Government College of Engineering, Aurangabad
Department of Civil Engineering
B.E. Civil

Proposed Scheme of Instruction and Evaluation (CBCS 2019-2020 Onwards)
Semester-VII

Course Code	Course Title	Scheme of Teaching (hrs/week)				Scheme of Evaluation (Marks)						
						Theory				TW	Pr/ VV	Total
		Th	T	Pr	Cr	CT -I	CT -II	TA	ESE			
CE 4001	Construction Management	3	0	0	3	15	15	10	60	-	-	100
CE 4002	Lab-Construction Management	0	0	2	1	-	-	-	-	25	25	50
AM 4003	Lab- Structural Design and Drawing II (RCC)	0	0	4	2	-	-	-	-	50	50	100
CE 4004	Mini Project	0	0	2	1	-	-	-	-	25	25	50
AM 4005 CE 4006 CE 4007 CE 4008 CE 4009	Professional Elective I (PE I)	3	0	0	3	15	15	10	60	-	-	100
AM 4014 CE 4015 CE 4017 CE 4019 CE 4020	Professional Elective II (PE II)	3	0	0	3	15	15	10	60	-	-	100
AM 4022 CE 4024	Professional Elective III (PE III)	3	0	0	3	15	15	10	60	-	-	100
CE 4010 CE 4011 CE 4012 CE 4013	Lab- PE I	0	0	2	1	-	-	-	-	25	25	50
CE 4016 CE 4018 AM 4021	Lab- PE II	0	0	2	1	-	-	-	-	25	25	50
AM 4025 CE 4027	Lab-PE III	0	0	2	1	-	-	-	-	25	25	50
CE 4028	Estimating and Costing	3	0	0	3	15	15	10	60	-	-	100
	Total of Semester-VII	**15**	**0**	**14**	**22**	**75**	**75**	**50**	**300**	**175**	**175**	**850**

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List of Professional Electives –I (PE I):

Course Code	Course Title	Scheme of Teaching (hrs/week)			
		Th	T	Pr	Cr
AM 4005	PE I- Advanced Structural Analysis	4	0	0	4
CE 4006	PE I- Open Channel Hydraulics	3	0	0	3
CE 4007	PE I- Advanced Water and Waste Water Treatment	3	0	0	3
CE 4008	PE I- Ground Improvement Techniques	3	0	0	3
CE 4009	PE I- Advanced Surveying	3	0	0	3
CE 4010	Lab- PE I- Open Channel Hydraulics	0	0	2	1
CE 4011	Lab-PE I- Advanced Water and Waste Water Treatment	0	0	2	1
CE 4012	Lab-PE I- Ground Improvement Techniques	0	0	2	1
CE 4013	Lab-PE I- Advanced Surveying	0	0	2	1

List of Professional Electives –II (PE II):

Course Code	Course Title	Scheme of Teaching (hrs/week)			
		Th	T	Pr	Cr
AM 4014	PE II- Concrete Technology	3	0	0	3
CE 4015	PE II- Ground Water Engineering	3	0	0	3
CE 4016	Lab-PE II- Ground Water Engineering	0	0	2	1
CE 4017	PE II- Air Pollution and Control	3	0	0	3
CE 4018	Lab -PE II- Air Pollution and Control	0	0	2	1
CE 4019	PE II- Advanced Transportation Engineering	4	0	0	4
CE 4020	PE II- Town Planning	4	0	0	4
AM 4021	Lab-PE II- Concrete Technology	0	0	2	1

List of Professional Electives –III (PE III):

Course Code	Course Title	Scheme of Teaching (hrs/week)			
		Th	T	Pr	Cr
AM 4022	PE III- Advanced Design of RC Structures	3	0	0	3
CE 4024	PEIII- Solid Waste Management	3	0	0	3
AM 4025	Lab-PE III- Advanced Design of RC Structures	0	0	2	1
CE 4027	Lab-PEIII- Solid Waste Management	0	0	2	1

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Government College of Engineering, Aurangabad
Department of Civil Engineering
B.E. Civil

Proposed Scheme of Instruction and Evaluation (CBCS 2019-2020 Onwards)
Semester-VIII

Course Code	Course Title	Scheme of Teaching (hrs/week)				Scheme of Evaluation (Marks)						
						Theory				TW	Pr/VV	Total
		Th	T	Pr	Cr	CT-I	CT-II	TA	ESE			
CE 4029	Project	0	0	12	6	-	-	-	-	150	150	300
CE 4030	Lab-Estimating and Costing	0	0	4	2	-	-	-	-	50	50	100
AM 4031 CE 4032 CE 4033 CE 4034 CE 4035 AM 4036	Professional Elective IV (PE IV)	3	0	0	3	15	15	10	60	-	-	100
AM 4043 AM 4044 CE 4045 CE 4046	Professional Elective V (PE V)	3	0	0	3	15	15	10	60	-	-	100
AM 4037 CE 4038 CE 4039 CE 4040 CE 4041 AM 4042	Lab- PE IV	0	0	2	1	-	-	-	-	25	25	50
AM 4047 AM 4048 CE 4049 CE 4050	Lab-PE V	0	0	2	1	-	-	-	-	25	25	50
	Total of Semester-VIII	**6**	**0**	**20**	**16**	**30**	**30**	**20**	**120**	**250**	**250**	**700**
	Grand Total B.E.	**21**	**0**	**34**	**38**	**105**	**105**	**70**	**420**	**425**	**425**	**1550**

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List of Professional Electives –IV (PE IV):

Course Code	Course Title	Scheme of Teaching (hrs/week)			
		Th	T	Pr	Cr
AM 4031	PE IV-Design of Bridges	3	0	0	3
CE 4032	PE IV-Water Power Engineering	3	0	0	3
CE 4033	PE IV-Industrial Waste Management	3	0	0	3
CE 4034	PE IV-Infrastructural Development	3	0	0	3
CE 4035	PE IV-Advanced Geotechnical Engineering	3	0	0	3
AM 4036	PE IV-Building Maintenance and Repairs	3	0	0	3
AM 4037	Lab- PE IV-Design of Bridges	0	0	2	1
CE 4038	Lab- PE IV-Water Power Engineering	0	0	2	1
CE 4039	Lab- PE IV-Industrial Waste Management	0	0	2	1
CE 4040	Lab- PE IV-Infrastructural Development	0	0	2	1
CE 4041	Lab- PE IV-Advanced Geotechnical Engineering	0	0	2	1
AM 4042	Lab- PE IV-Building Maintenance and Repairs	0	0	2	1

List of Professional Electives –V (PE V):

Course Code	Course Title	Scheme of Teaching (hrs/week)			
		Th	T	Pr	Cr
AM 4043	PE V-Prestressed Concrete Design	3	0	0	3
AM 4044	PE V- Earthquake Analysis and Design of Structures	3	0	0	3
CE 4045	PE V-Water Resources System and Management	3	0	0	3
CE 4046	PE V-Environmental Impact Assessment	3	0	0	3
AM 4047	Lab-PE V-Prestressed Concrete Design	0	0	2	1
AM 4048	Lab-PE V- Earthquake Analysis and Design of Structures	0	0	2	1
CE 4049	Lab-PE V-Water Resources System and Management	0	0	2	1
CE 4050	Lab-PE V-Environmental Impact Assessment	0	0	2	1

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CE 4001: Construction Management

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
		Class Test-II	15 Marks
Total Credits	3	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Prerequisite not required

Course Description:
Construction Management (CM) is a professional service that uses specialized, project management techniques to supervise, guide, review or direct the actions related with the planning, design, and construction of a project, from its beginning to its end. The purpose of CM is to control a project's time, cost and quality. Common responsibilities of a Construction Manager include Project Management Planning, Cost Management, Time Management, Quality Management, Contract Administration, Safety Management, Risk Management and Professional Practice. Professional practice includes specific activities, such as defining the responsibilities and management structure of the project management team, organizing and leading by implementing project controls, defining roles and responsibilities, developing communication protocols, and identifying elements of project design and construction likely to give rise to disputes and claims. This course introduces the above said aspects which are useful to civil engineer to perform and complete the project successfully.

Course Outcome: After successful completion of the course, students will be able to:

1. Describe the role of Engineer as a manager on site
2. Plan, schedule and control the activities on site
3. Analyze the situation on construction field to take the decision
4. Implement various operations related with construction

Detailed Syllabus:

Unit -1:	**Introduction and Overview** Construction, management: Necessity, application of management functions *viz.* Planning, Organizing, Staffing, Leading and controlling to the construction. Roles of clients, contractors, consultants. Overview of construction, Construction sequence, Specifications of typical construction items, Construction Industry – Nature, Characteristics, Size and Structures. Construction manager: Role, Qualities, Ethics, Duties, Responsibilities, Authorities. General principles of BOT system	**06 Hrs**
Unit -2:	**Construction Scheduling and Network Analysis** Construction scheduling: Network analysis, bar charts, Programme Evaluation and Review Techniques (PERT) and Critical Path method (CPM). Basics of construction industry and organizational structure; Engineering economy in construction projects-personnel, monitoring and control work study in constructions - contracting. Bidding and law for engineers-value engineering, safety engineering etc.	**06 Hrs**

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Unit -3:	**Resource and Financial Management** Introduction to resource leveling and allocation, 4-M's in Construction – Men, Money, Machine and Material. Material Management: definition by international federation of purchasing and material management, Objectives, Role Functions, Qualities, of material manager Material forecasting. Inventory Control- Necessity, Techniques, ABC analysis, Lead-time, safety stocks, Material Evaluation using differential indices. Financial Accounting Systems, Accounting methods	**06 Hrs**
Unit -4:	**Construction Equipments, Project Appraisal and Safety Engineering** Project feasibility analysis based on Technical, Financial and social benefits. Accident cost, injury sources and causes, Effective safety programmes occupational health, hazards, Personal protective equipment, Preparation of safety programmes for construction works Earth Moving Equipments: Power Shovels, Back-Hoe, Drag-line, Excavator, Dozers, Scrapers, Use of Trucks and Dumpers, Work Cycle, Suitability of Use, Factors affecting Selection, Calculation of Out Put estimation and economics of equipment, Concrete Mixers , Cranes, Road Construction Equipments etc. Different Equipment associated in a chain. Useful life estimation of equipments	**06 Hrs**
Unit -5:	**Management Information System (MIS)** Legal Aspect and Laws Applicable to Construction Industry: Works contract act, Child labour act, Workman's compensation Act, Employees provided fund Act 1952, Minimum wages Act, Payment of bonus Act 1965 Risk Management: Introduction –Principal-Types, Origin, Costs of Risks. Risk Control –Role of Risk Manager, Risk, financing methods – Insurance, Funds cash borrowing, external borrowing. Application of MIS: System Development, Data processing, Flow charting, DBM, Data Communication System, Developments, Data processing, Application in Civil Engineering Industry	**06 Hrs**

References:

1. Kumar NeerajJha, 'Construction Project Management-Theory and Practice' Pearson Publication
2. Peurify, Schexnayder, Shapira, Construction Planning, Equipment and Methods, Tata McGraw-Hill Publication (Latest Edition)
3. Sandra Christensen Weber, 'Scheduling Construction Projects-Principles and Practices' Pearson Publication
4. L.S.Srinath, 'PERT and CPM-Principles and Applications' Affiliated East-West Press Pvt. Ltd Publication
5. S.C.Sharma, 'Construction Equipment and its Management' Khanna Publishers

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Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H			M	M	H				H	
CO2	H	H		H	M	M	H	M			H	M
CO3	H	H	H	M					H		H	
CO4	H	H			H	H			H		H	M

H-High M-Medium L-Low

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CE 4002: Lab-Construction Management

Scheme of Teaching		Scheme of Evaluation	
Practical	02Hrs/Week	Term Work	25
Total Credits	**01**	Practical Examination/Viva Voce	25
		Total Marks	50

Prerequisite: Not Applicable

Course Description:
Construction Management (CM) is a professional service that uses specialized, project management techniques to supervise, guide, review or direct the actions related with the planning, design, and construction of a project, from its beginning to its end. The purpose of CM is to control a project's time, cost and quality. Common responsibilities of a Construction Manager include Project Management Planning, Cost Management, Time Management, Quality Management, Contract Administration, Safety Management, Risk Management and Professional Practice. This course is useful to civil engineer to perform and complete the project successfully.

Course Outcome:
After successful completion of the course, students will be able to:

1. Describe the role of Engineer as a manager on site
2. Plan, schedule and control the activities on site
3. Analyze the situation on construction field to take the decision

Term Work:
Term work shall consist of assignments on-

1. Bar chart/mile stone chart for construction project.
2. Network representation, assigning durations to various activities by considering available resources, computation of duration of project, cost optimization resources scheduling
3. To visit the construction site and study Inventory control, safety techniques adopted on construction project
4. Cost analysis of construction equipments
5. To do study of Benefit Cost ratio of project
6. Use of at least one soft computing technique in construction management such as Primavera, MS Project, etc.
7. To study the vision, mission of reputed construction industries

Practical Examination/Viva Voce Examination:
The panel of examiner shall consist of course coordinator as an internal examiner and one faculty member appointed by the Controller of Examination as an external examiner. The panel of examiners, as described above, shall evaluate the understanding/knowledge of the student by asking appropriate questions/asking students to perform/demonstrate experiments, etc.

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Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H		M	M	H		H		H	M
CO2	H	H	H		M	M	H	M	H		H	M
CO3	H	H	H				H		H		H	M

H-High M-Medium L-Low

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AM 4003 Lab-Structural Design and Drawing (RCC)

Scheme of Teaching		Scheme of Evaluation	
Practical	4 --Hrs/Week	Term Work	50
Total Credits	2	Practical Examination/Viva Voce	50
		Total Marks	100

Prerequisite: AM-3009 Design of RCC Structures

Course Description: . . To expose the students to analysis and design of three storey's RCC structures. And design of RCC structural members using software's/computer programming. To expose the students to prepare RCC structural detailing using AutoCAD and recent is codes.

Course Outcomes:
After successful completion of the course, students will be able to:

1. Analyse and design RCC building
2. Prepare detailed drawing of RCC building.
3. Use software for design and drawing of RCC structural members

Term Work: The term work shall consists of

UNIT-1 Design and drawing of residential/commercial/public RCC building using AutoCAD and recent IS codes.

UNIT-2 Design of RCC structural elements using computer programming singly reinforced beam, doubly reinforced beam, and column

NOTE: Minimum two drawing sheets must be prepared by manual drawing or using any drafting software.

Practical Examination/Viva Voce Examination:
In case of oral/practical examination across the table, the panel of examiners, as described above, shall evaluate the understanding/knowledge of the student by asking appropriate questions/asking students to perform/demonstrate experiments, etc.

References (if any):

1. Pillai S.U. and Devdas Menon, Reinforced Concrete Design, Tata-McGraw-Hill Publishing Company Limited, New Delhi.
2. Punmia B.C., A K Jain and A K Jain, Comprehensive Design of RCC Structures, Laxmi Publications (P) Ltd, New Delhi
3. Ramamrutham S., Design of Reinforced Concrete Structures, Dhanpat Rai Publishing Company, New delhi,
4. Shah V.L. and S R Karve, Limit State Theory and design of reinforced Concrete, Structures Publications, Pune, 2011

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5. IS 456: 2000 Plain and Reinforced Concrete- Code of Practice, Bureau of Indian Standards, New Delhi
6. Handbook on Concrete Reinforcement and detailing, Special Publication SP 34, Bureau of Indian Standards, New Delhi, 1987

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	H	H	H	M	M	M						M
CO2	H	M	H	M	M							M
CO3	M	M	M		M							M

H-High M-Medium L-Low

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CE 4004: Mini Project

Teaching Scheme		Evaluation Scheme	
Practical	2 Hrs/Week	Tem Work	25 Marks
		Viva Voce	25 Marks
Total Credits	1	Total	50 Marks

Prerequisite:
Not Applicable.

Course Description:
This course offers civil engineering students an opportunity to do some mini project based upon their own curiosity. They may attempt in this course to find useful solutions to some or the other real life problems which they might have noticed while studying various courses till sixth semester in the institute. This course is basically intended to create research aptitude amongst civil engineering undergraduate students in the institute to find solutions to real life socio-technical issues related to civil engineering in association with local industry or otherwise.

Course Outcomes:
After successful completion of the course, students will be able to:

1. Find, compile and interpret the literature relevant to given real life issues related to civil engineering.
2. Formulate and attempt trials of working solutions to defined problems through systematic approach in laboratory or field.
3. Apply his/her innovative mind in future for various issues in the field of civil engineering.

Term Work:
The students will go through reference books, important research papers, IS Codes/Handbooks and look for the literature relevant to some real life issues in the field of civil engineering. The students would be encouraged to go to local industry and look for problems through interaction/discussion with concerned industries in the neighborhood. This will help them define a topic for the Mini Project. Groups of students comprising 4 to 9 members will be guided by a teacher of their choice depending upon his/her availability and interest. The Term Work submission file will contain complete information of the Mini Project undertaken by the respective group of students.

Practical/Viva Voce Examination:
The students shall prepare power point presentations and deliver it before the panel of examiners and students. The panel of examiner shall consist of guide an an internal examiner and one faculty member appointed by the Head of the Department as an external examiner. The panel of examiner will comprehensively assess the seminar contents and seminar presentation.

References:

1. Reference Books of Civil Engineering
2. Standard Journals of Civil Engineering
3. IS Codes of Civil Engineering
4. C R Kothari and Gaurav Garg, Research Methodology-Methods and Techniques, New Age International Publishers, New Delhi

5. Relevant publications by Industrial Associations/Central Govt/ Govt of Maharashtra, etc.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		H		H	M			H				
CO2	H	H	H	H	M	L		M	H		H	
CO3							H			H		M

H-High M-Medium L-Low

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AM-4005 PE-I Advanced Structural Analysis

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
Tutorial		Class Test-II	15 Marks
Total Credits	4	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	**100 Marks**

Prerequisites:
The students should have undergone course of AM 2008: Structural Analysis

Course Description:

The course deals with matrix methods of analysis of beams, plane frames and trusses. It provides fundamental understanding required for analysis of three dimensional structures such as space frames, trusses etc. Analysis of arches, cables and suspension bridges are also included in the syllabus.

Course Outcomes:
After successful completion of this course, the student will be able to

1. Formulate compatibility equations for structural members
2. Apply and analyse the two dimensional structures using matrix methods of analysis
3. Apply and analyse two dimensional structures using direct stiffness method
4. Analyse determinate and indeterminate arches
5. Analyse Cables and Suspension Bridges

Detailed Syllabus:

Unit -1:	**Flexibility Matrix Method of Structural Analysis** Concept of Flexibility, Equations of compatibility of displacements, Flexibility matrix of a structure and its characteristics, Analysis of beams, plane frames and trusses.
Unit -2:	**Stiffness Matrix Method of Structural Analysis** Concept of Stiffness, Equations of equilibrium of forces, Stiffness matrix of a structure and its characteristics, Analysis of beams and plane frames.
Unit -3:	**Direct Stiffness Method** Member stiffness matrix, Joint stiffness matrix , Equivalent joint load vector. Compatibility equations, Application of the method for the analysis of continuous beams and plane frames. Algorithm for developing computer program
Unit -4:	**Analysis of Arches** Three hinged arch, Two hinged arch, Horizontal thrust, Bending moment, Radial shear and Normal thrust, Rib shortening, Temperature stresses
Unit -5:	**Cables and Suspension Bridges** Equilibrium of loaded cables, temperature stresses in cables , Analysis of suspension bridge with three hinged stiffening girder, two hinged stiffening girder, influence line diagrams

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Reference Books:

1. Weaver W. and Gere J.M., Matrix Analysis of Framed Structures, CBS, New Delhi
2. Pandit G.S. and Gupta S.P., Structural Analysis, Tata McGraw Hill, New Delhi
3. Timoshenko S.P. and Goodier J.N., Theory of Elasticity, Tata McGraw Hill, New Delhi
4. C.K. Wang, Indeterminate Structural Analysis, Tata McGraw Hill, New Delhi
5. Devdas Menon, Structural Analysis, Narosa Publications, New Delhi
6. C.S. Reddy, Basic Structural Analysis, Tata McGraw Hill, New Delhi
7. S. Ramamrutham and N. Narayan, Theory of Structures, Dhanpat Rai, New Delhi
8. N.C. Sinha and P.K. Gayen, Advanced Theory of Structures, Dhanpat Rai, New Delhi

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	H	H	M	L	M							
CO2	H	H	M	L	M	L						
CO3	H	H	M	L	M	L						
CO4	M	M	M	L	M	L						
CO5	M	M	M	M	M		L					

H- High, M- Medium, L- Low

Teacher's Assessment: Teacher's Assessment of 10 marks is based on one or combination of the following,

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution /Assignments
4. Group discussion /Oral Presentation
5. Punctuality

Teacher should make the students aware of these parameters of evaluation at the start of the course.

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CE 4006: PE-I- Open Channel Hydraulics

Teaching Scheme		Evaluation Scheme	
Theory	03 Hrs/Week	Class Test-I	15 Marks
Tutorial		Class Test-II	15 Marks
Total Credits	**03**	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: CE-2002- Fluid Mechanics

Course Description: The design of the open channels plays an important role in the irrigation planning and management. This course covers the concepts, analysis and design of the open channel considering sediment transport.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Compute the discharge through open channels
2. Select and use the discharge measuring devices.
3. Analyze and design the channel for required discharge.
4. Compute the depth of flow, energy dissipation , surface profile.

Detailed Syllabus:

Unit -1:	Introduction, Classification of flow in open channel, Computation of discharge, most economical rectangular and trapezoidal section, design of open channel.	**06-- Hrs**
Unit -2:	Non uniform flow, specific energy curve, alternate depths, computation of specific energy and discharge, specific force.	**06-- Hrs**
Unit -3:	Discharge measuring devices, gradually varied flow, Equation of gradually varied flow, flow profile.	**06-- Hrs**
Unit -4:	Rapidly varied flow, Hydraulic jump, Computation of depth of flow, energy dissipation works	**06-- Hrs**
Unit -5:	Sediment transportation through channels, Origin and classification of Sediment, measurement of sediment load.	**06-- Hrs**

References:

1. Subramanya K. (1998), "Flow in Open Channels", Tata McGraw Hill Publishing Co.
2. Chow V.T. (1979), "Open Channel Hydraulics", McGraw Hill Inc., New York
3. Garde R, J. and Ranga Raju K.G.(1980), "Mechanics of Sediment Transportation and Alluvial Stream Problems", Wiley Eastern Limited
4. French R.H. (1986), "Open Channel Hydraulics", McGraw Hill Publishing Co., New York
5. Bansal R.K.(2013), "A Text Book of Fluid Mechanics and Hydraulic Machines", Laxmi Publications

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Table 1: Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1		H	H	H	H	H	H	H	H	H		
CO2		H	H	H	H	H	H	H	H	H		
CO3		H	H	H	M	M		H	H			
CO4		H	H	H	M	M						

H-High M-Medium L-Low

Teacher's Assessment: Teachers Assessment of 10 marks may be based on one or more of the following

1. Technical quizzes
2. Question & answer / Numerical solution
3. Group discussion

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CE 4007: PE-I ADVANCED WATER AND WASTE WATER TREATMENT

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
Tutorial		Class Test-II	15 Marks
Total Credits	**3**	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: CE3003 AND CE3006

Course Description:

This course consist of advance knowledge about water and wastewater quality, quantity and Supply system, suitable method of treatment to be used for removal of impurities and design advanced water and wastewater treatment plant.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Students will learn about water and wastewater quality, quantity and Supply system
2. Students will identify suitable advanced method of treatment to be used for removal of impurities
3. Students will design advanced water and wastewater treatment plant
4. Students will analyse water distribution system

Detailed Syllabus:

Unit -1:	Water Quality – Physical, chemical and biological parameters of water, Water quality requirement for Potable water, agricultural, industrial water. Waste water effluent standards, Water quality indices, Water quality aspects of lakes & rivers. Theory of coagulation and flocculation processes, coagulation kinetics, effects of coagulation. Softening of water – Chemical precipitation, pH and solubility relationship, calculation of amounts of lime and soda required, softening by ion exchange, demineralization material sizes and regeneration	**6Hrs**
Unit -2:	De fluoridation- Causes of fluorides in water, significance of high and low fluorides in water, methods of de fluoridation Salinity and its effects, desalination by reverse osmosis, Electro dialysis, distillation and freezing. Break-point chlorination, advanced disinfection processes (ozone/UV).Modification of Rapid Sand Filter- Up flow Filters. Dual Media, Multimedia and mixed bed filters. Diatomaceous filters. Adsorption, Adsorption equilibriums, Adsorption isotherms, Langmuir, Freundlich. Ion exchange processes, Application Membrane Processes, Reverse Osmosis, Ultra filtration, Electrodialysis.	**6 Hrs**
Unit -3:	Effects of chemical Constituents in waste water. Nitrogen conversion and removal, forms of nitrogen, sources of nitrogen, operations and processes for control of nitrogen. Nitrification and de nitrification processes, stoichiometry, processes analysis, process application, Air stripping of ammonia and ion exchange methods	**6Hrs**

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	for removal of ammonia. Phosphorus removal- Forms of phosphorus, methods of phosphorus removal. Direct and indirect reuse of waste water. General: Objectives of sewage treatment, sewage treatment sewage characteristics, conventional sewage treatment flow sheet, and functions of different unit processes, treatment requirement.	
Unit -4:	Process analysis: Reaction and reaction kinetics, mass balance analysis, reactors and their hydraulic characteristics, reactor selection, practical aspects of reactor design. Physical and chemical treatment: Screening, grit removal, flow equalization and mixing, flocculation, sedimentation, flotation, disinfection. Biological treatment: Principal of biological treatment, Kinetics of biological growth, aerobic disc, packed bed and fluidized bed treatment, stabilization ponds.	**6Hrs**
Unit -5:	Sludge treatment: Sludge treatment flowsheets, Sludge quality and quantity, various methods of sludge treatment aerobic and anaerobic sludge digestion, Sludge conditioning, dewatering of sludge, conveyance, storage and disposal by dilution. Advance wastewater treatment: principles of tertiary treatment, reuse and resource recovery and recent development.	**6Hrs**

References:

1. Weber W.J. "Physicochemical processes for water quality control", John Wiley and Sons, New York
2. Peavy H.S., Rowe D.R. and Tchobanglous G. "Environmental Engineering", McGraw Hills, New York
3. Metcalf and Eddy "Waste water Engineering, Treatment and Reuse", Tata Mc-GrawHill, New Delhi.
4. S.J. Areeivala, Waste water treatment and disposal Mareeldeccar 1981
5. Qasim S.R. Waste waters treatment plant planning design & Operation Winston N.Y.

Table 1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		H	L		M				M		L	
CO2		M	M		M		L	M				
CO3		H	HM		M		H	L	L			
CO4		M			M	M	M	L	L	M	L	
CO5					M			M	L	M	L	L

H-High M-Medium L-Low

Teacher's Assessment: Teachers Assessment of 10 marks may be based on one ormore of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

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CE 4008:PE I –Ground Improvement Techniques

Teaching Scheme		Evaluation Scheme	
Theory	03 --Hrs/Week	Class Test-I	15 Marks
Tutorial		Class Test-II	15 Marks
Total Credits	**03**	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Knowledge of CE 3004: Geotechnical and Foundation Engineering

Course Description: This course introduces different ground improvement techniques, methods, cost and suitability.

Course Outcomes:
After successful completion of the course, students will be able to:

1. Improve ground conditions by excavation and replacement.
2. Improve ground conditions by Vibratory compaction in sands and vibrofloatation in clays.
3. Select methodologies to be adopted for particular ground improvement technique.
4. Implement densification, grouting, reinforcement mechanism, and design with geosynthetics.

Detailed Syllabus:

Unit -1:	Ground Improvement and Modification: New technologies, Relative costs, Processes of modification and their influence on soil, Improving by excavating and replacing, In-Situ ground improvement, Design methodology.	**06-- Hrs**
Unit -2:	In-Situ Densification of Soils: Response of sands and clays to externally applied stress, Compaction piles in sands, Impact compaction of sands, Vibratory compaction in sands, Explosion in sands, Comparison of in situ densification methods in sands, Vibrofloatation in clays, Accelerated pre-consolidation in clays.	**06-- Hrs**
Unit -3:	Grouting in soils: Types of grouts, Desirable characteristics of grouts, Grouting methods, Permeation grouting, Grouting pressure, technology, and arrangements, Displacement- compaction grouting, Displacement-soil fracture grouting, Jet or replacement-displacement grouting.	**06-- Hrs**
Unit -4:	Reinforced Soil: The mechanism, Reinforcement-soil interaction, Applications, Reinforced soil structures with vertical faces, Reinforced soil embankments, Open excavation using soil nails, Reinforcement of soil beneath unpaved roads and foundations.	**06-- Hrs**
Unit -5:	Geosynthetics: A manmade product, Why geosynthetics? Types of geosynthetics, Functions of geosynthetics, Properties of geosynthetics, Functional requirements, Designing with geosynthetics	**06-- Hrs**

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References:

1. M. R. Hausmann, "Engineering Principles of ground Modifications", McGraw-Hill International.
2. P. P. Xanthakos, L. W. Abramson and D. A. Bruce, " Ground Improvement and Control", John Wiley & Sons.
3. R. H. Manfired, "Engineering Principles of Ground Modifications", McGraw-Hill.,
4. Dr. P Purushothama Raj, "Ground Improvement Techniques", Laxmi Publications, New Delhi.
5. S. K Gulati and ManojDatta, "Geotechnical Engineering", Tata McGraw Hills Publications, New Delhi.

Table 1: Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1		H	H	H	H	H	H	H	H	H		
CO2		H	H	H	H	H	H	H	H	H		
CO3		H	H	H	M	M		H	H			
CO4		H	H	H	M	M						

H-High M-Medium L-Low

Teacher's Assessment: Teachers Assessment of 10 marks may be based on one or more of the following

1. Technical quizzes
2. Question & answer / Numerical solution
3. Group discussion

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CE 4009: PE-I-Advanced Surveying

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
Tutorial	--	Class Test-II	15 Marks
Total Credits	3	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisites: CE 2003 and CE 2010

Course description: Advanced topics in surveying computations and procedures, including traverse error analysis, mapping, this course introduces the advanced methods and instruments for measurement necessary for plotting maps and plans.

Course Outcomes:
After successful completion of the course, students will be able to:

1. Apply advanced surveying techniques in different fields of Civil Engineering
2. Select the advanced surveying technique which is best suited for a work
3. To compute and apply corrections to field measurements
4. Apply total station and EDM in distance measurement and traversing

Detailed Syllabus:

Unit 1	**Triangulation Adjustment** Kinds of errors, Laws of weights, Determination of most probable values (MPV) of conditioned and independent quantities, Method of least squares, Indirect observations, Probable error and its determination, Distribution of error to the field measurements, Normal equation, Method of correlates. Station and figure adjustment of geodetic quadrilateral without central station.
Unit 2	**Introduction to Satellite Based Positioning System** SBPS systems - GPS, Glonoss, Galileo, Gagan, Compass, etc and their features, Segments of SBPS (Space, Control and User), their importance and role in SBPS, Positioning with SBPS - Absolute & Differential Methods, Use of SBPS in Surveying, SBPS Co-ordinates & heights, Factors governing accuracy in SBPS positioning, Different types of errors in SBPS Positioning.
Unit 3	**Remote Sensing** Introduction, Definition, Necessity, Importance and use; Basic concepts in Remote Sensing , Basic Laws of electromagnetic radiation, Atmospheric effects on radiation, Interaction of EM energy with matter, Resolution in remote sensing, Satellite remote sensing, Problems confronting remote sensing system. Ideal and Real remote sensing systems. Space platforms for remote sensing: Imaging sensors and techniques. Image interpretation:- Visual image processing & Digital image processing. Applications of remote sensing. Introduction to LIDAR & Underground utility survey. Comparison between aerial photograph and satellite image.
Unit 4	**Geographical Information System** Introduction, Definition, Objectives, Components (people, procedure, hardware, software & data) & functions (input, manipulation, management,

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	query & analysis and visualization) of GIS. Coordinate systems and projections, Geo referencing, GIS data – spatial (Raster & vector) & aspatial data. Introduction to vector and raster data analysis such as network analysis, overlay analysis etc. for vector, DEM, Management of aspatial data. Applications of GIS such as Disaster management, Water resource, Land use – Land cover – Urban planning - Intelligent Transport Systems - Development of Resources Information Systems. Limitations of GIS
Unit 5	**Electromagnetic distance measurement (EDM)** Principle of EDM Carrier waves – Types of EDM instruments – Distomat – Total Station – Principle – procedure & surveying using Total Station – precise leveling - micro-optic theodolite.

Recommended Books:

1. Surveying: Vol. II. and III by Dr. B. C. Punmia :Laxmi Publication - New Delhi.
2. Surveying and Levelling Vol. II by T. P. Kanetkar and S. V. Kulkarni Pune Vidyarthi
3. Publication.
4. GPS Sattelite Surveying—Alfred Leick—Wiley
5. Remote sensing and Geographical Information System, By A. M. Chandra and S. K. Ghosh,
6. Narosa Publishing House.
7. Remote Sensing & GIS,2/E—Bhatta-- Oxford University Press
8. Principles of Geographical Information System—Burrough-- Oxford University Press
9. Surveying—M.D.Saikia—PHI Learning Pvt .Ltd.Delhi
10. Advanced Surveying -Total Station, GIS and Remote Sensing by SatheeshGopi,
11. R.Sathikumar and N. Madhu , Pearson publication
12. Surveying Vol. 2 by S. K. Duggal, McGraw Hill Publication
13. Remote sensing & image interpretation, Lillesand& Kiefer, John wiley Pub. Dr. B.C.Punmia , Surveying Vol I & II, Laxmi Publications (P) Ltd. New Delhi, Sixteenth Edition Reprint 2008
14. R. Subramanian, Surveying and Levelling, Oxford University Press, New Delhi, First Edition, 2007

Table 1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H			M	H		M	M	M		M	
CO2	H	M		M	H	M	H	M	H		M	
CO3	M	H	H	H	M	M		H	M	M		M
CO4	M	H	H	H	M	M	M	M	M		L	H

H-High M-Medium L-Low

Teacher's Assessment: Teachers Assessment of 10 marks is based on one of the / or combination of few of following

1. Simulation
2. Application development
3. Power point presentation of case studies
4. Question & answer / Numerical solution
5. Study of Industry processes and its presentation
6. Mini projects

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AM 4014: PE-II Concrete Technology

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
		Class test-II	15 Marks
Tutorials	0	Teacher Assessment	10 Marks
Total Credits	3	End-Semester Examination	60 Marks
		Total	100 Marks

Pre-requisites: AM-2007 Civil Engineering Materials

Course Description: The course consists of information about advanced materials used for making concrete, various mix design methods, durability, and special concretes.

Course Objectives: The objective of this course is to understand the fundamental concepts applicable to engineering materials to produce concrete and to learn the techniques of incorporating to produce good quality of concrete

The student will able to:

1. Gain a fundamental understanding of the concepts of concrete mix designing
2. Study importance of properties of concrete which affects quality of concrete structure
3. Learn Basic concepts of concrete technology, namely durability, strength of concrete

Course Outcomes: Upon successful completion of this course, students will acquire the skills to apply the basics of concrete technology to construct asses and supervise concrete construction activity.

The students will be able to or have:

1. Fundamental understanding of the concepts of Concrete mix design.
2. Apply the Basic concepts of concrete technology to construction of concrete structures
3. Carry out of assessment of concrete structures –durability, permeability and strength.
4. Know to produce HPC, fiber reinforced concrete ,SCC

Detailed Syllabus:

Unit -1:	**Admixtures and** Plasticizers Chemical Admixtures-Introduction, Definition, Classification of Admixtures: Plasticizers (Water Reducers), The Basic Products Constituting Plasticizers: Action of Plasticizers, Commercial Plasticizers (Water Reducing Admixtures) Available In India, Super plasticizers (High Range Water Reducers),Effects of Super plasticizers On Fresh Concrete, Compatibility of Super plasticizers And Cement, Effect of Super Plasticizers on the Properties of Hardened Concrete, Retarders, Retarding Admixtures, Accelerators-Accelerating Plasticizers, Air-Entraining Admixture, Air Entraining Agents. Factors Affecting Amount of Air Entrainment, the Effect of Air Entrainment on the Properties of Concrete, Resistance to Freezing and Thawing, Optimum Air Content in Concrete, Pozzolanic or Mineral Admixtures.	**06 Hrs**

Unit -2:	**Concrete Mix Design:** Introduction-Types of Mixes, Nominal Mixes, Standard Mixes, Designed Mixes, Factors Affecting the Choice of Mix Proportions, Mix Proportion Designations, different methods	**06 Hrs**
Unit -3:	**Durability of Concrete Structures and RMC** Definition, Materials Related Failures, Thermal Shrinkage, Factors Affecting Thermal Stresses, Degree Of Restraint (*Kr)*, and Temperature Change. Thermal Properties of Concrete, Extensibility and Cracking, Environmental-Related Causes of Concrete Durability, Concrete in Seawater, Ready Mix Concrete, Factors Delaying Entry of RMC in India Factors That Prompted Introduction of RMC, Status of RMC in India, A Typical 'RMC Ready-mix' Plant, RMC- Major Advantages Concrete (As per IS 4926-2003):	**06 Hrs**
Unit -4:	**Self-Compacting Concrete AND Fiber-Reinforced Concrete** From Traditional Concrete to SCC, Fresh SCC Requirements Characteristics of SCC, Fiber Reinforced Concrete, behaviour Properties and Application. Steel Fiber Reinforced Concrete (SFRC), Mix Design for SFRC, Factors Controlling SFRC. Mechanical Properties and Strength of SFRC, Fiber Shotcreting, Applications of SFRC. General Application of Steel Fibers, General Applications and Advantages Steel Fiber Concrete, Advantages of Using SFRC, Slurry Infiltrated Fibrous Concrete (SIFCON). Slurry Infiltrated Mat Concrete (SIMCON), Carbon Fiber Based Linear Reinforcing Elements, Lead line Rods/Tendons, and High-Performance Fiber-Reinforced Concrete (HPFRC). Continuous Fiber-Reinforced Concrete, Reinforcing Fibers, Compact Reinforced Concrete.	**06 Hrs**
Unit -5:	**High Performance Concrete and concrete mix design** Introduction, Definition of HPC, Methods for Achieving High Performance, Requirements for High-Performance Characteristics, Salient High-Performance Requirements, Mix Proportion. Limitations of Conventional Mix Designs: BIS Method (IS: 10262 – 1982), ACI Method.Road Note No.4, IRC-44 Method.	**06 Hrs**

References (all latest versions)

1. M.S.Shetty, "Concrete Technology Theory and practice", Chand technical, New Delhi, 110055, 2015 edition.
2. M.L.Gambhir,"Concrete technology theory and practice", McGraw Hill, New Delhi 110008,2015 edition.
3. A.M. Neville, "Concrete Technology"

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Table 1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H			M			L	L			H
CO2	H	H										M
CO3	H	H			L							H
CO4	H	H	L		L							

H – High M – Medium L – Low

Teacher's Assessment: Teachers Assessment of 10 marks is based on one of the / or combination of few of following:

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. PPT

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CE 4015: PE II- Ground Water Engineering

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
Tutorial		Class Test-II	15 Marks
Total Credits	3	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: CE 2002 Fluid Mechanics

Course Description: This course introduces the elements of ground water engineering, determination of permeability and transmissibility by Theim and Dupuit's theory. It also evaluates aquifer properties by Theis method, Jacob and Chow's method. Topics ranges from ground water well losses, water well design, drilling, ground water flow and ground water development and management.

Course Outcomes: After successful completion of the course, students will be able to:

1. Demonstrate the different terminologies related with groundwater hydrology
2. Identify suitable method of determination of aquifer parameters
3. Choose suitable ground water exploration techniques and assess ground water potential
4. Compare and contrast suitable ground water development and management methods

Detailed Syllabus:

Unit-1:	**Ground Water:** zone of aeration, saturation, soil water, adsorbed water, capillary water, capillary potential, storage coefficients of aquifers, porosity, specific yield, specific retention, unconfined and confined aquifer, fluctuation of water table, fluctuation of the piezometric surfaces, ground water potential in India, geophysical methods for groundwater explorations.	**6 Hr**
Unit-2:	**Well Hydraulics:** Darcy's law, permeability and transmissibility, Theim and Dupuit's theory for unconfined and confined aquifers. Groundwater flow potential, Ground water theory for one, two and three dimensional problem, Differential equations governing groundwater flow for steady and unsteady state problems, use of finite difference method to solve simple ground water flow problem.	**6 Hr**
Unit-3:	**Evaluation of Aquifer Properties:** aquifer tests control well, observation well, measurement during test, Theis method, Jacob and Chow's method of determination of aquifer parameters, Theis' recovery method, bounded aquifer, interference among wells, Image well theory and its application in groundwater flow.	**6 Hr**
Unit-4:	**Drilling of Wells and Ground Water Modeling:** Groundwater well losses, water well design and well drilling: well screen, development and completion of wells, Rotary drilling and Rotary percussion drilling, maintenance of wells. Groundwater Modeling: Groundwater flow, sand models, membrane model, thermal model, electric analog model and mathematical models.	**6 Hr**
Unit-5:	**Groundwater Development and Management:** Conjunctive use, artificial recharge of groundwater- different methods, subsurface dam, waste water recharge, recharge by urban storm runoff, ground water storage changes, percolation from tanks, recharge from irrigated fields, dating of ground water, estimation of ground water discharge, ground water resource evaluation in India, groundwater quality.	**6 Hr**

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References:

1. Todd, D.K. "Ground Water Hydrology", John Wiley & Sons, Singapore.
2. Raghunath, H.M. "Ground Water" New Age International (P) Limited, New Delhi.
3. Karanth, K. R. "Ground Water Assessment Development and Management", Tata McGraw Hill Publishing Company Limited, New Delhi
4. Domenico "Concepts and Models in Groundwater Hydrology", McGraw Hill Inc., NewYork
5. L. Harvil and F. G. Bell, *Ground Water Resources and Development*, Butterworth's, London.
6. Herbert F Wang and Mary P. Anderson "Introduction to Ground Water Modeling", W.H. Freeman and Company, NewYork

Table 1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H				M			L				H
CO2		L	M									M
CO3			M									M
CO4			M		L							L

H-High M – Medium L – Low

Teacher's Assessment: Teachers Assessment of 10 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

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CE 4017: PE II-AIR POLLUTION AND CONTROL

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
		Class Test-II	15 Marks
Total Credits	3	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite : Prerequisite not required

Course Description:

Air pollution occurs due to particulate pollutants or gaseous pollutants introduced into Earth's atmosphere. It may cause adverse effects on human being, plants, animals and property. Human activity and natural processes can both generate air pollution. Primary pollutants are usually produced from a process, while secondary pollutants are formed in the air when primary pollutants react or interact. There are various air pollution control technologies and strategies available to reduce indoor as well as outdoor air pollution. This course helps to students to identify the need of control of air pollution and methodologies to be adopted to control air pollution.

Course Outcome:

After successful completion of the course, students will be able to:

1. Explain the definition of air pollution & various types of sources, classification and effects of air pollutants.
2. Compare different methods of control of particulate pollutants
3. Predict the plume behavior as per stability conditions of atmosphere
4. Explain ambient air pollution monitoring and stack monitoring

Detailed Syllabus:

Unit -1:	**Meteorological aspects:** Zones of atmosphere, Scales of meteorology, Meteorological parameters, Temperature lapse rate, Plume behavior, Plume rise & plume dispersion. Gaussian diffusion model for finding ground level concentration. Formulae for stack height and determination of minimum stack height	**06 Hrs**
Unit -2:	**Air sampling and analysis**: Air pollution survey, basis and statistical considerations of sampling sites, devices and methods used for sampling gases and particulars. Stack emission monitoring, isokinetic sampling. Analysis of air samples chemical and instrumental methods. Ambient air quality monitoring. Causes and effects of air pollution on plants, human being, animals and property, sources and effects of indoor air pollutants, changes in indoor air quality, control of indoor air pollutants and air cleaning systems.	**06 Hrs**
Unit -3:	**Control of air pollution:** By process modification, change of raw materials, fuels, process equipment and process operation. By use of air pollution control equipment for particulate and gaseous pollutants. Design of control equipment as Settling chamber, Cyclone, Fabric filter, Electro static precipitator and Wet scrubber. Control of air pollution from automobiles.	**06 Hrs**

Unit -4:	**Legislation and regulation:** Air (Prevention and Control) Pollution Act, 1981. The Environment (Protection) Act 1986 in context with air pollution. Pollutant Emission standards for stationary and mobile sources. National Ambient Air Quality Standards and Air Quality Index	**06 Hrs**
Unit -5:	**Environmental impact assessment and management:** Methodology for preparing environmental impact assessment, Role of regulatory agencies and control boards in obtaining environmental clearance for project. Role of general public in environmental clearance, Public hearing, Green House effect, and Ozone layer Depletion, National and International policies related with global effects of air pollution.	**06 Hrs**

References:

1. H. V. N. Rao and M. N. Rao, 'Air Pollution', Tata McGraw-Hill Publishing Company Limited
2. C S Rao, 'Environmental Pollution Control Engineering' Wiley Eastern Limited, New Age International Limited Publication
3. Bare Act 'The Environment (Protection) Act, 1986'.
4. Crawford, 'Air Pollution Control Theory', Tata McGraw-Hill Publishing Company Ltd
5. Santosh Kumar Garg, 'Sewage Disposal and Air Pollution Engineering' Khanna Publishers

Table 1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H										
CO2	H	H	H		L		L	M	M			
CO3	H	H	H		L	L	H	M				
CO4	H	H	M	H	M	M	L	L	M			

H-High M-Medium L-Low

Teacher's Assessment: Teachers Assessment of 10 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any as decided by concerned course coordinator

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CE 4019 - Advanced Transportation Engineering

Teaching Scheme		Evaluation Scheme	
Theory	4 Hrs/Week	Class Test – I	15 Marks
Tutorial	--	Class Test -II	15 Marks
Total Credits		Teachers Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisites: Not Required

Course description:
This course introduces the elements of pavement and describes pavements material characteristics, Properties, Mixes of materials. Pavement design and construction techniques. Flexible and rigid pavements. Traffic analysis, Geometric design of roads

Course Outcomes

As an outcome of completing the course, students will able to:

CO1	Describe different terminologies related with pavements
CO2	Analyze pavement material parameters required for material mix design.
CO3	Derive appropriate pavements and its suitability -Flexible and rigid pavement, Overlays
CO4	Compute the trial sections of different types of pavements

Detailed Syllabus:

Unit 1	**Introduction of Transportation Systems** Role and importance of transportation, objectives of transportation system, transport policy, process and types of surveys, urbanization and transport demand, motorization trends, intermediate. Introduction to BRT, Mono rail, sky bus, metro projects, grade separated interchanges such as flyovers, underpasses, overpasses, concept of Integrated Inter Model transit system.	**6 Hours**
Unit 2	**Classification of Roads and Operation** Road classifications, standards and hierarchies, Route location, design speed and the principles of geometric alignment, horizontal, vertical and coordinated alignment, structural design of flexible, rigid and composite pavements, road surfaces, skidding resistances and road safety, Road construction and maintenance methods and operations, road condition monitoring and rehabilitation options/methods, Highway Engineering surface features: Road markings, signing, furniture, lighting, International Highway Engineering: Highway Capacity Manual (HCM), geometric design (ASSHTO) and road maintenance (HDM), Case study. Types and methods of construction of tunnels, Road safety issues.	**6 Hours**
Unit 3	**Traffic Management** Basic traffic theory, traffic studies, traffic volume count, traffic impacts, traffic analysis process, origin destination survey, parking surveys, road network inventory, accident study - need, methods of conducting surveys, analysis and interpretation, instrumentation of traffic monitoring. Traffic Management measures, Arterial Management; Traffic Signs - principles,	**6 Hours**

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	types and design considerations, road markings; Traffic Signals - types, optimal cycle length and signal settings, warrants; Regulation of Traffic - speed regulation, regulation of vehicle, parking regulations, Case Studies. Introduction to Intelligent Transportation System (ITS), public transport policies.	
Unit 4	**Pavement Design** Flexible and Concrete pavement design, construction and maintenance process, related issues, quality control issues and tests on pavement materials, rehabilitation and preservation of pavements, Pavement Failure: flexible pavement failure, rigid pavement failure, maintenance of different types of pavements, Strengthening of existing pavement: Objective of strengthening, types of overlay, different types of overlay, overlay design methodologies, effective thickness approach, design of overlays using effective thickness approach and deflection approach resorting to Benkelman Beam Method (IRC: 81-1981; IRC: 81-1997).	**6 Hours**
Unit 5	**Financing of Highway** Principles of economic evaluation and financing of a highway project, vehicle operation cost, running cost, pollution cost value of travel cost, road damage cost. Transportation Plans: Benefit cost method, net present value method, first year rate of return method, internal rate of return method and comparison of various methods. Highway financing: Pay as you go method, credit financing, private financing, BOT, BOOT, PPP model, dedicated road funds, road pricing, tolls, private provisions, advantages and limitations.	**6 Hours**

REFERENCE BOOKS

1. Morlok E K,Introduction to Transportation Engg. and Planning –McGraw-Hill company.
2. Laurence I Hewes& Clarkson H OglesbyHighway Engineering -
3. *Khanna, S.K. and Justo, C. E. G.*; Highway Engineering: Nem Chand and Bros., Roorkee,
4. *Rao, G.V.;* Principles of Transportation and Highway Engineering, Tata McGraw Hill Publishing House Pvt. Ltd., New Delhi.
5. L R Kadiyali.
6. Michel A Taylor, William Young, PeterWBonsall.
7. Traffic Engineering and Transport Planning - Understanding Traffic System -
8. M. J. Bruton.Introduction to transport planning -
9. Huang Y H, Prentice Hall, Englewood Cliff,Principles of Urban Transport Systems Planning - Pavement analysis and Design –New Jersey.

Table 1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		H							L			
CO3			M		M	M						
CO4			M									M

H-High M – Medium L – Low

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Teacher's Assessment: Teachers Assessment of 10 marks is based on one or more of the following

1. Technical Quizzes on Transportation Systems and Pavements
2. Application Development
3. Question & answer / Numerical solution
4. Study of any one of different types of disasters and its management
5. Other if any -Power point presentation

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CE 4020: PE-II- Town Planning

Teaching Scheme		Evaluation Scheme	
Theory	04 --Hrs/Week	Class Test-I	15 Marks
Tutorial		Class Test-II	15 Marks
Total Credits	04	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Not Required

Course Description: The course covers the concept and importance of town planning in the development of the cities. The various factors that affect the growth of the city and the regulations are covered. The various agencies involved and their role in the development of the cities is covered.

Course Outcomes:
After successful completion of the course, students will be able to:

1. Plan an ideal town
2. Select a site for the town and divide the plan in to various zones.
3. Analyze and design town with all amenities, decide sources for finance.
4. Suggest the remedial measures to reduce the slums and the rehabilitation techniques.

Detailed Syllabus:

Unit -1:	Introduction, town planning in ancient India, Evolution of planning, Principles of Town planning, necessity of planning, growth of town. Site selection for new town, Town planning surveys, its necessity, data collection, Drawings, Report.	**06-- Hrs**
Unit -2:	Zoning in town planning, principles of zoning, Housing, requirements of residential, public and industrial buildings, Government and Non Government agencies involved in Housing Finance	**06-- Hrs**
Unit -3:	Parks, Classification, Playgrounds, Public buildings, classification, principles of design of public buildings, town centers, grouping of public buildings, industries, Manufacturing industry, classification of industries, requirements, Industrial township	**06-- Hrs**
Unit -4:	Building Bye laws, importance of bye laws, local authorities, floor space index, Slums, causes of slums, characteristics of slums, rehabilitation of slums	**06-- Hrs**
Unit -5:	Development plan or Master plan, Objects of master plan, data collection, drawings, reports, Re-planning of existing towns	**06-- Hrs**

References:

1. Brown A.J. Sherrard H.M. and Shaw J.H. (1969), " An introduction to town and country planning", Angus and Robertson Ltd.

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2. Gopal Bhargava Ed.(1981), "Urban Problems and policy perspective", Abhinav publication New Delhi.
3. Rangwala S.C. (2015), "Town Planning", Charotar Publishing House New Delhi.

Table 1: Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1		H	H	H	H	H	H	H	H	H		
CO2		H	H	H	H	H	H	H	H	H		
CO3		H	H	H	M	M		H	H			
CO4		H	H	H	M	M						

1 – High 2 – Medium 3 – Low

Teacher's Assessment: Teachers Assessment of 10 marks may be based on one or more of the following

1. Technical quizzes
2. Question & answer / Numerical solution
3. Group discussion

AM 4022: PE III – Advanced Design of RC Structures

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
		Class Test-II	15 Marks
Total Credits	3	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite:
Students should have studied AM 3009 Design of RCC Structures.

Course Description:
The reinforced concrete building systems used in the modern age have typical structural systems in the form of slabs and beams integrated to form three dimensional complex structures. Such structures, subjected to various types of loads in combinations, call attention of designer to their proper analysis and design for their efficient performance. In this course, students can learn appropriate methods followed in literature for such safe and economical structures.

Course Outcomes:
After successful completion of the course, students will be able to:

1. Plan, analyze and design flat slabs, voided slabs, and grid floors
2. Design beams under combined actions of flexure, shear and torsion
3. Design stable RC buildings using ties, and controlled deflections and cracks in the structure
4. Design structurally efficient beam system in a reinforced concrete building, including deep beams
5. Design different types of reinforced concrete water tanks OR reinforced concrete retaining walls

Detailed Syllabus:

Unit -1:	**Design of Reinforced Concrete (RC) Slab Systems:** Design of flat slabs, voided RC Slabs, and grid floors	**08Hrs**
Unit -2:	**Behavior of RC Beams Subjected to Torsion:** Design of RC beams under flexure, shear and torsion; Design of ties in RC slab-frame System; Deflection of RC beams and slabs; Structural cracks in RC members	**06Hrs**
Unit -3:	**Analysis & Design of RC Beam Systems:** Physical layouts of continuous beams in structures, Combination of load cases for beam, Redistribution of moments in beams; Design and detailing of continuous beams, Design of deep beams	**08Hrs**
Unit -4:	**Analysis & Design of RC Shear Walls:** Necessity of shear walls, Location of shear walls, Loads acting on shear walls, Design and detailing of shear walls	**08Hrs**
Unit -5:	**Design of Water Tanks:** Types of water tanks, Estimation of loads on underground, on ground, and elevated water tanks, Behavior of underground, on ground, and elevated water tanks, Design and detailing of underground, on ground, and elevated water tanks	**10Hrs**

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Teacher's Assessment:

Teacher's Assessment of 10 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

References:

1. P C Varghese, Advanced Reinforced Concrete Design, 2nd Edition, Prentice-Hall of India Private Limited, New Delhi (2005)
2. Krishna Raju, Advanced Reinforced Concrete Design, CBS, New Delhi (1986)
3. IS 456-2000, Indian Standard Code of Practice for Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi
4. IS 3370:1967-Code of Practice for Concrete Structures for Storage of Liquids, Parts 1 to 4, Bureau of Indian Standards, New Delhi

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		H	L		M				M		L	
CO2		M	M		M		L	M				
CO3		H	H		M		H	L	L			
CO4		M			M	M	M	L	L	M	L	
CO5					M			M	L	M	L	L

H-High M-Medium L-Low

Approved in XVII th Academic Council, dated 10/01/2018

CE 4024: PE III- SOLID WASTE MANAGEMENT

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
		Class Test-II	15 Marks
Total Credits	3	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Student should have studied course ' Environmental Studies' (HS 2001)

Course Description:

Solid waste Management is a term that is used to refer to the process of collecting, treating and disposing the solid wastes. Due to rapid urbanization and industrialization, there is rapid increase in production and consumption processes. Societies generate as well as reject solid materials regularly from various sectors *viz.* agricultural, commercial, domestic, industrial, hospital and institutional. The increase in the quantity of solid waste seriously undermines efficient and sustainable development. It is necessary to collect, transport, treat and dispose the solid waste scientifically and efficiently. This course helps the students to study the various issues related with Municipal and other types of Solid Waste Management.

Course Outcome: On successful completion of this course, students will be able to-

1. Explain the definition of solid waste, classification and characteristics along with health and environmental effects of solid waste.
2. Explain the different waste processing and waste disposal techniques
3. Explain the reuse, recovery and recycle techniques of solid waste
4. Explain the rules and regulations related with solid waste

Detailed Syllabus:

Unit -1:	Sources, generation, classification & characteristics of solid wastes, Health and environmental effects, waste collection, storage and transport, waste disposal methods, sanitary land filling	**06 Hrs**
Unit -2:	Waste Processing Techniques, Volume, size and chemical reduction techniques, source reduction, product recovery and Recycling	**06 Hrs**
Unit -3:	Recovery of Biological Conversion products, composts and biogas, composting and Bio-gasification, environmental effects of composting and bio-gasification, Incineration and energy recovery	**06 Hrs**
Unit -4:	The Municipal Solid Wastes (Management and Handling) Rules, Role of State Government, local municipal authority and waste generator, The plastic Manufacture , sale and usage rules	**06 Hrs**
Unit -5:	The Bio-Medical Waste (Management and Handling) Rules, Hazardous Wastes (Management and Handling) Rules	**06 Hrs**

References:

1. Metcalf & Eddy, 'Wastewater Engineering Treatment and Reuse' Tata McGraw-Hill Edition
2. 'Environment and Pollution Laws' Universal Publishing Co. Pvt. Ltd.
3. Santosh Kumar Garg, 'Sewage Disposal and Air Pollution Engineering' Khanna Publishers
4. www.nptel.ac.in, E-learning courses on Municipal Solid Waste Management (web)

Table 1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H					L					
CO2	H	H	H		H	M	H	M	M			
CO3	H	H	H		H	M	H	M	M		M	M
CO4	H	H	M			H	M	M	M			

H – High M – Medium L – Low

Approved in XVIIth Academic Council, dated 10/01/2018

CE 4010: PE-I -Lab Open Channel Hydraulics

Scheme of Teaching		Scheme of Evaluation	
Practical/Seminar/Project/Dissertation/ etc.	02 --Hrs/Week	Term Work	25 Marks
Total Credits	**01**	Practical Examination/Viva Voce	25 Marks
		Total Marks	50 Marks

Prerequisite: Not Required

Course Description: The course consists of measurement of velocity, discharge in open channels. The experiments for verification of various characteristics of rapidly varied flow are included.

Course Outcomes:
After successful completion of the course, students will be able to:

1. Experience the theoretical concepts through the experimentation
2. Calibrate the measuring devices and use the output for analysis and design.
3. Calculate flow characteristics for gradually varied flow and rapidly varied flow

Detailed Syllabus:
List of the experiments and field visits

1. Measurement of Velocity of flow using pitot tube, current meter.
2. Measurement of discharge through open channel using weirs.
3. Measurement of discharge through open channel using notches.
4. Measurement of discharge over spillway
5. Determination of efficiency of Hydraulic jump
6. Design of Channel, Design of Economic section of channel.
7. Measurement of Sediment load.
8. Field visit report

Term Work:
The term work shall consist of the detailed report of the experiments conducted in the laboratory and the field visit report.

Practical Examination/Viva Voce Examination:
The practical /viva voce examination shall be conducted by the panel of examiners consisting of internal and external examiner. The panel of examiners, as described above, shall evaluate the understanding/knowledge of the student by asking appropriate questions/asking students to perform/demonstrate experiments, etc.

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Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	H	H	H	H	H	H	H					
CO2	H	H	H	H	H	H						
CO3	H	H	H	H	M	M						

H-High M-Medium L-Low

Approved in XVIIth Academic Council, dated 10/01/2018

CE-4011 Lab: PE I- Advanced Water and Waste Water Treatment

Scheme of Teaching		Scheme of Evaluation	
Practical/Seminar/Project/Dissertation/ etc.	2 Hrs/Week	Term Work	25 Marks
Total Credits		Practical Examination/Viva Voce	25 Marks
		Total Marks	50 Marks

Prerequisite: " Not Applicable"

Course Description:

This course broadly covers: characteristics of water and sewage, advance treatment methods of water and wastewater treatment, design of water and wastewater treatment plant, and standards for design of water and wastewater treatment plant

Course Outcome: On successful completion of this course, student will be able to-

1. Perform the experiments to determine characteristics of water and sewage
2. Specify the function of each unit of water and sewage treatment plant
3. Design the water and sewage treatment plant

Detailed Syllabus:

1. Detail Design report of water and sewage Treatment Plant for given population of town

2. **List of Experiments:** (Any six)
   1. Determination of Cation/anion analysis;
   2. Determination of BOD;
   3. Determination of COD;
   4. Determination of Residual chlorine analysis;
   5. Determination of Metal analysis;
   6. Instrumental methods of pollutant analysis;
   7. Characterization of sludge sample.
   8. Microbiology : Microscopy; Staining and detection of microbes;
   9. Methods of enumerating microbes;
   10. Multiple tube fermentation technique;
   11. Membrane filter technique.

Term Work:

The termwork shall consist of a record of laboratory experiments as mentioned below and detail Design report of water and sewage Treatment Plant for given population of town

Practical Examination/Viva Voce Examination:

The panel of examiner shall consist of course coordinator as an internal examiner and one external examiner appointed by the Head of the Department. Panel of examiners, as described above, shall evaluate the understanding/knowledge of the student by asking

appropriate questions/asking students to perform/demonstrate experiments, etc. The practical examination shall consist of viva-voce based on following experiments and their applications.

References:

1. APHA, "Standard Methods for the Examination of Water and Wastewater", 22nd Ed. Washington, 2012.
2. "Laboratory Manual for the Examination of water, wastewater soil Rump", H.H. and Krist, H. – Second Edition, VCH, Germany, 3rd Edition, 1999.
3. "Methods of air sampling & analysis" ,James P. Lodge Jr (Editor) 3rd Edition, Lewis publishers,Inc,USA,1989.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M			H	H				L	L	L	
CO2	M	L		S	H	M			M	L	L	
CO3	H	M	M	H	H	H			M	M	L	
CO4	H	H	H	M	M	M			H	M	M	

H-High M-Medium L-Low

Approved in XVII th Academic Council, dated 10/01/2018

CE 4012: Lab-PE I - Ground Improvement Techniques

Scheme of Teaching		Scheme of Evaluation	
Practical	2 Hrs/Week	Term Work	25 marks
Total Credits	1	Practical Examination/Viva Voce	25 marks
		Total Marks	50 marks

Prerequisite: Not Applicable

Course Description: Water is an important resource. This laboratory course deals with different aspects related to ground water potential, determination of aquifer parameters, interference among wells. It also deals conjunctive use, artificial recharge, and ground water modeling.

Course Outcomes:
After successful completion of the course, students will be able to:

1. Understand the problems on site and to design feasible ground improvement and modification technique
2. Improve ground conditions by densification and grouting
3. Improve ground conditions by use of geosynthetics and geogrids
4. Understand real life ground improvement problems with site visits

Detailed Syllabus:

List of the assignments (Perform any six exercises).

Sr. No.	Details
1	Assignment on Ground Improvement and Modification.
2	Assignment on In-Situ Densification of Soils.
3	Assignment on Grouting in soils.
4	Assignment on Reinforced Soil.
5	Assignment on Geosynthetics.
6	Assignment on Geogrids.

Term Work:
The term work shall consist of information based on exercises mentioned in the syllabus above.

Practical Examination/Viva Voce Examination:
Viva-voce examination across the table shall be conducted by the panel of examiners, to evaluate the understanding/knowledge of the student by asking appropriate questions/asking students to demonstrate experiments/exercises, etc.

References:

1. M. R. Hausmann, "Engineering Principles of ground Modifications", McGraw-Hill International.
2. M. P. Moseley," Ground Improvement", Blackie Academics and Professionals.
3. P. P. Xanthakos, L. W. Abramson and D. A. Bruce, " Ground Improvement and Control", John Wiley & Sons.
4. R. H. Manfired, "Engineering Principles of Ground Modifications", McGraw-Hill.,
5. Dr. P Purushothama Raj, "Ground Improvement Techniques", Laxmi Publications, New Delhi.
6. S. K Gulati and ManojDatta, "Geotechnical Engineering", Tata McGraw Hills Publications, New Delhi.

Table 1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	H	H	H					L
CO2	H	H	H	H	H	H						M
CO3	H	H	H	H	M	M						M
CO4	H	H	H	H	M	M						M

H– High M- Medium L- Low

CE 4013: Lab- PE I -Advanced Surveying

Scheme of Teaching		Scheme of Evaluation	
Practical	2 Hrs/Week	Term Work	25 marks
Total Credits	**1**	Practical Examination/Viva Voce	25 marks
		Total Marks	50 marks

Prerequisite: Not Applicable

Course Description: The course deals with hands on in advanced methods of measurement and mapping.

Course Outcome: On successful completion of this course, students will be able to

1. Apply principles of theory of errors for correction of measurements.
2. Utilize total station and other modern survey instruments.
3. Use GPS for surveying
4. Apply GIS in solving engineering problems

List of Experiments

Sr. No.	Details
1	Examples on triangulations adjustments
2	Solution of examples on theory of errors
3	Practical based on various special functions available in a total station
4	Local survey using GPS
5	Use of RS images and visual interpretation
6	Use of interface and tools in GIS software such as GRAM++ or QGIS or equivalent software.

Table 1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M			H	H				L	L	L	
CO2	M	L		H	H	M			M	L	L	
CO3	H	M	M	H	H	H			M	M	L	
CO4	H	H	H	M	M	M			H	M	M	

H-High M-Medium L-Low

CE 4016: Lab-PEII - Ground Water Engineering

Scheme of Teaching		Scheme of Evaluation	
Practical	2 Hrs/Week	Term Work	25 marks
Total Credits	**1**	Practical Examination/Viva Voce	25 marks
		Total Marks	50 marks

Prerequisite: Not Applicable

Course Description: Water is an important resource. This laboratory course deals with different aspects related to ground water potential, determination of aquifer parameters, interference among wells. It also deals conjunctive use, artificial recharge, and ground water modeling.

Course Outcomes:
After successful completion of the course, students will be able to:

1. Describe the different aspects related with groundwater engineering
2. Choose suitable method of determination of aquifer parameters
3. Assess ground water potential
4. Comment on suitable ground water development and management methods

Detailed Syllabus:

List of the experiments/assignments (Perform any six exercise).

Sr. No.	Details
1	Writing a brief report on "ground water potential" of a region or state or of India
2	Study of Maharashtra Ground Water Act
3	Compute hydraulic conductivity by Theim and Dupuit's theory
4	Exercise based on differential equations governing groundwater flow for steady and unsteady state problems
5	Determination of aquifer parameters by Theis method or Jacob or Chow's method
6	Exercise based on interference among wells
7	Exercise based on water well design
8	Case study based on ground water models
9	Case study based on conjunctive use or artificial recharge of groundwater
10	Exercise based on ground water resource evaluation in India

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Term Work:
The term work shall consist of information, exercise based on at least six exercises mentioned in detailed syllabus above.

Practical Examination/Viva Voce Examination:
Viva-voce examination across the table shall be conducted by the panel of examiners, to evaluate the understanding/knowledge of the student by asking appropriate questions/asking students to demonstrate experiments/exercises, etc.

Table 1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M		L									L
CO2		M	H		L							M
CO3		M	H									M
CO4			H			M						M

1 H – High 2-M – Medium 3- L - Low

Approved in XVIIth Academic Council, dated 10/01/2018

CE 4018: LAB- PE II- AIR POLLUTION AND CONTROL

Scheme of Teaching		Scheme of Evaluation	
Practical	02 Hrs/Week	Term Work	25
Total Credits	**01**	Practical Examination/Viva Voce	25
		Total Marks	50

Prerequisite : Not Applicable

Course Description:

Air pollution occurs due to particulate pollutants or gaseous pollutants introduced into Earth's atmosphere. It may cause adverse effects on human being, plants, animals and property. Human activity and natural processes can both generate air pollution. It is essential to have knowledge of plume rise and plume dispersion. This course helps the student about plume rise, plume dispersion. There are various air pollution control technologies and strategies available to reduce indoor as well as outdoor air pollution. This course helps to students to identify the various standards prescribed by authorities to control the ambient quality and principles of pollution control equipments. It is necessary to monitor the ambient air quality as well as pollutants emitted through a stack. This course helps to know the various techniques to be adopted for ambient air quality monitoring and stack monitoring.

Course Outcome: After successful completion of the course, students will be able to:

1. Explain the definition of air pollution & various types of sources, classification and effects of air pollutants.
2. Demonstrate the use of ambient air quality and stack monitoring equipments
3. Explain the legal provisions related with air pollution and control
4. Explain the design principles of air pollution control equipments

Term Work:

Term work shall consist of assignments on-

1. Stability conditions of atmosphere and Plume behavior
2. Problems on Plume rise, plume dispersion and stack height
3. Ambient air quality monitoring
4. Stack Monitoring
5. Design principles of air pollution control equipments and sketches thereof
6. Problems of air pollution control equipments such as Settling chamber, Cyclone, Fabric filter, Electrostatic precipitator and Wet scrubber etc.
7. Control of air pollution from automobiles.
8. Provisions related with air pollution in Air (Prevention and Control) Pollution Act, 1981 and The Environment (Protection) Act 1986.
9. Emission standards for stationary and mobile sources.
10. Air Quality Index and National Ambient Air Quality Standards.
11. Industrial visit report

Approved in XVIIth Academic Council, dated 10/01/2018

Practical Examination/Viva Voce Examination:
The panel of examiner shall consist of course coordinator as an internal examiner and one faculty member appointed by the Controller of Examination as an external examiner. The panel of examiners, as described above, shall evaluate the understanding/knowledge of the student by asking appropriate questions/asking students to perform/demonstrate experiments, etc.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H					H	M	M	L	M		L
CO2	H			H		H	M	M		M		
CO3	H		M	M		M	H	M		M		M
CO4	H	H	H	M	M		M		M	M		

H – High M – Medium L – Low

Approved in XVIIth Academic Council, dated 10/01/2018

AM 4021: PE-II Lab- Concrete Technology

Scheme of Teaching		Scheme of Evaluation	
Practical	02 Hrs/Week	Term Work	25
Total Credits	**01**	Practical Examination/Viva Voce	25
		Total Marks	50

Course Description: The course consists of conduction of various tests on hardened concrete

Course Outcome:
After successful completion of the course, students will be able to:

1. Use admixtures and additive to produce required concrete.
2. Design a concrete mix for given materials and requirements.
3. Assess quality of concrete

Term Work:

It shall consist of record of 10 experiments performed in the laboratory. The list of experiments is given below. A report of visit to a construction site shall also be included.

1. Properties of Hardened Concrete,
2. Stress-Strain Behaviour
3. Modulus of Elasticity
4. Poisson's Ratio
5. Modulus of Rupture
6. Splitting Tensile Strength
7. Shrinkage
8. Creep
9. Ductility
10. Fatigue Strength
11. Alkali-Aggregate Reaction
12. Abrasion Resistance
13. Carbonation
14. Porosity and Permeability
15. NDT

Practical Examination/Viva Voce Examination:
The panel of examiner shall consist of course coordinator as an internal examiner and one faculty member appointed by the Controller of Examination as an external examiner. The panel of examiners, as described above, shall evaluate the understanding/knowledge of the student by asking appropriate questions/asking students to perform/demonstrate experiments, etc.

Approved in XVIIth Academic Council, dated 10/01/2018

Table 1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	H	H					L	H	L	H
CO2	M	M	M	M					L	H	L	H
CO3												
CO4												

H – High M – Medium L – Low

Approved in XVIIth Academic Council, dated 10/01/2018

AM 4025: Lab PE III – Advanced Design of RC Structures

Teaching Scheme		Evaluation Scheme	
Practical	2 Hrs/Week	Tem Work	25 Marks
		Viva Voce	25 Marks
Total Credits	1	Total	50 Marks

Prerequisite:
This course should be taken along with AM 4022: PE III – Advanced Design of RC Structures

Course Description:
This course offers civil engineering students an opportunity to design selective types of RC structures learnt in AM 4022: PE III – Advanced Design of RC Structures, and prepare working drawings for the same.

Course Outcomes:
After successful completion of the course, students will be able to:

1. Plan and analyze any specified structures mentioned in AM 4020 PE III- ADVANCED DESIGN OF RC STRUCTURES course, viz. flat slabs/ voided slabs/grid floors/ beams under combined actions of flexure, shear and torsion/ ties for stable RC buildings/structurally efficient beam system in given building, including deep beams/different types of water tanks
2. Design the above mentioned structures.
3. Draw relevant drawings of the above mentioned structures.

Term Work:
The term work shall consist of a design report file containing proper problem statements followed by analysis, design and drawing of any three reinforced concrete structures mentioned in AM 4022 PE III- ADVANCED DESIGN OF RC STRUCTURES course, viz. flat slabs/ voided slabs/grid floors/ beams under combined actions of flexure, shear and torsion/ ties for stable reinforced concrete buildings/structurally efficient beam system in given building, including deep beams/different types of water tanks, accompanied by professional working drawings containing all necessary notes useful for construction team on sites. These drawings could be drawn by hand or using any drafting software.

Practical/Viva Voce Examination:
The viva voce shall be based on the term work mentioned above.

References:

1. P C Varghese, Advanced Reinforced Concrete Design, 2nd Edition, Prentice-Hall of India Private Limited, New Delhi (2005)
2. Krishna Raju, Advanced Reinforced Concrete Design, CBS, New Delhi (1986)

Approved in XVII th Academic Council, dated 10/01/2018

3. IS 456-2000, Indian Standard Code of Practice for Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi
4. IS 3370:1967-Code of Practice for Concrete Structures for Storage of Liquids, Parts 1 to 4, Bureau of Indian Standards, New Delhi

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		H		H	M			H				
CO2	H	H	H	H	M	L		M	H		H	
CO3							H			H		M

CE 4027: LAB- PE III-SOLID WASTE MANAGEMENT

Teaching Scheme		Evaluation Scheme	
Practical	2 Hrs/Week	Tem Work	25 Marks
		Viva Voce	25 Marks
Total Credits	1	Total	50 Marks

Prerequisite: Student should have studied course HS 2001 Environmental Studies

Course Description:

Solid waste Management is a term that is used to refer to the process of collecting, treating and disposing the solid wastes. Due to rapid urbanization and industrialization, there is rapid increase in production and consumption processes. Societies generate as well as reject solid materials regularly from various sectors *viz.* agricultural, commercial, domestic, industrial, hospital and institutional. The increase in the quantity of solid waste seriously undermines efficient and sustainable development. It is necessary to know the quantity of solid waste generated and classify the same. The Government has framed the rules and regulations for different types of wastes. The solid waste can be processed and disposed by different techniques. This course helps the students to study the various issues related with Municipal and other types of Solid Waste Management.

Course Outcome: On successful completion of this course, students will be able to-

1. Explain the definition of solid waste, classification and characteristics along with health and environmental effects of solid waste.
2. Explain the different waste processing and waste disposal techniques
3. Design the solid waste treatment unit
4. Explain the rules and regulations related with solid waste

Term Work:

Term work shall consist of assignments on-

1. Classification of solid waste from residence, institute or a industry
2. Study of waste processing and waste disposal technique for a city or town
3. Design of solid waste treatment unit for residence or canteen waste or biological waste
4. Study report on waste reduction or reuse
5. Report on legal aspects of solid waste management
6. Study report on Bio-medical waste management

Practical Examination/Viva Voce Examination:

The panel of examiner shall consist of course coordinator as an internal examiner and one faculty member appointed by the Controller of Examination as an external examiner. The panel of examiners, as described above, shall evaluate the understanding/knowledge of the student by asking appropriate questions/asking students to perform/demonstrate experiments, etc.

Approved in XVIIth Academic Council, dated 10/01/2018

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H					H	M	M	L	M		L
CO2	H			H		H	M	M		M		
CO3	H	H	M	M		M	H	M		M		M
CO4	H	H	H	M	M		M		M	M		

H – High M – Medium L – Low

Approved in XVII[th] Academic Council, dated 10/01/2018

CE-4028 : Estimation and Costing

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
Tutorial	0Hrs/Week	Class Test-II	15 Marks
Total Credits		Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: No prerequisite

Course Description:
This subject broadly covers about estimation of quantities for various civil engineering projects, computing rates for various items of construction, writing specifications and tender notice and various types of contracts.

Course Outcome: On successful completion of this course, students will be able to-

1. Estimate the quantities for various civil engineering projects.
2. Compute rates for various items of construction.
3. Prepare estimates for various civil engineering works.
4. Write specifications and tender notice.
5. Compose valuation report for buildings.

Detailed Syllabus:

Unit -1:	**Estimate:** Definition, importance of quantity surveying for civil engineer. Purpose, type of estimates, data required for estimates. Items of work, description of an item of work, unit of measurement & principles deciding the units, mode of measurement of building works. Abstracting, bill of quantities. Provisional &prime cost items, contingencies, establishment charges, centage charges, District Schedule of Rates(DSR) Introduction of IS:1200 for modes of measurement. **Approximate Estimate:** Definition, purpose, methods of approximate estimation of building & other civil engineering projects like roads, irrigation & water supply & sanitary engineering, electrical works.	**8 Hrs**
Unit -2:	Taking out Quantities Principles, methods of taking out quantities for different assignments mentioned in term work, Abstracting bill of quantities, provisional and prime cost items, contingencies, establishment charges.	**8 Hrs**

	Analysis of Rates : Factors affecting cost an item of work materials, labour, tools, and plant, overheads and profit. Task work- definition and factors affecting task work Transportation of material and cost Schedule of materials and labour, District Schedule of Rates(D.S.R).Analysis of rates of different items mentioned in T.W. Specifications: Definition and purpose, types, drafting specifications, legal aspect, specifications of stonemasonry, wood work, earth work, reinforcing brick work of R.C.C. work.	
Unit -3:	**Tenders:** Definition. Methods of inviting tenders, Types of tenders, tender notice, Pre-qualifications of contractor, tender documents, preparation of tenders. Submission in 3bid/2bid or single bid system. Qualitative and quantitative evaluation of tenders, comparative statement, pre-bid conference, acceptance of tenders, various forms of BOT tenders, global tendering. Administrative approval, technical sanction	**8 Hrs**
Unit -4:	**Valuation of Property**: Purpose, nature of value, price, factors affecting value of a property. Freehold and leasehold property. Depreciation and methods of working out depreciation, sinking fund, years purchase, outgoings. Methods of valuation Land and building basis, Rental basis, Reproduction and replacement cost basis, Profit basis, fixation of rent.	**8 Hrs**
Unit -5:	**Contracts:** General idea, types of contracts viz: lumpsum, item rate, cost plus, **E**ngineering Procurement Construction(EPC).Conditions of contracts. FIDIC document, standard contract conditions published by MOS and PI, Law of contract. Definition, objective & essentials of valid contract. **Conditions of contract:** General and Specific conditions. Condition regarding EM,SD, time as an essence of contract. Important conditions regarding addition, alteration, extra items, testing of materials, defective work, subletting, powers delegated to Engineer in- charge regarding the above aspect, defect liability period, retention money, interim payment or running account bills, advance payment, secured advance, final bill. Settlement of disputes viz. dispute resolving board, arbitration, concept of partnering. Liquidated damages, termination of contract. Liquidated	**8 Hrs**

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	damages, defect liability period, retention money, termination of contract, payment, secure advance.	

Reference Books :

1. Estimating and Costing in Civil Engineering: Theory and Practice, By: B.N. Dutta Published By: S.Dutta & Company, Lucknow.
2. Estimating, Costing Specifications & valuation in Civil Engineering, By: M. Chakraborty Published By: Author.
3. Estimating and Costing By: G.S.Birdie
4. Estimating and Costing By: Rangwala Published By: Charotar Publishing House, Anand
5. Civil Engineering Contracts & Estimates By: B.S.Patil Published By: Orient Longman Ltd. Mumbai.
6. I.S.1200 (Part01to25):Methods of Measurement of Building and Civil Engineering Works.
7. D.S.R: District Schedule of Rates
8. PWD Hand Book and Red Book
9. Standard Contract Clauses for Domestic Bidding Contracts: Ministry of Statistics and Programme Implementation, Government of India.
10. FIDIC Document: Federation International Des Ingenieurs Conseils i.e. International Federation of Consulting Civil Engineers, Geneva, Switzerland.

Table 1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO1 0	PO1 1	PO1 2
CO1		H	L		M				M		L	
CO2		M	M		M		L	M				
CO3		H	HM		M		H	L	L			
CO4		M			M	M	M	L	L	M	L	
CO5					M			M	L	M	L	L

Teacher's Assessment: Teachers Assessment of 10 marks may be based on one or more of the following

1) Technical quizzes
2) Application development
3) Question & answer / Numerical solution
4) Group discussion
5) Other if any

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CE 4029: PROJECT

Scheme of Teaching		Scheme of Evaluation	
Project	12Hrs/Week	Term Work	150
Total Credits	06	Practical Examination/Viva Voce	150
		Total Marks	300

Course Outcomes:

After successful completion of the course, students will be able to:

1. Work in a group to select a problem for project work
2. Perform and use literature and field survey.
3. Formulate the methodology to solve the identified problem
4. Apply the principles, tools and techniques to solve the problem
5. present and explain project report

Detailed Syllabus:

The project work shall consist of comprehensive review of recent development or detailed project report consisting of an experimentation / design/software development related to Civil Engineering. The project work may be related with social problem for which technical solution shall be given and implementation of the same may be carried out. The work shall be carried out by a group with maximum eight and minimum of three students. The project may be interdisciplinary in nature. However, the concerned guides shall decide the scope of the work with the consent of concerned Heads of the Departments for such interdisciplinary project works. The Project Guide may decide the number of students in a group.

Term Work:

The term work shall consist of detailed project in the prescribed format.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H				H	M		H	H	H	M	M
CO2	H	H		H								M
CO3	H	H	H	H				H				M
CO4	H	H	H			H	H		M	L	M	M
CO5	H				M					H		M

H – High M – Medium L – Low

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CE-4030 Lab: Estimation and costing

Scheme of Teaching		Scheme of Evaluation	
Practical/Seminar/Project/Dissertation/ etc.	4 Hrs/Week	Term Work	50 Marks
Total Credits		Practical Examination/Viva Voce	50 Marks
		Total Marks	100 Marks

Prerequisite: " Not Applicable"

Course Description:

This subject broadly covers advance knowledge about estimation of quantities for various civil engineering projects, knowledge about computing rates for various items of construction and writing specifications and tender notice.

Course Outcome:

On successful completion of this course, students will be able to-

1. Perform to take out the quantities for various construction projects.
2. Formulate estimates for various civil engineering works.
3. Develop draft specifications and tender notice.
4. Formulate valuation report for residential building.

Detailed Syllabus:

A) Working out Detailed Quantities for

i) A Two storied R.C.C. framed building based on prevailing DSR rates for Aurangabad District

ii) Estimation of quantities of steel reinforcement for an R.C.C. frame structure in (i) above

iii) Detailed Estimate of Residential Drainage and Water Supply Project

B) Preparation of Estimate manually or using Software
Detailed estimate of any two of the following

a. One column, column footing, beam and slab panel.
b. Pipe culvert and slab culvert.
c. Earthwork (for a road, Railway, Canal or a small dam)

C) Writing Detail specifications of any five items Work
From the items of works in (A) above

D) Analysis of Rates
For the ten Items of Works in (A) above based on the prevailing market rates of various items and labour involved.

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E) Valuation reports

Of a residential buildings using the format given in the O-1 form

F) *Preparation of draft of tender notice*

For the Work for which Detailed Estimate is Prepared.

Term Work:

The term work shall consist of above mentioned work.

Oral Examination would be based on the term work and theory covered in the class under the course Estimation and Costing. An Objective Multiple Choice Test may be conducted as a part of the Oral.

Practical Examination/Viva Voce Examination:

The panel of examiner shall consist of course coordinator as an internal examiner and one external examiner appointed by the Head of the Department. Panel of examiners, as described above, shall evaluate the understanding/knowledge of the student by asking appropriate questions/asking students to perform/demonstrate experiments, etc. The practical examination shall consist of viva-vice based on following experiments and their applications.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M			H	H				L	L	L	
CO2	M	L		S	H	M			M	L	L	
CO3	H	M	M	H	H	H			M	M	L	
CO4	H	H	H	M	M	M			H	M	M	

H – High M – Medium L – Low

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AM 4031: PE IV – Design of Bridges

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
		Class Test-II	15 Marks
Total Credits	3	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite:
The students should have studied AM2008 Structural Analysis, AM3009 Design of RCC Structures, and AM 4015 PE II- Concrete Technology courses.

Course Description:
Infrastructure development is essential for development of our country. This need includes construction of roads and bridges on a large scale. It is imperative therefore to create human resources capable of planning and designing of RCC and PSC bridge structures. This course offers an opportunity to civil engineering students to develop themselves to cater for the above mentioned need of the society.

Course Outcomes:
After successful completion of the course, students will be able to:

1. The students would be able to identify various types of highway bridges, and site-specific suitability of the same.
2. The students would be able to understand the standard design loads for respective bridges on highway.
3. The students would be able to analyze various types of highway bridges (Simply supported and continuous RCC and PSC bridges).
4. The students would be able to design various types of highway bridges (Simply supported and continuous RCC and PSC bridges).

Detailed Syllabus:

Unit -1:	**Introduction**: Classification of highway bridges; Illustrations of various types such as arch type, slab type, slab and beam/girder type, Skew and curved bridges, Super-elevation in curved bridges, Bridge-type selection factors, etc.	**08Hrs**
Unit -2:	**Design Loads for Highway Bridges**: Types of loads on highway bridges; Loading standards for highway bridges conforming to IRC; Load distribution in bridge decks: Courbon's theory, Morice and Little theory	**08Hrs**
Unit -3:	**Design Procedures for Simply Supported RCC Bridges**: Solid slab type bridges, Slab and girder type bridges	**08Hrs**
Unit -4:	**Design Procedures for RCC Continuous Bridges**:Slab and T-beam type, Box-girder type, Balanced-cantilever type, Arch type, etc.	**08Hrs**

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Unit -5:	**Design Procedures for PSC bridges**: Preliminary dimensions, design principles, cable profiles, end blocks, etc.	**08Hrs**

Teacher's Assessment:

Teacher's Assessment of 10 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

References:

1. E.C Hambly, Bridge Deck Behavior, E & FN SPON Publications.
2. V.K. Raina , Concrete Bridge Practice, Analysis, Design and Economics, Tata McGraw-Hills Publishing Company Limited.
3. M.J. Ryall, G.A.R Parke, J.E. Harding, The Manual of Bridge Engineering, Thomas Telford Publishers.
4. R. Rajagopalan, Bridge Superstructure, Tata McGraw- Hills Publishing Company Limited.
5. S. Ponnuswamy , Bridge Engineering, Tata McGraw – Hills Publishing Company Limited.
6. M. G. Aswanil, V.N.Vazirani, M.M. Ratwani , Design of Concrete Bridges, Khanna Publishers.
7. K. S. Rakshit, Design and Construction of Highway Bridges, New Central Book Agency (P) Ltd, Pune
8. D. Johnson Victor - Essentials of Bridge Engineering Fifth Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
9. T.R. Jagadeesh, M.A. Jayaram - Design of Bridge Structures, Prentice-Hall of India
10. N. Krishna Raju - Design of Bridges, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
11. David Lee – Bridge Bearings and Expansion Joints, E & FN Spon
12. Joseph E. Bowles – Foundation Analysis and Design, McGraw-Hill International Edition
13. Nainan P. Kurian – Design of Foundation Systems, Narosa Publishing House
14. Indian Road Congress codes IRC-6, 18, 21, 112-2011
15. Indian Standard Codes (latest versions): 456-2000, 1893-2002, 1343-1993

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		H	L		M				M		L	
CO2		M	M		M		L	M				
CO3		H	H		M		H	L	L			
CO4		M			M	M	M	L	L	M	L	
CO5					M			M	L	M	L	L

H – High M – Medium L – Low

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CE 4032: PE-IV- Water Power Engineering

Teaching Scheme		Evaluation Scheme	
Theory	03 --Hrs/Week	Class Test-I	15 Marks
Tutorial	00 --Hrs/Week	Class Test-II	15 Marks
Total Credits	**03**	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: CE-2002- Fluid Mechanics

Course Description: The course covers planning and development aspects of multipurpose irrigation projects, the various components of a Hydro electric power plant, selection of various types of turbines, the safety measures and the computation of power.

Course Outcomes:
After successful completion of the course, students will be able to:

1. Plan and design a hydro electric power project
2. Select a site and design the components of a power project.
3. Analyze and design the turbines / pumps required.
4. Compute the energy generated through power station

Detailed Syllabus:

Unit -1:	Introduction, Energy, Reservoir Planning, Multipurpose irrigation projects, Environment and Water Power development, reservoir sedimentation	**06-- Hrs**
Unit -2:	Principle component of hydroelectric power project, and planning for water power development. Storage power development, River power development, Pumped storage power development.	**06-- Hrs**
Unit -3:	Intake structures, Penstocks, Surge tanks, Turbines, Classification of turbines, Characteristic curves of turbines, Francis and Kaplan Turbines, selection of turbines, Draft tubes.	**06-- Hrs**
Unit -4:	Valves and Gates, Water hammer, Surge in power tunnel, Design of surge tank, Small Hydro Power development	**06-- Hrs**
Unit -5:	Centrifugal Pump, Classification of Pumps, Component parts of Pump, Priming and working of pumps, characteristics of pumps, Reciprocating pumps, air vessels, Hydraulic ram	**06-- Hrs**

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References:

1. Garg S.K. (2010), " Irrigation Engineering and hydraulic Structures", Khanna Publishers, New Delhi
2. Garde R, J. and Ranga Raju K.G.(1980), "Mechanics of Sediment Transportation And Alluvial Stream Problems", Wiley Eastern Limited
3. Bansal R.K.(2013), "Fluid Mechanics and Hydraulic Machines", Laxmi Publications
4. PunmiaB.C.(2016), "Irrigation and Water Power Engineering", Laxmi Publications, New Delhi.
5. Sharma R.K.(2003), "Water Power Engineering", S.Chand Publication, New Delhi

Table 1: Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1		H	H	H	H	H	H	H	H	H		
CO2		H	H	H	H	H	H	H	H	H		
CO3		H	H	H	M	M		H	H			
CO4		H	H	H	M	M						

H – High M – Medium L– Low

Teacher's Assessment: Teachers Assessment of 10 marks may be based on one or more of the following

1. Technical quizzes
2. Question & answer / Numerical solution
3. Group discussion

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CE 4033: PE IV- INDUSTRIAL WASTE MANAGEMENT

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
		Class Test-II	15 Marks
Total Credits	3	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Student should have studied course 'Environmental Studies' (HS 2001) and Environmental Engineering CE 3003

Course Description:

Industrial waste is the waste produced by industrial activity. This course deals with the pollution from major industries and methods of controlling and treatment the same. The student is expected to know about the pollution strength of waste from industries and methods of controlling the same.

Course Outcome: After successful completion of the course, students will be able to:

1. Explain the characteristics of different types of industrial wastewater and environmental effects
2. Design the different treatment units
3. Explain the reuse, recovery and recycle techniques of solid waste
4. Explain the rules and regulations related with industrial waste

Detailed Syllabus:

Unit -1:	Types of industries and industrial pollution, Physical, Chemical, Organic and Biological properties of industrial wastewater and effects of the same on inland surface water, disposal methods and standards	**06 Hrs**
Unit -2:	Chemical and biological treatment of wastewater, removal of dissolved inorganic solids, removal of color and odour, removal of heavy metals from wastewater	**06 Hrs**
Unit -3:	Waste reduction alternatives for raw materials, process changes, housekeeping, preliminary treatment of wastes, collection of waste segregation, equalization, neutralization	**06 Hrs**
Unit -4:	Sources, Characteristics, waste treatment flow sheets for selected industries such as sugar, distillery, tannery, dairy and electroplating	**06 Hrs**
Unit -5:	Legal aspects related with Hazardous wastes management and handling, secured landfills	**06 Hrs**

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References:

1. Metcalf & Eddy, 'Wastewater Engineering Treatment and Reuse' Tata McGraw-Hill Edition
2. 'Environment and Pollution Laws' Universal Publishing Co. Pvt. Ltd.
3. M.N.Rao, A.K.Datta, ' Waste water Treatment' Oxford & IBH Publishing Co. Pvt. Ltd.
4. Soli J Arceivala, 'Wastewater Treatment for Pollution Control' , Tata McGraw-Hill Edition

Table-1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M		M		M	L					
CO2	H	H	H		H		H		M			
CO3	H	M	M		H		H		M			
CO4	H	M				H	H	M	M			M

H – High M – Medium L – Low

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CE 4034 - PE-IV INFRASTRUCTURE DEVELOPMENT

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test – I	15 Marks
Tutorial	--	Class Test -II	15 Marks
Total Credits		Teachers Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisites: Not Required
Course description: This course introduces the elements of different types of Infrastructures Roads, Rail, Airports, Industries, Tunneling, Docks and Harbors. Management techniques with regards to construction aspects of infrastructural elements

Course Outcomes

As an outcome of completing the course, students will able to:

CO1	Describe different terminologies related with Infrastructural elements
CO2	To understand planning aspects and scheduling of infrastructural projects.
CO3	Analyze different parameters required for developments and its management infrastructures.
CO4	Preparation detail program for requirements of suitable infrastructural project need base

Detailed Syllabus:

Unit 1	**Introduction to Infrastructures** Scope of Infrastructure Engineering in National & Global development, Necessity of mechanization, Provisions made for various infrastructure sectors like Roads & Highways, Industry Sector, Housing, Energy & Power sector with reference to 12 th Five Year Plan. Necessity advantages & disadvantages of PPP (Public Private Partnership.)	**6Hours**
Unit 2	Indian Rails and its Role Role of Indian railways in national development, railways for urban transportation, engineering surveys for track alignment, obligatory points, conventional modern methods (remote sensing, GIS), permanent way track component and their function, Geometrics: gradients, transition curves, widening of gauge on curves, cant deficiency, construction and maintenance of railway track, methods of construction, maintenance of tracks traffic operation, modernization of track railway station for high speed trains special measures for high speed track. Mono and Metro rail.	**6 Hours**
Unit 3	**Airport Engineering** Aircraft component parts its function, aircraft characteristics their	**6 Hours**

	influence on airport planning, Airport planning: topographical geographical features, existing airport in vicinity, air traffic characteristics, development of new airports, factors affecting airport site selection, Airport Obstruction: zoning laws, classification of obstructions, imaginary surfaces, approach zones, turning zones, Airport layout: runway orientation, wind rose diagrams, basic runway length, corrections for runway length, airport classification, geometric design, airport capacity, runway configuration, taxiway design.	
Unit 4	**Docks ,Harbours, Ports** Introduction, Requirements of Docks, Harbors and Ports. Classification of harbors with examples Selection of site for harbor, various components of ports (b) Break waters types, comparison, design criteria, methods of construction. Tetra pod Tri bar hexa pod quay wall wet & dry dock floating dick wharves, jetties, types of fenders dolphins Marin railway	**6 Hours**
Unit 5	**Tunneling** Tunneling, Functions & year of tunnel, criteria for selection of size & shape of tunnels. Pilot tunnel, shaft, and portal, Needle Beam, NATM, TBM & Earth Pressure Balance Method of tunneling in soft soil, Drilling & blasting method of tunneling including various operations like mucking, micro tunneling and trenchless tunneling.	**6 Hours**

REFERENCE BOOKS

1. S.C Sharma Construction Equipments& its Management:,Khanna Publication
2. Puerifoy –Construction Planning Methods &Equipment:Tata MC Graw Hill
3. Saxena, S. C. and Arora, S. PA Course of Railway Engineering DhanpatRai Sons, New Delhi.
4. Agarwal, M. M.Indian Railway Track:, Suchdeva Press New Delhi
5. Khanna, S.K., Arora, M.G. and Jain, J.J.; Airport Planning Design: Nemchand Bros., Roorkee.
6. HoronjeffMckelrey, TPlanning Design of Airport: Tata Mc-Graw Hill India Publishing House, New Delhi.
7. Quinn, A. D., Design and Construction of Ports and Marine Structures: Tata Mc-Graw Hill India Publishing House
8. Bindra, S.P. Principles and Practice of Bridge Engineering:;DhanpatRai and Sons, New Delhi.

Approved in XVIIth Academic Council, dated 10/01/2018

Table 1:Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		H							L			
CO3			M		M	M						
CO4			M									M

H-High M – Medium L – Low

Teacher's Assessment: Teachers Assessment of 10 marks is based on one or more of the following

1. Technical Quizzes on Infrastructures
2. Application Development
3. Question & answer / Numerical solution
4. Study of any one of different types of disasters and its management
5. Other if any -Power point presentation

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CE 4035:PE IV –Advanced Geotechnical Engineering

Teaching Scheme		Evaluation Scheme	
Theory	03 --Hrs/Week	Class Test-I	15 Marks
Tutorial		Class Test-II	15 Marks
Total Credits	**03**	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Knowledge of CE 3004: Geotechnical and Foundation Engineering

Course Description: This course introduces different site investigation methods, Types of foundations, loading conditions and suitability.

Course Outcomes:
After successful completion of the course, students will be able to:

1. Suggest and prepare plan to be adopted for exploration of soil depending on field conditions.
2. Design of foundation under different loading conditions.
3. Evaluate bearing capacity for varied site conditions.
4. Select methodologies to be adopted for foundations on expansive soil.

Detailed Syllabus:

Unit -1:	Site investigations: Methods of exploration, Methods of boring, Soil samples, Number and disposition of trial pits and borings, Depth of exploration, Ground water observations, Field Tests, Geophysical methods, Borehole logs, Site investigation report.	**06-- Hrs**
Unit -2:	Shallow foundations: Types of foundations, Location and depth of foundation, Bearing capacity of shallow foundations, Bearing capacity from building codes, Effect of water table on bearing capacity, Proportioning of footings. Settlement of shallow foundations, Loading conditions.	**06-- Hrs**
Unit -3:	Pile foundation: Introduction, Uses of piles, Classification of piles, Selection of pile type, Pile driving, Pile capacity, Pile groups, Negative skin friction, Load test on piles, Static pile load formulae, Dynamic pile formulae, Laterally loaded piles, Batter piles.	**06-- Hrs**
Unit -4:	Cofferdams, Caissons: Cofferdams uses and features, Types of caissons, Components of a well foundation, Shapes of wells, Forces acting on well foundation, Construction and sinking of a well, Rectification of tilts and shifts.	**06-- Hrs**
Unit -5:	Foundations on expansive and collapsible soils: Parameters of expansive soil, Identification of expansive soils, Free swell test, Differential free swell test, Swelling pressure tests, Field conditions that favor swelling, Effects of swelling on a structure, Foundation techniques	**06-- Hrs**

Approved in XVIIth Academic Council, dated 10/01/2018

References:

1. V.N.S.Murthy, "Soil mechanics and foundation engineering"Vol.1, Saikrupa Technical Consultants, Bangalore.
2. J.E.Bowles, Foundation analysis and design, McGraw Hill International, New York.
3. K.R. Arora, "Soil Mechanics and Foundation Engineering" Standard Publishers Distributors.
4. Shashi K. Gulhati and ManojDatta, "Geotechnical Engineering"Tata McGraw Hill Publication, Latest edition.
5. Gopal Ranjan,A.S.R.Rao, " Basic and Applied Soil Mechanics", New Age International Publishers, New Delhi.
6. Relevant Indian Standard Specifications and Codes.

Table 1: Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1		H	H	H	H	H	H	H	H	H		
CO2		H	H	H	H	H	H	H	H	H		
CO3		H	H	H	M	M		H	H			
CO4		H	H	H	M	M						

H-High M – Medium L – Low

Teacher's Assessment: Teachers Assessment of 10 marks may be based on one or more of the following

1. Technical quizzes
2. Question & answer / Numerical solution
3. Group discussion

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AM 4036: PE IV – Building Maintenance and Repairs

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
		Class Test-II	15 Marks
Total Credits	3	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite:
Students should have studied AM 2007 Civil Engineering Materials, CE2009 Building Planning and Design, AM 4014 PE-II-Concrete Technology courses.

Course Description:
The reinforced concrete buildings are susceptible to deterioration due to various causes including environmental factors. The proper maintenance and repairs needed for such buildings is very important issue for the whole society. This course offers civil engineering students to learn various details related to this topic of concern for everyone.

Course Outcomes:
After successful completion of the course, students will be able to:

1. Find causes of deterioration of given buildings, and conduct the condition survey
2. Analyze structural requirements for repair and rehabilitation works for a given building, and design the same.
3. Execute rehabilitation and retrofitting works in practice.
4. Prepare contract documents for repairs and rehabilitation works in buildings.
5. Devise specifications for structural repair works.

Detailed Syllabus:

Unit -1:	**Durability of RC Buildings:** Causes of deterioration and durability aspects of RC buildings, Condition survey and non-destructive evaluation of buildings	**08Hrs**
Unit -2:	**Planning & Design for Restoration of RC Buildings:** Structural analysis and design for repairs, Selection of repair materials	**08Hrs**
Unit -3:	**Restoration Works:** Rehabilitation and retrofitting methods	**08Hrs**
Unit -4:	**Restoration Work Contracts:** Guidelines for framing terms and conditions for repair and rehabilitation work contracts	**08Hrs**
Unit -5:	**Specifications for Restoration Works:** Detailed specifications for structural/non-structural repair works	**08Hrs**

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Teacher's Assessment:

Teacher's Assessment of 10 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

References:

1. Handbook on Repair and Rehabilitation of RCC Buildings, Central Public Works Department, Government of India, Nirman Bhavan, New Delhi (2002)

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		H	L		M				M		L	
CO2		M	M		M		L	M				
CO3		H	H		M		H	L	L			
CO4		M			M	M	M	L	L	M	L	
CO5					M			M	L	M	L	L

H-High M – Medium L – Low

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AM 4043: PE V- Prestressed Concrete Design

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
Tutorial	--	Class Test-II	15 Marks
Total Credits	03	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: Students should have studied AM 2008- SRUCTURAL ANALYSIS and AM 3009-Design of RCC Structures.

Course Description: Prestressed concrete is widely used in many important structures due to its advantages over RCC like increased load carrying capacity, absence of cracks at service loads, economy etc. This course, therefore, introduces the students to the fundamentals of prestressed concrete, methods of prestressing and systems of prestressing. Students will be exposed to analysis of strength and behavior of prestressed concrete structures. The subject will deal with limit state of design of prestressed concrete structures like beams, axially loaded members, slabs, composite sections, liquid tanks, pipes, sleepers etc.

Course Outcomes:

After successful completion of the course, students will be able to

1. recognize type of prestressing and able to explain the mechanism of various prestressing systems and choose the proper system.
2. differentiate between behavior of PSC and RCC members and visualize the effect of prestressing on stress condition across the cross-section of the member.
3. analyze the stresses, evaluate the losses of prestress and determine the behavior of determinate and indeterminate prestressed concrete members.
4. determine ultimate flexural, shear, and torsional strength of PSC member.
5. design the PSC members using limit state concept (IS-1343) and apply to various members like beams, slabs, pipes, tanks, poles etc.

Detailed Syllabus:

Unit -1:	**Introduction to prestressed concrete:** Basic concepts of prestressing, Methods and system of prestressing, Analysis of section under flexure, Thrust line, Stresses at transfer and service loads, Cracking moment, Kern point, Loses of prestress, Codal provisions.	**7 Hrs**
Unit -2:	**Analysis and Design of Determinate Beams:**	**7 Hrs**

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	Analysis of ultimate strengths of rectangular and flanged beams, Design of rectangular and flanged beams for flexure, shear, torsion, and bond by limit state method, Design of end block.	
Unit -3:	**Analysis of Composite Beams (determinate); Analysis of Continuous Beams:** Analysis of propped and un-propped composite sections with precast PSC beams and cast-in-situ RC slab. Analysis of continuous beams (Two spans), primary and secondary moments stresses, cable profile, line of prestress, linear transformation of cables, concordant cables, Analysis of ultimate strength.	**7 Hrs**
Unit -4:	**Axially loaded member; Design of Prestressed Concrete Slabs:** Analysis and design of sections for axial tension, Design consideration for compression member; Design of one way and two way prestressed concrete slabs, spacing of cables, eccentricity of cables, serviceability requirements.	**7 Hrs**
Unit -5:	**Design of Tanks, Pipes, Pole, and Sleepers:** Analysis and design of pretressed concrete pipes, Analysis and design of circular tanks, Design considerations for prestressed concrete poles and railway sleepers.	**7 Hrs**

References:

1. Krishna Raju N., "Prestressed Concrete", Tata McGraw Hill Company, New Delhi, 2012.
2. Mallic S. K. and Gupta A. P., "Prestressed Concrete", Oxford and IBH publishing Co. Pvt. Ltd. 1997.
3. Dayaratnam P., "Prestressed Concrete", Oxford and IBH , 2013.
4. Rajagopalan N., "Prestressed Concrete", Alpha Science, 2002.
5. Ramaswamy G. S., "Modern Prestressed Concrete Design", Arnold Heinimen, New Delhi, 1990.
6. Lin T. Y., "Design of Prestressed Concrete Structures", Third Edition, Wiley India Pvt. Ltd., New Delhi, 2013
7. David A. Sheppard, William R. and Phillips, "Plant Cast Precast and Prestressed Concrete-A Design Guide", McGraw Hill, New Delhi, 1992.
8. IS 1343: 2012, Code of Practice for Prestressed Concrete, Bureau of Indian Standard, New Delhi, 2012.

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Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	H	H	M	M	H	M	L					
CO2	H	H	M	M	M	M	L					
CO3	H	H	M	M	M	M	L					
CO4	H	H	M	M	M	M	L					
CO5	H	H	M	M	M	M	L					

H – High M – Medium L – Low

Teacher's Assessment: Teachers Assessment of 10 marks may be based on one or more of the following

1. Technical quizzes.
2. Assignments-Numerical solution.
3. Punctuality.

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AM 4044: PE-V Earthquake Analysis and Design of Structures

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
Tutorial	0 Hrs/Week	Class Test-II	15 Marks
Total Credits	**3**	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: AM 3009 Design of RCC structures

Course Description: The course exposes the student to the fundamentals of earthquake resistant analysis and design as per the relevant codes. This is an important course to be taken-up by a student who wishes to make career in design and execution of Civil Engineering structures irrespective of the seismicity of a region as it is seen that 60% of the land mass of our country is prone to earthquakes of considerable intensity.

Course Outcomes: After successful completion of the course, students will be able to:

1. Recognise the causes of earthquakes and their quantification and associate to the effects on civil engineering structures.
2. Illustrate the applications of fundamentals of structural dynamics and associate them to earthquake loading.
3. Recognise the importance of earthquake response spectrum and design response spectrum and apply the theory for their construction.
4. Analyse structures for earthquake loads using code provisions.
5. Design RC structures for earthquake loads using code provisions.
6. Demonstrate the ability to use earthquake resistant features in masonry structures.

Detailed Syllabus:

Unit -1:	**Seismology** Structure of earth, Causes of earthquakes, Plate tectonic theory and continental drift theory, faults and their types, measurement of earthquakes, earthquake intensity and magnitude, seismic waves, recording instruments; review of damages during past earthquakes.	**Hrs**
Unit -2:	**Principles of dynamics and Response Spectrum theory** Dynamic loads, Single degree of freedom system, free and forced vibrations (Harmonic motion), Concept of time period and damping, Base motion, Duhamel's integral, strong motion, Characterization of ground motion, Strong motion, Concept of earthquake spectra, Tripartite spectra, Design Spectra.	**Hrs**
Unit -3:	**Analysis for earthquake loads**	**Hrs**

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	Earthquake resistant design philosophy, structural systems for resistance to lateral loads, planning & architectural provisions for earthquake resistance, provisions of IS:1893-2016, evaluation of lateral loads due to earthquakes using equivalent static loads, load combinations, determination of design forces	
Unit -4:	**Design for earthquake loads** Ductility of members and structures, types of failures in RC members, desired sequence of failure, strong-column-weak beam concept, provisions of IS:13920-2016, ductile design and detailing of RC members	**Hrs**
Unit -5:	**Earthquake resistant design of non-engineered buildings** Seismic behaviour of masonry load-bearing units, provisions for seismic resistance of masonry buildings, reinforced masonry, confined masonry, RC bands, timber structures, Provisions of IS:4326-2013.	**Hrs**

References:

Latest editions of the following

1. Duggal S.K., "Earthquake Resistant Design of Structures", Oxford University press
2. Hosur Vinod, "Earthquake Resistant Design of Building Structures", Wiley
3. Kramer Steven, "Geotechnical Earthquake Engineering", Pearson Education
4. Mario Paz, "Structural Dynamics", Springer
5. Dowrick D.J., "Earthquake Resistant Design for Engineers", Wiley
6. Ray W. Clough and Joseph Penziene, "Dynamics of Structures", Mc-Graw Hill, 3rd Edition, 1975.
7. Chopra A. K., "Dynamics of Structures: Theory and Applications to Earthquake Engineering", Pearson Education, 3rd Edition, 2007.
8. IS: 1893 (Part-I) -2016, "Criteria for earthquake resistant design of structures" Bureau of Indian Standards
9. IS:13920-2016, "Ductile Detailing of Reinforced Concrete Structures subjected to seismic forces-code of practice" Bureau of Indian Standards, New Delhi
10. IS: 4326-2013, "Earthquake resistant design and construction of buildings-code of practice", Bureau of Indian Standards, New Delhi

Approved in XVII[th] Academic Council, dated 10/01/2018

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	M	L	L									
CO2	H	H	H	M	L							
CO3	H	H	H		L							
CO4	H	H	H		H	M						
CO5	H	H	H		H	H		L				
CO6	H	H	H		H	H		L				

H-High M – Medium L – Low

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CE 4045: PE V-Water Resources System and Management

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
Tutorial		Class Test-II	15 Marks
Total Credits	**3**	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite: CE 3010: Water Resources Engineering

Course Description: This course introduces the water resource system and its economical analysis. The course provides detailed knowledge of various methods that are used for system analysis. You will also learn various irrigation techniques, its design aspects and performance of those techniques, selection and design of various water conservation structures.

Course Outcomes:

After successful completion of the course, students will be able to:

1. solve the optimization problem in water resources engineering
2. analyze the economics of water resources project
3. design micro irrigation system
4. design watershed structures

Detailed Syllabus:

Unit -1:	**Economics of Water Resources Systems:** General principles of system analysis, objectives of water resources system, economic analysis of water resources system, principles of engineering economy, depreciation, benefit cost evaluation, direct and indirect benefits, discounting techniques - present worth method, rate of return method, benefit cost ratio method, annual cost method	**6 Hrs**
Unit -2:	**Optimization Techniques** Methods of system analysis, Linear programming models, simplex method, graphical method, introductory concepts of dynamic programming, non-linear programming, stochastic programming, simulation	**6 Hrs**
Unit -3:	**Canal Irrigation Management** Management of canal irrigation, Need for canal irrigation management, inadequacies of canal irrigation management, objective and criteria of good canal irrigation management, methods of improving canal irrigation management, participatory irrigation management.	**6 Hrs**
Unit -4:	**Watershed Management** Watershed management, Conservation of land and water, necessity of	**6 Hrs**

	water shed development and management, funding sources, structures involved in watershed management, Area treatment, drainage line treatment, impact assessment	
Unit -5:	**Micro-irrigation** Sprinkler irrigation, types of sprinklers, layout of sprinkler irrigation system, design aspects of sprinkler irrigation system, Drip irrigation: types of drips, layout of drip irrigation system, design aspects of drip irrigation system	**6 Hrs**

References:

1. Loucks, D.P., Stedinger, J.R. and Haith, D.A., "Water Resources Systems Planning and Analysis", Prentice Hall Inc. New York
2. Chaturvedi, M.C., "Water Resources Systems Planning and Management", Tata McGraw Hill Pub. Co., New Delhi
3. Taha, H.A.,"Operations Research", Prentice Hall of India, New Delhi.
4. Gupta, B.L. and Gupta Amit, "Water Resources Systems and Management", Standard Publishers Distributors, New Delhi
5. Asawa, G.L., "Irrigation Engineering", New Age International Pub. Co., New Delhi.
6. Michael, B.A.M., "Irrigation", Vikas Publishing House Pvt. Ltd., New Delhi.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		H	H		H		L		M			
CO2		H	H			M	M		M			M
CO3		H	H		H		M		M			
CO4		H	H		H		M	M		M		

H – High M – Medium L – Low

Teacher's Assessment: Teachers Assessment of 10 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

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Council, dated 10/01/2018

CE 4046 : PE-V ENVIROMENTAL IMPACT ASSESSMENT

Teaching Scheme		Evaluation Scheme	
Theory	3 Hrs/Week	Class Test-I	15 Marks
Tutorial		Class Test-II	15 Marks
Total Credits	**3**	Teacher's Assessment	10 Marks
		End Semester Examination	60 Marks
		Total	100 Marks

Prerequisite:

CE3003 AND CE3006

Course description:

In this course, student will learn environment impact assessment, environment management plan and environmental audit.

Course Outcomes:

1. Students will learn about environment impact assessment
2. Students will learn environment management plan
3. Students will do environmental audit

Detail syllabus:

Unit -1:	General : Global and Indian Scenario. National Environmental Policy	**6 Hrs**
Unit -2:	Environmental Organizations for planning and implementation Sustainable Development	**6 Hrs**
Unit -3:	Preventive and reactive strategies for environmental pollution control. Environmental impact and risk assessment. Methodology : Adhoc, Checklist, Network, Matrix etc.	**6 Hrs**
Unit -4:	Environmental Management plan Typical Case Studies of Environmental Impact Assessment Environmental impact statements	**6 Hrs**
Unit -5:	Environmental Audit Environmental Legislation Air, Water and Environmental Acts.	**6 Hrs**

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REFERENCE :

1. A Rosencranz, S. Divan, M.I. Noble, Environmental Law and policy in India Cases, Materials and statutes, Tripathi Pvt. Ltd, Bombay.
2. S. Musharaf, Legal aspects of Environmental Pollution and its management, C.B.S. Publishers, Delhi 19932.
3. R. K. Jain, L.V. Urban, B. S. Staccy, H.E. Balkbach, Environmental Assessment, McGraw Hill Inc, NY.
4. Rao, J. G. and wooten, Environmental Impact Analysis, Handbook 1980.
5. Center, L.W. Environmental Impact Assessment, New York : McGraw Hill Book Company. 1977.

Table 1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO1 0	PO1 1	PO1 2
CO1		H	L		M				M		L	
CO2		M	M		M		L	M				
CO3		H	HM		M		H	L	L			
CO4		M			M	M	M	L	L	M	L	
CO5					M			M	L	M	L	L

Teacher's Assessment: Teachers Assessment of 10 marks may be based on one or more of the following

1. Technical quizzes
2. Application development
3. Question & answer / Numerical solution
4. Group discussion
5. Other if any

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AM 4037--: Lab PE IV – Design of Bridges

Teaching Scheme		Evaluation Scheme	
Practical	2 Hrs/Week	Tem Work	25 Marks
		Viva Voce	25 Marks
Total Credits	1	Total	50 Marks

Prerequisite:
This course should be studied alongwithAM4031: PE IV – Design of Bridges.

Course Description:
The students will get an opportunity in this course to plan, design and prepare drawings for various types of concrete bridges with professional approach of bridge designers.

Course Outcomes:
After successful completion of the course, students will be able to:

1. Plan component to component structural details of RCC and PSC highway bridges.
2. Analyze, design and detail different types of highway bridges using IRC provisions.
3. Draw detailed drawings of different types of highway bridges using IRC provisions.

Term Work:
The term-work shall consist of the following:

1. Mini project on design of RCC bridge
2. Mini project on design of PSC bridge

Practical/Viva Voce Examination:
The viva voce shall be based on the term work mentioned above.

References:

1. E.C Hambly, Bridge Deck Behaviour, E & FN SPON Publications.
2. V.K. Raina , Concrete Bridge Practice, Analysis, Design and Economics, Tata McGraw-Hills Publishing Company Limited.
3. M.J. Ryall, G.A.R Parke, J.E. Harding, The Manual of Bridge Engineering, Thomas Telford Publishers.
4. R. Rajagopalan, Bridge Superstructure, Tata McGraw- Hills Publishing Company Limited.
5. S. Ponnuswamy , Bridge Engineering, Tata McGraw – Hills Publishing Company Limited.
6. M. G. Aswanil, V.N.Vazirani, M.M. Ratwani , Design of Concrete Bridges, Khanna Publishers.
7. K. S. Rakshit, Design and Construction of Highway Bridges, New Central Book Agency (P) Ltd, Pune

8. D. Johnson Victor - Essentials of Bridge Engineering Fifth Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
9. T.R. Jagadeesh, M.A. Jayaram - Design of Bridge Structures, Prentice-Hall of India
10. N. Krishna Raju - Design of Bridges, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
11. David Lee – Bridge Bearings and Expansion Joints, E & FN Spon
12. Joseph E. Bowles – Foundation Analysis and Design, McGraw-Hill International Edition
13. Nainan P. Kurian – Design of Foundation Systems, Narosa Publishing House
14. Indian Road Congress codes IRC-6, 18, 21, 112
15. Indian Standard Codes (latest versions): 456-2000, 1893-2002, 1343-1993

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		H		H	M			H				
CO2	H	H	H	H	M	L		M	H		H	
CO3							H			H		M

H-High M – Medium L – Low

CE 4038: PE-IV -Lab Water Power Engineering

Scheme of Teaching		Scheme of Evaluation	
Practical/Seminar/Project/Dissertation/ etc.	02 -- Hrs/Week	Term Work	25 Marks
Total Credits	**01**	Practical Examination/Viva Voce	25 Marks
		Total Marks	50 Marks

Prerequisite: Not Required

Course Description:

Course Outcomes:

After successful completion of the course, students will be able to:

1. Experience the theoretical concepts through the experimentation
2. Calibrate the measuring devices and use the output for analysis and design.
3. Calculate flow characteristics for gradually varied flow and rapidly varied flow

Detailed Syllabus:

List of the experiments and field visits

1. Measurement of Velocity of flow using pitot tube, current meter.
2. Measurement of discharge through open channel using weirs.
3. Measurement of discharge through open channel using notches.
4. Measurement of discharge over spillway
5. Determination of efficiency of Hydraulic jump
6. Measurement of Sediment load.
7. Study of Turbines
8. Study of Pumps
9. Field visit report

Term Work:

The term work shall consist of the detailed report of the experiments conducted in the laboratory and the field visit report.

Practical Examination/Viva Voce Examination:

The practical /viva voceexamination shall be conducted by the panel of examiners consisting of internal and external examiner. The panel of examiners, as described above, shall evaluate the

understanding/knowledge of the student by asking appropriate questions/asking students to perform/demonstrate experiments, etc.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	H	H	H	H	H	H	H					
CO2	H	H	H	H	H	H						
CO3	H	H	H	H	M	M						

H-High M – Medium L – Low

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CE 4039: LAB-PE IV- INDUSTRIAL WASTE MANAGEMENT

Scheme of Teaching		Scheme of Evaluation	
Practical	02Hrs/Week	Term Work	25
Total Credits	01	Practical Examination/Viva Voce	25
		Total Marks	50

Prerequisite: Student should have studied course ' Environmental Studies' (HS 2001) and Environmental Engineering CE 3003

Course Description:

Industrial waste is the waste produced by industrial activity. This course deals with the pollution from major industries and methods of controlling and treatment the same. The student is expected to know about the pollution strength of waste from industries and methods of controlling the same.

Course Outcome: After successful completion of the course, students will be able to:

1. Explain and determine characteristics of different types of industrial wastewater and their environmental effects
2. Explain the principles of working of treatment units and design the same
3. Explain the flowcharts of process units and treatment plant for selected industries
4. Explain the rules and standards of discharge of industrial waste

Term Work:

Term work shall consist of assignments on-

1. Determination of wastewater characteristics of a industrial wastewater
2. Flow charts of process, wastewater sources and treatment units for different industries
3. Design of different treatment units
4. Rules and standards for disposal of industrial waste

Practical Examination/Viva Voce Examination:

The panel of examiner shall consist of course coordinator as an internal examiner and one faculty member appointed by the Controller of Examination as an external examiner. The panel of examiners, as described above, shall evaluate the understanding/knowledge of the student by asking appropriate questions/asking students to perform/demonstrate experiments, etc.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H					H	M	M	L	M		L
CO2	H			H		H	M	M		M		
CO3	H	H	M	M		M	H	M		M		M
CO4	H	H	H	M	M		M		M	M		

H – High M – Medium L – Low

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CE 4040: Laboratory – PE IV Infrastructure Development

Scheme of Teaching		Scheme of Evaluation	
Practical's	2Hours /Week	Term Work	25 Marks
Total Credits	02	Practical Exam /Viva Voce	25 Marks

Prerequisites – Not Applicable

Course Description – To conduct practical on materials and pavement to know the properties

Course Outcomes

After successful completion .students will be able to:

CO1	Demonstrate the experiments
CO2	Choose the appropriate tests on material and perform the practical.
CO3	Prepare the material Mix design for pavement materials

List of Experiments

Preform any six experiments.

Sr. No.	Details
1	Tests on Bitumen – Modulus of resilience , fatigue strength test on beam
2	Different Tests on steel ,pipes
3	Design of Runways
4	Design of rail track
5	Design of minor bridge
6	Bump Integrator Method for pavements
7	Laboratory and Field C.B.R. Methods and stiffness of soil mass determination
8	A report based on site visit to any Road or Bridge project during the academic term

Term Work – To write the journal based on conducting the practical's in the Laboratory and Field

Practical Examination/Viva Voce Examination

In case of Practical /Oral examination across the table , panel of examiners shall evaluate the understanding /knowledge of the students by asking appropriate questions /asking students to perform /demonstrate the experiments based on syllabus

Table 1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M		L									L
CO2		M	H		L							M
CO3		M	H									M
CO4			H			M						M

H-High M – Medium L - Low

CE 4041: Lab-PE I – Advanced Geotechnical Engineering

Scheme of Teaching		Scheme of Evaluation	
Practical	2 Hrs/Week	Term Work	25 marks
Total Credits	1	Practical Examination/Viva Voce	25 marks
		Total Marks	50 marks

Prerequisite: Knowledge of CE 3004 Geotechnical and Foundation Engineering

Course Description: Water is an important resource. This laboratory course deals with different aspects related to ground water potential, determination of aquifer parameters, interference among wells. It also deals conjunctive use, artificial recharge, and ground water modeling.

Course Outcomes:
After successful completion of the course, students will be able to:

1. Understand the problem solving and Load calculations for different types of foundations.
2. Evaluate Bearing capacity for different types of soils.
3. Carry out and interpret the results of field tests such as Standard Penetration Test, Plate bearing test.
4. Student will be able to understand real life Geotechnical problems with the help of site visits.

Detailed Syllabus:

List of the assignments (Complete any six)

Sr. No.	Details
1	Problems on Plate Load Test, Standard Penetration Test and corrections.
2	Preparation of Soil investigation report based on given data.
3	Problems on Bearing capacity calculations for different conditions.
4	Problems on Settlement analysis.
5	Problems on pile foundations.
6	Assignment on caissons and well foundation.
7	Assignment on under reamed pile.

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8	Demonstration of Plate load test.
9	Demonstration Standard penetration test.
10	Demonstration of Swelling pressure test

Term Work:

The term work shall consist of information based on exercises mentioned in the syllabus above.

Practical Examination/Viva Voce Examination:

A Record book consist of assignments would be submitted for the term-work.

Oral Examination would be based on the term-work and theory covered in the class under the subject CE 4033: Lab- PE IV- Advanced Geotechnical Engineering

References:

1. Wayne C. Teng, "Foundation Design" Prentice Hall of India, New Delhi.
2. J.E.Bowles, "Foundation analysis and design", McGraw Hill International editions.
3. Publications of Bureau of Indian Standards.

Table 1: Mapping of Course outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	H	H	H					L
CO2	H	H	H	H	H	H						M
CO3	H	H	H	H	M	M						M
CO4	H	H	H	H	M	M						M

1– High 2- Medium 3- Low

AM 4042: Lab PE IV – Building Maintenance and Repairs

Teaching Scheme		Evaluation Scheme	
Practical	2 Hrs/Week	Tem Work	25 Marks
		Viva Voce	25 Marks
Total Credits	1	Total	50 Marks

Prerequisite:

Students should have studied AM2007 Civil Engineering Materials, CE2009 Building Planning and Design, and AM4015 PE-II-Concrete Technology courses. This course should be studied alongwithAM4036: PE IV – Building Maintenance and Repairs

Course Description:

The reinforced concrete buildings are susceptible to deterioration due to various causes including environmental factors. The proper maintenance and repairs needed for such buildings is very important issue for the whole society. This course offers civil engineering students to learn various details related to this topic of concern for everyone.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Do systematic inspection of deteriorated buildings
2. Analyze of the deteriorated buildings
3. Plan and design specific types of repairing/retrofitting rehabilitation works

Term Work:

The term work shall consist of visual inspection reports, nondestructive evaluation report, and proposed scheme of repairs/retrofitting rehabilitation of any deteriorated building accompanied by professional working drawings containing all necessary notes useful for repairing team on site. These drawings could be drawn by hand or using any drafting software.

Practical/Viva Voce Examination:

The viva voce shall be based on the term work mentioned above.

References:

1. Handbook on Repair and Rehabilitation of RCC Buildings, Central Public Works Department, Government of India, NirmanBhavan, New Delhi (2002)

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		H		H	M			H				
CO2	H	H	H	H	M	L		M	H		H	
CO3							H			H		M

H-High M – Medium L – Low

AM 4047: Lab-PE V-Prestressed Concrete Design

Scheme of Teaching		Scheme of Evaluation	
Practical/Seminar/Project/Dissertation/ etc.	2 Hrs/Week	Term Work	25
Total Credits	1	Practical Examination/Viva Voce	25
		Total Marks	50

Prerequisite: Students should have opted for Elective AM 4043: Prestressed Concrete Design.

Course Description: This lab course is aimed to expose the students to analysis and design of Prestressed concrete rectangular and/or flanged beam, end blocks, Cylinder and non-cylinder pipes, circular tanks , one way/ two way slabs and prepare its report. The students will be made to prepare drawings showing detailing of prestressed concrete structures.

Course Outcomes:
After successful completion of the course, students will be able to:

1. analyze the stresses, behavior and ultimate strengths of PSC structures.
2. design PSC structures with use of relevant codes (IS:1343-2012).
3. detail the PSC structures on drawing sheets by using relevant codes.

Detailed Syllabus:
List of assignments and drawings.

A) Students should solve minimum five assignments on Analysis and/or Design examples with necessary figures/detailing as required based on the syllabus of AM 4043- Prestressed concrete Design.
B) Students should analyze , design and prepare drawings showing detailing of the PSC structures, of any four from the list below other than examples in **A**,
   1. Design of prestressed concrete rectangular beam and its detailed drawings.
   2. Design of prestressed concrete flanged beam (T/I sections) and its detailed drawing.
   3. Design of prestressed non-cylinder pipe and its detailed drawings.
   4. Design of prestressed cylinder pipe and its detailed drawings.
   5. Design of prestressed concrete circular tank and its detailed drawings.
   6. Design of one way and two way prestressed concrete slabs and its detailed drawings.

Term Work Assessment: Term work shall be assessed continuously based on syllabus and term work mentioned for 25 marks.

Approved in XVIIth Academic Council, dated 10/01/2018

Practical Examination/Viva Voce Examination:

Viva-voce: Viva-voce examination shall be conducted externally based on the syllabus and Term work mentioned for 25 marks.

References:

1. Krishna Raju N., "Prestressed Concrete", Tata McGraw Hill Company, New Delhi, 2012.
2. Mallic S. K. and Gupta A. P., "Prestressed Concrete", Oxford and IBH publishing Co. Pvt. Ltd. 1997.
3. Dayaratnam P., "Prestressed Concrete", Oxford and IBH , 2013.
4. Rajagopalan N., "Prestressed Concrete", Alpha Science, 2002.
5. Ramaswamy G. S., "Modern Prestressed Concrete Design", Arnold Heinimen, New Delhi, 1990.
6. Lin T. Y., "Design of Prestressed Concrete Structures", Third Edition, Wiley India Pvt. Ltd., New Delhi, 2013
7. David A. Sheppard, William R. and Phillips, "Plant Cast Precast and Prestressed Concrete-A Design Guide", McGraw Hill, New Delhi, 1992.
8. IS 1343: 2012, Code of Practice for Prestressed Concrete, Bureau of Indian Standard, New Delhi, 2012.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	H	H	M	M	M	H	M					
CO2	H	H	M	M	M	H	M					
CO3	H	H	L	L	L	H	L					

H – High M – Medium L – Low

Approved in XVIIth Academic Council, dated 10/01/2018

AM 4048 : Lab PE-V: Lab Earthquake Analysis and Design of Structures

Scheme of Teaching		Scheme of Evaluation	
Practical/Seminar/Project/Dissertation/ etc.	2 Hrs/Week	Term Work	25
Total Credits	**1**	Practical Examination/Viva Voce	25
		Total Marks	50

Prerequisite: In conjunction with theory course AM 4032: Earthquake Analysis and Design of Structures

Course Description: This is a Lab course in support to the theory course AM 4032: Earthquake Analysis and Design of Structures

Course Outcomes: (Minimum 3)
After successful completion of the course, students will be able to:

1. Determine dynamic properties of SDOF systems
2. Analyse multi-storeyed buildings subjected to earthquake loading
3. Incorporate ductile detailing provisions in design of RC members
4. Identify the incorporation of ductility provisions on site.

Detailed Syllabus:
Part-A - Assignments and experiments

1. Determination of natural time period and damping of a single storey model using shake table
2. Numerical assignments on dynamics of SDOF systems
3. Field visit to observe the ductile detailing of RC elements of a under-construction building

Part-B - Course Project

1. Analysis and design of a RC framed building subject to earthquake loading using IS: 1893 and IS: 13920

Term Work:
The term work shall consist of a comprehensive journal consisting of assignments, experiments and course project as detailed under the syllabus above.

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Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	M	H	M	H								
CO2	H	H	M	M	H							
CO3	M	H	H	M	M	M		M				
CO4	M	M	H	H	H	H		H	M	M	L	

H-High M – Medium L – Low

Approved in XVII[th] Academic Council, dated 10/01/2018

CE 4049: Lab-PE V- Water Resources System and Management

Scheme of Teaching		Scheme of Evaluation	
Practical/Seminar/Project/Dissertation/ etc.	2 Hrs/Week	Term Work	25
Total Credits	1	Practical Examination/Viva Voce	25
		Total Marks	50

Prerequisite: Not Applicable

Course Outcomes:
After successful completion of the course, students will be able to:

1. Identify and solve optimization problems
2. Understand canal irrigation management and economics
3. Understand the procedure and requirement for design of irrigation systems
4. Understand design of various water conservation structure and its implementation

List of the experiments

1. Solve optimization problem by using Simplex method and Graphical Linear programming
2. Solution to the water resources projects for Benefit cost evaluation and discounting techniques
3. Current status of participatory irrigation management and pipe irrigation system
4. Design of water conservation structures
5. Design of soil conservation structures
6. Design of sprinkler irrigation system
7. Design of drip irrigation system
8. Implementation and impact of watershed management at local level / Explanatory note on 'Jal Yukt ShivaarYojna'

Term Work:
The term work shall consist of solution of design problems given in the laboratory course

Practical Examination/Viva Voce Examination:
The panel of examiners shall evaluate the understanding/knowledge of the student by asking appropriate questions/asking students to solve some of the parameters, if required, etc.

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Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		H	H		H		L		M			
CO2		H	H			M	M		M			M
CO3		H	H		H		M		M			
CO4		H	H		H		M	M		M		

H-High M – Medium L – Low

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CE-4050 Lab: PE V-Environmental Impact Assessment

Scheme of Teaching		Scheme of Evaluation	
Practical/Seminar/Project/Dissertation/ etc.	2 Hrs/Week	Term Work	25 Marks
Total Credits	1	Practical Examination/Viva Voce	25 Marks
		Total Marks	50 Marks

Prerequisite: " Not Applicable"

Course Description:

In this course, student will learn environment impact assessment, environment management plan and environmental audit.

Detailed Syllabus:

1. Delphi technique for assigning significance to Environmental Attributes
2. Adhoc Method of EIA
3. Matrices Method of EIA
4. Network Method of EIA
5. Overlays Method of EIA
6. Visit to a Project site/ Office of EIA expert
7. Collection data of Environmental attributes of project ongoing near by
8. A report of EIA is to be prepared by a student on the project of his specialization

Term Work:

The term work shall consist of detail report of environment impact assessment of industry/township.

Practical Examination/Viva Voce Examination:

The panel of examiner shall consist of course coordinator as an internal examiner and one external examiner appointed by the Head of the Department. Panel of examiners, as described above, shall evaluate the understanding/knowledge of the student by asking appropriate questions/asking students to perform/demonstrate experiments, etc. The practical examination shall consist of viva-voce based on following experiment sand their applications.

Table 1: Mapping of Course Outcome with Program Outcomes

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M			H	H				L	L	L	
CO2	M	L		S	H	M			M	L	L	
CO3	H	M	M	H	H	H			M	M	L	
CO4	H	H	H	M	M	M			H	M	M	

H-High M – Medium L – Low

Approved in XVII th Academic Council, dated 10/01/2018