip to Smart Route Systems (6)</p> <p>Advanced Transportation Management Systems (ATMS), including network operations; incident detection; (4)</p> <p>congestion pricing, tolling, HOT lanes, example deployments (4)</p> <p>Fleet-oriented ITS services, including Advanced Public Transportation Systems (APTS); BRT; Commercial Vehicle Operations (CVO); Intermodal Freight, including International Operations and Supply Chains (4)</p> <p>ITS and Technology, including automated highway systems (AHS); sensors, electronic toll collection (ETC); dedicated short range communication and standards (4)</p> <p>Regionally-scaled ITS deployment, including regional architecture; organizational and institutional issues; standards; developed vs. developing countries; (3)</p> <p>ITS and strategic regional transportation planning; Integrating infrastructure and operations planning (4)</p> <p>Critical ITS Issues, including (as time permits) ITS and security; safety; human factors; privacy; sustainability; funding (as contrasted with conventional infrastructure); technology deployment/R &amp;D/policy; other institutional issues (4)</p> <p>Conclusion, including regional ITS planning and architecture presentation; the future of ITS; (4)</p> <p>International ITS Programs Case Studies: applications in bus transport, metro, and highways; Emerging Issues.(2)</p>
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Text Books, and/or reference material(s)	<p><i>Text Books:</i></p> <ul style="list-style-type: none"> <li>Mashrur A. Chowdhury, and Adel Sadek, Fundamentals of Intelligent Transportation Systems Planning, Artech House, Inc., 2003.</li> <li>Ghosh, S., Lee, T.S. Intelligent Transportation Systems: New Principles and Architectures, CRC Press, 2000.</li> </ul> <p><i>Reference Books:</i></p> <ul style="list-style-type: none"> <li>May, A. D. Traffic Flow Fundamentals, PHI: USA, 1990</li> <li>Roess R., Prassas.E.S and McSHANE W. Traffic Engineering, 5th Edition, Pearson., 2019</li> </ul>
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Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	3	4	-	-	-	-	-	-	-	-	3	3	3
CO3	-	3	3	-	3	-	-	-	2	-	-	3	2	1	1
CO4	3	3	3	-	-	-	2	-	2	-	-	3	3	3	3

	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE619	Remote Sensing and its applications for Disaster Management	PEL	3	0	0	3	3
Pre-requisites:		Course Assessment methods					
No pre-requisites		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes	<ul style="list-style-type: none"> <li>CO1: Understand hazards, risks, and various types of natural disasters.</li> <li>CO2: Identify different remote sensing platforms and their applications in disaster management.</li> <li>CO3: Utilize GIS for spatial data analysis and disaster risk management.</li> <li>CO4: Understand disaster management components and government roles in disaster response.</li> </ul>						
Topics Covered	<p><b>Introduction:</b> Hazard, Vulnerability, Risk, Disaster, Earth Observation Using Satellites, Disasters- their types and effects: Hydrological Disasters - Flood, Flash flood, Drought, cloud burst, Geological Disasters- Earthquakes, Landslides, Avalanches, Volcanic eruptions, Mudflow, Wind related- Cyclone, Storm, Storm surge, tidal waves, Heat and cold Waves, Climatic Change, Global warming, Sea Level rise (8) <b>Basic Concepts of Remote Sensing:</b> History, Development, Definition, Concept &amp; Principles, Electromagnetic Radiation (EMR) and Its Characteristics, Wavelength Regions and their Significance, Interaction of EMR with Atmosphere and Earth's Surface: Absorption, Reflectance and Scattering, Atmospheric Windows, Spectral Response and Spectral Signature, Spectral, Spatial, Temporal and Radiometric resolutions, Introduction to microwave remote sensing (8) <b>Satellite Platforms</b> – Types and their Characteristics: Satellites and their characteristics – geo-stationary and sun-synchronous Earth Resources Satellites - LANDSAT, SPOT, IRS, IKONOS satellite series Meteorological satellites – INSAT, NOAA, GOES (8) <b>Fundamental of GIS:</b> Definition, concept and history of developments in the field of information systems, Hardware and software requirements for GIS, Coordinate system and projections in GIS, Spatial data models – raster and vector, Spatial data analysis – significance and type, attribute query, spatial query, Vector based spatial data analysis, Raster based spatial data analysis, GPS, Web based GIS Technology (8) <b>Disaster Management:</b> Disaster Management Act 2005, Definitions, Components of DM Disaster Management Cycle, Impact of disaster on development, Disaster Management Authority at National, State and District levels, Roles and responsibilities of Govt. Authorities including Local Self Govt. at various levels, CBDRM (7)</p>						
Text Books, and/or reference material	<p><b>Textbooks:</b>  1. Ingleton, J. (1999). Natural disaster management. UK: Tudor-Rose.  2. Murthy, D. B. N. (2007). Disaster Management: Text and case studies. Deep and Deep Publications.</p> <p><b>References:</b>  3. Nayak, S., &amp; Zlatanova, S. (Eds.). (2008). Remote sensing and GIS technologies for monitoring and prediction of disasters. Springer Science &amp; Business Media.  4. Haripavan, N., Ramalingeshwararao, G. V., &amp; Abbaiah, G. (2019). Proceedings of International Conference on Remote Sensing for Disaster Management.  5. Bhattacharya, T. (2012). Disaster Science and Management. Tata McGraw-Hill Education.  6. Botterill, L. C., &amp; Wilhite, D. A. (Eds.). (2006). From disaster response to risk management: Australia's national drought policy (Vol. 22). Springer Science &amp; Business Media.  7. UN/ISDR. (2004). Living with Risk: A global review of disaster reduction initiatives. 2004 Version, Volume I &amp; II Annexes. Geneva.</p>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solution	Conduct investigation of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	Code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	3	-	3	3	3	2	3	-	3	-	-	-
CO2	2	3	-	-	3	2	-	3	-	2	-	2	-	-	2
CO3	2	3	3	2	3	2	-	3	2	3	-	2	-	3	-
CO4	3	3	-	3	-	3	3	3	2	3	3	3	-	-	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CEE620</b>	<b>Advanced Design of Concrete Structures</b>	<b>PCL</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>
Pre-requisite(s)		Course Assessment methods					
Design of Concrete Structures		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs)	<ul style="list-style-type: none"> <li>• CO1: Acquire knowledge of engineering design of different Member</li> <li>• CO2: Ability to analyze the Utility Structures: Bunker, Silo, Water Tank, Shell etc</li> <li>• CO3: Ability for understanding the need of future studies</li> </ul>						
Topics Covered (Hrs)	<p>TOPIC-1. Recapitulation and Quick revision of WSM &amp; LSM, Indian Standard code, Serviceability Limit State: [3]</p> <p>TOPIC-2. Design of Continuous beam, Redistribution of Moments [3]</p> <p>TOPIC-3. Design of Curved beam in plan [4]</p> <p>TOPIC-4. Design of Deep Beams and corbels [4]</p> <p>TOPIC-5. Design of Multi-stored /Portal frames, frames, Design of Tension Members, Earthquake resistant design of structure, Ductile detailing. [6]</p> <p>TOPIC-6. Design of Combined Footing, Pile-cap [6]</p> <p>TOPIC-7. Design of Flat Slab, Methods of analysis and design [4]</p> <p>TOPIC-8. Analysis and Design of Bunkers, silo, Chimney [6]</p> <p>TOPIC-9. Design of Under-ground, Ground-supported, Overhead Tanks [6]</p>						
Text Books, and/or reference material (s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Reinforced Concrete Design, 2nd Edition, by S. Unnikrishna Pillai and Devdas Menon, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003</li> <li>2. Adv. R. C. C Design, by N.K. Raju, CBS Publishers &amp; Distributor, New Delhi</li> <li>3. IS 456: 2000, Plain and Reinforced Concrete – Code of Practice (4th Revision).</li> <li>4. IS 875 (Part 1 to 5) : Design loads (other than earthquake) for buildings and structures</li> <li>5. IS 3370 (I, II, IV): 2009 &amp; 1965, Concrete structures for storage of Liquids.</li> <li>6. IS 1893 (I): 2016, Criteria for earthquake resistance design of Structures-General provisions and building (6th Revision), BIS, New Delhi.</li> <li>7. IS 13920: 2016, Ductile design &amp; detailing of R. C. structures subjected to seismic forces- code of practice (1st Revision), BIS, New Delhi</li> <li>8. SP-24 : Explanatory Handbook on IS 456: 1978</li> <li>9. SP-34, Handbook on Concrete, Reinforcement and detailing BIS, New Delhi</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>10. Adv. R. C. C Design, by S.S. Bhavikatti, New Age International (P) Limited, New Delhi</li> <li>11. Design of Reinforced Concrete Structure N Subramanian, Oxford Univ Press</li> <li>12. www.nptel.ac.in</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	-	-	-	1	2	2	3
CO2	-	-	3	-	2	-	1	-	-	-	-	1	2	2	3
CO3	-	-	-	-	-	-	-	-	-	-	-	3	1	1	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE621	Construction Planning and Management	PEL	3	0	0	3	3
Pre-requisites:		Course Assessment methods					
CEC303 + CES544		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs)	<ul style="list-style-type: none"> <li>• CO1: Learn preliminaries of construction planning and management.</li> <li>• CO2: Learn construction safety aspects.</li> <li>• CO3: Learn contract management. Get exposed to tendering and contracting.</li> <li>• CO4: Learn about the running &amp; operation of government-run engineering department., elements of project financing, project selection &amp; use of construction equipment.</li> </ul>						
Topics Covered	<p><b>Construction project Organization:</b> Introduction, phases of construction project, principles of organization, Types of organization, Site organisation, Temporary services, Job layout. (6)</p> <p><b>Construction planning:</b> Introduction to planning, Stages of planning, Work breakdown structure, Scheduling, Preparation of schedules for job, materials, labour, equipment and finance, Network techniques in construction management, direct and indirect cost, Resources allocation and levelling. (12)</p> <p><b>Safety in construction:</b> Importance of safety &amp; its measures in construction activities, Causes of accidents, incident investigation and analysis, Accident Statistics and Indices, Safety and health management system: safety policy and organization, safety budget, safety plan, safety audit. (6)</p> <p><b>Construction Contracts:</b> Contract document, Different types of contracts, Notice inviting tender, Contract documents, Condition of contract, Earnest money, Security money, Termination of contract, Arbitration, Specification – different types. (5)</p> <p><b>Public works accounts:</b> Muster roll, Measurement book, Cash book, Material-at-site account, Imprest, Temporary advance, Mode of payment, Bill, Voucher, Running account bill, Final bill, Advance payment to contractor, Secured advance, Stock, Tools and plants. (4)</p> <p><b>Construction equipment:</b> Classification of construction equipment, Factors affecting selection of equipment, various construction equipment, Depreciation, method for calculation of depreciation. (6)</p>						

Text Books, and/or reference material	<b>Text Books:</b>
	1. Estimating, costing and specification in civil engineering by M. Chakraborty
	2. Civil engineering Contracts and Estimates by B.S. Patil, Orient Longman, New Delhi, 1981.
	3. PERT & CPM principles and applications by L.S. Srinath, Affiliated East-West Press Pvt. Publishers, Delhi-6, 1978.
	4. Construction Management and Accounts by V.N. Vazirani, and S.P. Chandola, Khanna Publishers, Delhi-6, 1978.
	<b>Reference Books:</b>
	5. Management in Construction Industry by P. P. Dharwadker, Oxford & IBH Publishing Co. Pvt.Ltd. New Delhi, 1992.
6. Building Construction by S.C. Rangawala, Charotar Book Stall, Anand, 1980.	
7. Construction equipment and its planning & application by M. Verma, Metropolitan book co. (p) Ltd. New Delhi, 1979	

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	investigation of complex	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions / guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	3	-	3	3	-
CO2	3	-	-	-	-	3	-	-	-	-	-	-	3	-	-
CO3	3	-	-	-	-	-	-	-	-	-	3	-	3	-	-
CO4	3	-	-	-	-	-	-	-	-	-	3	-	3	-	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CEE622</b>	<b>Introduction to Random Vibrations</b>	<b>PEL</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>
Pre-requisite(s)		Course Assessment methods					
Basic Engineering vibrations, statistics and probability		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>• CO1: Development of skills for predicting engineering system behaviour under random vibrations</li> <li>• CO2: Knowledge of basics of random vibration analysis for further applications.</li> <li>• CO3: Developing the requisite skill that helps in the advanced courses related to random vibration study.</li> </ul>						
Topics Covered (Hrs)	<p><b>Review</b> of basic topics in probability theory and vibrations <b>(4)</b></p> <p><b>Introduction</b> to the theory of random processes Time- and frequency-domain characteristics Stationary and nonstationary processes Continuity, differentiation and integration, Poisson, Gaussian processes. <b>(10)</b></p> <p><b>Random vibration</b> of linear structures Unit-impulse and frequency-response functions Time- and frequency-domain analysis Single- and multi-degree-of-freedom systems Stationary and nonstationary responses State-space formulation Modal cross-correlations Response to multi-support excitation, coherency function <b>(12)</b></p> <p><b>Crossings and reliability</b> analysis Threshold Crossings The envelope process First passage probability Distribution of local and extreme peaks <b>(8)</b></p> <p><b>Response spectrum</b> methods Response spectrum methods (CQC, CQC3, MSRS) PSD consistent with response spectrum. <b>(8)</b></p>						
Text Books, and/or reference	<p><b>Text Books:</b></p> <p>1. Probabilistic Theory of Structural Dynamics by Y. K. Lin, McGraw-Hill, New York, NY, 1967 Krieger Pub., Huntington, NY, 1976.</p> <p>2. Probabilistic Structural Dynamics: Advanced Theory and Applications by Y. K. Lin and</p>						

material(s)	G.Q. Cai, McGraw-Hill, New York, NY, 1995. <b>Reference Books:</b> 3. An Introduction to Random Vibrations, Spectral & Wavelet Analysis: Third Edition by D.E. Newland, Dover Publications, Mineola, NY, 2005. 4. Introduction to Random Vibrations by N. C. Nigam, MIT Press, Cambridge, MA, 1983. 5. Applications of Random Vibrations by N.C. Nigam and S. Narayanan, Narosa Pub., New Delhi, India, 1994.
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Mapping of Course Outcomes COs→POs→PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions / guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	2	-	-	-	-	2	-	-	-	1	1	-
CO2	3	-	3	-	-	-	1	-	-	2	-	2	2	2	-
CO3	-	-	3	-	-	-	-	2	-	2	1	3	-	-	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE623	Mechanics of Composite Structures	Program Elective (PEL)	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Knowledge of Solid Mechanics, Structural Analysis & Design		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Development of skills of finding out mechanical properties of composite materials as well as predicting structural behaviour of composites under different loads.</li> <li>CO2: Knowledge of basics of analysis and design of structural components, made of variety of composite materials.</li> <li>CO3: Knowledge of using numerical tools for modeling and analysis of simple structural components</li> </ul>						
Topics Covered (Hrs)	Introduction, Types of composite materials, Lamina and Laminate, Matrix and Fibre, Fibre-reinforced Composites, Comparison of strengths between bulk material and fibres. <b>(6)</b> Co-ordinate systems, Effect of orientation of fibres on the strength and stiffness of Composites. <b>(6)</b> Brief outline of manufacturing processes. <b>(4)</b> Micromechanics and Macro mechanics, Constitutive relations, Stresses and Strains, Failure criteria of composites. <b>(8)</b> Analysis of Composites: beams and plates <b>(12)</b> Finite Element Method in analysis of Composite Structures <b>(6)</b>						
Text Books, and/or	<b>Text Books:</b> 1. Mechanics of Composite Materials by Robert M. Jones, Taylor and Francis (2015) 2. Mechanics of Composite Structures by Autar K. Kaw, Taylor and Francis (2006)						

reference material(s)	<b>Reference Books:</b> 3. Mechanics of Composite Materials and Structures by Madhujit Mukhopadhyay, University Press (2004)
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Mapping of Course Outcomes COs→POs→PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions / guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO2	-	3	2	-	-	-	-	-	-	-	-	-	3	-	2
CO3	-	2	-	-	3	-	-	-	-	-	-	-	-	3	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
<b>CEE624</b>	<b>Theory of Plates and Shells</b>	<b>PEL</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>
Pre-requisite(s)		Course Assessment methods					
Solid Mechanics, Structural Analysis		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs):	<ul style="list-style-type: none"> <li>CO1: Derive the expressions of the curvature and displacement relationships of plates subjected to bending moments, twisting moments and shear force.</li> <li>CO2: Analyse the simply supported plates and solve them by using Navier's and Levy's Methods.</li> <li>CO3: Analyse the thin shell structures using membrane theory.</li> <li>CO4: Design the cylindrical shell and review the IS code provisions of it.</li> </ul>						
Topics Covered (Hrs)	<p><b>Basic curvature and displacement relationships.</b> Expressions for bending, moment, twisting moments, shear forces. <b>(4)</b></p> <p><b>Plate equation.</b> Edge conditions. Solution of simply supported plates by Navier's and Levy's methods. Introduction to anisotropic plates. <b>(10)</b></p> <p><b>Plates subjected to in-plane forces,</b> Buckling of plates. Numerical analysis of plates. Design of plates. <b>(6)</b></p> <p><b>Shell structures</b> Classification, Differential geometry, Curvature, Strain, Displacement relations. <b>(4)</b></p> <p><b>Membrane theory of thin shells</b> and design of cylindrical shells of double curvature (Synclastic and anticlastic), Shells of revolution, North light shell. <b>(9)</b></p> <p><b>Design of shell</b> and review of IS code provisions, Introduction to bending theories: Application to cylindrical shells and design. <b>(6)</b></p>						
Text Books, and/or reference material(s)	<p><b>Text Book(s):</b></p> <ol style="list-style-type: none"> <li>Theory of Plates and Shells by Timoshenko and Krieger, McGraw Hill</li> <li>Theory and Analysis of Plates by Classic and Numerical Methods, Rudolph Szilard, Prentice Hall Inc. New Jersey</li> </ol> <p><b>Reference Book:</b></p> <ol style="list-style-type: none"> <li>Design and Construction of Concrete Shell Roofs by G.S. Ramaswamy, CBS Publisher &amp; Distributors (2005)</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	1	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-	3	1	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	3	1	-
CO4	-	1	3	-	-	-	-	-	-	-	-	-	3	2	3

Course Code	Title of the course	Program Core (PCR)/Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE625	Environmental Pollution & Control	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
None		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Apply knowledge of different types of environmental affecting the community life pollutants (air, solid wastes and noise) for design solutions.</li> <li>CO2: Understand basic design philosophies applicable to control and safe disposal of different types of environmental pollutants.</li> <li>CO3: Formulate, analyze, and design basic control and disposal systems of different types of environmental pollutants.</li> </ul>						
Topics Covered (Hrs)	<p><b>Natural &amp; manmade sources of pollution</b>, types of pollutants. (3)</p> <p><b>Air pollution</b>: Its effects, measurement, methods of control, air pollution control equipment. (14)</p> <p><b>Community Solid wastes</b> – quantity &amp; characteristics, methods of collection, disposal &amp; reuse. (14)</p> <p><b>Noise pollution</b> – Its effects, noise measurement, methods of control of environmental noise. (6)</p> <p><b>Legal aspects of environmental pollution &amp; control.</b> (2)</p>						
Text Books, and/or reference material (s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Introduction to Environmental Engineering by M.L. Davis &amp; D.A. Cornwell (Tata McGraw-Hill Education Private Limited, New Delhi)</li> <li>Environmental Engineering by H.S. Peavy, D. R. Rowe &amp; G. Tchobanoglous [McGrawHill Education (India) Private Limited, New Delhi]</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Environmental Engineering – A Design Approach by A.P. Sincero &amp; G.A. Sincero (Prentice – Hall of India Private Limited, New Delhi)</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	Code/provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	2	-	-	-	2	-	-
CO2	3	-	3	-	-	-	1	-	-	2	-	2	2	-	-
CO3	-	-	3	-	-	-	-	2	-	2	1	3	3	-	2

	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE626	Geotechnical Physical Modelling	PEL	3	0	0	3	3
Pre-requisites:		Course Assessment methods					
Nopre-requisites		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes	<ul style="list-style-type: none"> <li>CO1: Understand different modelling techniques and the relevance of physical modelling in Geotechnical engineering</li> <li>CO2: Learn different physical modelling techniques used in Geotechnical Engineering, limitations of each technique and understand the applications</li> <li>CO3: Develop skills in centrifuge modelling pertinent to geotechnical engineering</li> <li>CO4: Apply scaling laws and principles to ensure that physical models accurately represent real-world geotechnical scenarios.</li> </ul>						
Topics Covered	<p><b>Introduction:</b> Fundamentals and steps of modelling; Modelling techniques in Geotechnical engineering (Basic definitions and Examples)- Empirical, Theoretical, Numerical, Analogue, Physical Modelling (3)</p> <p><b>Physical Modelling at 1g:</b> Full scale Prototype modelling (1:1); Small scale (1:N) modelling at 1g- development of scaling relationship, dimensional analysis; Buckingham <math>\pi</math> Theorem; Example Problems (6)</p> <p><b>Physical Modelling at Ng:</b> Small scale (1:N) modelling at Ng (N = scale factor); Relevance of Ng Modelling; Hydraulic gradient simulate method and its applications (Example problems); Physical modelling using Centrifuge- Mechanics and principle of Centrifuge modelling and developments, Possibility of geotechnical centrifuge studies- modelling of prototypes, investigation of new phenomena, Parametric studies, validation of numerical model, Geotechnical engineering instruction (8)</p> <p><b>Geotechnical Centrifuge Modelling:</b> Equipment - type of centrifuges, Beam centrifuge, Drum centrifuge; Rotational acceleration and stress field- vertical stress in the radial acceleration field, radial acceleration field effects, selection of effective radius for a beam centrifuge; Soil layer in prototype and its respective centrifuge model, dependency of soil behavior on stress level and stress history; Verification of static equilibrium of a centrifuge model; Scaling laws in Centrifuge modelling for static and dynamic models- force, work, energy, time, dynamic compaction, consolidation, seepage, capillary rise, earthquake, etc.; Coriolis effect in centrifuge; Limitations in centrifuge based physical modelling; Modelling of models; Grain size effects (12)</p> <p><b>Applications of centrifuge modelling:</b> Embankments and Dams, Shallow foundations, Deep foundations, Retaining structures, Anchorages, Ground improvement, Environmental geotechnics, Earthquake effects, Other relevant Geotechnical problems (10)</p>						
Text Books, and/or reference material	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>David Muir Wood, Geotechnical Modelling, CRC Press, Taylor &amp; Francis, 2004.</li> <li>Madabhushi, G., Centrifuge Modeling for Civil Engineers, CRC Press, Taylor and Francis Group, 2015.</li> <li>Taylor, R.N., Geotechnical Centrifuge Technology, Taylor and Francis Publication, 1994.</li> </ol> <p><b>Reference Materials:</b></p> <ol style="list-style-type: none"> <li>Relevant IRC/IS codes/Technical papers</li> <li>Basic and Applied Soil Mechanics by Gopal Ranjan &amp; A.S.R. Rao, New Age International (P) Ltd.</li> <li>Foundation Analysis and Design by J. E. Bowles</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	1	2	2	1	-	-	-	-	-	-	-	-	-	-	-
CO3	1	1	-	1	1	-	-	-	-	-	-	-	1	-	-
CO4	1	2	2	2	-	-	-	-	-	-	-	-	3	-	2

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE627	Systems approach to Civil Engineering design	PEL	3	0	0	3	3
Pre-requisites:		Course Assessment methods					
No pre-requisites		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes	<ul style="list-style-type: none"> <li>CO1: Develop system approach based model of Civil Engineering systems.</li> <li>CO2: Solve optimization problems.</li> <li>CO3: Learn decision theory and its application to CE problems</li> </ul>						
Topics Covered	<p><b>Introduction:</b> System concept for engineering design, System classification, system modeling, Methodology of system design. (3)</p> <p><b>Optimization Techniques:</b> Linear Programming-Simplex Method Duality Theory, Dual Simplex, Sensitivity analysis, Integer programming (8)</p> <p><b>Network analysis:</b> Transportation problems, Assignment problems, Maximal flow, Project management (8)</p> <p><b>Non-Linear programming:</b> Basic concept, Introduction to Lagrange multipliers, Kuhn-Tucker conditions (3)</p> <p><b>Common Probabilistic models (8)</b></p> <p><b>Decision theory:</b> Decision problems, Decision criteria, Maximax, Equally likely, Minimax, Maximum likelihood, Bays' decision rule, Application to civil engineering systems design. (9)</p>						
Text Books, and/or reference material	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Engineering Hydrology by R.S. Varshney, Nem Chand &amp; Bros. Roorkee (U.P.) 1986.</li> <li>Operations Research by A. Ravindran, D. J. Philips, and J. J. Solberg, Principles and Practice 2<sup>nd</sup> Edition, John Weley &amp; Sons, New York, 1987.</li> <li>Engineering Optimization – Theory and Practice by S. S. Rao, 3<sup>rd</sup> Edition, New Age Int. (P) Ltd. Publishers, New Delhi, 2001.</li> <li>Introduction to Operations Research – A computer oriented Algorithmic Approach by B.E. Gillett, TMH Edition, New Delhi 1985.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Nonlinear Programming – Theory and Algorithms by M. S. Bazaraa, &amp; C. M. Shetty, John Wiley &amp; Sons, New York, 1990.</li> <li>Introduction to Optimum Design by J. S. Arora, McGraw Hill Int. Editions, McGraw Hill Book Co. Singapore, 1989.</li> <li>Engineering Optimization – methods and Applications by G.V. Reklaitis, A. Ravindran, and K. M. Ragsdell, John Wiley &amp; Sons, New York, 1983.</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code/provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	3	3	-	-	-	-	2	2	-	-	-	3	-	-
CO2	-	3	3	-	-	-	1	-	-	3	-	2	3	-	-
CO3	-	3	3	-	-	-	-	-	-	-	-	-	3	-	-

	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE628	Artificial Intelligence in Civil Engineering	PEL	3	0	0	3	3
Pre-requisites:		Course Assessment methods					
No pre-requisites		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes	<ul style="list-style-type: none"> <li>CO1: understand the basic of machine learning</li> <li>CO2: cognize the theory of machine learning based on knowledge of probability statistics and linear algebra.</li> <li>CO3: solve different engineering problems applying the machine learning methods.</li> <li>CO4: apply the different software of machine learning to solve civil engineering problems.</li> </ul>						
Topics Covered	<p><b>Introduction to Machine Learning:</b> What is learning? What is machine learning? Machine learning activities, Basic types of data in machine learning. <b>(4 hours)</b></p> <p><b>Basis of Probability and Statistics:</b> Axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' theorem and independence, Random Variable, Few Distributions, Joint Distributions, Some Basic Statistics. <b>(4 hours)</b></p> <p><b>Linear Algebra:</b> Linear algebra and problem. <b>(2 hours)</b></p> <p><b>Artificial Neural Network:</b> Understanding biological neuron, artificial neuron, architectures of neural network, learning process of ANN. <b>(6 hours)</b></p> <p><b>Bayesian Learning:</b> Bayes theorem and concept learning. Naïve Bayes classifier. <b>(2 hours)</b></p> <p><b>Machine Learning:</b> Types of machine learning Approach: Supervised learning, Unsupervised learning and Reinforced learning, Applications of machine learning, usage of different software. <b>(6 hours)</b></p> <p><b>Supervised Learning:</b> (a) Supervised learning-classification- Basics of supervised learning classification, Decision tree, Support vector machine. <b>(8 hours)</b></p> <p>(b) Supervised learning -Regression- Simple regression, other regression techniques. <b>(4 hours)</b></p> <p><b>Applications of Machine Learning:</b> Apply machine learning methods to solve Civil Engineering problems using Python, Keras, TensorFlow, etc. <b>(4 hours)</b></p>						
Text Books, and/or reference material	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Goulet, James-A, Probabilistic Machine Learning for Civil Engineers, MIT Press.</li> <li>Mitchell Tom M. Machine Learning, McGraw-Hill Education.</li> </ol> <p><b>REFERENCE BOOKS:</b></p> <ol style="list-style-type: none"> <li>Marsland Stephen, Machine Learning, CRC Press.</li> <li>Ang, A. H.-S. and Tang, W. H. 1984. Probability Concepts in Engineering Planning and Design: Volume 2 Decision, Risk and Reliability, Wiley, New York.</li> </ol>						

Mapping of Course Outcomes Cos → Pos → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	Code/provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-			
CO2	1	1	-	3	-	-	-	-	-	-	-	-			
CO3	3	3	-	-	2	-	-	-	-	-	-	-			
CO4	1	3	3	-	3	-	-	-	-	-	-	-			

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE629	Open channel Hydraulics	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Fluid Mechanics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>• <b>CO1:</b> Understanding mechanics of flow, energy &amp; momentum in an open channel</li> <li>• <b>CO2:</b> Computation of different components of flow in an open stream.</li> <li>• <b>CO3:</b> Capability for design of different type of open channel for operationalization of water-resources systems</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction:</b> Descriptions, types of flow, state of flow, regime of flow (2)</p> <p><b>Open-Channels and their properties:</b> Types, geometry, geometric elements of channel sections, velocity distribution, wide open channel, measurement of velocity, velocity-distribution coefficients and determination, pressure distribution in a channel section, effect of slope on pressure distribution. (7)</p> <p><b>Energy and Momentum Principles:</b> Energy, specific energy, criterion for a critical state of flow, interpretation of local phenomena, energy in non-prismatic channels, momentum in open-channel flow, specific force, momentum principle applied to non-prismatic channels. (6)</p> <p><b>Critical flow computations and Applications:</b> Critical flow, factors, flow computation, hydraulic exponent for flow computation, control &amp; measurement (6)</p> <p><b>Uniform flow in open channels:</b> Qualifications, establishment, expressing the velocity of a uniform flow, hydraulic gradient, Equation for uniform flow, Chezy formula, Chezy's resistance, factor, Manning's formula, Manning's roughness coefficient, factors, Manning's roughness coefficient table. (6)</p> <p><b>Computations of Uniform Flow:</b> The conveyance of a channel section, the section factor for uniform-flow computation, the hydraulic exponent for uniform-flow computation, flow in a channel section with composite roughness. Determination of the Normal Depth and Velocity, determination of the Normal and Critical Slopes, problems of uniform flow computation, computation of flood discharge, uniform surface flow (6)</p> <p><b>Design of Channels for Uniform Flow: (6)</b></p> <p><b>Non-erodible channels:</b> Non-erodible channel, non-erodible material and lining, minimum permissible velocity, channel slopes, freeboard, best hydraulic section, determination of section dimensions</p> <p><b>Erodible channels with scour not silt:</b> Method of approach, maximum permissible velocity, method of permissible velocity, tractive force, tractive-force ratio, permissible tractive force, method of tractive force, stable hydraulic section</p> <p><b>Grassed channel:</b> Grassed channel, retardance coefficient, the permissible velocity, selection of grass, procedure of design.</p>						

Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <p>1. Open Channel Hydraulics by K. Subramanya, Fourth Edition, McGraw-Hill Education (India) Private Limited, New Delhi.</p> <p><b>Reference Books:</b></p> <p>2. Open-Channel Hydraulics by V. T. Chow, McGraw-Hill Book Company, Inc., New York</p>
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Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	-	1
CO2	-	3	-	-	-	-	-	-	3	-	-	-	2	1	1
CO3	-	-	3	-	3	3	-	-	-	3	3	3	1	1	2

Course Code	Title of the course	Program Core (PCR)/ Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE710	Structural Dynamics	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Solid Mechanics		Continuous (CT) and end assessment (EA). CT+EA					

Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>• CO1: Develop &amp; analyze damped &amp; un-damped SDOF systems for free &amp; forced vibration.</li> <li>• CO2: Develop and analyze the MDOF systems for free &amp; forced vibration.</li> <li>• CO3: Model civil engineering structures &amp; derive the dynamic properties of structures</li> <li>• CO4: Calculate natural frequencies, mode shapes &amp; structural responses numerically</li> <li>• CO5: Apply the concepts &amp; principles of structural dynamics for earthquake analysis of civil engineering structures &amp; evaluate their seismic performance</li> </ul>
Topics Covered (Hrs)	<p><b>Introduction:</b> D'Alembert's principle, dynamic loads, definition of degrees of freedom (1)</p> <p><b>SDOF system:</b> Equations of motion, undamped and damped SDOF systems, viscous damping, critically damped, over-damped and under-damped system, damping coefficient determination, dynamic magnification factor and transmissibility. (6)</p> <p><b>Forced vibration of SDOF systems:</b> Vibration under sinusoidal loads, response to general dynamic loading - Duhamel's integral: impulse, rectangular, triangular loading problems. (4)</p> <p><b>Fourier analysis and response in the frequency domain</b> theory, problems (2)</p> <p><b>MDOF system:</b> Development and solution of equations of motion, problems (2)</p> <p><b>Free vibration of MDOF systems:</b> Eigen values and vectors, natural frequencies and modes, orthogonality of modes, normalization of modes, modal expansion, concept of normal/generalized coordinates, problems (5)</p> <p><b>Free vibration response:</b> Free vibration of un-damped systems, modal analysis. (3)</p> <p><b>Forced vibration of MDOF systems:</b> Modal expansion of excitation vector, modal analysis, modal contribution factors. (3)</p> <p><b>Forced vibration response:</b> Modal analysis, forced vibration for un-damped systems subjected to sinusoidal loading and arbitrary loading. (5)</p> <p><b>Damping in structures:</b> Classical, non-classical damping, mass proportional, stiffness proportional, Rayleigh, Caughey damping, Modal analysis for classically damped free and forced vibration systems (4)</p> <p><b>Earthquake analysis of structures:</b> Equations of motion for un-damped and classically damped systems single and multiple degree of freedom systems, modal participation factors, modal analysis, response spectrum analysis, modal combination rules (4)</p>

Text Books, and/or reference material(s)	<b>Text Books:</b>
	1. DynamicsofStructuresbyAnilK.Chopra,PHI 2. EarthquakeResistantDesignofstructurebyPankajAgarwalandManishShrikhande. 3. StructuralDynamics:TheoryandComputationbyMarioPaz,KluwerAcademicPublishers <b>Reference Books:</b> 4. ElementsofEarthquakeEngineering,JaiKrishna,A.R.Chandrasedkaran,B.Chandra.SouthAsian Publishers. 5. TheoryofVibrationwithApplications,W.T.Thomson,PHI

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	-	-	-	-	-	-	-	-	-	2	-	-
CO2	2	3	3	-	-	-	-	-	-	-	-	-	2	-	-
CO3	3	2	2	-	1	-	-	-	-	-	-	2	-	1	2
CO4	3	3	3	3	2	-	-	-	-	-	1	2	-	1	1
CO5	3	2	-	2	1	1	-	1	-	-	1	2	-	-	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE711	Advanced Design of Steel Structures	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Design of Steel Structures		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Understand the design aspects, principles of few steel structures as a whole.</li> <li>CO2: Apply basic knowledge of steel design of components for design solutions of whole structure.</li> <li>CO3: Formulate, analyze, and design of various Civil Engineering Steel structures.</li> </ul>						
Topics Covered (Hrs)	<p><b>Design of Industrial Shed:</b> Description of Different components, Loads Calculation, Analysis and Design of Truss members, Purlin, Top Chord and Bottom Chord Diagonals, Shoe Plate and Bolts design, Columns Design, Base Plate and Anchor Bolts Design. <b>(10)</b></p> <p><b>Design of water tank:</b> Staging, Columns braced type staging. <b>(8)</b></p> <p><b>Design of Castellated beams</b> and open web structures. <b>(4)</b></p> <p><b>Bridges:</b> Design loads for highway / railway bridges, Design of truss bridges for highway and railway. <b>(10)</b></p> <p><b>Introduction to Plastic Design:</b> Plastic hinge, Plastic-Collapse method, Plastic Analysis of Frames <b>(7)</b></p>						

Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Design of steel Structures by N. Subrahmaniam (Oxford publications)</li> <li>2. IS 800-2007: General Construction in Steel - Code of Practice</li> <li>3. IS 808-1989: Dimensions of Hot Rolled Steel beam, column, channel and angle sections</li> <li>4. SP 6(1)-1964: Handbook for Structural Engineers.</li> <li>5. IS 3370-1965 code for concrete structures for the storage of liquids</li> <li>6. IS 805: 1968 Code of Practice for Use of Steel in Gravity Water Tanks</li> <li>7. IRC: 6-2017 Standard Specifications and Code of Practice for Road Bridges</li> <li>8. <a href="http://www.nptel.iitm.ac.in/courses/">www.nptel.iitm.ac.in/courses/</a></li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>9. Limit State Design of Steel Structures by S.K. Duggal (McGraw Hill publications)</li> <li>10. Design of steel Structures by S.S. Bhavikatti (IK Int'l Publishing House, N Delhi)</li> </ol>
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Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	code provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	3	-	-	-	-	2	2	-	-	-	3	-	2
CO2	3	-	3	-	-	-	1	-	-	3	-	2	-	2	-
CO3	-	3	3	-	1	-	-	2	-	2	1	3	2	1	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE712	Earthquake Resistant Design of Structures	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Basic Civil Engineering		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>• CO1: Learn basic of earthquake engineering</li> <li>• CO2: Applying engineering mathematics in seismic analysis</li> <li>• CO3: Ability to design a structure earthquake resistive</li> <li>• CO4: Ability to manage earthquake disaster</li> </ul>						

Topics Covered (Hrs)	<p><b>Earthquake ground Motion Engineering Seismology (5) [CO1]</b> Theory of plate tectonics, seismic waves, earthquake size and magnitude, earthquake ground motion, characteristics, seismic zoning map of India</p> <p><b>Earthquakes Resistant Design and general guideline (5) [CO1]</b> Basic elements of earthquakes resistant design, structural modelling, seismic method of analysis – code based procedures and design philosophy, response spectra and design spectrum. Effect of Structural Irregularities on seismic performance of RC buildings.</p> <p><b>Earthquake resistant design of RC buildings (10) [CO2, CO3]</b> Determination of design lateral load: Equivalent lateral force procedure, dynamic analysis procedure.</p> <p><b>Earthquake resistant design of masonry buildings (5) [CO2, CO3]</b> Earthquake resistant design of masonry buildings - elastic properties of structural masonry, Behaviour of masonry structure during earthquake, bands &amp; reinforcement in masonry, lateral load analysis.</p> <p><b>Vulnerability assessment and rapid visual screening (5) [CO1, CO4]</b> Rapid visual screening by FEMA, Preliminary investigation and detailed evaluation</p> <p><b>Repair and Retrofitting (9) [CO1, CO4]</b> Repair, rehabilitation and retrofitting, local and global retrofitting. Materials for Retrofitting. Seismic base isolation</p>
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Earthquake resistant design of structures by Pankaj Agarwal and Manish Shrikhande</li> <li>2. Basics of Structural dynamics and aseismic Design by S. R. Damodarasamy and S. Kavitha</li> <li>3. Elements of Earthquake Engineering by Jai Krishna, A.R. Chandrasekharan, Brijesh Chandra</li> </ol>

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyses, design and prepare	Computer aided skills and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						1	1					1	3		2
CO2	2	2												1	2
CO3			3		2									1	2
CO4	3										2		3		

Course Code	Title of the course	Program Core (PCR)/ Electives (PEL)	Total number of contact hours				Credits
			Lecture (L)	Tutorial (T)	Practical (P)	Total hours	
CEE713	Green Building and Sustainable Materials	PEL	3	0	0	3	3

Pre-requisite(s)	Course Assessment methods
Building Science and Technology	Continuous (CT) and end assessment (EA). CT+EA

Course Outcomes (COs)	<ul style="list-style-type: none"> <li>CO1: Understand the concepts of green buildings, and sustainable construction.</li> <li>CO2: Learn about national and international green building assessment system and requirements.</li> <li>CO3: Learn the green building design elements and use of sustainable materials.</li> <li>CO4: Understand the techniques to reduce the carbon footprint of a green building.</li> </ul>
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Topics Covered (Hrs)	<p><b>Introduction to Green Buildings: (7)</b> Sustainable Development and Sustainable Construction, Rationale for High-Performance Green Buildings, Green Building Progress and Obstacles.</p> <p><b>Green Building Assessment: (10)</b> Purpose of Green Building Assessment Systems, Major Green Building Assessment Systems (international and national): BREEAM, LEED, GRIHA etc., Case study.</p> <p><b>Green Building Design: (10)</b> Conventional vs green building delivery systems, executing the green building project, the integrated design process role of Charrette in the design process; green building documentation requirements, Sustainable Site and Landscape</p> <p><b>Low-energy building strategies: (12)</b> Components of embodied energy, Calculation of embodied energy for construction materials, Energy concept and primary energy, Embodied energy via-a-vis operational energy in conditioned building, Life Cycle energy use, Control of energy use and carbon-footprint in building, distinguishing between green building products and green building materials, LCA of building materials and products, environmental product declaration; materials and product certification systems, emerging construction materials and products.</p>
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Text Books, and/or reference material (s)	<p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>G. Ballard, I. Tommelein, L. Koskela and G. Howell, Lean construction tools and techniques, 2002.</li> <li>C. J. Kibert, Sustainable Construction: Green Building Design &amp; Delivery, 4th ed. Wiley Publishers, 2016.</li> <li>C. Corfe and B. Clip, Implementing lean in construction: Lean and the sustainability agenda, CIRIA, 2013.</li> <li>C. A. Langston &amp; G.K.C. Ding, Sustainable Practices in the Built Environment, Butterworth Heinemann Publishers, 2011.</li> </ol>
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### Mapping of Course Outcome

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	Code provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	2	-	3	3	-	-	-	-	3	3	-	3
CO2	3	-	3	3	2	3	3	-	-	-	2	3	3	2	3
CO3	3	2	3	3	3	3	3	-	-	-	-	3	3	-	3
CO4	3	3	3	3	-	3	3	-	-	-	-	3	3	-	3

Course Code	Title of the course	Program Core (PCR)/Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE714	Structural Health Monitoring	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Knowledge of Solid Mechanics and Structural Design		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Knowledge of assessment and monitoring of existing structures as well as for newly constructed structures.</li> <li>CO2: Exposure and skill to use relevant NDT equipment for research and industrial applications.</li> <li>CO3: Knowledge on instrumentations in structures, their use and interpret the collected data from instrumentations.</li> <li>CO4: Based on the above, the students are expected to suggest remedial measures for distressed structures.</li> </ul>						
Topics Covered (Hrs)	<p><b>Preamble:</b> Definition of structure, different types of structures, behaviour of structures under variety of loading conditions, deterioration and failure of structures, structural materials. (4)</p> <p><b>Introduction:</b> What is structural health and SHM, importance, application and present scenario of SHM in India and abroad, parameter related to structural health. (3)</p> <p><b>Types of SHM:</b> Periodic and continuous, methods for implementation of each. (6)      <b>Measurement techniques:</b> Destructive and non-destructive (6)</p> <p><b>Equipment:</b> For non-destructive testing, working principles of this equipment and use (8)</p> <p><b>Health monitoring in dynamic condition:</b> Basics of structural dynamics, sensing technologies, data collection and analysis, basic concept of signal processing, identification of structural health using modal parameters. (10)</p> <p><b>Field visit:</b> Visit to the site(s) of old structure(s) for assessing their existing condition for SHM purpose. (2)</p>						
Text Books, and/or reference material (s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Structural Health Monitoring by Victor Giurgiutiu</li> <li>New trends in Structural Health Monitoring by Ostachowich, Witslaw, Guemes, Alfredo.</li> <li>Dynamics of structures by AK Chopra, Pearson/Prentice Hall.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Non-destructive Testing of Materials and structures by Buyukozturk and Tasdemir: Springer</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	code/provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	2	-
CO2	-	-	-	3	2	-	-	-	-	-	-	-	-	2	3
CO3	-	-	-	2	3	-	-	-	-	-	-	-	-	3	1
CO4	-	3	-	-	-	-	-	-	-	-	-	-	3	-	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			L	T	P	H	
CEE715	Railways, Airports, and Harbour Engineering	PCR	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
None		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	CO1- To develop a basic understanding and knowledge of Railway, Airport, and water transportation to measure transportation demand. CO2- Develop in-depth knowledge for assessing the infrastructural facility CO3- To understand the influencing parameters and components for infrastructural facilities like-railways, airports, runways, ports, and harbors. CO4- Design the infrastructure like- railways, airports, runways, ports, and harbours.						
Topics Covered (Hrs)	MODULE-I (8 Classes) <b>Components &amp; Geometric Design of Railways:</b> Introduction of Indian railways, component parts of railway track, problems of multi-gauge system, coning of wheels, alignments, and survey, permanent way track components, Type of rail sections, creep of rails, wear and failure in rails, Ballast requirements, sleeper requirements, types of sleepers, various train resistances. MODULE-II (6 Classes) <b>Railway Operation and Control:</b> Gradients and grade compensation, various speeds on a railway track, super-elevation, horizontal and vertical curves, Points and crossings, Design of simple turn-out, Signalling, and interlocking. MODULE-III (4 Classes) <b>Urban Mass Transit Rail:</b> Introduction of modern urban rail facilities like- Metro Rail, Mono Rail, Suburban Railway, Light rail, regional rapid rail, Tram, etc---- Technical details of those facilities,--National Urban Transport Policy MODULE-IV (8 Classes) <b>Airport Engineering:</b> Airport site selection, Air craft characteristics, various surface of an airport, Wind rose diagram, Geometric elements of run way and taxiway, holding apron, parking configuration, terminal building, visual aids, air traffic control, airport marking and lighting. MODULE-V (8 Classes) <b>Harbour Engineering:</b> Classification of Harbour basin, general layout of harbors, Docks, and Different components of docks. MODULE-V (5 Classes) <b>Inland waterways,</b> Inland water transportation in India, classification of waterways, economics of inland waterways transportation, national waterways						
Text Books and/or reference material(s)	Books: 1. A text book on railway engineering, By S.C.Saxena and M.G.Arora 2. Railway Engineering by Satish Chandra & MM Agrawal, Oxford University Press. 3. Transportation Engineering, Volume-II- Railways, Airports, Docks and Harbours, Bridges and Tunnels by C. Venkatramiah, Universities Press 4. Air-port Engineering by S.K.Khanna and M.G.Arora						

### Mapping of Course Outcomes Cos-POs-PSOs

	Engineering knowledge	Problem analysis	Design/development of solution	Conduct investigations of complex problem	Modern tool usage	The engineer and team	Environment and sustainability	Ethics	Individual & team	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	Professional code of conduct/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	-	-	-	2	-	-	3	2	-	2
CO2	2	3	3	1	-	-	1	-	-	2	-	3	2	-	3
CO3	3	3	3	1	-	1	-	2	-	2	1	1	3	1	3
CO4	3	3	3	1	-	1	1	2	-	-	1	2	3	1	3

Course Code	Title of the course	Program Core (PCR)/Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEC716	Industrial Wastes	PEL	3	0	0	3	3
Pre-requisite(s) Environmental Engineering		Course Assessment methods Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Apply knowledge of different types of industrial pollutants (air, solid waste and wastewater) for design solutions.</li> <li>CO2: Understand basic design philosophies applicable for control and safe disposal of different types of industrial pollutants.</li> <li>CO3: Formulate, analyze, and design basic control and disposal systems of different types of industrial pollutants.</li> </ul>						
Topics Covered (Hrs)	<p style="text-align: center;"><b>Industrial sources of pollution, types of pollutants. (5)</b>  <b>Air pollution</b> – Its effects, measurement, methods &amp; equipment of control. (12)  <b>Solid wastes</b> – quantity &amp; characteristics, methods of collection, disposal &amp; reuse. (12) <b>Wastewater</b> – characteristics, methods of collection, treatment &amp; disposal. (10)</p>						
Text Books, and/or reference material (s)	<p style="text-align: center;"><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Environmental Engineering by H.S. Peavy, D. R. Rowe &amp; G. Tchobanoglous, McGraw Hill Education (India) Private Limited, New Delhi</li> <li>Introduction to Environmental Engineering by M.L. Davis &amp; D.A. Cornwell, Tata McGraw-Hill Education Private Limited, New Delhi</li> </ol> <p style="text-align: center;"><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Environmental Engineering – A Design Approach by A.P. Sincero &amp; G.A. Sincero, Prentice – Hall of India Private Limited, New Delhi</li> <li>Industrial Water Pollution Control by W.W. Eckenfelder, Jr. (McGraw-Hill Higher Education)</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigation of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	2	-	-	-	1	-	-
CO2	3	-	3	-	-	-	1	-	-	2	-	2	3	1	1
CO3	-	-	3	-	-	-	-	2	-	2	1	3	3	2	2

Course Code	Title of the course	Program Core (PCR)/Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE717	Ground Improvement	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Soil Mechanics & Foundation Engineering		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: understand how to improve the geotechnical properties of soft soil by different techniques.</li> <li>CO2: identify ground conditions and suggest method of improvement</li> <li>CO3: understand the principles of soil reinforcement and confinement in engineering constructions.</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction:</b> Formation of soil, major soil type, collapsible soil, expansive soil, ground improvements; objective, potential. (8)</p> <p><b>Ground Improvement in Granular Soil:</b> In place densification by (i) Vibro floatation (ii) Compaction pile (iii) Vibro Compaction Piles (iv) Dynamic Compaction. (12)</p> <p><b>Ground Improvement in Cohesive Soil:</b> Preloading with and without vertical drains, Compressibility, vertical and radial consolidation, preloading methods. Types of Drains, Design of vertical Drains, construction techniques. Stone Column: Function Design principles, load carrying capacity, construction techniques, settlement of stone column foundation. (19)</p>						
Text Books, and/or reference material (s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Ground Improvement by M.P. Moseley and K. Krish, (2006) – II edition, Taylor and Francis</li> <li>Designing with Geosynthetics by Koerner, R.M (1994), Prentice Hall, New Jersey</li> <li>Engineering Principles of Ground Modifications by Hausmann, M. R. (1990), McGraw Hill publications</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Earth Reinforcement and soil structures by Jones C.J.F.P. (1985), Butterworths, London.</li> <li>Ground Control and Improvement by Xianthakos, Abreimson and Bruce</li> <li>Ground Control and Improvement by K. Krish &amp; F. Krish (2010), John Wiley &amp; Sons, 1994.</li> <li>Foundation Design principles and Practices by Donald P Coduto, 2nd edition, Pearson, Indian edition, 2012</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	Code/provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	3	-	2	-	-	-	-	-	-	-	-	3		1
CO2	-	2	3	2	-	-	1	-	-	-	-	-		3	1
CO3	-	3	2	-	-	-	-	-	-	-	-	-	3		1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE718	Soil Dynamics	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Soil Mechanics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes	<ul style="list-style-type: none"> <li>CO1: develop a mechanism to design the foundations for resisting vibrations and achieve static equilibrium conditions of structures.</li> <li>CO2: understand the classical geotechnical failures due to liquefaction and mitigate the same.</li> <li>CO3: design of foundations in large structures like power plants, other industrial buildings etc., for analysing the vibrating waves which can be isolated and measures for achieving safety of the adjacent foundations.</li> </ul>						
Topics Covered (Hrs)	Vibration of elementary system, Single degree and two-degree freedom systems, Wave propagation in an elastic, homogeneous, isotropic medium. (10) Propagation of waves in saturated media, Behaviour of dynamically loaded soils, Evaluation of dynamic properties of soil. (10) Theories for vibration of foundations in elastic media, Design procedures for dynamically loaded foundations for vertical and rocking vibrations. (10) Foundations under reciprocating engines, Foundations for forge hammers, motor generators, turbo-generators and crushers. (9)						
Text Books, and/or reference material (s)	<b>Text Books:</b> 1. Soil Dynamics and Machine Foundation by Swami Saran, Galgotia Publications 2. Vibrations Vibration Analysis and Foundation Dynamics by NSVKameswara Rao, Wheeler Publishing, New Delhi. 3. Fundamentals of Soil Dynamics by BM Das <b>Reference Books:</b> 4. Vibrations of Soils and Foundations by Richart Hall and Woods 5. Foundations of Machines - Analysis and Design by Prakash and Puri. 6. Analysis and design of Foundations for Vibrations by P J Moore 7. Dynamics of bases and Foundations by DDB Barkar						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	3	2	-	-	-	-	-	1	-	-	2	-	3
CO2	-	3	-	-	-	-	1	-	-	-	-	-	3	-	1
CO3	-	-	3	-	-	-	2	-	-	-	1	-	3	-	2

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE719	Slope Stability and Reinforced Earth	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Foundation Engineering		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: learn basic mechanism of reinforced earth.</li> <li>CO2: design wall with reinforced backfill</li> <li>CO3: analyze stability of reinforced slopes</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction</b>, Basic mechanism of reinforced earth, Practical application. <b>(4)</b></p> <p><b>Basic components of reinforced soil:</b> Soil or fill matrix, Reinforcements, facing elements. <b>(7)</b></p> <p><b>Strength characteristics of reinforced soil:</b> Basic concept, Sigma and Tau models, laboratory studies, sliding shear test, pull-out tests. <b>(8)</b></p> <p><b>Wall with reinforced backfill:</b> Pressure intensity on the wall, Stability against sliding, overturning and bearing failure, Increase of earth pressure due to a line load on the backfill, design procedure. <b>(10)</b></p> <p><b>Methods of Slope Stability:</b> Taylor Charts, Method of Slices, Effect of Tension Cracks, Vertical Cuts. Bishop's Analysis. Non-circular Failure Surfaces, Stabilization of slopes: Drainage measures, Soil reinforcement (geosynthetics/soil nailing etc). <b>(10)</b></p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Reinforced Earth &amp; Geotextiles by Koerner</li> <li>Reinforced Earth &amp; Geotextiles by G.V. Rao</li> <li>Earth and Earth-Rock Dams by Sherard, Woodward, Gizienski and Clevenger. John Wiley &amp; Sons. 1963</li> <li>Earth and Rock Fill Dams by Bharat Singh and H. D. Sharma, 1999</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Slope Stability and Stabilisation methods by L.W. Abramson, T.S. Lee, and S. Sharma, John Wiley &amp; Sons. (2002)</li> <li>The Stability of Slopes by E.N. Bromhead, (1992), Blackie academic and professional, London.</li> <li>Earth &amp; Rockfill Dams, Principles of Design and Construction by Christian, Kutzner Published Oxford and IBH.</li> <li>Handbook of Slope Stabilization by J.A.R. Ortiago, and A.S.F. J. Sayao, 2004.</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	Code provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	2	3	-	-	-	-	-	-	-	-	-	2	1	1
CO3	-	3	-	2	-	-	-	-	-	-	-	-	2	1	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE720	Material Technology	Program Elective (PEL)	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Engineering Mechanics and Mathematics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Development of skills for predicting structural behaviour of different materials under different loads</li> <li>CO2: Knowledge of basics of analysis and design of structural components, made of variety of materials</li> <li>CO3: Developing the requisite skill that helps in studying the advanced courses related to Structural Analysis, Design of Structures</li> </ul>						
Topics Covered (Hrs)	<p><b>Material and Material Defects:</b> Metallic materials, Polymeric Materials, Ceramics and Composites, elastic and plastic deformation, Mechanism of deformation and its significance in design and shaping. (8)</p> <p><b>Failure mechanisms of Materials: Fracture:</b> Definition and types of fracture, Brittle fracture: Critical stress and crack propagation velocity for brittle fracture. Ductile fracture: Notch effect on fracture. Fracture toughness. Ductility transition. Definition and signification. Conditions of ductility transition factors affecting it. (6)</p> <p><b>Fatigue Failure:</b> Definition of fatigue and significance of cyclic stress. Mechanism of fatigue and theories of fatigue failure, Fatigue testing. Test data presentation and statistical evolution. S-N Curve and its interpretation. Influence of important factors on fatigue. Notch effect, surface effect, Effect of pre-stressing, corrosion fatigue, Thermal fatigue. (4)</p> <p><b>Creep:</b> Definition and significance of creep. Effect of temperature and creep on mechanical behaviour of materials. Creep testing and data presentation. (6)</p> <p><b>Introduction to New Materials: Composites:</b> Basic concepts of composites, Processing of composites, advantages over metallic materials, various types of composites and their applications. Nano Materials: Introduction, Concepts, synthesis of nanomaterials, examples, applications and nano-composites. Polymers: Basic concepts, Processing methods, advantages and disadvantages over metallic materials, examples and applications. (8)</p> <p><b>Strength Analysis of materials under different loading:</b> Stress, strain due to normal, shear, flexure, impact, torsion loads. Analysis by energy method. (7)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. A Text Book of Strength of Materials by Ghosh &amp; Datta, 2ed, New Age International Publication Pvt. Ltd, New Delhi</li> <li>2. Engineering Materials Technology by W. Bolton, 3ed, Taylor &amp; Francis Ltd</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>3. Engineering Materials: An Introduction to Properties, Applications and Design by David R.H. Jones, Michael F. Ashby, 4ed, Elsevier (BH)</li> </ol>						

### Mapping of Course Outcomes COs □ POs □ PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	2	-	-	-	3	-	1
CO2	3	-	3	-	-	-	1	-	-	2	-	2	3	1	1
CO3	-	-	3	-	-	-	-	2	-	2	1	3	3	-	1

Course Code	Title of the course	Program Core (PCR)/Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE721	Offshore Structural Dynamics	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Solid mechanics & Structural analysis		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Identify the types of offshore structures, parameters governing solid-fluid interaction and environmental forces acting on offshore structures.</li> <li>CO2: Apply static methods of analysis for stresses in Offshore structures</li> <li>CO3: Solve for response analysis of offshore structures – single and multi-degree of freedom problems, frequency and time domain analyses.</li> <li>CO4: Evaluate responses under random waves</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction:</b> Loads and structural terms of different types of offshore structures. (2)</p> <p><b>Fundamental of offshore structural analysis:</b> Stress and strain, bending of beams, Beams under torsion, Beam deflection, Buckling of beams, Bernoulli-Euler beam theory, Matrix analysis of plane, Space trusses, and Plane space frames. (8)</p> <p><b>Environmental loadings:</b> Winds forces, Ocean surface waves, Wave loads on offshore structures, Buoyant forces, Current loadings, additional environmental loadings. (6)</p> <p><b>Static methods of analysis:</b> Frame analysis of steel offshore structures, bending stresses correction from axial loading, Pressure induced stresses in steel structures, Ring stiffeners, Analysis of joints. (10)</p> <p><b>Dynamics of offshore structures:</b> Modelling of offshore structures-. Single and multi-degree freedom systems- Dynamic amplification factor- Response of offshore structures- Coupled and uncoupled motions- Frequency domain analysis- Time domain analysis- Newmark-Beta method- Wilson <math>\theta</math> method- Response analysis of fixed platforms- Response analysis of compliant platforms. Response in Random Waves (13)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Offshore Structural Engineering by Thomas H Dawson, Prentice Hall, 1983</li> <li>Dynamic Analysis and Design of Ocean Structures by Srinivasan Chandrasekaran, Springer, 2015.</li> <li>Dynamics of Offshore Structures by Wilson, J. F., John Wiley, 2002.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Offshore Mechanics by Madjid Karimirad, Constantine Michailides and Ali Nematbakhsh, Wiley, 1 edition</li> <li>Offshore structures – Vol. 1 &amp; 2 by Clauss, G, Lehmann, E &amp; Ostergaard, C., Springer-Verlag, 1992.</li> </ol>						

### Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	1	-	-	-	-	-	2	-	-
CO2	3	-	2	-	3	-	-	-	-	-	-	-	3	-	-
CO3	3	-	2	-	3	-	-	-	-	1	-	-	3	2	-
CO4	3	-	2	-	3	-	-	-	-	1	-	-	3	2	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE722	Pre-stressed Concrete	PCL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Solid mechanics and Design of Concrete Structures		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs)	<ul style="list-style-type: none"> <li>CO1: Apply knowledge of solid mechanics &amp; concrete structures for design solutions.</li> <li>CO2: Understand basic design philosophies applicable to pre-stressed concrete structures.</li> <li>CO3: Formulate, analyse, and design basic components of Civil Engineering Pre-stressed Concrete structures.</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction:</b> Basic principles, advantage, Comparison with RC, Types of pre-stressing and Stress analysis (4)</p> <p><b>Materials:</b> Specifications and characteristics of concrete and high tensile steel (2)</p> <p><b>Loss of Prestress:</b> Different types of loss with derivation and numerical problems (4)</p> <p><b>Flexural Analysis:</b> Derivation of moment of resistance, Pre-stressing force and eccentricity with numerical problems (6)</p> <p><b>Shear and torsion:</b> Design of beam for shear and torsion (5)</p> <p><b>Deflection and Cracking:</b> Cause and requirement along with numerical problems (5)</p> <p><b>Design of end blocks:</b> Transmission length, design of bearing plate and burst reinforcement (4)</p> <p><b>Member Design:</b> One-way slab and beam design, two-way pre-stressing, Circular pre-stressing, Partial pre-stressing, Composite construction with pre-stressed concrete and reinforced concrete. (9)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Prestressed Concrete, 5<sup>th</sup> Edition by N. Krishna Raju, Tata McGraw-Hill Publishing Company Limited, New Delhi.</li> <li>Prestressed Concrete, 5<sup>th</sup> Edition, by S. Ramamrutham, Dhanpat Rai Publishing Co. Pvt. Ltd. New Delhi.</li> <li>IS 1343:2012, Prestressed Concrete – Code of Practice (2<sup>nd</sup> Revision), BIS, New Delhi.</li> <li>www.nptel.ac.in</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Fundamentals of Prestressed Concrete by N.C. Sinha &amp; S. K. Roy, S. Chand &amp; Company Ltd, New Delhi</li> </ol>						

### Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	2	-	-	-	2	2	2
CO2	3	-	3	-	-	-	1	-	-	2	-	2	3	3	3
CO3	-	-	3	-	-	-	-	2	-	2	1	3	3	3	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE723	Piping Engineering	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Solid Mechanics, Structural Analysis		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs):	<ul style="list-style-type: none"> <li>At the end of the course, the student will be able to:</li> <li>CO1: understand basic of piping system</li> <li>CO2: analyse the piping based on the knowledge of mechanics.</li> <li>CO3: design the pipes using the analytical and codal specifications</li> <li>CO4: apply the different software of machine learning to solve civil engineering problems.</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction to Piping Engineering:</b> Role of piping, Scope of piping engineering, selection of materials, piping specifications. <b>(9 hours)</b></p> <p><b>Pipe Stress Analysis:</b> Forces and moments on a piping system, Failure theories, Stress categories, Stress limits, Fatigue <b>(10 hours)</b></p> <p><b>Design of Pipes:</b> Sustained loads, Occasional loads, Expansion loads, Hydraulic design consideration. Calculation of minimum wall thickness of a pipe. <b>(10 hours)</b></p> <p><b>Pipe Supports:</b> Rigid supports, Spring support, Snubbers, Sway Braces. Design of pipe supports. <b>(6 hours)</b></p> <p><b>Codes, standards, and regulations:</b> Use of different codes, standards and regulations related to piping. <b>(4 hours)</b></p>						
Text Books, and/or reference material(s)	<p><b>TEXT BOOKS:</b></p> <ol style="list-style-type: none"> <li>Sam Kannapan, P.E. Pipe Stress Analysis Willey – Interscience Publications.</li> <li>Sahu, G.K. Handbook of Piping Design, New Age International Publisher.</li> </ol> <p><b>REFERENCE BOOKS:</b></p> <ol style="list-style-type: none"> <li>Kellogg, Design of Piping System, 2/e M.W. Kellogg Co. 1976.</li> <li>McAllister E.W. Pipeline Rules of Thumb Handbook, Gulf Publication</li> </ol>						

**Mapping of Course Outcomes COs → POs → PSOs**

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigation of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	3	1	2	-	-	-	2	-	-	-	-	-	-
CO4	-	3	3	-	-	-	-	-	2	-	-	-	-	-	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE724	Theory of Elasticity and Plasticity	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Engineering & Solid Mechanics		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes	<ul style="list-style-type: none"> <li>CO1: To develop basic understanding of the behaviour of materials.</li> <li>CO2: To define the stress and strain behaviour of structural elements.</li> <li>CO3: To apply theory of elasticity in bending and torsion problems.</li> <li>CO4: To apply theory of plasticity in failures of different materials and structures.</li> </ul>						
Topics Covered	<p><b>Stress &amp; Strain:</b> Stress equilibrium equations, rectangular, cylindrical and spherical coordinates, Generalized Hooke's Law, Stress and strain compatibility equations. Plane stress and plane strain problems, Airy's stress function, Principal Stresses and strains, stress &amp; strain invariants, numerical problems. (12)</p> <p><b>Torsion:</b> Shafts of circular and non-circular prismatic sections, Saint Venant theory, warping function, stress function. (7)</p> <p><b>Theories of Failure:</b> Basic concepts and Yield Criteria, Different Theories of Failure, Yield Locus and Yield Surfaces. Equations of Plasticity. (8)</p> <p><b>Plasticity:</b> hydrostatic stresses, deviatoric stresses, invariants of deviatoric stresses, yield criteria, von Mises, Tresca yield criteria, theories of plastic flow, plane stress, plane strain problems in plasticity, thick cylinders, thick spheres. (12)</p>						
Text Books, and/or reference material	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Theory of Elasticity and Plasticity by S. Timoshenko, McGraw Hill Book company.</li> <li>Theory of Elasticity and Plasticity by Sadhu Singh, Khanna Publishers.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Advanced Strength of materials by Papov, McGraw Hill Book Company.</li> <li>Plasticity for structural Engineers by Chen, W.F. and Han, D.J., Springer-Verlag, New York.</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	code/provisions/guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	1	1	-
CO3	3	3	2	2	-	-	-	-	-	-	-	-	2	1	-
CO4	3	3	2	2	-	-	-	-	-	-	-	-	2	2	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE725	Traffic Engineering and Management	PEL	3	0	0	3	3
Pre-requisite (s)		Course Assessment methods					
Transportation Engineering		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs):	<ul style="list-style-type: none"> <li>• CO1: Apply knowledge of traffic study &amp; analysis for design solutions.</li> <li>• CO2: Understand basic design philosophy applicable to traffic flow &amp; highway intersections.</li> <li>• CO3: Formulate, analyze, and design basic components of highway intersections.</li> </ul>						
Topics Covered (Hrs)	<p><b>Traffic characteristics</b>, Traffic engineering studies and analysis: Volume, speed, delay, origin and destination. (18)</p> <p><b>Highway intersections</b>, Traffic flow theory, Traffic capacity, Traffic operations and control, Signal systems, Parking and terminal facilities, Traffic safety. (18)</p> <p><b>Impact of highway traffic on environment</b>. (3)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <p>1. Traffic Engineering by R.P. Roess, W.R. McShane and E.S. Prassas, Prentice Hall.</p> <p><b>Reference Books:</b></p> <p>2. Transportation Engineering and Planning, C.S. Papacostas, and P.D. Prevedouros, Prentice Hall India</p> <p>3. Principles of Transportation Engineering, P. Chakroborty and A. Das, Prentice Hall India.</p>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	-	-	-	2	-	-	-	3	3	1
CO2	3	-	3	-	-	-	1	-	-	2	-	2	3	2	1
CO3	-	-	3	-	-	-	-	2	-	2	1	3	1	2	3

Course Code	Title of the course	Program Core (PCR)/ Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE726	Soil Structure Interaction	PEL	3	0	0	3	3
Pre-requisite(s)			Course Assessment methods				
Structural Analysis, Soil Mechanics and Foundation Engineering			Continuous (CT) and end assessment (EA). CT+EA				
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Understand the basis of soil-structure interaction.</li> <li>CO2: Understand various soil interaction models like beam on elastic foundation (Winkler beam model), infinite beam, finite beam models.</li> <li>CO3: Apply soil-structure interaction model to different type of foundations like pile, sheet pile walls (cantilever and anchored sheet pile walls).</li> <li>CO4: Analyse the foundation of different civil structures with considering soil-structure interaction in static as well as dynamic conditions.</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction</b>, Superstructure-foundation interaction, Analytical formulations. (4)</p> <p><b>Interaction problems</b> of shallow foundation combined footing, Rigid method, and Flexible method. (5)</p> <p><b>Beams on elastic foundation</b>, Infinite beam, Finite beam, Modulus of subgrade reaction and effecting parameters. (8)</p> <p><b>Sheet pile wall</b>, Cantilever and anchored sheet pile wall, Fixed earth support, Free earth support. (6)</p> <p><b>Retaining walls</b>, Conduits, Load on different types of conduits, Design charts. (5)</p> <p><b>Braced excavation</b>, Pressure distribution in braced walls, Estimation of strut load etc., Stability of bottom of excavation. (4)</p> <p><b>Piles</b> under different loading conditions, Analysis under lateral load, Different approaches, Mechanism of failure, Ultimate load, Deflections, Elastic continuum approach, Analysis and design. (7)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Geotechnical Engineering: Principal and Practices of Soil Mechanics and foundation Engineering by V N.S. Murthy,</li> <li>Foundation analysis and Design by J.E. Bowles.</li> <li>Basic and Applied Soil Mechanics by G. Ranjan and A. S. Rao</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Advanced Geotechnical Engineering soil-structure Interaction using Computer and Material Models by C. S. Desai, and M. Zaman</li> <li>Advanced Soil Mechanics by B.M. Das, McGraw Hills Publishers</li> </ol>						

**Mapping of Course Outcomes COs → POs → PSOs**

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
CO3	2	-	2	-	-	-	-	-	-	-	-	-	2	1	1
CO4	1	2	-	1	-	-	-	-	-	-	-	-	2	1	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE727	Machine Foundation	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Mechanics of structures		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>CO1: Acquire knowledge of Machines and its Foundation: Types and Forces acting upon, dynamic analysis</li> <li>CO2: Ability to conduct Field-Experiment and Analyze the data with interpretation for determining dynamic properties of Soil</li> <li>CO3: Ability to Design Suitable Foundations based on Soil as a Spring, and a Half-Space continuum</li> <li>CO4: Ability for understanding the need of future studies</li> </ul>						
Topics Covered (Hrs)	<p><b>Single Degree freedom system:</b> Free vibration of Single Degree freedom system, natural frequency and time period, damping, Amplitude, Forced vibration, dynamic magnification factor (5)</p> <p><b>Two Degree Freedom System:</b> Free and Forced Vibration of Two Degree Freedom System, Natural frequencies and their arrangement, Eigen value and Eigen vector, normal coordinates, Effect of damping, generalized mass and stiffness matrices. (7)</p> <p><b>Soil Stiffness and damping:</b> Experimental Procedure for finding out Soil Stiffness and damping. (2)</p> <p><b>Machine Vibration:</b> Type of Machines, permissible amplitude vs. time period, Soil modeling as linear un-damped springs. Soil as Half-Space, inclusion of damping, embedment effect. (6)</p> <p><b>Foundation design:</b> Foundation analysis and design as linear spring, vertical vibration, pure sliding and rocking vibration. (6)</p> <p><b> Couple vibration of sliding and rocking. (6)</b></p> <p><b>Elastic half-space approach of analysis and design (7)</b></p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>Hand book of Machine Foundations by P. Srinivasulu and C.V. Vaidyanathan, Tata-Mc-Graw-Hill Publishing Company Ltd.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>Design Aids in Soil Mechanics and Foundation Engineering by S.R. Kaniraj, Tata-Mc-Graw-Hill Publishing Company Ltd.</li> </ol>						

Mapping of Course Outcomes COs → POs → PSOs

	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigation of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	code/provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	3	-	-	-	-	-	-	-	1	-	-
CO2	-	3	-	-	2	-	-	-	-	-	-	-	1	1	1
CO3	-	-	3	-	-	2	-	1	-	-	-	-	2	1	1
CO4	-	-	-	-	-	2	-	1	-	-	-	3	1	1	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE728	Water resource System Planning and Management	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
Fluid Mechanics, Irrigation Engineering, Water Resources Engineering, Economics and Computer Applications		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs) :	<ul style="list-style-type: none"> <li>• CO1: Understanding of different aspects of systems of water resources</li> <li>• CO2: Learning of optimization techniques, linear and dynamic Programming.</li> <li>• CO3: Ability to formulate models of reservoir systems, size, operation and hydropower production</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction:</b> Overview and Role of engineers (2)</p> <p><b>Engineering economic analysis:</b> Principles of engineering economics, Mathematics of economic analysis, Price theory and resources allocation, Conditions of project optimality, Benefit-cost analysis, Discount rate. (5)</p> <p><b>Identification and evaluation of water management plans:</b> System concept, System design methodology, Optimal design, Introduction to classical optimisation techniques with simple numerical examples, Simulation analysis. (5)</p> <p><b>Planning for flood control:</b> Planning context, Developing the supply, Estimating the demand, Project feasibility. (5)</p> <p><b>Planning for drainage:</b> Planning context, Developing the supply, Estimating the demand, Project feasibility. (5)</p> <p><b>Planning for water supply:</b> Planning context, Developing the supply, Estimating irrigation demand, Estimating urban demand and Project feasibility. (5)</p> <p><b>Planning for hydroelectric power:</b> Planning context, Developing the supply, Estimating the demand, Project feasibility. (4)</p> <p><b>Planning for navigation:</b> Planning context, Developing the supply, Estimating the demand, Project feasibility. (4)</p> <p><b>Irrigation planning and operation:</b> Planning context, Developing the supply, Estimating the demand, Project feasibility. (4)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b></p> <ol style="list-style-type: none"> <li>1. Water Resources Systems – Modelling Techniques and Analysis by S. Vedula and P.P. Mujumdar, Tata McGraw-Hill Publishing Company Limited, New Delhi.</li> </ol> <p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>2. Irrigation System Design – An Engineering Approach by H. Cuenca, Richard, Prentice Hall, Englewood Cliffs, New Jersey 07632</li> <li>3. Water Demand Management by Butler, David and Memon, Fayyaz Ali, IWA Publishing, London</li> </ol>						

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	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigation of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skill and tools	code/provisions/ guide lines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO2	-	-	3	-	-	-	-	-	-	-	-	-	3	-	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-	3	-	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CEE729	Sediment Transport	PEL	3	0	0	3	3
Pre-requisite(s)		Course Assessment methods					
CEC302, CEC601.		Continuous (CT) and end assessment (EA). CT+EA					
Course Outcomes (COs):	<ul style="list-style-type: none"> <li>CO1: Understanding of the origin and mechanism of sediment transport</li> <li>CO2: Development of capabilities to analyze sediment load.</li> <li>CO3: Ability to develop model to predict sediment load.</li> <li>CO4: Capability to design stable channel to carry the predicted sediment load</li> </ul>						
Topics Covered (Hrs)	<p><b>Introduction: (2)</b>  <b>Sediment properties:</b> particle size shape and density, fall velocity, viscosity, colloids and flocculation. Introduction (4)  <b>Threshold of particle motion. (3)</b>  <b>Sand transport by air:</b> Surface creep, effects of sand movement on wind, instability of a flat sand surface, ridges and dunes. (4)  <b>Sediment movement in water:</b> bed features and meanders, analytical models, stresses in flow of fluid-solid mixtures. (4)  <b>Channel roughness and resistance to flow. (2)</b>  <b>Sediment load:</b> Bed Load, Bed Forms; Effective bed roughness; Armouring, suspended sediment, diffusion approach, energy approach, statistical approach, suspended sediment load, total Load. (6)  <b>Stable Channel Design:</b> The empirical stable channel design - Tractive force method of stable channel design - Drag distribution and resistance to motion - Design values for boundary shear - The stable cross-section - Design by tractive force method (8)  <b>Cohesive sediments: (2)</b>  Erosion, deposition, scour, local scour at different structures. (2)  Dimensional Analysis and Similitude (2)</p>						
Text Books, and/or reference material(s)	<p><b>Text Books:</b>  1. Mechanics of Sediment Transportation and Alluvial Stream Problems by R.J. Garde, K. G. Ranga Raju, Revised Third Edition, New Age International Publishers, and New Delhi.  2. Loose boundary hydraulics by A. J. Raudkivi, 2nd edition Pergamon press</p> <p><b>Reference Books:</b>  3. Sediment Transport by V.T. Chow, McGraw-Hill Book Company, Inc., New York</p>						

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	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment & sustainability	Ethics	Individual & team work	Communication	Project management & finance	Life-long learning	Plan, analyse, design and prepare	Computer aided skills and tools	codal provisions/ guidelines
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	3	-	-	-	2	-	-
CO2	-	3	-	-	-	-	-	-	3	-	-	-	2	-	-
CO3	-	-	-	-	3	-	-	3	-	-	-	-	2	-	-
CO4	-	-	-	-	-	-	-	-	-	3	3	3	2	-	-