SEMESTER –VII

DESIGN OF CONCRETE STRUCTURES-II

Course code	**PE/CE/17-T**			
Category	**Program Core**			
Course title	**Design of Concrete Structures-II**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course Outcomes:

S. No.	**Course outcomes** At the end of the course students will be able to:	**RBT* Level**
CO1	Explain design of special concrete structures like continuous/ curved beams, stair-cases, water tanks, domes, retaining walls and bridges.	**L2(Understanding)**
CO2	Employ the concepts of structural engineering for the construction of special structures.	**L3(Applying)**
CO3	Examine the structural aspects of special structures.	**L4 (Analyzing)**
CO4	Evaluate the structural condition of special structures	**L5 (Evaluating)**
CO5	Design special concrete structures like continuous/ curved beams, stair-cases, water tanks, domes, retaining walls and bridges.	**L6 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT I

Continuous Beams: Basic assumptions, Moment of inertia, settlements, Modification of moments, maximum moments and shear, redistribution of moments for single and multi-span beams, design examples.

Prestressed Concrete: Basic principles, classification of prestressed members, various prestressing systems, losses in prestress, initial and final stress conditions, analysis and design of sections for flexure and shear, load balancing concept, I:S:Specifications. End blocks-Analysis of stresses, Magnel's method, Guyon's method, Bursting and spalling stresses, design examples

UNIT II

Flat slabs: Advantages of flat slabs, general design considerations, approximate direct design method, design of flat slabs, openings in flat slab, design of various types of staircases, design examples.

Foundations: Combined footings, raft foundation, design of pile cap and piles, under-reamed piles, design examples.

UNIT III

Water Tanks, Silos and Bunkers: Estimation of Wind and earthquake forces, design requirements, rectangular and cylindrical underground and overhead tanks, Intze tanks, design considerations, design examples.

Silos and Bunkers: Various theories, Bunkers with sloping bottoms and with high side walls, battery of bunkers, design examples.

UNIT IV

Building Frames:

Introduction, Member stiffnesses, Loads, Analysis for vertical and lateral loads, Torsion in buildings, Ductility of beams, design and detailing for ductility, design examples.

Yield Line Theory:

Basic assumptions, Methods of analysis, yield line patterns and failure mechanisms, analysis of one way and two way rectangular and non-rectangular slabs, effect of top corner steel in square slabs, design examples.

Text Books

1. Reinforced Concrete Structures, P. C. Varghese, Tata McGraw Hill.
2. Advanced Reinforced Concrete Structures, P. C. Varghese, Tata McGraw Hill.
3. Reinforced Concrete Design, M.L. Gambhir, Macmillan India Ltd., New Delhi.
4. Limit State Design of Reinforced Concrete, A.K. Jain, Nern Chand and Bros., Roorkee.
5. Pre-Stressed Concrete, N. Krishna Raju, TMH Publishers, New Delhi.
6. IS 456-2000, Indian Standard of Practice for Plain and Reinforced Concrete, IS 1893, 4326 & 13920 Indian Standard Code of Practice for Earthquake Resistant Design of Structures.
7. Plain and Reinforced concrete, Vol. 2, 0 P Jain and J. Krishna, Nern Chand and Bros., Roorkee.
8. Reinforced Concrete Design, SU Pillai and D Menon, Tata McGraw Hill.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	2	2	2	2	1	-	-	-	-	-	-	-	2	2	2
CO2.	2	2	2	2	1	-	-	-	-	-	-	-	2	3	3
CO3.	2	2	2	2	1	-	-	-	-	-	-	-	2	2	3
CO4.	2	2	3	3	1	-	-	-	-	-	-	-	2	3	2
CO5.	2	2	3	3	1	-	-	-	-	-	-	-	2	3	2
3 –High 2-Medium 1-Low															

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CONCRETE STRUCTURES-II (DRAWING)

Course code	**PC/CE/17-P**			
Category	**Program Core**			
Course title	**Concrete Structures-II (Drawing)**			
Scheme and credits	**L**	**P**	**Credits**	
	-	**2**	**1.0**	
Course Assessment Methods	**Course Assessment Methods (Internal: 50; External: 50)** The internal and external assessment is based on the level of participation in laboratory Sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. There will be a continuous process for laboratory course evaluation. Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the Performa (attached herewith as Annexure II and III) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.			

Course outcomes:

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Illustrate the sketch of reinforcement of Flat Slab.	**L2(Understanding)**
CO2.	Illustrate the sketches of different Water tanks.	**L2(Understanding)**
CO3.	Illustrate the sketches of different types of foundations.	**L2(Understanding)**
CO4.	Elaborate the sketch of component parts of T-Beam Bridge.	**L6(Creating)**
CO5.	Elaborate the sketch of component parts of Bunkers/Silos.	**L6(Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

Preparing drawing sheets showing reinforcement details in case of:

1. Flat slabs.
2. Underground Water Tanks.

3. Overhead Water Tanks
4. Combined Footings.
5. Pile Foundations.
6. Raft foundation.
7. Component Parts of T-Beam Bridge.
8. Component parts of Silo/Bunker.

Note: Emphasis would be given to the computer aided drawings of some of above structures.

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1.	**2**	**1**	**2**	**1**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO2.	**2**	**1**	**2**	**1**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO3.	**2**	**1**	**2**	**1**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO4.	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO5.	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
3 –High 2-Medium 1-Low															

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HIGHWAY MATERIAL TESTING-I LAB

Course code	**PC/CE/18-P**			
Category	**Program Core**			
Course title	**Highway Material Testing-I Lab**			
Scheme and credits	**L**	**P**	**Credits**	
	-	**2**	**1.0**	
Course Assessment Methods	**Course Assessment Methods (Internal: 50; External: 50)** The internal and external assessment is based on the level of participation in laboratory Sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. There will be a continuous process for laboratory course evaluation. Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the Performa (attached herewith as Annexure II and III) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.			

Course outcomes

S.No.	**Course outcomes** At the end of the course students will be able to:	RBT* Level
CO1	Identify the properties of aggregates to be used in Highway construction.	**L3 (Applying)**
CO2	Classify the type of aggregates based on requirement.	**L4 (Analyzing)**
CO3	Identify the properties of bitumen to be used in Highway construction.	**L3 (Applying)**
CO4	Classify the type of bitumen based on requirement.	**L4 (Analyzing)**
CO5	Assess the soil properties for suitability or necessary improvement.	**L5 (Evaluating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

List of Experiments:-

1. Flakiness and Elongation Index of aggregates.
2. Specific gravity and water absorption test on aggregates.
3. Specific gravity of bitumen.
4. Proportioning of aggregates.

5. Marshall's stability test.
6. Stripping test on aggregates.
7. Determination of bitumen content.
8. CBR lab test on soil.

REFERENCE BOOKS:

2. Khanna S.K. and C.E.G. Justo, Highway Engineering, Nemchand Bros.
2. Kadyali L. R.; Highway Engineering, Nem Chand & Brothers, Roorkee.
3. Rao G. V.; Transportation Engineering, Tata McGraw Hill Publisher, New Delhi.
4. LR. Kadiyali, Traffic Engineering and Transportation Planning, Khanna Publishers, New Delhi.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	2	3	2	3	2	2	-	-	-	-	-	-	1	1	2
CO2.	2	3	2	3	2	2	-	-	-	-	-	-	1	1	2
CO3.	2	3	2	3	2	2	-	-	-	-	-	-	1	1	2
CO4.	2	3	2	3	2	2	-	-	-	-	-	-	1	1	2
CO5.	2	3	2	3	2	2	-	-	-	-	-	-	1	1	2
3 –High 2-Medium 1-Low															

ESTIMATION, COSTING AND VALUATION

Course code	**EEC/CE/2-P**			
Category	**Employment Enhancement Course**			
Course title	**Estimation, Costing and Valuation**			
Scheme and credits	**L**	**P**	**Credits**	
	-	**4**	**2.0**	
Course Assessment Methods	**Course Assessment Methods (Internal: 50; External: 50)** The internal and external assessment is based on the level of participation in laboratory Sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. There will be a continuous process for laboratory course evaluation. Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the Performa (attached herewith as Annexure II and III) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.			

Course outcomes

S. No.	**Course outcomes** At the end of the course students will be able to:	**RBT* Level**
CO1	Explain the basics of preparing estimates, costs and valuation for civil engineering works	**L2 (Understanding)**
CO2	Prepare specifications for different items of civil works	**L3 (Applying)**
CO3	Analyze rates for various items of works	**L4 (Analyzing)**
CO4	Estimate quantities of different items of civil engineering works	**L5 (Evaluating)**
CO5	Prepare tender documents for civil work and perform valuation of different Civil Engineering structures.	**L6 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

Theoretical portion to be discussed before Submissions.

Module-I

Estimate: Principles of estimation, units, items of work, different kinds of estimates, different methods of estimation, estimation of materials in single room building, two

roomed building with different sections of walls, foundation, floors and roofs, R.B. and R.VC.C. works, Plastering, White-washing, Distempering and painting, doors and windows, lump sum items, Estimates of canals, roads etc.

SUBMISSIONS:-

(I) For Given plans and sections determine:-

1. Earthwork,
2. Concrete works,
3. R.C.C. works,
4. Reinforced brick work.
5. Plastering, painting, finishing (white-washing, distempering).

Module-II

Specification of Works: Necessity of specifications, types of specifications, general specifications, specification for bricks, cement, sand, water, lime, reinforcement; Detailed specifications for Earthwork, Cement, concrete, brick work, floorings, D.P.C., R.C.C., cement plastering, white and color washing, distempering, painting.

SUBMISSIONS:-

(II) Application of Haryana P.W.D. Schedule of Rates and Estimation for Exercise at S.No 1 to 5 in (I).

Module-III

Valuation: Different terms used the role of a valuer, purpose and necessity of the same. Capitalized Value, Years purchase, sinking fund, depreciation, types of values. Purpose of valuation. Different methods of valuation for (i) open plots, (ii) open plots with existing residential & commercial structures, (iii) lease hold properties. Use of valuation tables and formulae.

SUBMISSIONS:-

(III) Valuation of any Existing building.

Module-IV

Rate Analysis: Purpose, importance and requirements of rate analysis, units of measurement, preparation of rate analysis, procedure of rate analysis for items:- Earthwork, concrete works, R.C.C. works, reinforced brick work, plastering, painting, finishing(white-washing, distempering).

Public Works Account: Introduction, function of P.W. department, contract. guidelines, types of contracts, their advantages and disadvantages, Tender and acceptance of tender, Earnest money, security money, retention money, measurement book, cash book, preparation, examination and payment of bins, first and final bills, administrative sanction, technical sanction.

SUBMISSIONS:-

(IV) Preparation of tender document as per (I) and (II).

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REFERENCE BOOKS

I. Estimating & Costing in Civil Engg..: Theory & Practice by B.N.Dutta, S.Dutta & Co., Lucknow.

2. Estimating, Costing & Specification in Civil Engg. by M.Chakarborty, Calcutta

3. Estimating and Costing for Building & Civil Engg.Works by P.L.Bhasin, S.Chand & Co., N.Ddhi.

4. Building Construction Estimating by George H.Cooper, McGraw Hill Book Co., New York.

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1.	**2**	**2**	**-**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO2.	**2**	**2**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO3.	**2**	**2**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO4.	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO5.	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**3**
3 –High 2-Medium 1-Low															

PROJECT – I

Course code	**EEC/CE/3-P**			
Category	**Employment Enhancement Course**			
Course title	**Project-I**			
Scheme and credits	**L**	**P**	**Credits**	
	-	**6**	**3.0**	
Course Assessment Methods	**Course Assessment Methods (Internal: 50; External: 50)** The internal and external assessment is based on the level of participation in laboratory Sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. There will be a continuous process for laboratory course evaluation. Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the Performa (attached herewith as Annexure II and III) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.			

Course outcomes

S. No.	**Course outcomes** At the end of the course students will be able to:	**RBT* Level**
CO1	Relate the on-site problem to its category.	**L2 (Understanding)**
CO2	Analyze the problem and find its solution.	**L4 (Analyzing)**
CO3	Prepare the framework to solve the problem	**L6 (Creating)**
CO4	Create the model of prototype of the solution.	**L6 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1.	**2**	**2**	**1**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO2.	**2**	**2**	**1**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**2**
CO3.	**1**	**2**	**3**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**2**
CO4.	**1**	**2**	**3**	**1**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
3 –High 2-Medium 1-Low															

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INTERNSHIP/TRAINING

Course code	**EEC/CE/4-P**			
Category	**Employment Enhancement Course**			
Course title	**Internship/Training**			
Scheme and credits	**L**	**P**	**Credits**	
	-	**4**	**2.0**	
Course Assessment Methods	**Course Assessment Methods (Internal: 100)** The assessment is based on the level of participation in laboratory Sessions, timely submission and presentation of training reports, the quality of presentations, the performance in VIVA-VOCE, the quality of Report file and ethical practices followed. There will be a continuous process for laboratory course evaluation. The course coordinator will conduct the presentation and viva voce examination in the slots assigned to them as per their timetable. The marks for Presentations and viva-voce examinations must be submitted at the end of the semester. The Course Coordinator/Internal Examiners will maintain and submit the bifurcation of marks obtained by the students in internal evaluations, accordingly, in the Performa (attached herewith as Annexure II and III) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.			

Course outcomes

S. No.	**Course outcomes** At the end of the course students will be able to:	**RBT* Level**
CO1	Compare practical problem with theoretical	**L4 (Analyzing)**
CO2	Analyze the problem and find its solution.	**L4 (Analyzing)**
CO3	Estimate the material, men and machinery	**L5 (Evaluating)**
CO4	Improve the quality and technology	**L6 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1.	**2**	**2**	**1**	**1**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO2.	**2**	**2**	**3**	**1**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**2**
CO3.	**2**	**2**	**3**	**1**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**2**
CO4.	**2**	**2**	**3**	**1**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
3 –High 2-Medium 1-Low															

SEMESTER –VIII

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PAVEMENT ANALYSIS & DESIGN

Course code	**PC/CE/19-T**			
Category	**Program Core**			
Course title	**Pavement Analysis & Design**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes

S. No.	**Course outcomes** At the end of the course students will be able to:	RBT* Level
CO1	Design the flexible and rigid type of pavements.	L6 (Creating)
CO2	Identify the type of machinery for the type of road construction.	L3 (Applying)
CO3	Decide about the type of maintenance required in the pavements.	L5 (Evaluating)
CO4	Evaluate the funds for budget proposal.	L5 (Evaluating)
CO5	Analyze the construction of tunnels.	L4 (Analyzing)

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Design of Flexible Pavements: Types of pavements. Flexible and rigid pavements. Components of a pavement and their functions. Factors affecting design of pavements. Design of thickness of a flexible pavement by Group Index method, CBR method (including latest IRC guidelines), Triaxial method and Burmister's method.

Design of Rigid Pavements: Westergaard's theory, critical locations of loading, load and temperature stresses. Critical combination of stresses. IRC guidelines for determination of thickness of a rigid pavement. Joints: requirements, types, patterns. Spacing of expansion and contraction joints. Functions of dowel and tie bars.

UNIT-II

Highway Construction: Non-Bituminous Pavements: Brief introduction to earthwork machinery: shovel, hoe, clamshell, dragline, bulldozers. Principles of field compaction of subgrade. Compacting equipments. Granular roads. Construction steps of WBM. WMM. Construction of cement concrete pavements. Slip-form pavers. Basic concepts of the following: soil stabilized roads, use of geo-synthetics, reinforced cement concrete pavements, prestress

concrete pavements, roller compacted concrete pavements and fibre reinforced concrete pavements.

Construction of Bituminous Pavements: Various types of bituminous constructions. Prime coat, tack coat, seal coat and surface dressing. Construction of BUSG, Premix carpet, BM, DBM and AC. Brief coverage of machinery for construction of bituminous roads: bitumen boiler, sprayer, pressure distributer, hot-mix plant, cold-mix plant, tipper trucks, mechanical paver or finisher, rollers. Mastic asphalt. Introduction to various IRC and MOST specifications.

UNIT-III

Highway Maintenance: Pavement failures. Maintenance operations. Maintenance of WBM, bituminous surfaces and cement concrete pavements. Pavement evaluation. Benkelman beam. Introduction to various types of overlays.

Highway Economics and Finance: Need of economic evaluation. Highway user benefits and costs. Methods of economic evaluation: benefit cost ratio method, net present value method, internal rate of return method, comparison. Highway finance.

UNIT-IV

Highway Drainage and Hill Roads: Surface drainage: types, brief design. Types of sub-surface drainage. Special characteristics of hill roads: geometrics, hair pin bends, construction of hill roads, drainage of hill roads, maintenance problems of hill roads

Tunnels: Sections of tunnels: advantages, limitations and suitability of each section. Shaft. Pilot tunnel. Driving tunnel in rocks: sequence of construction operations, full face method, heading and bench method, drift method. Driving tunnels in soft ground: sequence of construction operations, needle beam method, shield tunneling, compressed air tunneling.

Recommended Books

1. Highway Engg *by* S. K. Khanna & C.E.G. Justo, Nem Chand Bros., Roorkee.
2. Principles and Practice of Highway Engg. *By* L. R. Kadiyali, Khanna Publishers, Delhi.
3. Principles of Pavement Design *by* Yoder, E. J & Witczak, M.W., John Wiley and Sons, USA.
4. Tunnel Engineering *by* S. C. Saxena, Dhanpat Rai Publications, N. Delhi.
5. A text book of Tunnel, Bridges and Railway Engg. By S. P. Bindra, Dhanpat Rai Delhi.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	2	2	3	1	1	1	-	-	-	-	-	-	1	3	2
CO2.	2	2	3	1	1	1	-	-	-	-	-	-	1	2	2
CO3.	2	2	3	1	3	1	1	-	-	-	-	-	2	2	2
CO4.	2	2	2	1	2	1	-	-	-	-	-	-	1	1	2
CO5.	2	2	1	1	1	1	1	-	-	-	-	-	3	1	2
3 –High 2-Medium 1-Low															

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HIGHWAY MATERIAL TESTING-II LAB

Course code	**PC/CE/19-P**			
Category	**Program Core**			
Course title	**Highway Material Testing-II Lab**			
Scheme and credits	**L**	**P**	**Credits**	
	-	**2**	**1.0**	
Course Assessment Methods	**Course Assessment Methods (Internal: 50; External: 50)** The internal and external assessment is based on the level of participation in laboratory Sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. There will be a continuous process for laboratory course evaluation. Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the Performa (attached herewith as Annexure II and III) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.			

Course outcomes

S.No.	**Course outcomes** At the end of the course students will be able to:	RBT* Level
CO1	Identify the properties of aggregates to be used in Highway construction.	**L3 (Applying)**
CO2	Classify the type of aggregates based on requirement.	**L4 (Analyzing)**
CO3	Identify the properties of bitumen to be used in Highway construction.	**L3 (Applying)**
CO4	Classify the type of bitumen based on requirement.	**L4 (Analyzing)**
CO5	Assess the soil properties for suitability or necessary improvement.	**L5 (Evaluating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

List of Experiments:-

1. Aggregate Impact Test.
2. Los-Angeles Abrasion Test on Aggregates.
3. Dorry's Abrasion Test on Aggregates.

4. Deval Attrition Test on Aggregates.
5. Crushing Strength Test on Aggregates.
6. Penetration Test on Bitumen.
7. Ductility Test on Bitumen.
8. Viscosity Test on Bituminous Material
9. Softening Point Test on Bitumen.
10. Flash and Fire Point Test on Bitumen.

REFERENCE BOOKS:

1. Khanna S.K. and C.E.G. Justo, Highway Engineering, Nemchand Bros.
2. Kadyali L. R.; Highway Engineering, Nem Chand & Brothers, Roorkee.
3. Rao G. V.; Transportation Engineering, Tata McGraw Hill Publisher, New Delhi.
4. LR. Kadiyali, Traffic Engineering and Transportation Planning, Khanna Publishers, New Delhi.

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1.	**2**	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO2.	**2**	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO3.	**2**	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO4.	**2**	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO5.	**2**	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
3 –High 2-Medium 1-Low															

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ENVIRONMENTAL ENGG. – II Lab

Course code	**PC/CE/20-P**			
Category	**Program Core**			
Course title	**Environmental Engineering-II Lab**			
Scheme and credits	**L**	**P**	**Credits**	
	-	**2**	**1.0**	
Course Assessment Methods	**Course Assessment Methods (Internal: 50; External: 50)** The internal and external assessment is based on the level of participation in laboratory Sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. There will be a continuous process for laboratory course evaluation. Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the Performa (attached herewith as Annexure II and III) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.			

Course outcomes:

S.No.	**Course outcomes** At the end of the course students will be able to:	RBT* Level
CO1	Determine the properties of a sewage sample.	**L5 (Evaluating)**
CO2	Classify the type of sewage based on its properties.	**L4 (Analyzing)**
CO3	Determine the BOD, COD of sewage sample.	**L5 (Evaluating)**
CO4	Select the type of treatment for the given sewage sample.	**L5 (Evaluating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

List of Experiments

1. To determine the acidity of a sewage sample.
2. To determine the alkalinity of a sewage sample.
3. To determine total, suspended, dissolved and settable solids in a sewage sample.
4. To determine volatile and fixed solids in a sewage sample.
5. To determine oil and grease in a sewage sample.

6. To determine the chloride concentration in a sewage sample.
7. To determine the sulphate concentration in a sewage sample.
8. To determine the B.O.D. of a given sewage sample.
9. To determine the C.O.D. of a given sewage sample.
10. To determine the T.O.C. of a given sewage sample.

REFERENCE BOOKS:

1. Pant M.K., Laboratory Manual for Civil Engineering, S.K. Kataria & Sons, New Delhi.
2. Moondra H.S. and Rajiv Gupta, Laboratory Manual for Civil Engineering, CBS Publishers.

CO-PO Mapping:

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

PROJECT – II

Course code	**EEC/CE/5-P**			
Category	**Employment Enhancement Course**			
Course title	**Project-II**			
Scheme and credits	**L**	**P**	**Credits**	
	-	**8**	**4.0**	
Course Assessment Methods	**Course Assessment Methods (Internal: 50; External: 50)** The internal and external assessment is based on the level of participation in laboratory Sessions, timely submission of experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA-VOCE, the quality of laboratory file and ethical practices followed. There will be a continuous process for laboratory course evaluation. Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator will conduct these minor evaluations in the slots assigned to them as per their timetable. The Chairperson of the Department will only notify the week for the internal laboratory course evaluations. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the laboratory course coordinator, appointed by the Chairperson of the Department. The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the Performa (attached herewith as Annexure II and III) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.			

Course outcomes

S. No.	**Course outcomes** At the end of the course students will be able to:	**RBT* Level**
CO1	Relate the on-site problem to its category.	**L2 (Understanding)**
CO2	Analyze the problem and find its solution.	**L4 (Analyzing)**
CO3	Prepare the framework to solve the problem	**L6 (Creating)**
CO4	Create the model of prototype of the solution.	**L6 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1.	**1**	**2**	**1**	**1**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**
CO2.	**1**	**2**	**1**	**1**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**
CO3.	**1**	**2**	**3**	**1**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**
CO4.	**1**	**2**	**3**	**1**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**
3 –High 2-Medium 1-Low															

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SEMINAR

Course code	**EEC/CE/6-P**			
Category	**Employment Enhancement Course**			
Course title	**Seminar**			
Scheme and credits	**L**	**P**	**Credits**	
	-	**2**	**1.0**	
Course Assessment Methods	**Course Assessment Methods (Internal: 100)** The assessment is based on the level of participation in laboratory Sessions, timely submission and presentation of Seminar reports, the quality of presentations, the performance in VIVA-VOCE, the quality of Report file and ethical practices followed. There will be a continuous process for laboratory course evaluation. The course coordinator will conduct the presentation and viva voce examination in the slots assigned to them as per their timetable. The marks for Presentations and viva-voce examinations must be submitted at the end of the semester. The Course Coordinator/Internal Examiners will maintain and submit the bifurcation of marks obtained by the students in internal evaluations, accordingly, in the Performa (attached herewith as Annexure II and III) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.			

Course outcomes

S. No.	**Course outcomes** At the end of the course students will be able to:	**RBT* Level**
CO1	Outline the latest practical problems.	**L2 (Understanding)**
CO2	Analyze the problem and find its solution.	**L4 (Analyzing)**
CO3	Distinguish the latest material and machinery	**L4 (Analyzing)**
CO4	Develop the quality and technology	**L6 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1.	**1**	**2**	**1**	**1**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**
CO2.	**1**	**2**	**3**	**1**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**
CO3.	**2**	**2**	**3**	**1**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**
CO4.	**2**	**2**	**3**	**1**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**
3 –High 2-Medium 1-Low															

GENERAL FITNESS & PROFESSIONAL APTITUDE

Course code	**EEC/CE/7-P**			
Category	**Employment Enhancement Course**			
Course title	**General Fitness & Professional Aptitude**			
Scheme and credits	**L**	**P**	**Credits**	
	-	**-**	**1.0**	
Course Assessment Methods	**Course Assessment Methods (External: 100)** The assessment is based on the level of performance in VIVA-VOCE and ethical practices followed. The course coordinator will conduct the presentation and viva voce examination in the slots assigned to them. The marks for Presentations and viva-voce examinations must be submitted at the end of the semester. The Course Coordinator/Internal/External Examiners will maintain and submit the bifurcation of marks obtained by the students in External evaluation, accordingly, in the Performa (attached herewith as Annexure II and III) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office.			

Course outcomes

S. No.	**Course outcomes** At the end of the course students will be able to:	**RBT* Level**
CO1	Outline the potential for job opportunities.	**L2 (Understanding)**
CO2	Identify their skills and ability in a particular field	**L3 (Applying)**
CO3	Develop overall health and well-being, deemed for a job.	**L6 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1.	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**2**	**1**	**1**	**1**
CO2.	**1**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**1**	**2**	**1**
CO3.	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**1**	**2**	**1**
3 –High 2-Medium 1-Low															

Scheme of Examination & Detailed Syllabus of B.Tech (CE)

Program Elective Courses

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Program Elective-I

Course Code	Course Name	L	T	P/D	Credits
PE/CE/1-T	Highway Engineering	3	-	-	3.0
PE/CE/2-T	Highway Construction & Management	3	-	-	3.0
PE/CE/3-T	Highway and Traffic Engineering	3	-	-	3.0
PE/CE/4-T	Pavement Materials and Design	3	-	-	3.0

Program Elective-II

Course Code	Course Name	L	T	P/D	Credits
PE/CE/5-T	Geotechnology	3	-	-	3.0
PE/CE/6-T	Foundation Engineering	3	-	-	3.0
PE/CE/7-T	Geotechnical Design	3	-	-	3.0
PE/CE/8-T	Analysis and Design of Sub-Structures	3	-	-	3.0

Program Elective-III

Course Code	Course Name	L	T	P/D	Credits
PE/CE/9-T	Water Supply & Treatment	3	-	-	3.0
PE/CE/10-T	Environment Engineering	3	-	-	3.0
PE/CE/11-T	Environmental Impact Assessment and Life Cycle Analysis	3	-	-	3.0
PE/CE/12-T	Water and Air Quality Modeling	3	-	-	3.0

Program Elective-IV

Course Code	Course Name	L	T	P/D	Credits
PE/CE/13-T	Irrigation Engineering	3	-	-	3.0
PE/CE/14-T	Design of Hydraulic Structures	3	-	-	3.0
PE/CE/15-T	Urban Hydrology and Hydraulics	3	-	-	3.0
PE/CE/16-T	Groundwater Engineering	3	-	-	3.0

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Program Elective-V

Course Code	Course Name	L	T	P/D	Credits
PE/CE/17-T	Railway & Airport Engineering	3	-	-	3.0
PE/CE/18-T	Intelligent Transport System	3	-	-	3.0
PE/CE/19-T	Transportation Engineering	3	-	-	3.0
PE/CE/20-T	Airport Planning & Design	3	-	-	3.0

Program Elective-VI

Course Code	Course Name	L	T	P/D	Credits
PE/CE/21-T	Project Planning & Management	3	-	-	3.0
PE/CE/22-T	Construction Engineering & Management	3	-	-	3.0
PE/CE/23-T	Construction Planning, Scheduling and Control	3	-	-	3.0
PE/CE/24-T	Contract Laws and Regulations	3	-	-	3.0

Program Elective-VII

Course Code	Course Name	L	T	P/D	Credits
PE/CE/25-T	Sewerage & Sewage Treatment	3	-	-	3.0
PE/CE/26-T	Industrial Waste Water Treatment	3	-	-	3.0
PE/CE/27-T	Air and Noise Pollution Control Engg	3	-	-	3.0
PE/CE/28-T	Solid and Hazardous Waste Management	3	-	-	3.0

Program Elective-VIII

Course Code	Course Name	L	T	P/D	Credits
PE/CE/29-T	Concrete Technology	3	-	-	3.0
PE/CE/30-T	Geosynthetics Engineering	3	-	-	3.0
PE/CE/31-T	Bridge Engineering	3	-	-	3.0
PE/CE/32-T	Prestressed Concrete	3	-	-	3.0

Program Elective-I

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HIGHWAY ENGINEERING

Course code	**PE/CE/1-T**			
Category	**Program Elective**			
Course title	**Highway Engineering**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Explain the requirement of road network.	**L2(Understanding)**
CO2.	Identify the elements in road construction.	**L3(Applying)**
CO3.	Analyze the different road surveys for road network planning.	**L4(Analyzing)**
CO4.	Utilize the traffic control devices.	**L3(Applying)**
CO5.	Determine the material properties for road construction.	**L5(Evaluating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Introduction: Road transportation. Brief review of history of road development in India and abroad: Roman, Tresaguet, Telford and Macadam constructions. Road patterns. Classification of roads, Objectives of highway planning, Planning surveys. Saturation system of planning.

Highway Plans, Highway Alignment and Surveys: Main features of 20 years road development plans in India. Requirements of an ideal highway alignment. Factors affecting alignment. Surveys for highway alignment.

UNIT-II

Cross Section Elements and Sight Distance Considerations: Cross section elements: friction, carriageway, formation width, land width, camber, IRC recommended values. Types of terrain Design speed. Sight distance, stopping sight distance, overtaking sight distance,

overtaking zones, intermediate sight distance, sight distance at intersections, head light sight distance, set back distance. Critical locations for sight distance.

Design of Horizontal and Vertical Alignment: Effects of centrifugal force. Design of super-elevation. Providing super-elevation in the field. Radius of circular curves. Extra-widening. Type and length of transition curves. Gradient, types, values. Summit curves and valley curves, their design criterion. Grade compensation on curves.

UNIT-III

Traffic Characteristics and Traffic Surveys: Road user and vehicular characteristics. Traffic studies such as volume, speed and O & D study. Parking and accident studies. Fundamental diagram of traffic flow. Level of service. PCU Capacity for non-urban roads. Causes and preventive measures for road accidents.

Traffic Control Devices: Traffic control devices: signs, signals, markings and islands. Types of signs. Types of signals. Design of an isolated fixed time signal by IRC method. Intersections at grade and grade separated intersections. Design of a rotary. Types of grade separated intersections.

UNIT-IV

Highway Materials: Soil and Aggregates: Subgrade soil evaluation: CBR test, plate bearing test. Desirable properties of aggregates. Various tests, testing procedures and IRC/IS specification for suitability of aggregates. Proportioning of aggregates for road construction by trial and error method.

Bituminous Materials and Bituminous Mixes: Types of bituminous materials: bitumen, tar, cutback and emulsions. Various tests, testing procedures and IRS/IS specifications for suitability of bituminous materials in road construction. Bituminous mix, desirable properties. Marshall' method of mix design. Basic concept of use of polymers and rubber modified bitumen in bituminous mixes.

Books:

1. Highway Engg. By S. K. Khanna & C. E. G. Justo, Nem Chand & Bros, Roorkee.
2. Principles of Transportation and Highway Engg. By G.V.Rao, Tata McGraw Hill Pub., N.Delhi.
3. Traffic Engg. And Transport Planning by L. R. Kadiyali, Khanna Pub. Delhi.
4. Traffic Engg. by Matson, T.M., Smith, W.S. and Hurd, P.W. McGraw Hill Book Co., New York.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	2	1	2	1	1	1	-	-	-	-	-	1	1	1
CO2.	1	2	2	1	2	1	-	-	-	-	-	-	1	1	1
CO3.	1	2	1	3	1	2	-	-	-	-	-	-	2	1	1
CO4.	1	2	1	2	2	1	-	-	-	-	-	-	1	1	1
CO5.	1	2	2	2	1	1	-	-	-	-	-	-	1	1	1
3 –High 2-Medium 1-Low															

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HIGHWAY CONSTRUCTION & MANAGEMENT

Course code	**PE/CE/2-T**			
Category	**Program Elective**			
Course title	**Highway Construction & Management**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1	Understand the requirements and specifications of material required for road construction as per IRC/IS standards.	**L2(Understanding)**
CO2	Able to evaluate the pavement and can suggest methods for pavement maintenance as per the pavement type.	**L5(Evaluating)**
CO3	Analyze and understand the different road construction methods	**L4(Analyzing)**
CO4	Able to utilize the pavement management system for better results in construction and to fulfill future traffic needs.	**L3(Applying)**
CO5	Understand the construction procedure and equipments required in road construction.	**L2(Understanding)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Highway Materials: Soil and Aggregates: Subgrade soil evaluation: MDD & OMC, CBR test, plate bearing test. Road aggregates - desirable properties and various tests, IRC/IS specification for suitability of aggregates. Proportioning of aggregates for road construction by trial-and-error method.

Bituminous Materials and Bituminous Mixes: Types of bituminous materials: bitumen, tar, cutback and emulsions. Various tests and IRS/IS specifications for suitability of bituminous materials in road construction. Bituminous mixes – requirements, design - Marshall method. Basic concept of use of polymers and rubber modified bitumen in bituminous mixes.

UNIT-II

Flexible Pavement Construction: Earthwork, compaction and compacting equipments, stabilization of soil - mechanical stabilization, cementing additives and chemicals, thermal

stabilization, construction of embankments, different materials for subgrade, sub-base, base course and surface/ wearing course, material specification and construction procedure for earth roads, gravel roads, GSB, WBM & WMM road constructions. Bituminous constructions – types, specifications and construction procedure.

UNIT-III

Cement Concrete Pavement Construction: Cement Concrete Pavement Layers: Specifications and method of cement concrete pavement construction; Construction of interlocking block pavements, construction steps, Construction of various types of joints, joint filler and sealer, construction of reinforced concrete pavements, introduction to prestressed concrete pavements.

Soil Stabilized Pavement Layers: soil-cement, soil-bitumen and soil-lime stabilization – principles, applications and construction.

UNIT-IV

Pavement Evaluation & Maintenance: Pavement evaluation methods, Functional condition evaluation of pavements- Roughness, Skid Resistance, Overlay – types and design, Benkelman Beam and Falling Weight Deflectometer. Pavement Maintenance and rehabilitation techniques – pavement failures (flexible & rigid) types, maintenance of WBM, bituminous surface and CC roads.

Pavement Management: Pavement Management Systems - Pavement Management Systems- Components, structure, data requirements, Project level and Network level needs. Pavement performance prediction – concepts, introduction to modelling techniques – CRRI and HDM models, Introduction to life cycle cost analysis.

Books:

1. Highway Engg. By S. K. Khanna & C. E. G. Justo, Nem Chand & Bros, Roorkee.
2. Principles of Transportation and Highway Engg. By G.V.Rao, Tata McGraw Hill Pub., N.Delhi.
3. Traffic Engg. And Transport Planning by L. R. Kadiyali, Khanna Pub. Delhi.
4. Traffic Engg. by Matson, T.M., Smith, W.S. and Hurd, P.W. McGraw Hill Book Co., New York.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	3	1	2	3	1	1	-	-	-	-	-	1	1	1
CO2.	1	3	2	2	2	1	1	-	-	-	-	-	1	1	1
CO3.	1	2	1	1	1	1	-	-	-	-	-	-	2	1	1
CO4.	1	3	2	2	2	2	1	-	-	-	-	-	1	1	1
CO5.	1	2	1	1	1	1	-	-	-	-	-	-	1	1	1
3 –High 2-Medium 1-Low															

HIGHWAY AND TRAFFIC ENGINEERING

Course code	**PE/CE/3-T**			
Category	**Program Elective**			
Course title	**Highway and Traffic Engineering**			
	L	**T**	**Credits**	
Scheme and credits	**3**	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No.	**Course outcomes:** At the end of the course students will be ab to:	**RBT* Level**
CO 1	Understand the requirement of road network.	**L2(Understanding)**
CO 2	Analysis and design of geometric features of the highway	**L6 (Creating)**
CO 3	Able to analyze the highway survey data and can utilize in highway planning for new road construction projects.	**L4(Analyzing)**
CO4	Understand the various traffic regulations and importance traffic control devices.	**L2(Understanding)**
CO5	Understand as to how to conduct the traffic surveys and analyze the data to be used in the transportation/ traffic planning and geometric design.	**L3(Applying)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Introduction: Importance and role of transportation systems; different modes of transportation, historical development of road construction, brief history of road development in India; overview of various roads development programmes in the country and present status thereof, classification of roads according to different criteria.

Highway Planning, Alignment and Surveys: Road development plans, Various surveys for planning of the highway, highway alignment, basic requirements of an ideal alignment, factors governing the alignment, different types of surveys for locating highway.

UNIT-II

Highway Geometric Design: Factors governing the design of geometric features, cross-sectional elements, camber, sight distance, stopping sight and passing sight distances, passing zones. Design of horizontal alignment-super elevation. Extra widening on curves, transition curves. Design of vertical alignment, gradients, types of vertical curves and their design.

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UNIT-III

Traffic Engineering: Traffic characteristics, PIEV theory, gross weight and axle weight of different types of vehicles, power performance of vehicles.

Traffic Studies: Various traffic studies (volume, speed, O & D, flow characteristics, capacity, parking, & accident studies), objectives/ uses, methods of conducting these studies with pros and cons thereof, methods of analysis of data and interpretation of results, design capacity and level of service, Passenger Car Unit, factors affecting capacity PCU. Relation between speed, travel time, volume density and capacity.

UNIT-IV

Traffic Regulations and Control: Traffic regulations, Traffic control devices, Access control, basic requirements, Traffic signs, Traffic Signals- Types and design, types of traffic markings, traffic islands, Road Intersections, Classification of intersections, factors to be considered in the design of intersection, requirements of different types of intersections, various forms of intersections, rotary intersections, design of rotary. Highway Lighting, need for street lighting, illumination level, luminaire distribution of light, types of lamps, mounting height, spacing, lateral placement, lighting layout, design of highway lighting systems.

Books:

1. Highway Engg. By S. K. Khanna & C. E. G. Justo, Nem Chand & Bros, Roorkee.
2. Principles of Transportation and Highway Engg. By G.V.Rao, Tata McGraw Hill Pub., N.Delhi.
3. Traffic Engg. And Transport Planning by L. R. Kadiyali, Khanna Pub. Delhi.
4. Traffic Engg. by Matson, T.M., Smith, W.S. and Hurd, P.W. McGraw Hill Book Co., New York.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	1	1	1	1	1	1	-	-	-	-	-	1	1	2
CO2.	1	3	3	3	3	1	-	-	-	-	-	-	1	2	2
CO3.	1	2	1	2	2	1	1	-	-	-	-	-	1	1	2
CO4.	1	2	1	1	2	2	1	-	-	-	-	1	1	1	2
CO5.	1	2	1	2	3	2	1	-	1	-	-	1	1	1	2
3 –High 2-Medium 1-Low															

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PAVEMENT MATERIALS AND DESIGN

Course code	**PE/CE/4-T**			
Category	**Program Elective**			
Course title	**Pavement Materials and Design**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No.	**Course outcomes:** At the end of the course students will be able to:	**RBT* Level**
CO1	Explain the type and requirement of material used for road construction.	**L2(Understanding)**
CO2	Able to analysis various design elements required for pavement design.	**L4(Analyzing)**
CO3	Able to design flexible and rigid pavement as per IRC methods.	**L6 (Creating)**
CO4	Understand the various paving mix design methods.	**L2(Understanding)**
CO5	Able to conduct various type of tests on material required for different layers of pavement.	**L3(Applying)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Pavement Materials: Soil - Subgrade soil evaluation, evaluation of soil strength, MDD & OMC, CBR test, plate bearing test. Aggregates - desirable properties and various tests, IRC/IS specification for suitability of aggregates. Bituminous Materials**:** Types of bituminous materials – bitumen, tar, cutback and emulsions, properties and tests for paving bitumen, IRS/IS specifications for suitability of bituminous materials in road construction.

UNIT-II

Paving Mix Design: Granular mix design, Proportioning of aggregates for road construction by trial-and-error method. Design of Bituminous Mix, Marshall method of bituminous mix design. Basic concept of use of polymers and rubber modified bitumen in bituminous mixes.

Polymer and Rubber Modified binders: Physical and chemical properties. Fly ash and its characterization. Performance based mix design Approaches. Visco elastic properties of bitumen and bituminous mixture.

UNIT-III

Pavement Design Elements: Definition, Highway and Airport Pavement comparison, Wheel Loads, Tyre Pressure, Contact Pressure, ESWL, Design Factors, Type of distresses: structural and functional, Serviceability. Stresses in Flexible Pavements: Layered system concept, multilayered solutions, Burmister's method, Fundamental Design concepts.
Stresses in Rigid Pavements: Relative stiffness of slabs, Modulus of subgrade reaction, Stresses due to warping, stresses due to friction, effect of warping, contraction and expansion, plain versus reinforced pavements, stresses in dowel bar, tie bar, combined stresses.

UNIT-IV

Pavement Design: Design of Flexible Pavements: Design factors, Design wheel load, Equivalent single wheel load, Difference between Airport and Highway Design concept, Different design methods, Examples of comprehensive design process as per IRC.
Design of Rigid Pavement: General design considerations, Design of joints in cement concrete pavements, spacing of expansion joint, Spacing of contraction joints, Design of dowel bars and tie bars, IRC recommendations and design steps for design of Concrete pavements.

Books:
1. Highway Engg. By S. K. Khanna & C. E. G. Justo, Nem Chand & Bros, Roorkee.
2. Principles of Transportation and Highway Engg. By G.V.Rao, Tata McGraw Hill Pub., New Delhi.
3. Traffic Engg. And Transport Planning by L. R. Kadiyali, Khanna Pub. Delhi.
4. Traffic Engg. by Matson, T.M., Smith, W.S. and Hurd, P.W. McGraw Hill Book Co., New York.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	2	1	1	1	1	1	-	-	-	-	-	1	1	2
CO2.	1	3	2	1	2	1	-	-	-	-	-	-	1	2	2
CO3.	1	3	3	2	3	2	-	-	-	-	-	-	1	1	2
CO4.	1	3	3	3	2	1	-	-	-	-	-	-	1	1	2
CO5.	1	2	2	2	2	1	-	-	-	-	-	-	1	1	2
3 –High 2-Medium 1-Low															

Program Elective-II

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GEOTECHNOLOGY

Course code	**PE/CE/5-T**			
Category	**Program Elective Course**			
Course title	**Geotechnology**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**-**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1	Identify and classify the soil based on standard Geotechnical Engg. practice.	**L3(Applying)**
CO2	Determine the soil properties like allowable bearing pressures and load carrying capacity.	**L5(Evaluating)**
CO3	Analyze and implement a site investigation program.	**L4(Analyzing)**
CO4	Understand and design the shallow and deep foundations.	**L6(Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Sub-Surface Exploration: Purpose, stages in soil exploration, depth and lateral extent of exploration, guidelines for various types of structures, ground water observations, excavation and boring methods, soil sampling and disturbance, major types of samplers, sounding methods-SCPT, DCPT, SPT and interpretation, geophysical methods, pressure-meter test, exploration logs.

Drainage & Dewatering: Introduction, ditches and sumps, well point systems, shallow well system, deep well drainage, vacuum method, Electro-osmosis, consolidation by sand piles.

UNIT-II

Shallow Foundations-I: Design criteria for structural safety of foundation (i) location of footing, (ii) shear failure criterion, (iii) settlement criterion. Ultimate bearing capacity, modes of shear failure, Rankine's analysis. Tergazi's theory. Skempton's formula. Effect of fluctuation of G.W.T. Effect of eccentricity on bearing capacity, inclined load, I.S Code

recommendations. Factors affecting bearing capacity, methods of improving bearing capacity.

Shallow Foundations-II: Various causes of settlement of foundation, allowable bearing pressure based on settlement, settlement calculation, elastic and consolidation settlement, allowable settlement according to I.S.Code. Plate load test and its interpretation, bearing capacity from penetration tests, design bearing capacity.

Shallow Foundations-III: Situation suitable for the shallow foundations, types of shallow foundations and their relative merits, depth of foundation, footing on slopes, uplift of footings, conventional procedure of proportioning of footings, combined footings, raft foundations, bearing capacity of raft in sands and clays, various methods of designing rafts, floating foundations.

UNIT-III

Pile Foundations-I : Introduction, necessity of pile foundations, classification of piles, load capacity, static analysis, analysis of pile capacity in sands and clays, dynamic analysis, pile load tests, negative skin friction, batter piles, lateral load capacity, uplift capacity of single pile, under-reamed pile.

Pile Foundations-II : Group action in piles, pile spacing, pile group capacity, stress on lower strata, settlement analysis, design of pile caps, negative skin friction of pile group, uplift resistance of pile group, lateral resistance, batter pile group.

UNIT-IV

Drilled Piers and Caisson Foundations: Drilled piers-types, uses, bearing capacity, settlement, construction procedure. Caissons-Types, bearing capacity and settlement, construction procedure. Well foundations-shapes, depth of well foundations, components, factors affecting well foundation design lateral stability, construction procedure, sinking of wells, rectification of tilts and shifts, recommended values of tilts & shifts as per I.S.3955.

Books Recommended

1 Basic and Applied Soil Mechanics by GopalRanjan& ASR Rao. New Age Int.(P)Ltd..
2 Analysis and Design of Sub-Structures by Swamisaran, IBH & Oxford.
3 Principles of Foundation EngineringByB.M.das, PWS Kent, Boston.
4 Foundation Analysis & Design by J.E.Bowles, McGraw Hills.
5 Design Aids in Soil Mechanics & Foundation Engineering by S.R.Kaniraj, McGraw Hills.
6 Foundation Design by Teng, Prentice Hall, India.

CO-PO Mapping:

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

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FOUNDATION ENGINEERING

Course code	**PE/CE/6-T**			
Category	**Program Elective Course**			
Course title	**Foundation Engineering**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**-**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes

S.No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1	Describe and discuss the concepts of foundation engineering	L2 (Understanding)
CO2	Employ various methods of soil exploration for foundation engineering	L3 (Applying)
CO3	Analyze and determine earth pressure behind a retaining structure- for various soil and loading conditions.	L4 (Analyzing)
CO4	Evaluate the use of soil stabilization and geo-textiles in foundation engineering	L5 (Evaluating)
CO5	Develop and design various types of foundations for civil engineering works	L6 (Creating)

***Revised Bloom's Taxonomy Action verbs/Levels**

Course Contents

UNIT I

Introduction to soil exploration: Scope- Methods of soil exploration- spacing- significant depth-boring and sampling techniques- types of samples- sample disturbances- penetration tests (Standard Cone Penetration Test and Standard Penetration Test)- and Geophysical methods (Seismic Refraction Method & Electrical Resistivity Method).

Earth Pressure: Earth Pressures at rest condition- states of plastic equilibrium- Rankine's theory for active and passive conditions- Influence of surcharge- water table- wall friction- Numerical Problems for the determination of Active and Passive Earth Pressure diagrams- Critical height of an Unsupported Vertical Cut.

UNIT II

Stability of Slopes: Infinite slopes- Critical Depth of a cohesive Infinite Slope- types of failure- Swedish Slip Circle Method- Taylor's stability Number and Stability Curves- Concept of factors of safety- Bishop's Method of slices- Effect of sudden draw down and submergence.

Design of Shallow Foundation: Bearing Capacity- Definitions- depth of foundation- Terzaghi's general bearing capacity equation- JS code equation- factors affecting bearing capacity- Influence of eccentric and inclined loads. Bearing capacity by penetration tests - Plate load test.
Design Criteria for Shallow Foundations- Stability- Shear- and Settlement Failures

UNIT III

Pile Foundations: Types- function- selection of piles- pile driving formulae- point- bearing and friction piles. Load carrying capacity of single pile- group action- spacing of piles- Negative skin friction- Concept of under reamed piles.
Caissons and Wells: Introduction-components- shapes- stability of well foundation- sinking of we11- tilts and shifts.

UNIT IV

Drainage and Dewatering of Soil: Methods of Ditches and Sump- Well Point System- Shallow Well System- Deep Well Drainage- Vacuum Method- Electro Osmosis Method- Seepage Analysis for various conditions of Ful1y penetrating slot and partially penetrating slot- Protective Filters.

Soil stabilization and Geo-textiles: Need and advantages of Ground Improvement techniques- Stabilization. Mechanical- Lime- Cement- bitumen- Chemical Stabilization of Soils and its advantages.
Geo-textiles: Concept- Types- Functions- Use of Geo-textiles in Earth Dam Construction- Road Works- Railway works- Erosion Control and in Bearing capacity Improvement.

REFERENCE BOOKS:-

1. Foundation Analysis and Design- by J.E. Bowles McGraw Hill Book Company- NewYork.
2. Foundation Engineering by Peck- Wiley Eastern India Limited- New Delhi.
3. Soil Dynamics and Machine Foundations by Swami Saran- Galgotia Publishers- New Delhi
4. Basic and Applied Soil Mechanics- by Gopal Ranjan Rao- ASR Rao- New Age Int. (P) Ltd. Pub.- New Delhi.
5. A Text Book of Soil Mechanics Foundation Engg. by VNS Murthy- U.B.S- New Delhi.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	2	2	1	2	2	-	-	-	-	-	-	-	1	1	1
CO2.	2	2	1	2	1	-	-	-	-	-	-	-	1	2	1
CO3.	2	2	2	2	1	-	-	-	-	-	-	-	1	1	1
CO4.	2	2	3	3	1	-	-	-	-	-	-	-	1	1	1
CO5.	2	2	3	3	1	-	-	-	-	-	-	-	1	1	1
3 –High 2-Medium 1-Low															

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GEOTECHNICAL DESIGN

Course code	**PE/CE/7-T**			
Category	**Program Elective**			
Course title	**Geotechnical Design**			
	L	**T**	**Credits**	
Scheme and credits	**3**	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks). • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course Outcomes:

S. No.	**Course outcomes:** At the end of the course students will be able to:	**RBT* Level**
CO 1	Understood the various design methods required for foundation design on slopes.	**L2(Understanding)**
CO2	Design the piles subjected to lateral and uplift loads	**L6(Creating)**
CO3	Analyze and design drilled piers and well foundations	**L4(Analyzing)**
CO4	Evaluate the design methods for sheet piles and coffer dams	**L5(Evaluating)**
C05	Understanding the foundation design procedure on expansive soils	**L2(Understanding)**

***Revised Bloom's Taxonomy Action verbs/ levels**

UNIT-I

Shallow Foundations: Introduction, bearing capacity of footings, Skempton's bearing capacity factor, footings on layered soils, footings with eccentricity, allowable bearing pressure, raft foundations floating raft, uplift capacity of footing.

Pile Foundations: Introduction, bearing capacity of piles, vertical piles subjected to lateral loads, proportioning and design of pile foundations, lateral load capacity of single pile, batter piles under lateral load, uplift capacity of piles ultimate lateral load resistance of a pile group.

UNIT-II

Drilled Piers: Introduction, current construction methods, use of Drilled Piers, analysis and design of drilled piers, settlements of drilled piers, structural design of drilled piers, laterally loaded drilled pier analysis.

Bridge Sub Structures: Definitions, elements of substructures, maximum depth of scour, depth of foundation allowable bearing pressure, loads to be considered, lateral stability, design of pier cap & pier, sinking stresses in wells, design of well cap, well staining, well curb, cutting edge, bottom plug.

UNIT-III

Sheet Piles and Coffer Dams: Types of sheet piles structures, design of cantilever sheet pile wall, design of anchored bulkheads, anchorage methods design of braced sheeting in cuts, Design of cellular coffer dams, Calculation of allowable bearing pressure, Conditions for stability of a well. Terzaghi's analysis for Lateral stability of a well, embedded in sand, Forces acting on a well foundation, Computation of scour depth, Tilts & Shifts.

UNIT-IV

Foundation in Expansive Soils: Introduction, Material structure, identification of expansive soils, Indian expansive soils, swell potential and swelling pressure, traditional Indian practice, methods of foundations in expansive soils, replacement of soils and CNS concept, under reamed pile foundations, remedial measures for cracked buildings.

Books:

1. Analysis and Design of Substructures: Limit State Design by Swami Saran, oxford &IBH Publishing Co. Pvt. Ltd.
2. Ranjan G. and Rao A.S.R., 2000, Basic and Applied Soil Mechanics, New Age International Pvt. Ltd., Publishers, New Delhi.
3. Murthy V.N.S., 2001, Principles of Soil Mechanics and Foundation Engineering, UBSPD.
4. Das, B.M. 2004, Principles of Foundation Engineering, Cengage Pulishers.
5. Couduto, D.P., 2002, Geotechnical Engineering – Principles and Practices", Prentice Hall of India.
6. Peck R. B., Hanson W. B. and Thornburn T. H., 1974, Foundation Engineering. John Wiley and Sons Inc., New York.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	3	2	2	1	1	1	-	-	-	-	-	1	1	1
CO2.	1	3	3	2	2	1	-	-	-	-	-	-	1	2	1
CO3.	1	3	3	2	2	-	-	-	-	-	-	-	1	1	1
CO4.	1	3	3	2	2	-	-	-	-	-	-	-	1	1	1
CO5.	1	2	2	1	1	-	-	-	-	-	-	-	1	1	1
3 –High 2-Medium 1-Low															

ANALYSIS AND DESIGN OF SUB-STRUCTURES

Course code	**PE/CE/8-T**			
Category	**Program Elective**			
Course title	**Analysis and Design of Sub-structures**			
	L	**T**	**Credits**	
Scheme and credits	**3**	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks). • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course Outcomes:

S. No.	**Course outcomes:** At the end of the course students will be able to:	RBT* Level
COl	Knowledge of different tests for soil exploration.	**L2(Understanding)**
CO2	To get familiar general design principles of foundation design with reference to IS codes.	**L6(Creating)**
CO3	Able to analyze and understand the design elements of bridge sub-structure components.	**L4(Analyzing)**
CO4	Able to analyze and design of Marine sub-structure components.	**L6(Creating)**
CO5	Understating the behavior of foundations in expensive soils.	**L2(Understanding)**

***Revised Bloom's Taxonomy Action verbs/ levels**

Unit-I

Introduction to soil exploration: Scope- Methods of soil exploration- spacing-significant depth-boring and sampling techniques- types of samples- sample disturbances-penetration tests (Standard Cone Penetration Test and Standard Penetration Test)- and Geophysical methods (Seismic Refraction Method & Electrical Resistivity Method).
Lateral Earth pressure: introduction, Earth pressure at rest, Rankine's active & passive states of plastic equilibrium, Rankine's earth pressure theory, Coulomb's earth pressure theory, Culmann's graphical construction, Dynamic Earth pressure, Dynamic Earth pressure for c-φ Soils.

Unit-II

Shallow Foundations: Introduction, bearing capacity of footings, Skemptons bearing capacity factor, footings on layered soils, footings with eccentricity, allowable bearing pressure, raft foundations floating raft, uplift capacity of footing.

Pile Foundations: Introduction, bearing capacity of piles, vertical piles subjected to lateral loads, proportioning and design of pile foundations, lateral load capacity of single pile, batter piles under lateral load, uplift capacity of piles ultimate lateral load resistance of a pile group.

Unit-III

Bridge Sub Structures: Definitions, elements of substructures, maximum depth of scour, depth of foundation allowable bearing pressure, loads to be considered, lateral stability, design of pier cap & pier, sinking stresses in wells, design of well cap, well staining, well curb, cutting edge, bottom plug.

Unit-IV

Marine Sub Structures : Introduction , types of marine structures; Breakwaters, Wharves, Piers, Sea walls, Docks, Quay walls, Locks, Moorings, design loads, Combined loads, wave action, wave pressure on vertical wall, Ship impact on piled wharf structure, Design of Break water, design of Rubble-Mound Breakwaters, Design of wall type Break water, Design of Gravity wall and Anchored Bulk head wharf Structures.

Foundation in Expansive Soils: Introduction, Material structure, identification of expansive soils, Indian expansive soils, swell potential and swelling pressure, traditional Indian practice, methods of foundations in expansive soils, replacement of soils and "CNS" concept. Under reamed pile foundations, Remedial measures for cracked buildings.

Books:

1. Analysis and Design of Substructures: Limit State Design by Swami Saran, oxford &IBH Publishing Co. Pvt. Ltd.
2. Ranjan, G. and Rao A.S.R., 2000, Basic and Applied Soil Mechanics. New Age International Pvt. Ltd., Publishers, New Delhi.
3. Murthy V N S., 2001, Principles of Soil Mechanics and Foundation Engineering. UBSPD.
4. Bowles J. E., 1988, Foundation Analysis and Design. McGraw Hill, New York.
5. Das, B.M. 2004, Principles of Foundation Engineering, Cengage Pulishers.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	1	1	2	2	1	1	-	-	-	-	-	1	1	2
CO2.	1	1	2	2	2	1	-	-	-	-	-	-	1	2	2
CO3.	1	1	3	3	2	-	-	-	-	-	-	-	1	1	2
CO4.	1	1	3	2	2	-	-	-	-	-	-	-	1	1	2
CO5.	1	2	2	1	1	1	-	-	-	-	-	-	1	1	2
3 –High 2-Medium 1-Low															

Program Elective-III

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WATER SUPPLY & TREATMENT

Course code	**PE/CE/9-T**			
Category	**Program Elective Course**			
Course title	**Water Supply & Treatment**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Estimate the quantity of water requirement.	**L5(Evaluating)**
CO2.	Select the source of water supply.	**L3(Applying)**
CO3.	Compare the water quality with the available standards.	**L4(Analyzing)**
CO4.	Select the type of treatment to be provided to water for the type of suitability.	**L3(Applying)**
CO5.	Select the type of distribution system to be adopted as per the requirement.	**L3(Applying)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Water Quantity:

Importance and necessity of water supply scheme. Water demands and its variations. Estimation of total quantity of water requirement. Population forecasting. Quality and quantity of surface and ground water sources. Selection of a source of water supply. Types of intakes.

UNIT-II

Water Quality:

Impurities in water and their sanitary significance. Physical, chemical and bacteriological analysis of water. Water quality standards.

UNIT-III

Water Treatment:

Objectives, treatment processes and their sequence in conventional treatment plant, sedimentation – plain and aided with coagulation. Types, features and design aspects. Mixing

basins and Flocculation units. Filtration – mechanism involved, types of filters, slow and rapid sand filtration units (features and design aspects). Disinfection principles and aeration.

UNIT-IV

Water Distribution:

Distribution system – Gravity system, Pumping System, Dual system, Layout of Distribution System – Dead End System, Grid Iron System, Ring System, Radial System, their merits and demerits. Distribution Reservoir-functions & determination of storage capacity.

Books:

1. Water Supply Engineering: Subhash Verma, Varinder Kanwar, Siby John, Vikas Publishers, New Delhi.
2. Water Supply and Sanitary Engineering: S.C. Rangwala, Charotra Publishers, New Delhi.
3. Water Supply Engineering: S.K. Garg, Khanna Publishers, New Delhi.
4. Water Supply Engineering: B.C. Punmia, Laxmi Publications Pvt Limited, New Delhi.

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1.	**1**	**3**	**2**	**3**	**1**	**2**	**1**	-	-	-	-	-	**1**	**1**	**2**
CO2.	**2**	**2**	**2**	**3**	**1**	**2**	**1**	-	-	-	-	-	**1**	**1**	**2**
CO3.	**2**	**3**	**2**	**2**	**1**	**2**	**1**	-	-	-	-	-	**1**	**1**	**2**
CO4.	**1**	**2**	**2**	**2**	**1**	**2**	**1**	-	-	-	-	-	**1**	**1**	**2**
CO5.	**1**	**2**	**2**	**2**	**1**	**2**	**1**	-	-	-	-	-	**1**	**1**	**2**
3 –High 2-Medium 1-Low															

ENVIRONMENTAL ENGINEERING

Course code	**PE/CE/10-T**			
Category	**Program Elective Course**			
Course title	**Environmental Engineering**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course Outcome

Sr. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Identify and describe various elements of water supply, sewerage and air & noise pollution.	**L1 (Remembering)**
CO2.	Differentiate between various types of pollutants with their sources, effects on environment and quantifications	**L2 (Understanding)**
CO3.	Analyze the effects of different kinds of pollution and outline their respective measures for treatment.	**L4(Analyzing)**
CO4.	Design and compare sewerage systems and storm water drains.	**L6(Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

Course Content

UNIT I

Water: Water Supply systems: Need for planned water supply schemes, Sources of Water, Water demand and Potable, industrial and agricultural water requirements, Components of water supply system; Transmission of water, Distribution system, Various valves used in W/S systems, service reservoirs and design.

UNIT II

Sewage: Domestic and Storm water, Quantity of Sewage, Sewage flow variations. Conveyance of sewage: Sewers, shapes design parameters, operation and maintenance of sewers, Sewage pumping; Sewerage, Sewer appurtenances, Design of sewerage systems.

Storm Water: Quantification and design of Storm water; Sewage and Sludge, Pollution due to improper disposal of sewage, National River cleaning plans, recycling of sewage - quality requirements for various purposes.

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UNIT III

Air: Composition and properties of air, Quantification of air pollutants, Monitoring of air pollutants, Air pollution - Occupational hazards, Urban air pollution: automobile pollution, Chemistry of combustion, Automobile engines, quality of fuel, operating conditions and interrelationship. Air quality standards, Control measures for Air pollution, construction and limitations

UNIT IV

Noise: Basic concept, measurement, effects and various control methods.

Case studies on Pollution (Air, Water, Noise)

REFERENCE BOOKS:

1. Environmental Engineering, Vol. I, S.K Garg , Khanna Publishers, New-Delhi.
2. Environmental Pollution Control Engineering, C. S. Rao
3. Environmental Engineering by H.S.Peavy, D.R.Rowe, G.Tchobanoglous: 1991, Tata-Mcgraw Hill
4. Manual on Water Supply and Treatment, (latest Ed.), Ministry of Works & Housing,New Delhi.
5. Integrated Solid Waste Management. Tchobanoglous, Theissen & Vigil. McGraw Hill Publication

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1.	**1**	**2**	**1**	**2**	**-**	**1**	**3**	**1**	**-**	**-**	**-**	**1**	**1**	**1**	**2**
CO2.	**1**	**2**	**1**	**2**	**-**	**2**	**3**	**1**	**-**	**-**	**-**	**1**	**1**	**1**	**2**
CO3.	**2**	**3**	**2**	**1**	**1**	**1**	**3**	**1**	**1**	**2**	**-**	**1**	**1**	**1**	**2**
CO4.	**3**	**2**	**3**	**1**	**2**	**-**	**2**	**1**	**3**	**2**	**2**	**1**	**1**	**1**	**2**
3 –High 2-Medium 1-Low															

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ENVIRONMENTAL IMPACT ASSESSMENT AND LIFE CYCLE ANALYSIS

Course code	**PE/CE/11-T**			
Category	**Program Elective Course**			
Course title	**Environmental Impact Assessment and Life Cycle Analysis**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course Outcome

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1	Be aware of the environmental legislations- policies of the country and of international environmental conventions and protocols	**L1(Remembering)**
CO2	Identify the environmental attributes to be considered for the EIA study	**L2(Understanding)**
CO3	Illustrate objectives of the EIA studies	**L3(Applying)**
CO4	Evaluate the methodology to prepare rapid EIA	**L5(Evaluating)**
CO5	Formulate the methodology Environmental Auditing	**L6(Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

Course Content

UNIT-I

Basic Concepts of Environmental Impact Assessment: Description of the project and the environmental setting- identification of impacts- measurement and monitoring- prediction and assessment of impacts and communication ofimpacts.

UNIT – II

Environmental Impact Assessment Methodologies: Checklists- matrices- networks and overlays Prediction and Assessment of Impact on the physical environment- on the resources- and on the socio-economic- Environmental cost benefit analysis Sustainable development. Life Cycle Assessment -Environmental Risk Analysis- Definition of Risk

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UNIT – III

Environmental auditing: Definition and types of audits- EMS audits- performance audits; compliance audits- registration audits ISO 14000 series of standards and environmental auditing- Methodologies for Environmental Auditing: Objectives- audit teams- planning audits- conducting audits- reporting audit findings.

UNIT – IV

EIA related to the following sectors - Infrastructure –construction and housing Mining – Industrial - Thermal Power

- River valley and Hydroelectric Acts: Water act- Water Cess act- Air act- Environment Protection act and their amendments- Wildlife act and Forest acts. Case Studies on EIA

Reference Books:

1. Environmental Impact Analysis by R.K. Jail and L.V. Urban.
2. Environmental Impact Assessment by Canter.
3. Environmental Impact Assessment by J. Glasson

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	2	-	-	-	-	1	1	-	1	2	1	1	1	2
CO2.	-	2	-	-	-	2	1	1	-	-	2	1	1	1	2
CO3.	1	2	-	-	-	1	1	-	-	-	-	1	1	1	2
CO4.	1	2	1	2	-	-	-	-	1	--	2	1	1	1	2
CO5.	1	2	1	2	-	-	-	-	1	-	2	1	1	1	2
3 –High 2-Medium 1-Low															

WATER AND AIR QUALITY MODELING

Course code	**PE/CE/12-T**			
Category	**Program Elective Course**			
Course title	**Water and Air Quality Modeling**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course Outcome

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1	Define different mathematical models for air and water quality	L1(Remembering)
CO2	Recognize the risks of disposal of treated wastewater into the river	L2(Understanding)
CO3	Predict the quality of water and air through modeling	L4(Analzing)
CO4	Evaluate the physical- chemical and biological water quality which isessential for the abatement of water pollution	L5(Evaluating)
CO5	Design sound and sustainable water and air models under specified conditions	L6(Creating)

***Revised Bloom's Taxonomy Action verbs/Levels**

Course Content

UNIT – I

Water and air quality management- Introduction to Mathematical Models: kinds of mathematical models – model development- Model requirements and limitations- validation effluent and stream standards; ambient air quality standards.

UNIT – II

Water quality model development- D.O. Models for Streams: Dissolved oxygen model for streams sources and sinks of dissolved oxygen estimation of system parameters Streeter

Phelps model - oxygen 'sag' curve-determination of deoxygenation and re-aeration coefficients- Benthal oxygen demand mass transport mechanisms

UNIT – III

Models for Estuary and Lakes: Assumptions- Benefits- Limitations- Physical- chemical and biological processes in estuaries and lakes;

Mass transport of solutes- degradation of organic compounds- application of concepts to predict groundwater contaminant movement- seawater intrusion – basic concepts and modeling

UNIT – IV

Air quality models: Micrometeorological processes- wind rose- dispersion- coefficients and stability classes- Gaussian and dispersion model- Stack height computation- Regional air quality models- Source inventories and significance. Air pollution modeling and prediction – Plume rise modeling techniques- modeling for non-reactive pollutants- single source – short term impact- multiple sources and area sources- model performance and utilisation- computer models.

References Books

1. Environmental Engineering Peavy- Rowe and Tchobanglous- McGraw Hill.
2. Water Supply Engineering P.N. Modi- Standard Book House New-Delhi.
3. Environmental Engg.: by Howard S. Peavy & Others- MGH International.
4. Metacaf – EDDY – Waste-water engineering revised by George Teholonobus (TMH)
5. Manual on Water Supply and Treatment by Ministry of Urban Development- New Delhi.
6. Water Supply and Sewerage- McGhee- McGraw Hill.
7. Environmental Engineering- Vol. I- S.K. Garg- Khanna Publishers- New-Delhi.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	2	-	-	1	-	-	-	-	-	-	1	1	1	2
CO2.	1	2	-	-	-	2	2	2	-	-	-	1	1	1	2
CO3.	-	3	-	1	2	1	3	1	-	-	2	1	1	1	2
CO4.	1	3	1	2	-	1	-	-	2	1	2	2	1	1	2
CO5.	1	1	3	2	2	1	1	-	1	-	1	1	1	1	2
3 –High 2-Medium 1-Low															

Program Elective-IV

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IRRIGATION ENGINEERING

Course code	**PE/CE/13-T**			
Category	**Program Elective**			
Course title	**Irrigation Engineering**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Explain the necessity of irrigation.	**L2(Understanding)**
CO2.	Outline the soil properties pertaining to irrigation.	**L2(Understanding)**
CO3.	Analyze the alignment of canals.	**L4(Analyzing)**
CO4.	Propose the solution for the soil affected from water logging and requirement of lining of canals.	**L6(Creating)**
CO5.	Explain the requirement of canal outlets and river training works.	**L2(Understanding)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Introduction: Irrigation-necessity, advantages, disadvantages, impact of irrigation on human environment , need and development of irrigation in India, crops and crop seasons, ideal cropping pattern and high yielding varieties of crops.

Soil-water relationship and irrigation methods: Soil-water relationship, root zone soil water, infiltration, consumptive use, field capacity, wilting point, available moisture in soil, GCA, CCA, intensity of irrigation, delta, base period, Kor depth, core period, frequency of irrigation, duty of water, relation between delta, duty and base period, irrigation requirement, flooding methods, border strip method, check basin and furrow method, assessment of irrigation water, sprinkler irrigation, favorable conditions, sprinkler systems, hydraulics of sprinkler irrigation, planning, design and maintenance of sprinkler systems, drip irrigation-components parts, advantages and limitations, suitability of drip irrigation.

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UNIT-II

Canal irrigation: Component of canal distribution system, alignment of channels, losses in irrigation channels, design discharge, silt theories and design of alluvial channels, comparison of Kennedy's and Lacey's theories, canal section and design procedure, Garrets and Lacey's diagrams.

UNIT-III

Water logging and land reclamation: Water logging-effects, causes and measures of prevention, lining of irrigation channels, types of lining, design of lined channel land drainage, open drains, design considerations, advantages of tile drains, depth of tile drains, layout of closed drains, discharge and spacing of closed drains, diameter of tile drain, outlets for tile drains, maintenance of tile drains, purpose of land reclamation and methods of land reclamation.

UNIT-IV

River Training: Classification of rivers, river training and its objectives, classification of river training works, methods of river training, marginal embankments, guide-banks, spurs, cutoffs, bank pitching and launching apron.

Canal outlets: Classification, requirements of a good outlet, design of pipe, APM and open flume outlet, flexibility proportionality, setting and sensitivity of outlet.

Books:

1 Irrigation, Water Resources and Water Power Engg. By P. N. Modi.
2 Fundamentals on Irrigation Engg. by Bharat Singh.
3 Irrigation Engg & Hydraulic Structures by S. K. Garg, Khanna Publihers, New Delhi
4 Irrigation Engg. By S. K. Sharma, S. Chand Publishers, New Delhi.
5 Irrigation -Theory & Practice by G.L. Asawa

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1.	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO2.	**3**	**2**	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO3.	**3**	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO4.	**3**	**3**	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO5.	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
3 –High 2-Medium 1-Low															

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DESIGN OF HYDRAULIC STRUCTURES

Course code	**PE/CE/14-T**			
Category	**Program Elective**			
Course title	**Design of Hydraulic Structures**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course Outcomes:

S. No.	**Course outcomes:** At the end of the course students will be able to:	RBT* Level
COl	Explain concepts and designs of hydraulic structures and water distribution systems for irrigation.	**L2(Understanding)**
CO2	Design of cross drainage works and diversion head works	**L6(Creating)**
CO3	Analyzing alignments for construction of water distribution system and construction of hydraulic structures for them.	**L4(Analyzing)**
CO4	Evaluate the water losses in canal & systems	**L5(Evaluating)**
CO5	To know about energy dissipation devices and their applications	**L2(Understanding)**

*Revised Bloom's Taxonomy Action verbs/ levels

UNIT-I

Regulation works: Canal falls-necessity and location, development of falls, design of cistern element, roughening devices, design of Sarda type fall, and design of straight Glacis fall. Off-take alignment, cross-regulator and distributory, head regulators, devices to control silt entry into the off-taking channel and silt ejector, canal escapes, types of escapes.

UNIT-II

Cross drainage works: Classification and their selection, hydraulic design aspects of aqueducts, syphon aqueducts, super passage, canal syphon and level crossing, design of transitions.

Diversion canal Headworks: Various components and their functions, layout plan, selection of site for diversion headworks, Bligh's creep theory, Khosla's method of independent variables, use of Khosla's curves, various corrections, silt excluders.

UNIT-III

Storage Headworks: Types of dams, selection of a site, gravity dam-two dimensional design, forces acting, stability criterion, elementary profile of a dam, cutoffs and drainage galleries, arch dams-constant angle and constant radius arch dam, simple design and sketchs, most economical angle, Earth dam, design principles, seepage through earth dams, seepage line, control of seepage, design of filters.

UNIT-IV

Spillways and Energy Dissipaters: Essential requirements of spillway and spillway's capacity, types of spillways and their suitability, Ogee spillways, chute, side channel, shaft and syphon spillways, energy dissipation below spillways, stilling basins, USBR and I.S. Stilling Basins.

Books:

1. Irrigation, Water Resources and Water Power Engineering by P.N.Modi.
2. Fundamentals on Irrigation Engineering by Bharat Singh.
3. Irrigation Engineering and Hydraulic Structures by S.K.Garg.
4. Theory and Design of Irrigation Structures Vol.I & II by R.S.Varshney, Gupta & Gupta.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	2	2	2	1	1	-	-	-	-	-	-	1	1	2
CO2.	1	3	3	2	1	-	-	-	-	-	-	-	1	1	2
CO3.	1	2	2	2	1	-	-	-	-	-	-	-	1	1	2
CO4.	1	3	3	2	2	-	-	-	-	-	-	-	1	1	2
CO5.	1	2	3	3	2	-	-	-	-	-	-	-	1	1	2
3 –High 2-Medium 1-Low															

URBAN HYDROLOGY AND HYDRAULICS

Course code	**PE/CE/15-T**			
Category	**Program Elective**			
Course title	**Urban Hydrology and Hydraulics**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course Outcomes:

S. No.	**Course outcomes:** At the end of the course students will be able to:	**RBT* Level**
COl	Understand and explain the effects of urbanization on rainfall and runoff.	**L2(Understanding)**
CO2	Identify factors affecting urban hydrological cycle	**L3(Applying)**
CO3	Design various urban drainage system elements.	**L6(Creating)**
CO4	Develop integrated urban water management system.	**L3(Applying)**
CO5	Prepare master drainage plan for an urbanized area.	**L6(Creating)**

***Revised Bloom's Taxonomy Action verbs/ levels**

UNIT- I

Urbanization: Process of urbanization, Trends of urbanization and industrialization, influence on hydrologic cycle, effects and consequences for drainage.
Urban water Management: Rain water harvesting, managed aquifer recharge, effect of water management practices on urban water infrastructure, hydrology and ground water regime, mapping of water supply and sewage networks.

Unit-II

Urban water Infrastructure: Urban water supply: Estimate of demand, sources in surface and groundwater, Reservoir, capacity estimation, sanitation, sewerage and wastewater conveyance infrastructures, Water supply and sewerage network hydraulics, Structural safety and mitigating plans against natural and human caused threats.

Unit-III

Urban Storm water: Master drainage plans, Estimation of urban storm water quantity, Wastewater collection systems, Design of storm sewer network systems, Storage facilities. Interaction between urban drainage and solid waste management, Storm water Management, Operation and maintenance of urban drainage system.

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Unit IV

Sustainable Design: Sustainable urban designs, Methodologies for assessing sustainability of urban water infrastructures, Emerging sustainable materials and design procedures for water supply and sewerage pipelines, determination of design flow; runoff for highways, airports, and urban areas; design of drainage gutters, channels, sewer networks, and culverts.

Books:

1. Chow V T, Handbook of Applied Hydrology: A Compendium of Water resources technology, McGraw Hill, New York.
2. Gupta R S, Hydrology and Hydraulic Systems, Prentice Hall Publishers, New Jersey.
3. Geiger, W.F., Marsalek, J. Zudima and Rawls, G.J, "Manual on Drainage in Urban Areas", 2 Volumes, UNESCO, Paris.
4. Wanielista, M.P., and Yousef, Y.A., "Storm water Management" John Wiley and Sons, Inc., New York.
5. Hall, M.J., "Urban Hydrology", Elsevier Applied Science Publishers.
6. Mays, L.W., Hydraulic Design Handbook, McGraw-Hill.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	2	1	2	1	2	1	-	-	-	-	-	1	1	2
CO2.	1	2	1	2	1	-	1	-	-	-	-	-	1	1	2
CO3.	1	3	3	1	3	-	-	-	-	-	-	-	1	1	2
CO4.	1	3	3	2	3	1	-	-	-	-	-	-	1	1	2
CO5.	1	3	3	2	3	1	-	-	-	-	-	-	1	1	2
3 –High 2-Medium 1-Low															

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GROUNDWATER ENGINEERING

Course code	**PE/CE/16-T**			
Category	**Program Elective Course**			
Course title	**Groundwater Engineering**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Understand aquifer properties and its dynamics.	**L2(Understanding)**
CO2.	Identify design and practical problems.	**L4(Analyzing)**
CO3.	Develop a model for groundwater management.	**L4(Analyzing)**
CO4.	Understand the importance of artificial recharge and groundwater quality concepts.	**L2(Understanding)**
CO5.	Examine conservation of groundwater.	**L4(Analyzing)**

***Revised Bloom's Taxonomy Action verbs/Levels**

Unit-I

Hydrogeological Parameters: Introduction – Water bearing Properties of Rock – Type of aquifers - Aquifer properties – permeability, specific yield, transmissivity and storage coefficient – Methods of Estimation – GEC norms - Steady state flow - Darcy's Law - Groundwater Velocity –- Dupuit Forchheimer assumption – Steady Radial Flow into a Well

Unit-II

Well Hydraulics: Unsteady state flow - Theis method - Jacob method – Chow's method – Law of Times – Theis Recovery – Bailer method – Slug method - tests - Image well theory – Partial penetrations of wells – Well losses – Specific Capacity and Safe yield - Collector well and Infiltration gallery

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Unit-III

Groundwater Management: Need for Management Model – Database for Groundwater Management – Groundwater balance study – Introduction to Mathematical model – Model Conceptualization – Initial and Boundary Condition – Calibration – Validation – Future Prediction – Sensitivity Analysis – Uncertainty – Development of a model

Unit-IV

Ground Water Quality: Ground water chemistry - Origin, movement and quality - Water quality standards – Drinking water – Industrial water – Irrigation water - Ground water Pollution and legislation - Environmental Regulatory requirements.

TEXT BOOKS:

1. Raghunath H.M., "Ground Water Hydrology", New Age International (P) Limited, New Delhi.
2. Todd D.K., "Ground Water Hydrology", John Wiley and Sons, New York.
3. Fitts R Charles, "Groundwater Science". Elsevier, Academic Press.
4. Ramakrishnan, S, Ground Water, K.J. Graph arts, Chennai.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	1	1	1	1	1	1	-	-	-	-	-	1	1	2
CO2.	1	2	3	3	1	1	-	-	-	-	-	-	1	1	2
CO3.	1	3	3	3	2	1	-	-	-	-	-	-	1	1	2
CO4.	1	3	3	3	1	1	-	-	-	-	-	-	1	1	2
CO5.	1	1	1	1	1	1	1	-	-	-	-	-	1	1	2
3 –High 2-Medium 1-Low															

Program

Elective-V

RAILWAY AND AIRPORT ENGINEERING

Course code	**PE/CE/17-T**			
Category	**Program Elective Course**			
Course title	**Railway and Airport Engineering**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Explain the type of rails and its parts.	**L2(Understanding)**
CO2.	Examine the fastenings and design for joints.	**L4(Analyzing)**
CO3.	Develop the control of the movement of trains using various signals	**L3(Applying)**
CO4.	Design the components of the rail track.	**L6(Creating)**
CO5.	Classify the types of Airports	**L2(Understanding)**
CO6.	Design the pavements used in airports.	**L6(Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Introduction, Permanent Way and Rails : Rail transportation and its importance in India. Permanent way: requirements and components. Gauges in India and abroad. Selection of gauge. Coning of wheels. Adzing of sleepers. Rails: functions, composition of rail steel, types of rail sections, requirements of an ideal rail section, length of rails. Defects in rails. Creep of rails. Long welded rails and continuously welded rails.

Sleepers, Fastenings and Ballast: Sleepers: functions, requirements of an ideal sleeper. Types of sleepers: wooden, cast iron, steel and concrete sleepers, advantages, disadvantages and suitability of each type. Sleeper density. Fastenings for various types of sleepers: fish plates, spikes, bolts, bearing plates, keys, chairs, jaws, tie bars. Elastic fastenings. Ballast: functions, requirements, types of ballast and their suitability.

UNIT-II

Points and Crossings: Necessity, Turnout: various components, working principle. Switch: components, types. Crossing : components and types. Design elements of a turnout, design of

a simple turnout. Layout plan of track junctions: crossovers, diamond crossing, single-double slips, throw switch, turn table, triangle.

Signaling, Interlocking and Train Control: Signals: objects, types and classification. Semaphore signal: components, working principle. Requirements / principles of a good interlocking system. Brief introduction to devices used in interlocking. Methods of control of train movements: absolute block system, automatic block system, centralized train control and automatic train control systems.

UNIT-III

Geometric Design of the Track: Gradients, grade compensation. Super elevation, cant deficiency, negative super elevation. Maximum permissible speed on curves. Tractive resistances, types. Hauling capacity of a locomotive.

Stations, Yards and Track Maintenance: Stations: functions and classification. Junction, non-junction and terminal stations. Yards: functions, types. Marshalling yard: functions, types. Maintenance of railway track: necessity, types of maintenance. Brief introduction to mechanized maintenance, M.S.P and D.T.M.

UNIT-IV

Introduction and Airport Planning: Air transportation, its importance and characteristics, status in India. Layout plan of an airport and its basic elements: terminal area, apron, taxiway, runway, hanger. Aircraft characteristics, their effect on elements of an airport. Site selection of an airport. Classification of airports.

Runway Layout and Pavement Design: Runway orientation, Wind Rose diagram. Basic runway length. Corrections to basic runway length. Runway patterns. Difference between highway and runway pavement. Types of runway pavements. Design factors for runway pavement. Brief introduction to design of thickness of a runway pavement.

Books:

1. A text book of Railway Engineering *by* S.C.Saxena and S.P.Arora, Dhanpat Rai Publicatios, N.Delhi.
2. Railway Track Engg. *by* J.S.Mundray, Tata McGraw-Hill Publishing Co. Ltd. N.Delhi.
3. Airport Planning and Design *by* S.K.Khanna, M.G.Arora, Nem Chand Bros., Roorkee.
4. The Planning and Design of Airports *by* Robort Hornjeff, McGraw Hill Book Co.
5. Air Transportation Planning and Design *by* Virender Kumar & Satish Chandra, Galgotia Publications, N.Delhi.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	1	1	1	1	1	1	-	-	-	-	-	1	1	2
CO2.	1	2	3	3	1	1	-	-	-	-	-	-	1	1	2
CO3.	1	3	3	3	2	1	-	-	-	-	-	-	1	1	2
CO4.	1	3	3	3	1	1	-	-	-	-	-	-	1	1	2
CO5.	1	1	1	1	1	1	1	-	-	-	-	-	1	1	2
CO6.	1	2	1	1	1	1	1	-	-	-	-	-	1	1	2
3 –High 2-Medium 1-Low															

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INTELLIGENT TRANSPORT SYSTEM

Course code	**PE/CE/18-T**			
Category	**Program Elective**			
Course title	**Intelligent Transport System**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No.	**Course outcomes:** At the end of the course students will be able to:	**RBT* Level**
CO 1	Understands the fundamentals of ITS and ITS functional areas	**L2(Understanding)**
CO 2	Understand the communication technologies in transportation	**L2(Understanding)**
CO 3	Able to apply the various ITS methodologies	**L3(Applying)**
CO 4	Understand the ITS implementation in developing countries	**L2(Understanding)**
CO 5	Able to understand and the advantages of ITS and apply the appropriate technologies for field conditions.	**L3(Applying)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Introduction to Intelligent Transportation Systems (ITS) – Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

UNIT-II

Telecommunications in ITS – Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Vehicle – Road side communication – Vehicle Positioning System.

UNIT-III

ITS functional areas – Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS).

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UNIT-IV

ITS User Needs and Services – Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management; Automated Highway Systems - Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries

Books:

1. Intelligent Transport Systems by Pradip Kumar Sarkar, Amit Kumar Jain, PHI Learning Private Limited, New Delhi
2. Intelligent Transport Systems by R Srinivasa Kumar, Orient Blackswan Pvt. Ltd.
3. Intelligent Transport Systems: New Principles and Architectures by S. Ghosh, T.S. Lee, CRC Press.
4. Fundamentals of Intelligent Transportation system planning, Mashrur A. Chowdhury and A del Sadek, Artech House.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	3	1	1	1	1	1	-	-	-	-	-	1	1	2
CO2.	1	3	1	2	2	1	-	-	-	-	-	-	1	1	2
CO3.	1	2	1	2	3	2	-	-	-	-	-	-	1	1	2
CO4.	1	2	1	2	2	1	1	-	-	-	-	-	1	1	2
CO5.	1	2	1	2	2	1	-	-	-	-	-	-	1	1	2
3 –High 2-Medium 1-Low															

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TRANSPORTATION ENGINEERING

Course code	**PE/CE/19-T**			
Category	**Program Elective**			
Course title	**Transportation Engineering**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No.	**Course outcomes:** At the end of the course students will be able to:	RBT* Level
CO 1	Understand the basic concepts of highways, railway, airport, tunnel and harbour engineering.	**L2(Understanding)**
CO 2	Analysis and design airport pavement thickness, super-elevation in rails.	**L6 (Creating)**
CO 3	Apply the techniques for designing the geometric features of railways and runway layout of airports.	**L3(Applying)**
CO4	Understand the various methods used for tunneling	**L2(Understanding)**
CO5	Analyze the various design requirements needed for the design of docks and harbours.	**L4(Analyze)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Introduction: Road transportation. Brief review of history of road development in India and abroad: Roman, Tresaguet, Telford and Macadam constructions. Road patterns. Classification of roads, Objectives of highway planning, Planning surveys. Saturation system of planning.

Cross Section Elements and Sight Distance Considerations: Cross section elements: friction, carriageway, formation width, land width, camber, IRC recommended values. Types of terrain Design speed. Sight distance, stopping sight distance, overtaking sight distance, overtaking zones, intermediate sight distance, sight distance at intersections, head light sight distance, set back distance. Critical locations for sight distance.

UNIT-II

Introduction, Permanent Way and Rails: Rail transportation and its importance in India. Permanent way: requirements and components. Gauges in India and abroad. Selection of gauge. Coning of wheels. Adzing of sleepers. Rails: functions, composition of rail steel, types of rail sections, requirements of an ideal rail section, length of rails. Defects in rails. Creep of rails. Long welded rails and continuously welded rails.

Sleepers, Fastenings and Ballast: Sleepers: functions, requirements of an ideal sleeper. Types of sleepers: wooden, cast iron, steel and concrete sleepers, advantages, disadvantages and suitability of each type. Sleeper density. Fastenings for various types of sleepers: fish plates, spikes, bolts, bearing plates, keys, chairs, jaws, tie bars. Elastic fastenings. Ballast: functions, requirements, types of ballast and their suitability.

UNIT-III

Introduction to Airport Planning : Air transportation, its importance and characteristics, status in India. Layout plan of an airport and its basic elements: terminal area, apron, taxiway, runway, hanger. Aircraft characteristics, their effect on elements of an airport. Site selection of an airport. Classification of airports.

Runway Layout and Pavement Design: Runway orientation, Wind Rose diagram. Basic runway length. Corrections to basic runway length. Runway patterns. Difference between highway and runway pavement. Types of runway pavements. Design factors for runway pavement. Brief introduction to design of thickness of a runway pavement.

UNIT-IV

Tunnels: Sections of tunnels: advantages, limitations and suitability of each section. Shaft. Pilot tunnel. Driving tunnel in rocks: sequence of construction operations, full face method, heading and bench method, drift method. Driving tunnels in soft ground: sequence of construction operations, needle beam method, shield tunneling, compressed air tunneling.

Docks and Harbour Engineering: Definition of basic terms – Harbour, Port, Satellite Port, Docks, Waves and Tides. Planning and design of Harbours: Harbour layout and terminal facilities, Coastal structures: Piers, Break waters, wharves, Jetties, Quays, spring fenders, dolphins and floating landing stage.

Books:

1. A text book of Railway Engineering by S.C.Saxena and S.P.Arora, Dhanpat Rai Publicatios, N.Delhi.
2. Railway Track Engg. by J.S.Mundray, Tata McGraw-Hill Publishing Co. Ltd. N.Delhi.
3. Airport Planning and Design by S.K.Khanna, M.G.Arora, Nem Chand Bros., Roorkee.
4. The Planning and Design of Airports by Robort Hornjeff, McGraw Hill Book Co.
5. Air Transportation Planning and Design by Virender Kumar & Satish Chandra, Galgotia Publications, N.Delhi.
6. Tunnel Engineering by S.C.Saxena, Dhanpat Rai Publications, N.Delhi.
7. A text book of Tunnel, Bridges and Railway Engg. by S.P.Bindra, Dhanpat Rai Delhi.
8. Highways, Railways, Airport and Harbour Engineering, by K.P. Subramanian, V Scitech Publications, Chennai.
9. Railway, Airport, Docks and Harbour Engineering by R.Saravanan, R. Dinesh Kumar and L. Deepak, Suchitra Publications, (Lakshmi Publications).

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	1	1	1	1	2	1	-	-	-	-	-	1	1	2
CO2.	1	1	3	2	3	1	-	-	-	-	-	-	1	1	2
CO3.	1	1	2	3	2	1	-	-	-	-	-	-	1	1	2
CO4.	1	1	1	3	2	1	-	-	-	-	-	-	1	1	2
CO5.	1	1	3	2	2	1	-	-	-	-	-	-	1	1	2
3 –High 2-Medium 1-Low															

AIRPORT PLANNING & DESIGN

Course code	**PE/CE/20-T**			
Category	**Program Elective**			
Course title	**Transportation Engineering**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No.	**Course outcomes:** At the end of the course students will be able to:	RBT* Level
CO 1	Understand the basic concepts of airport engineering.	**L2(Understanding)**
CO 2	Analysis and design of airport pavement thickness	**L6 (Creating)**
CO 3	Able to apply the methods for designing the geometric features of runway pavement.	**L3(Applying)**
CO4	Understand the various methods used for air traffic control and visual aids required for airports.	**L2(Understanding)**
CO5	Able to analyze the various design requirements needed for the design of drainage system for airports.	**L4(Analyze)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Airport Engineering: Air transportation and its importance, status in India, IAAI, Civil aviation department & AAI rules and regulations, open sky policy, Component parts of aeroplane, Aircraft characteristics, Minimum circling radius, minimum turning radius, classifications of airports and aerodromes.

Airport surveys: Types of airport surveys – approach zone, traffic, topographical survey etc., airport site section survey, airport size, airport obstructions - Imaginary surfaces and objects with actual heights, clear zone, turning zone and zoning laws.

UNIT-II

Airport Planning: National airport authority & FAA recommendation for master plan, regional planning, layout plan of an airport and its basic elements: terminal area, apron, taxiway, runway, hanger, airport architecture – features of building, international airports and seating arrangement, traffic forecast, existing airport capacity improvement and planning of a new airport environmental considerations.

Airport markings and Visual aids: requirement of visual aids. Types of airport markings, alignment guidance, height information, visual parameters, airport lighting and factors affecting airport lighting, runway lighting, taxiway lighting, approach lighting, apron and hanger lighting, instrumental landing system, precision approach radar.

UNIT III

Runway Orientation: Runway orientation, Wind Rose diagram. Basic runway length – landing and take-off, emergency stopping length requirement, corrections to basic runway length, runway patterns, Terminal area, building area, parking area, apron, hanger typical airport layouts, difference between highway and runway pavement, types of runway pavements.

Runway Pavement Design: Geometric design of runway, design factors for runway pavement, Structural design of runway pavements LCN/PCN method of rigid pavement design, Design of flexible and rigid runways as per FAA procedure, Specifications for the different layers of runway and taxiway pavements, design of overlay pavements.

UNIT-IV

Air Traffic Control: Importance and need of air traffic control, flight rules, types of control, control centres and towers, flight service stations, air traffic control aids – airway and terminal aids, GPS air traffic control system, free flight types and different approaches.

Airport Drainage System: Grading – importance and requirement, functions of airport drainage, requirements of drainage system – capacity, strength, rapid drainage and future scope, runoff estimation, design and layout of airport drainage system.

Books:

1. Airport Planning and Design by S.K.Khanna, M.G.Arora, Nem Chand Bros., Roorkee.
2. Airport Engineering, by Ranwala, Charotar Publishing House, PVT., LTD.
3. Air Transportation Planning and Design by Virender Kumar & Satish Chandra, Galgotia Publications, N.Delhi.
4. Highways, Railways, Airport and Harbour Engineering, by K.P. Subramanian, V Scitech Publications, Chennai.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	2	1	1	1	2	1	-	-	-	-	-	1	1	2
CO2.	1	3	3	3	3	1	-	-	-	-	-	-	1	1	2
CO3.	1	3	2	3	2	1	-	-	-	-	-	-	1	1	2
CO4.	1	2	2	3	2	1	-	-	-	-	-	-	1	1	2
CO5.	1	3	3	2	2	1	-	-	-	-	-	-	1	1	2
3 –High 2-Medium 1-Low															

Program Elective-VI

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PROJECT PLANNING & MANAGEMENT

Course code	**PE/CE/21-T**			
Category	**Program Elective Course**			
Course title	**Project Planning & Management**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Identify the type of types of contract	**L3 (Applying)**
CO2.	Analyze a project life cycle, and can map each stage in the cycle.	**L4(Analyzing)**
CO3.	Estimate the time needed to successfully complete a project.	**L6 (Creating)**
CO4.	Develop a project scope while considering factors such as customer requirements and internal/external goals.	**L6 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Construction Management: Significance, objectives and functions of construction management, types of constructions, resources for construction industry, stages for construction, construction team, engineering drawings.

Construction Contracts & Specifications: Introduction, types of contracts, contract document, specifications, important conditions of contract, arbitration.

UNIT-II

Construction Planning: Introduction, work breakdown structure, stages in planning-pre-tender stages, contract stage, scheduling, scheduling by bar charts, preparation of material, equipment, labour and finance schedule, limitation of bar charts, milestone charts.

Construction Organization: Principles of Organization, communication, leadership and human relations, types of Organizations, Organization for construction firm, site organization, temporary services, job layout.

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UNIT-III

Network Techniques in Construction Management-I: CPM- Introduction, network techniques, work break down, classification of activities, rules for developing networks, network development-logic of network, allocation of time to various activities, Fulkerson's rule for numbering events, network analysis , determination of project schedules, critical path, ladder construction, float in activities, shared float, updating, resources allocation, resources smoothing and resources leveling.

Network Techniques in Construction Management-II-PERT- Probability concept in network, optimistic time, pessimistic time, most likely time, lapsed time, deviation, variance, standard deviation, slack critical path, probability of achieving completion time, central limit theorem.

UNIT-IV

Cost-Time Analysis: Cost versus time, direct cost, indirect cost, total project cost and optimum duration, contracting the network for cost optimization, steps in time cost optimization, illustrative examples.

Inspection & Quality Control: Introduction, principles of inspection, enforcement of specifications, stages in inspection and quality control, testing of structures, statistical analysis.

Books Recommended

1 Construction Planning & Management by P.S. Gehlot & B.M. Dhir, Wiley Eastern Ltd.
2 PERT & CPM -Principles & Applications by L.S. Srinath. Affiliated East-West Press (P)Ltd.
3 Project Planning & Control with PERT & CPM by B.C. Punmia & K. K. Khandelwal, Lakshmi Pub. Delhi
4 Construction Management & Planning by B. Sengupta & H. Guha, Tata McGraw -Hills.

CO-PO Mapping:

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

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CONSTRUCTION ENGINEERNG & MANAGEMENT

Course code	**PE/CE/22-T**			
Category	**Program Elective Course**			
Course title	**Construction Engineering & Management**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Identify the types of construction projects.	**L3 (Applying)**
CO2.	Analyze a project planning using network techniques.	**L4(Analyzing)**
CO3.	Estimate the time needed to successfully complete a project.	**L6 (Creating)**
CO4.	Develop a project scope while considering factors such as customer requirements and internal/external goals.	**L6 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

Unit-I

Basics of Construction: Unique features of construction, construction projects types and features, phases of a project, agencies involved and their methods of execution.

Construction project planning: Stages of project planning: pre-tender planning, preconstruction planning, detailed construction planning, role of client and contractor, level of detail.

Process of development of plans and schedules, work break-down structure, activity lists, assessment of work content, concept of productivities, estimating durations, sequence of activities, activity utility data; Techniques of planning- Bar charts, Gantt Charts.

Unit-II

Networks: basic terminology, types of precedence relationships, preparation of CPM networks: activity on link and activity on node representation, computation of float values, critical and semi critical paths, calendaring networks.

PERT: Assumptions underlying PERT analysis, determining three time estimates, analysis, slack computations, calculation of probability of completion.

Construction Methods basics: Types of foundations and construction methods, Basics of Formwork and Staging; Common building construction methods (conventional walls and

slabs; conventional framed structure with block work walls; Modular construction methods for repetitive works; Precast concrete construction methods; Basics of Slip forming for tall structures; Basic construction methods for steel structures; Basics of construction methods for Bridges.

Unit-III

Construction Equipment basics: Conventional construction methods Vs Mechanized methods, Equipment for Earthmoving, Dewatering, Concrete mixing, transporting & placing; Cranes, Hoists and other equipment for lifting, Equipment for transportation of materials.

Planning and organizing construction site and resources: Site - site layout including enabling structures, developing site organization, Documentation at site; Manpower: planning, organizing, staffing, motivation; Materials- concepts of planning, procurement and inventory control; Equipment- basic concepts of planning and organizing. Funds- cash flow, sources of funds; Earned Value; Resource Scheduling- Bar chart, line of balance technique, resource constraints and conflicts; resource aggregation, allocation, smoothening and leveling.

Unit-IV

Project Monitoring & Control: Supervision, record keeping, periodic progress reports, periodical progress meetings. Updating of plans: purpose, frequency and methods of updating. Common causes of time and cost overruns and corrective measures. Basics of Modern Project management systems such as Lean Construction; Use of Building Information Modelling (BIM) in project management; Quality control: concept of quality, quality of constructed structure, use of manuals and checklists for quality control, role of inspection, basics of statistical quality control. Safety, Health and Environment on project sites: accidents; their causes, effects and preventive measures, costs of accidents, occupational health problems in construction, organizing for safety and health.

Contracts and Construction Costs: Importance of contracts; Types of Contracts, parties to a contract; Common contract.

Make-up of construction costs; Classification of costs, time cost trade-off in construction projects, compression and decompression.

Reference Books:

1. Varghese, P.C., "Building Construction", Prentice Hall India, 2007.
2. National Building Code, Bureau of Indian Standards, New Delhi, 2017.
3. Peurifoy, R.L. Construction Planning, Methods and Equipment, McGraw Hill, 2011.
4. Nunnally, S.W. Construction Methods and Management, Prentice Hall, 2006.
5. Jha, Kumar Neeraj., Construction Project management, Theory & Practice, Pearson Education India.
6. Punmia, B.C., Khandelwal, K.K., Project Planning with PERT and CPM, Laxmi Publications.

CO-PO Mapping:

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

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CONSTRUCTION PLANNING, SCHEDULING AND CONTROL

Course code	**PE/CE/23-T**			
Category	**Program Elective Course**			
Course title	**Construction Planning, Scheduling and Control**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Identify the types of technology and construction methods.	**L3 (Applying)**
CO2.	Analyze a project schedule and its planning.	**L4(Analyzing)**
CO3.	Analyze the cost and its control throughout the project.	**L4(Analyzing)**
CO4.	Develop a project with quality control and safety provisions.	**L6 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

Course Content

Unit-I

Construction Planning : Basic Concepts in the Development of Construction Plans – Choice of Technology and Construction Method – Defining Work Tasks – Defining Precedence Relationships among Activities – Estimating Activity Durations – Estimating Resource Requirements for Work Activities – Coding Systems.

Unit-II

Scheduling Procedures and Techniques: Construction Schedules – Critical Path Method – Scheduling Calculations – Float – Presenting Project Schedules – Scheduling for Activity-on-Node and with Leads, Lags, and Windows – Scheduling with Resource Constraints and Precedence – Use of Advanced Scheduling Techniques – Scheduling with Uncertain Durations – Calculations for Monte Carlo Schedule Simulation – Crashing and Time/Cost Tradeoffs – Improving the Scheduling Process.

Unit-III

Cost Control, Monitoring and Accounting: The Cost Control Problem – The Project Budget – Forecasting for Activity Cost Control – Financial Accounting Systems and Cost Accounts – Control of Project Cash Flows –Schedule Control – Schedule and Budget Updates – Relating Cost and Schedule Information.

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Unit-IV

Quality Control and Safety During Construction: Quality and Safety Concerns in Construction – Organizing for Quality and Safety – Work and Material Specifications – Total Quality Control – Quality Control by Statistical Methods – Statistical Quality Control with Sampling by Attributes – Statistical Quality Control with Sampling by Variables – Safety.

Reference Books:

1. Calin M. Popescu, Chotchai Charoenngam, "Project Planning, Scheduling and Control in Construction: An Encyclopedia of terms and Applications", Wiley, New York, 1995.
2. Chitkara, K.K. "Construction Project Management: Planning, Scheduling and Control", McGraw-Hill Publishing Company, New Delhi, 1998.
3. Chris Hendrickson and Tung Au, "Project Management for Construction – Fundamental Concepts for Owners, Engineers", Architects and Builders, Prentice Hall, Pittsburgh, 2000.
4. Halpin, D. W., "Financial and Cost Concepts for Construction Management", John Wiley & Sons, New York, 1985.
5. Jha, Kumar Neeraj., Construction Project management, Theory & Practice, Pearson Education India.
6. Punmia, B.C., Khandelwal, K.K., Project Planning with PERT and CPM, Laxmi Publications.

CO-PO Mapping:

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

CONTRACT LAWS AND REGULATIONS

Course code	**PE/CE/24-T**			
Category	**Program Elective Course**			
Course title	**Contract Laws and Regulations**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Identify the types of Contracts and develop the content.	**L3 (Applying)**
CO2.	Identify and Analyze the types of Tenders.	**L4(Analyzing)**
CO3.	Examine the causes of arbitration for removal.	**L4(Analyzing)**
CO4.	Decide the legal requirements of a project.	**L5 (Evaluating)**
CO5.	Adapt the labour regulations to avoid litigations in a project	**L6 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

Course Content

Unit-I

Construction Contracts: Indian Contracts Act – Elements of Contracts – Types of Contracts – Features – Suitability – Design of Contract Documents – International Contract Document – Standard Contract Document – Law of Torts.

Unit-II

Tenders: Prequalification – Bidding – Accepting – Evaluation of Tender from Technical, Contractual and Commercial Points of View – Contract Formation and Interpretation – Potential Contractual Problems – World Bank Procedures and Guidelines.

Unit-III

Arbitration: Comparison of Actions and Laws – Agreements – Subject Matter – Violations – Appointment of Arbitrators – Conditions of Arbitration – Powers and Duties of Arbitrator – Rules of Evidence – Enforcement of Award – Costs.

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Unit-IV

Legal Requirements: Insurance and Bonding – Laws Governing Sale, Purchase and Use of Urban and Rural Land – Land Revenue Codes – Tax Laws – Income Tax, Sales Tax, Excise and Custom Duties and their Influence on Construction Costs – Legal Requirements for Planning – Property Law – Agency Law – Local Government Laws for Approval – Statutory Regulations.

Labour Regulations: Social Security – Welfare Legislation – Laws relating to Wages, Bonus and Industrial Disputes, Labour Administration – Insurance and Safety Regulations – Workmen's Compensation Act – Indian Factory Act – Child Labour Act - Other Labour Laws.

Reference Books:

1. Gajaria G.T., "Laws Relating to Building and Engineering" Contracts in India.
2. Patil. B.S, "Civil Engineering Contracts and Estimates", Universities Press (India) Private Limited, 2006.
3. Joseph T. Bockrath, "Contracts and the Legal Environment for Engineers and Architects", McGraw Hill, 2000.
4. Jimmie Hinze, "Construction Contracts", McGraw Hill, 2001.
5. Punmia, B.C., Khandelwal, K.K., Project Planning with PERT and CPM, Laxmi Publications.

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1.	**1**	**1**	**1**	**1**	**3**	**1**	-	-	-	-	-	-	**1**	**1**	**2**
CO2.	**1**	**1**	**1**	**1**	**3**	**1**	-	-	-	-	-	-	**1**	**1**	**2**
CO3.	**1**	**1**	**1**	**1**	**3**	**1**	-	-	-	-	-	-	**1**	**1**	**2**
CO4.	**1**	**1**	**1**	**1**	**3**	**1**	-	-	-	-	-	-	**1**	**1**	**2**
CO5.	**1**	**1**	**1**	**1**	**3**	**1**	-	-	-	-	-	-	**1**	**1**	**2**
3 –High 2-Medium 1-Low															

Program

Elective-VII

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SEWERAGE AND SEWAGE TREATMENT

Course code	**PE/CE/25-T**			
Category	**Program Elective Course**			
Course title	Sewerage and Sewage Treatment			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Identify the types of sewerage system.	**L3 (Applying)**
CO2.	Identify and Analyze the characteristics of sewage.	**L4(Analyzing)**
CO3.	Examine the causes and decide the treatment required for sewage.	**L5 (Evaluating)**
CO4.	Propose the disposal of sewage.	**L6 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Collection of sewage: Importance of sanitation, Systems of sewerage – separate, combined and partially separate. Quantity of sanitary sewage and variations. Shapes of sewer – circular and egg shaped. Design of sewers, self-cleansing velocity and slopes, Construction and testing of sewer lines. Sewer materials. joints and appurtenances.

UNIT-II

Sewage Characterization: Quality parameters- BOD, COD, Solids, D.O., Oil & Grease. Indian Standards for disposal of effluents into inland surface sources and on land.

UNIT-III

Sewage Treatment: Objectives, sequence and efficiencies of conventional treatment units. Preliminary treatment, screening and grit removal units. Theory and design aspects of primary treatment, secondary treatment- activated sludge process & its modifications, Tricking filter, sludge digestion and drying beds. Stabilization pond, aerated lagoon, UASB process , septic tank and Imhoff tank.

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UNIT-IV

Disposal of Sewage: Disposal of sewage by dilution – self-purification of streams. Sewage disposal by irrigation (Sewage treatment).

Recommended Books:

1. Waste Water Engineering: Metcalf and Eddy.
2. Sewage and Sewage Treatment: S.K. Garg.
3. Sewage and Sewage Treatment: S.R. Krishansagar.
4. Waste Water Engineering: B.C. Punmia.
5. Manual on Sewerage and Sewage Treatment: Ministry of Urban Dev., New Delhi.

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1.	**1**	**1**	**1**	**1**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**2**
CO2.	**1**	**1**	**1**	**1**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**2**
CO3.	**1**	**1**	**1**	**1**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**2**
CO4.	**1**	**1**	**1**	**1**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**2**
3 –High 2-Medium 1-Low															

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INDUSTRIAL WASTE WATER TREATMENT

Course code	**PE/CE/26-T**			
Category	**Program Elective Course**			
Course title	**Industrial Waste Water Treatment**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Identify the effect of industrial waste.	**L3 (Applying)**
CO2.	Analyze the characteristics of industrial waste.	**L4(Analyzing)**
CO3.	Propose the kind of disposal of industrial waste.	**L6 (Creating)**
CO4.	Identify the type and treatment of industrial waste.	**L3 (Applying)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Effects of industrial wastes on streams, sewerage systems and wastewater treatment plants.

UNIT-II

Minimizing the effects of industrial effluents on waste water treatment plants and receiving streams-conservation of water, process change, reuse of waste water, volume reduction, strength reduction, neutralization, equalization and proportioning.

UNIT-III

Population equivalent. Industrial effluent standards for disposal into inland surface water sources and on land for irrigation.

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UNIT-IV

Study of the following Industries from waste generation, quality and its treatment including brief overview of manufacturing process:

Textile, tannery, sugar mill, distillery, dairy, pulp & paper, metal plating, oil refinery, nitrogenous fertilizers, thermal power plants and radio active wastes.

Books:

1. Industrial and Hazardous Waste Treatment by N.L.Nemerow & A.Dasgupta.
2. Industrial Effluents by N.Manivasakam.
3. Waste Water Treatment by M.N.Rao & A.K.Dutta.

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1.	**1**	**1**	**1**	**1**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**2**
CO2.	**1**	**1**	**1**	**1**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**2**
CO3.	**1**	**1**	**1**	**1**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**2**
CO4.	**1**	**1**	**1**	**1**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**1**	**1**	**2**
3 –High 2-Medium 1-Low															

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AIR AND NOISE POLLUTION CONTROL ENGG.

Course code	**PE/CE/27-T**			
Category	**Program Elective Course**			
Course title	**Air and Noise Pollution Control Engg.**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Sr. No.	**Course outcomes** At the end of the course students will be able to:	**RBT* Level**
CO1	Understand sources of air pollution , air pollution problems	**L1(Remembering)**
CO2	Demonstrate a detailed knowledge of study the effect of meteorological parameters in the dispersion of air pollutants	**L3(Applying))**
CO3	Analyze Environment legislation and regulations for air and noise pollution	**L4(Analyzing)**
CO4	Evaluate efficiency of various air pollution control devices used for particulate removal	**L5(Evaluating)**
CO5	Design, operate and control the devices used for gaseous emission control and noise emission control	**L6(Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT I

Air pollutants, Sources, classification, Combustion Processes and pollutant emission, Effects on Health, vegetation, materials and atmosphere, Reactions of pollutants in the atmosphere and their effects, Smoke, smog and ozone layerdisturbance, Greenhouse effect.

UNIT II

Air sampling and pollution measurement methods, principles and instruments, ambient air quality and emissionstandards, Air pollution indices, Air Act, legislation and regulations

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UNIT III

Control principles, Removal of gaseous pollutants by adsorption, absorption, reaction and other methods. Particulate emission control, settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators and other removal methods like absorption, adsorption, precipitation etc. Biological air pollution control technologies, Indoor air quality.

UNIT IV

Noise pollution: Basics of acoustics and specification of sound; sound power, sound intensity and sound pressure levels; plane, point and line sources, multiple sources; outdoor and indoor noise propagation; psychoacoustics and noise criteria, effects of noise on health, annoyance rating schemes; special noise environments: Infrasound, ultrasound, impulsive sound and sonic boom; noise standards and limit values; noise instrumentation and monitoringprocedure. Noise indices. Noise control methods

REFERENCE BOOKS:

1. C. S. Rao, "Environmental Pollution Control Engineering", Wiley Eastern Limited, 2000.
2. M. N. Rao, H. V. N. Rao, Air pollution, Tata McGraw Hill Pvt. Ltd, New Delhi, 1993.
3. G.K. Nagi, M.K. Dhillon, G.S. Dhaliwal, Commonwealth Publishers, Noise Pollution.
4. S.K. Garg, Khanna publishers, Sewage Disposal and Air Pollution Engineering.
5. S.M. Khopkar, Environmental pollution analysis, New Age International Publications

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	2	-	-	-	1	2	1	-	-	-	1	1	1	2
CO2.	1	2	3	-	-	1	2	1	-	-	1	1	1	1	2
CO3.	1	3	-	-	-	1	2	1		1	1	2	1	1	2
CO4.	1	2	3	2	-	1	2	-	-	-	2	2	1	1	2
CO5.	1	2	3	1	-	1	2	-	2	-	2	3	1	1	2
3 –High 2-Medium 1-Low															

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SOLID AND HAZARDOUS WASTE MANAGEMENT

Course code	**PE/CE/28-T**			
Category	**Program Elective Course**			
Course title	**Solid and Hazardous Waste Management**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1	Describe the principles of solid & hazardous waste management.	**L1(Remembering)**
CO2	Acquire knowledge on specialized solid & hazardous waste treatment	**L2(Understanding)**
CO3	Illustrate various techniques for treatment of solid waste and hazardous waste	**L3(Applying)**
CO4	Analyze policies regarding solid and hazardous wastes including legal implications.	**L4(Analyzing)**
CO5	Design & optimize techniques in solid & hazardous waste management	**L6(Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Solid Wastes: Origin- Analysis- Composition and Characteristics. Integrated Solid Waste Management System: Collection- Storage- Segregation- Reuse and Recycling possibilities- Transportation- Treatment / Processing and Transformation Techniques- Final Disposal.

UNIT-II

Management of: Municipal- Biomedical- Nuclear- Electronic and Industrial Solid Wastes and the rules and regulations.

UNIT-III

Introduction to Hazardous wastes- Definition of Hazardous waste- The magnitude of the problem; Hazardous waste: Risk assessment- Environmental legislation- Characterization

and site assessment- Waste minimization and resource recovery- Transportation of hazardous waste- Physical- chemical and biological treatment- Ground water contamination- Landfill disposal

UNIT-IV

Current Management Practices- Environmental audit- Pollution Prevention- Facility Development and operation- Site Remediation: Quantitative risk assessment- site and subsurface characterization- Containment- remedial alternatives.

Reference Books:

1. Solid and Hazardous Waste Management , M.N. Rao and Razia Sultana
2. Environmental Hazards-Smith- Keith
3. Environmental Hazards-Iqbal- M-Srivastava- A.S. and Siddiqu- T.Q.
4. Basic Environmental Technology-Nathanson- J.A.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	2	-	-	-	1	2	1	-	-	-	2	1	1	2
CO2.	2	1	-	1	-	1	1	2	-	1	1	2	1	1	2
CO3.	1	3	3	2	1	1	2	1	1	-	2	2	1	1	2
CO4.	1	2	2	1	-	1	1	2	-	1	2	2	1	1	2
CO5.	1	1	3	3	3	1	1	1	1	-	2	2	1	1	2
3 –High 2-Medium 1-Low															

Program

Elective-VIII

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CONCRETE TECHNOLOGY

Course code	**PE/CE/29-T**			
Category	**Program Elective Course**			
Course title	**Concrete Technology**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Identify the concrete making materials.	**L3 (Applying)**
CO2.	Classify the concrete on basis of its quality.	**L4(Analyzing)**
CO3.	Design the concrete on basis of its requirement.	**L6 (Creating)**
CO4.	Examine the concrete using non-destructive technique.	**L4(Analyzing)**
CO5.	Outline special types of concrete.	**L2 (Understanding)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Concrete as Structural Material: Introduction, preparation of concrete, grades of concrete, advantages of concrete, concept of quality control.

Concrete Making Materials: Cement- tests on cement (physical tests), types of Portland cement, various types of cement-ordinary Portland cement, rapid hardening cement, low heat cement, sulphate resistant cement, Portland-pozzolona cement, high strength Portland cement, high alumina cement, waterproof cement, white Portland cement, hydrophobic cement, colored Portland cement.

Aggregates- classification of aggregates based on petrography, size, shape and textures, deleterious substances in aggregates, bulking of fine aggregates, grading of aggregates as per IS-383-1970, fineness modulus.

UNIT-II

Properties of Concrete: Introduction, workability, factors influencing workability, measurement of workability, requirements of workability, properties of hardened concrete,

stress and strain characteristics of concrete, Young's modulus of concrete, creep and shrinkage of concrete, permeability of concrete, durability of concrete sulphate attack, fire-resistance, thermal properties of concrete, construction joints, expansion and contraction joints.

Production of Concrete: Introduction, batching of materials, mixing of concrete materials, transportation of concrete, compaction of concrete, ready mixed concrete, vibrators, Internal vibrators, external vibrators, concrete curing and formwork removal.

UNIT-III

Non-Destructive Testing of Concrete: Significance of Non-Destructive Testing, Rebound Hammer, Ultrasonic pulse velocity techniques, Penetration techniques, pullout tests, vibration methods, Radio-active techniques, Cover meter, core-tests.

Deterioration of Concrete & its Prevention: Causes of concrete deterioration, deterioration by water, surface weir, frost action, deterioration by chemical reactions, sulphate attack, alkali-aggregate reaction, corrosion of embedded steel in concrete, Prevention of deterioration of concrete

UNIT-IV

Repair Technology for Concrete Structures: Symptoms and diagnosis of distress, evaluation of cracks, repair of cracks, common types of repairs, distress in fire damaged structures, underwater repairs.

Special Concrete: Light weight concrete, definition and its properties, applications, high strength concrete, definitions, its properties and applications, Mass Concrete, waste material based concrete, shotcrete, fiber reinforced concrete: Materials Fibre types and properties, ferrro-cement, polymer concrete composites, heavy weight concrete for radiation shielding.

Prestressed Concrete: Introduction, basic concepts, classifications and types of prestressing, prestressing systems, properties of materials, pre tensioned and post tensioned concrete elements,

Books Recommended:

1. Gambhir, M.L. 'Concrete Technology'. TMH Pub. N. Delhi
2. Shetty, M.S. 'Concrete Technology', S. Chand & Co. N. Delhi
3. Nevelli, A.M., 'Concrete Technology', Pearson Education

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	1	1	1	3	1	-	-	-	-	-	-	1	1	2
CO2.	1	1	1	1	3	1	-	-	-	-	-	-	1	1	2
CO3.	1	1	1	1	3	1	-	-	-	-	-	-	1	1	2
CO4.	1	1	1	1	3	1	-	-	-	-	-	-	1	1	2
CO5.	1	1	1	1	3	1	-	-	-	-	-	-	1	1	2
3 –High 2-Medium 1-Low															

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GEO-SYNTHETICS ENGINEERING

Course code	**PE/CE/30-T**			
Category	**Program Elective Course**			
Course title	**Geo-synthetics Engineering**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Identify types of Geosynthetics.	**L3 (Applying)**
CO2.	Illustrate the manufacturing methods.	**L2 (Understanding)**
CO3.	Explain the usefulness of Geogrids.	**L5 (Evaluating)**
CO4.	Identify the use of Geosynthetics in Water resources projects.	**L3 (Applying)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT I

Basic Description of Geosynthetics: Historical Development, the Nomenclature, Function, Use around the World, Applications, Development in India.

Raw Materials – Their Durability and Ageing: Raw Materials, Durability, Degrading Agencies, Polymers, Biological Resistance, Chemical Resistance, Weathering Resistance

UNIT II

Manufacturing Methods: Fibres, Yarn, Nonwoven Geotextiles, Woven Geotextiles, D.S.F. Fabrics.

Geogrids- Testing and Evaluation: Factors influencing Testing, Sampling, Physical Properties, and Mechanical Properties under Uniaxial loading, Creep Testing

UNIT III

Erosion Control with Geogrids: Wind Erosion, Rain Water Erosion, Erosion Control Measures, Placement of Geogrids

Bearing Capacity Improvement with Geogrids: Advantages, Mechanism, Modes of Failure, Friction Coefficient, Experimental Studies.

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UNIT IV

Application of Geosynthetics in Water Resource Projects: Case Study: Dharoidam, Hiran II Dam, Meda Creek Irrigation Scheme, Lining of Kakarpar Canal

Reference Books:

1. Robert M. Koerner, Designing with Geosynthetics, Prentice Hall.
2. **G.V. Rao & G.V.S. Raju, Engineering with Geosynthetics, Tata MacGraw Hill.**

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1.	**1**	**1**	**1**	**1**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO2.	**1**	**1**	**1**	**1**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO3.	**1**	**1**	**1**	**1**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO4.	**1**	**1**	**1**	**1**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
3 –High 2-Medium 1-Low															

BRIDGE ENGINEERING

Course code	**PE/CE/31-T**			
Category	**Program Elective Course**			
Course title	**Bridge Engineering**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Identify types of Bridge and its components.	**L3 (Applying)**
CO2.	Explain the load specifications for roads and railways.	**L2 (Understanding)**
CO3.	Design the bridge structures for roads and railways.	**L6 (Creating)**
CO4.	Design the joinery for bridges.	**L6 (Creating)**

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Introduction: Definition, components of bridge, classification of bridges, selection of site, economical span, aesthetics consideration, necessary investigations and essential design data.

Standard Specifications for Roads and Railways Bridges: General, Indian Road Congress Bridge Code, width of carriage way, clearance, various loads to be considered for the design of roads and railway bridges, detailed explanation of IRC standard live loads.

UNIT-II

Design Consideration for R. C. C. Bridges: Various types of R.C.C. bridges(brief description of each type), design of R.C.C. culvert and T-beam bridges.

UNIT-III

Design Consideration for Steel Bridges: Various types of steel bridges (brief description of each), design of truss and plate girder bridges.

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UNIT-IV

Hydraulic & Structural Design: Piers, abutments, wing-wall and approaches.

Brief Description: Bearings, joints, articulation and other details.

Bridge Foundation: Various types, necessary investigations and design criteria of well foundation.

Books:

1 Essentials of Bridge Engineering, D. J. Victor, Oxford & IBH Pub. New Delhi.
2 Design of Bridges, N. Krishna Raju, Oxford & IBH, New Delhi.
3 Bridge Deck Analysis, R. P. Pama & A. R. Cusens, John Wiley & Sons.
4 Design of Bridge Structures, T. R. Jagadish & M. A. Jairam, Prentice Hall of India, New Delhi.

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1.	**1**	**1**	**1**	**1**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO2.	**1**	**1**	**1**	**1**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO3.	**1**	**1**	**1**	**1**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
CO4.	**1**	**1**	**1**	**1**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**2**
3 –High 2-Medium 1-Low															

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PRESTRESSED CONCRETE

Course code	**PE/CE/32-T**			
Category	**Program Elective Course**			
Course title	**Prestressed Concrete**			
Scheme and credits	**L**	**T**	**Credits**	
	3	**0**	**3.0**	
Course Assessment Methods	**Internal Examination (30 marks):** • Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. • Class Performance will be measured through percentage of lectures attended (04 marks) • Assignments, quiz etc. will have weightage of 06 marks			
	End semester examination (70 marks): • Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks. • A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.			

Course outcomes:

Sr. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Understand the requirement of PSC members for present scenario.	**L3 (Applying)**
CO2.	Analyse the stresses encountered in PSC element during transfer and at working.	**L4(Analyzing)**
CO3.	Understand the effectiveness of the design of PSC after studying losses	**L4(Analyzing)**
CO4.	Capable of analyzing the PSC element and finding its efficiency.	**L5 (Evaluating)**
CO5.	Design PSC beam for different requirements.	

***Revised Bloom's Taxonomy Action verbs/Levels**

UNIT-I

Introduction and Analysis of Members: Concept of Pre stressing - Types of Pre stressing - Advantages - Limitations –Pre stressing systems - Anchoring devices - Materials - Mechanical Properties of high strength concrete - high strength steel - Stress-Strain curve for High strength concrete.

Analysis of members at transfer - Stress concept - Comparison of behavior of reinforced concrete – pre stressed concrete - Force concept - Load balancing concept - Kern point - Pressure line.

UNIT-II

Losses in Pre stress: Loss of Pre stress due to Elastic shortening, Friction, Anchorage slip, Creep of concrete, Shrinkage of concrete and Relaxation of steel - Total Loss.

Deflection and Crack Width Calculations of Deflection due to gravity loads - Deflection due to prestressing force-Total deflection - Limits of deflection - Limits of span-to-effective depth ratio -Calculation of Crack Width - Limits of crack width.

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UNIT-III

Design of Sections for Flexure: Analysis of members at ultimate strength - Preliminary Design - Final Design for Type 1 members.

UNIT-IV

Design for Shear: Analysis for shear - Components of shear resistance - Modes of Failure - Limit State of collapse for shear - Design of transverse reinforcement.

Different anchorage system and design of end block by latest IS codes.

Reference Books:

1. Krishna Raju, N. "Pre-stressed Concrete", Tata McGraw Hill Publishing Company, New Delhi 2006
2. Krishna Raju. N., "Pre-stressed Concrete - Problems and Solutions", CBS Publishers and Distributors, Pvt. Ltd., New Delhi.
3. Rajagopalan N, "Pre-stressed Concrete", Narosa Publishing House, New Delhi.
4. Pundit G S and Gupta S P, "Pre-stressed Concrete", C B S Publishers, New Delhi
5. IS: 1343: Indian Standard code of practice for Pre-stressed concrete, BIS, New Delhi.
6. IS: 3370-Indian Standard code of practice for concrete structures for storage of liquids, BIS, New Delhi.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	1	1	2	2	1	1	-	-	-	-	-	-	1	1	2
CO2.	1	2	2	2	1	1	-	-	-	-	-	-	1	1	2
CO3.	1	2	2	1	1	1	-	-	-	-	-	-	1	1	2
CO4.	1	1	2	1	1	1	-	-	-	-	-	-	1	1	2
CO5.	1	1	2	1	1	1	-	-	-	-	-	-	1	1	2
3 –High 2-Medium 1-Low															