Semester VIII

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CE-C801	Design and Drawing of Reinforced Concrete Structures	4	2	--	4	1	--	5
CE-C802	Construction Engineering	4	2	--	4	1	--	5
CE-C803	Construction Management	4	2	--	4	1	--	5
CE-E804	Elective – II	4	2	--	4	1	--	5
CE-P805	Project – Part II	--	8	--	--	4	--	4
Total		**16**	**16**	**--**	**16**	**8**	**--**	**24**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CE-C801	Design and Drawing of Reinforced Concrete Structures	20	20	20	80	4	25	--	25	150
CE-C802	Construction Engineering	20	20	20	80	3	25	--	25	150
CE-C803	Construction Management	20	20	20	80	3	25	--	25	150
CE-E804	Elective – II	20	20	20	80	3	25	--	25	150
CE-P805	Project – Part II	--	--	--	--	--	50	--	50#	100
Total		**80**	**80**	**80**	**320**		**150**	**--**	**150**	**700**

 # Presentation on Project and Oral (Internal and External)

N.B.: Guidelines for Project, i.e., Dissertation (Part-I& II)

(i) Students can form groups with minimum of 2 (Two) and not more than 4 (Four)

(ii) Faculty load: In Semester VII – 1 (One) period of 1 hour per week per project group.

(iii) In Semester VIII- 2 (Two) periods of 1 hour each per week per project group.

(iv) Each faculty member shall be permitted to guide maximum 4 (Four) project groups.

University of Mumbai

Fourth Year Civil Engineering

List of Electives

Semester VII (Theory: 4, Practical: 2)

1. Advanced Surveying
2. Rock Mechanics
3. Applied Hydrology Flood Control
4. Solid Waste Management
5. Systems Approach in Civil Engineering
6. Risk Value Management
7. Advanced Structural Analysis
8. Structural Dynamics
9. Advanced Structural Mechanics
10. Advanced Foundation Engineering
11. Ground Water Hydrology
12. Pavement Subgrade Materials
13. Air Pollution
14. Prestressed Concrete
15. Traffic Engineering Control
16. Reinforced Concrete Repairs Maintenance
17. Advanced Computational Techniques

Semester VIII (Theory: 4, Practical: 2)

1. Advanced Construction Engineering
2. Advanced Engineering Geology
3. Geographical Information Systems
4. Water Resources Engineering Management
5. Bridge Design Engineering
6. Environmental Impact Assessment Audit
7. Appraisal Implementation of Infrastructure Projects
8. Disaster Management
9. Pavement Design and Construction
10. Advanced Design of Steel Structures
11. Earthquake Engineering
12. Soil Dynamics
13. Building Services
14. Design of Hydraulic Structures
15. Industrial Waste Treatment
16. Transportation Planning Economics
17. Advanced Repairs and Rehabilitation of Structures
18. Geosynthetics and Reinforced Structures

Semester VIII

Subject Code	Subject Name	Credits
CE-C801	Design and Drawing of Reinforced Concrete Structures	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	04	25	--	25	150

Rationale

Different civil engineering structures such as residential and industrial buildings resting on different types of foundation depending upon the sub-soil conditions and constraints at the site if any. The water tanks and retaining walls are to be planned and designed by the civil engineers. This subject helps the students to enable them to design these systems by resorting to the available concept of the RCC.

Objectives

1. To understand the complete analysis and design of residential and industrial buildings using relevant IS codes.
2. To understand the complete analysis and design of different types of retaining walls.

3. To understand the complete analysis and design of different types of water tanks using relevant IS codes by working stress method.
4. To develop the students well versed with concepts of civil engineering techniques and ability to use it in practice.

Detailed Syllabus

Module	Sub- Modules/ Contents	Periods
I.	**Design of Foundations:** Design of simple raft subjected to symmetrical loading using limit state method.	09
II.	**Design of Staircases:** Design of dog legged andopen well type staircase using limit state method.	08
III.	**Comprehensive Design of the Building:** Complete design of residential, commercial or Industrial building includingstaircase and foundations using limit state method; Introduction to ductile design and detailing ofstructures.	12
IV.	**Design of Retaining Walls:** Design of cantilever andcounter fort type retaining wall using limit state method.	09
V.	**Design of Water Tanks:** Circular and rectangular, at ground level, underground and overhead water tank both by IS coefficient and - approximate methods, includingsupporting structure for overhead water tanks using working stress method.	14

Note: Relevant and latest IS codes of practice shall be followed for all the topics.

Contribution to Outcomes

On successful completion of the course:

1. The student shall be able to independently or as a member of the team design the structures using structural analysis and design knowledge for safety, serviceability and economy.
2. The student shall be able to design different types of water tank, retaining wall by limit state method.
3. The student shall be able to design a residential and industrial buildings by relevant IS code.

Theory Examination:-

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:

The oral examination accompanied by sketching will be based on entire syllabus and the term work.

Term Work:

The term work shall consist of a neatly written Design Report including detailed drawings on the following topics:

1. Design report of (G+3) industrial or residential building using relevant IS codes.
2. Design report of counter fort retaining wall.

3. Design report of rectangular or circular underground water tank or overhead water tank using relevant IS codes by working stress method.

Design report and at least four A-1 (Full imperial) size drawings sheets for above three projects shall be submitted as term work. All drawing work is to be done in pencil only. Design of building project will be done using design aids and anyone of available softwaressuch as STAAD-Pro and ETABS, etc.

Distribution of Term Work Marks:

The marks of term-work shall be judiciously awarded depending upon its quality. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments, properly compiled design report; and the minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

1. Design report: 20 Marks
2. Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Limit State Theory for Reinforced Concrete Design: *Huges B. P*., Pitman
2. Limit State Design - Reinforced Concrete: *Jain A. K*., New Chand, India
3. Reinforced Concrete: *Warener R. F., Rangan B.C.* and *Hall A. S.*
4. Illustrated Design of G+3 Building: *Shah and Karve*, Structures Publishers.
5. Reinforced Concrete: *S. N. Sinha*, TMH, New Delhi
6. Reinforced Concrete: *H. J. Shah*, Charotar Publisher
7. Relevant I.S. codes and Design Aids, BIS Publications.
8. Reinforced Concrete Fundamentals: *Ferguson P.M., Breen J.E.*, and *Jirsa J.O.*, 5th Edition,John Wiley and Sons, 1988.
9. Illustrated Reinforced Concrete Design: *Dr. V.L. Shah* and *Dr. S.R. Karve*, Structures Publishers.

10. Earthquake Resistant Design of Structures- *S.K.Duggal*, Oxford University Press, New Delhi
11. Earthquake Resistant Design of Structures –*PankajAgrawaland Manish Shrikhande*, PHI Learning Pvt. Ltd.

Semester VIII

Subject Code	Subject Name	Credits
CE-C802	Construction Engineering	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

Proper planning, selection, procurement, installation, operation, maintenance and equipment replacement policy plays an important role in the equipment management for a successful completion of project. With the growing use of machinery it has become necessary for construction engineer to be thoroughly familiar with the working application and upkeep of the wide range of modern equipment. Since the modern construction projects require a huge amount of capital, one has to adopt latest technology, modern equipment and modern management techniques to achieve economy, quality and quick result. The course covers the full range of principal construction equipment, latest technology and other allied aspects of the construction.

Objectives

- To study the different types of standard / special equipment used in the construction industry.

- To learn the different sources of equipment, economic life and depreciation cost of equipment.
- To determine owning and operating costs, evaluate maintenance and repair costs.
- To study the various equipment related to earthmoving, drilling and blasting, pile driving, pumping, stone crushing, air compressors, equipment for moving materials etc.
- To understand the complex processes involved in the construction of tunnels.
- To learn various soil stabilization techniques such as sand drains and stone columns, use of geotextiles and chemicals, diaphragm wall, rock anchors, foundation grouting, etc.
- To understand the concept of mass concreting, vacuum concreting and modern slip forms.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I	**Construction equipment:** **1.1** Standard types of equipment, special equipment, cost of owning and operating equipment, depreciation costs, investment and operating costs, economic life, sources of construction equipment, factors affecting selection of construction equipment, balancing of equipment.	05
	1.2 Study of equipments with reference to available types and their capacities, operations and factors affecting their performance:	
	1.2.1 Earthmoving equipment: tractors and attachments, dozers and rippers, scrapers, shovels, draglines, trenching machines, clamshell, hoes, trucks and wagons, dumpers, dozers, trenching machines, rollers and compactors	05
	1.2.2 Drilling and blasting equipment: bits, jackhammers, drifters, drills, blasting material, firing charge, safety fuse, electric blasting caps, drilling patterns, transporting and handling of explosives	05
	1.2.4 Pile driving equipment: types, pile driving hammers: single acting anddouble acting, differential acting hammers, hydraulic and	05

	diesel hammers, vibratory pile drivers	
	1.2.5 Pumpingequipment:reciprocating, diaphragm andcentrifugalpumps,wellpoint system	02
	1.2.6 Stone crushing equipment: jaw, gyratory and cone crushers, hammer mills, roll crushers, rod and ball crushers, aggregate screens and screening plants, portable plants	04
	1.2.7 Air compressor	02
	1.2.8 Equipment for moving materials: builder's hoists, forklifts, cranes, belt-conveyors, cableways, ropeways	02
II	**Tunneling:** Selection of alignment, methods of tunneling in soft soils and in hard rock,sequence of operations for drilling and blasting method, mechanical moles, boomers, tunnel boring machines, mucking, ventilation of tunnels, dust control, types of tunnel supports, sequence of lining operation, lining with pneumatic placers and by pumpcretemethodsize, sampling distributions: t, F and ȥ ²distributions.	10
III	**Soil stabilization techniques:** sand drains, stone columns use ofgeotextilesand chemicals, diaphragm wall, rock anchors,foundation grouting	05
IV	**Concrete:** massconcreting, vacuumconcrete, forms for concrete construction: slip forms, collapsible forms, forms for cantilevers	05
V	**Different types of cladding:** fixing and maintenance arrangements	02

Contribution to Outcomes

At the end of this course, the students will be able:

- To know the different types of standard / special equipment used in the construction industry and select the appropriate equipment.
- To determine the optimal use of the equipment, owning, operating and maintenance and repair costs of the equipment.
- To decide judiciously whether the equipment should be purchased or hired, repaired or sold.

- To select the alignment for tunnels, various methods of tunneling in soft soils as well as in hard rock, sequence of operations to be followed along with the various tunneling machines.
- To decide the ground improvement and soil stabilization methods such as sand drains and stone columns, use of geo-synthetics and chemicals based on the suitability of the site conditions.
- To suggest mass concreting, vacuum concreting and modern slip forms techniques.

Theory Examination:-

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt any **three** questions out of remaining five questions. Total **four** questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work.

Term Work:

The term work shall comprise of the neatly written report based on assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and/or questions on each modules or sub-modules and contents thereof further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on assignments. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments; and the minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Construction Equipment and Planning: *Purifoy, R. L., and Ledbetter,* McGraw Hill
2. USBR, Earth Manual
3. USBR, Concrete Manual
4. Handbook of Heavy Construction: *O'Brien, Havers and Stubb*, McGraw Hill
5. Foundation Analysis and Design: *Bowels, J. E*., Mc Graw Hill Publications
6. Construction Engineering and Management: *Seetharaman, S., Umesh,* S Chand Publications, New Delhi
7. Concrete Technology: *Shetty, M. S*., Khanna Publishers
8. Construction Equipment and its Management: *Sharma, S. C*., Khanna Publishers

Semester VIII

Subject Code	Subject Name	Credits
CE-C803	Construction Management	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	-	25	150

Rationale

This course is intended to teach students the management skills to be applied during all the stages of any civil engineering project. The professional construction engineering practice will be rendered meaningless if the service is not offered with a scientific approach and managerial practices. This course deals with the techniques to be applied for scheduling projects, optimizing time-cost and other resources in construction, monitoring and ensuring quality and safety aspects in projects.

Objectives

- To understand the basic principles and functions of construction management.
- To learn scheduling techniques such as CPM and PERT.
- To gain the knowledge of time-cost optimization and effective utilization of resources on construction sites.

- To understand allocating the resources and project monitoring.
- To know about safety and quality aspect of construction works.

Detail Syllabus

Module	Sub- Modules/Contents	Periods
I	**Introduction to Construction Management:** 1.1 Concept of Management, Principles of management, contribution by eminent personalities towards growth of management thoughts. 1.2 Significance of construction, management, objectives and functions of construction management 1.3 Resources required for construction.	04
II	**Construction Projects:** 2.1 Unique features of construction industry. 2.2 Construction projects- classification, characteristics life cycle concept of project etc. 2.3 Roles and responsibilities of various agencies associated with a Construction project. 2.4 Pre-requisites of commencing construction work sanctions, approvals to be sought, and feasibility studies. 2.5 Site layout, organizing and mobilizing the site	05
III	**Construction Project Planning and Scheduling:** 3.1Stages of planning in the view of owner/Department as well as contractor. 3.2 W.B.S, Bar Charts. 3.3Network-Terminology, Network Rules, Fulkerson's rule, skip numbering, Precedence network etc. 3.4 C.P.M - Activity and event with their types, activity times, event times, critical path, forward pass, backward pass, float and its types. 3.5 P.E.R.T- Assumption underlying PERT analysis time estimates, slack and its types, probability of completing the project etc.	14

IV	**Resources Management and Allocation :** 4.1 Material Management- Importance, objectives, functions of material management, inventory control, A-B-C analysis, E.O.Q etc. 4.2 Human Resource Management- Manpower planning, recruitment, Selection training, performance evaluation of worker etc. 4.3 Financial Management- accounting and Accounting principles, source of finance, cash flows associated with project, time value of money, economic appraisal criterias for project. 4.4 Resources Allocation Methods- Resource leveling resource smoothening. 4.5 Introduction to project Management MS Project and PRIMAVERA	12
V	**Project Monitoring and Cost Control :** 5.1 Supervision, record keeping, Periodic progress reports etc. 5.2 Updating- Purpose of frequency of updating method of updating a network etc. 5.3 Time cost optimization in construction projects compression and decompression of network etc. 5.4 Common causes of time over run and cost overrun and Corrective measures.	05
VI	**Safety and Health on Construction Sites** 6.1 Common causes of accidents on construction sites, costs of accident, precautionary measures to avoid accidents, 6.2 Occupational health hazards in construction industry. 6.3 Safety and Health Campaign. 6.4 O.S.H.A	04
VII	**Quality Control :** 7.1 Concept of Quality, quality control check list in quality control etc. 7.2 Role of inspection in quality control, 7.3 Quality manual, Quality assurance statistical quality control 7.4 ISO 14000	04
VIII	**Construction Labors and Legislation :** 8.1 Need for legislation 8.2 Acts applicable to Indian construction labours such as payment of wages act, min wages act, workmen's compensation act, factories act etc.	04

Contribution to Outcomes

On successful completion of the course:

- The students will be able to understand and apply the knowledge of management functions like planning, scheduling, executing and controlling to construction projects.
- The students will be able to demonstrate their capability for preparing the project networks to work out best possible time for completing the project.
- The students will be able to understand and exercise the time- cost relationship in practices.
- The students will be able to implement the safety as well as quality aspects during the execution of civil engineering project.
- The course will inculcate the managerial skills among the students which will be helpful for them in future during actual execution of projects.

Theory examination:

1. The question paper will comprise of **six** questions, each carrying 20 marks.
2. The **first** question will be **compulsory** and will have short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the syllabus. For this, the modules shall be divided equally and further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-modules and contents thereof.
4. The student will have to attempt **any three** questions out of remaining five questions. Total **four** questions need to be solved.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work.

Term work:

The term-work shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and/ or questions on each modules/ sub-modules and contents thereof, further. In

addition to this, the students will carry out the mini project based on the application of softwareslike MSP/ PRIMAVERA. This project will form a part of the term work.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on assignments. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments;and the minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended books:

1. Construction Engineering and Management: *Seetaraman, S.*
2. Construction Planning andManagement – *Dr. Shrivastava, U. K.*
3. Professional Construction Management: *Barrie, D.S.*and *Paulson, B. C.*, McGraw Hill
4. Construction Project Management: *Chitkara, K. K.*, Tata McGraw Hill
5. Handbook of Construction Management: *Joy, P. K.*, Macmillan, India
6. Critical Path Methods in Construction Practice: *Antill, J. M. and Woodhead, R. W.*, Wiley
7. Construction Hazard and Safety Handbook: *King and Hudson*,Butterworths

Semester VIII

Subject Code	Subject Name	Credits
CE-E804	Elective – II: Advanced Construction Engineering	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

Engineering constructions have grown to become highly sophisticated and organized in nature and involves safety concerns, quality measures and use of modern equipment and materials. This course provides an extensive overview of materials and equipment used in construction industry and methods used to construct facilities with these materials. The construction of large engineering projects including major activities such as excavation, concreting, steel fabrication and erection are also discussed in this course. This course also incorporates the process and theory of pre-fabrication and steel construction are also explained in detail.

Objectives

- To understand the characteristics and complexities involved in large engineering projects.

- To study the excavation methods in various types of soils including selection of equipment, safety measures and drainage.
- To study the pre-fabrication process involved in various construction techniques.
- To gain knowledge regarding selection of appropriate equipment and techniques in construction for large and heavy engineering projects.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	Large and heavy engineering projects: Characteristics and complexities, methods statement for major activities like excavation, concreting, steel fabrication and erection for projects like earthen dams, hydropower projects, nuclear power plant, refineries and other industrial projects etc.	06
II.	Excavation for heavy engineering projects: Excavation in various types of soils, selection of equipment, safety measures in excavation, drainage in excavation	06
III.	Concrete construction for heavy engineering projects: Selection of equipment for batching, mixing, transporting, placing andcompacting for various types of jobs, safety measures during concreting, Special concretes and mortars: preplaced aggregate concrete, roller compacted concrete, grouting	06
IV.	Prefabricated construction: Planning for pre-casting, selection of equipment for fabrication, transport and erection, quality measures, safety measures during erection	06
V.	Steel construction: Planning for field operations, selection of equipment and erection tools, tools and methods of welding, tools and methods of cutting and joining, bridge erection, quality measures, safety measures during fabrication and erection	06
VI.	Specific issues related to planning, site layouts, equipment selection and pre-project activities for large size construction projects like	06

	earthen dams, concrete dams, thermal power stations, nuclear power stations, light houses, airports and ports, bridges	
VII.	Information related to special equipment and their applications to Off-shore construction, underground utility construction	06
VIII.	New materials and equipment for construction	05
IX.	Case studies of heavy construction projects	05

Contribution to Outcomes

On successful completion of this course, students shall be able to:

- Understand the importance of quality and safety measures involved during fabrication process and erection of steel structures.
- Select new materials and equipment appropriate for the respective construction procedure.
- Undertake procedure related to large engineering projects including excavation, concreting, steel fabrication and erection.
- Gain knowledge in the field of special equipment used for off-shore construction.

Theory Examination:-

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:-

The oral examination shall be based upon the entire syllabus and the term work.

Term work:

The term work shall comprise of the neatly written report based on assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and/or questions on each modules/ sub-modules and contents thereof, further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon its quality. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments; and the minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Handbook of Heavy Construction: *Stubbs*, McGraw Hill Publications, New York
2. Construction Equipments: *Jagdish Lal*.
3. Erection of Steel Structures: *Thomas baron*
4. Journals of Civil Engineering and Construction Engineering of Various Publishers.

Semester -VIII

Subject Code	Subject Name	Credits
CE-E804	Elective-II: Advanced Engineering Geology	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

This subject gives the information about Deccan Trap Basalts. It is most useful in Civil Engineering field with regard to the construction point of view of dams, tunnels and bridges. It also helps in understanding the formation of various types of soil and factors that affect the characteristics of soil.It also gives the ideas about indirect geological investigation with regard to foundation point of view.

Objectives

1. To study the various methods of geological investigation in engineering field.
2. To study the types of basalt and various factors affecting strength and water tightness of basalt.
3. To study the significance of the features such as gas cavities, joints, dykes, fractures, etc. in civil engineering projects.

4. To study physical properties of the basalt such as compressive strength, water absorption, etc. and weathering effects on the rock masses and suitable treatment for such rock masses from foundation point of view of dam.
5. To study the foundation levels/ cut off levels for dam, application of grouting with height of dams; and foundation treatment for fractures having different rocks.
6. To study the different types of tunnels passing through different types of basalt.
7. To study the difficulties intruded by volcanic breccia, tuff, intertrapean beds, etc.
8. To study the protective measures such as guniting, rock bolting, shotcreting, steel fibre shotcreting.
9. To study the bridge foundation.
10. To study the different types of soil and influence of climate in the deccan trap areas.
11. To study the use of compact and amygdaloidal basalt as a construction material.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	**Introduction:** Importance of geological studies in engineering investigations, precautions to avoid misleading conclusions likely to be drawn while interpreting drilling data with particular reference to RQD, case histories illustrating economics made possible by proper geological studies.	04
II.	**Engineering Geology of Deccan trap basalts:** Factors affecting strength and water tightness, stability of cuts and ability to stand without support, significance of features like gas cavities, jointing, weathering, hydrothermal alteration, volcanic breccia, techylytes, dykes, fractures, field structures of flows, stratigraphic sequence of flows etc. and their significance in civil engineering projects.	07
III.	**Dams:** Strength and water tightness of Deccan trap rocks from foundation point of view, physical properties such as compressive strength, water absorption etc. of basalts, effect of weathering and hydrothermal	11

	alteration on engineering properties of rocks, deterioration of rock masses on exposure to atmosphere and suitable treatment for such rocks. Investigations for determining the foundation treatment for adverse geological features, determination of foundation levels/cutoff levels for dams, groutability of rocks, correction of adverse feature by grouting, purpose of consolidated and curtain grouting, determining depth and zones of grouting, relation of zones of grouting with height of dams, foundation treatment for fractures having different manifestations, jointed rocks, techylytes and dykes. Erosion of tail channel as a factor in selecting site for spillway causes of rapid erosion from side spillways, geological conditions leading to erosion. Case histories.	
IV.	**Tunneling:** Methodologies of investigations for different types of tunnels for different purposes, location spacing ,angles and depths of drill holes for different types of tunnels, difference in behavior of basalts because of jointing as exemplified by compact basalts and amygdaloidal basalts. Difficulties introduced by techylytes, volcanic bracias, tuffs, intertrappean beds, fractures, dykes, hydrothermal alteration, flow contacts unfavorable field characters. Computing structural discontinuities in rock masses, RQD, joint frequency index. RMR values, Q system, standup time. Selection and provision of protective measures such as guniting, rock bolting, shotcreting, steel supports depending on geological conditions. Suitability of TBM for tunneling. Case histories.	09
V.	**Bridges:** Investigations for bridge foundations, computing SBC for bridge foundation based on nature and structure of rock, foundation settlements. Case histories.	05

VI.	**Geology of soil formation:** Residual and transported soils. Rock weathering conditions favorable for decomposition and disintegration, influence of climate on residual and transported soils in the Deccan trap area. Nature of alluvium of Deccan trap rivers and its engineering character. Effect of deposition of calcium carbonate, Scarcity of sand in the rivers in Deccan trap area.	06
VII.	**Geophysical Investigations:** Seismic and electrical resistivity methods of explorations.	05
VIII.	**Construction Material:** Deccan trap basalts as construction Material. Use of compact basalt and amygdaloidal basalt as Rubble for masonry metal for concrete making.	05

Contribution to Outcomes

On completion of the course, the student shall be able to:

1. Understand various methods of direct and indirect geological investigation which are important in civil engineering field.
2. Recognize various types of basalt and significance of geological structures of basalts like gas cavities, joints, etc.
3. Understand the treatment of rocks show secondary geological structures like joints, fractures, etc.
4. Understand foundation level/ cut off level of dam.
5. Recommend suitable basalt for tunneling and understand difficulties intruded by volcanic breccia, tuff and intertrapean beds.
6. Apply preventive measures for dam and tunnels.
7. Understand the bridge foundation.
8. Understand the formation of soil and use of basalts.

Theory Examination:-

1. Question paper will comprise of **six** questions; each carrying 20 marks.

2. The **first** question will be **compulsory**whichwill have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:

The oral examination shall be based upon the entire syllabus and the term work.

List of Practical:

- Logging of drill core, preparation of logs and interpreting drilling data, calculation of RQD and joint frequency index.
- Preparing geological cross section from drill hole data and using them for designing of civil engineering structures.
- Use of electrical resistivity method for determining depth of bed rock.
- Study of geological aspects of an engineering projects and writing a report based on studies carried out during visits to civil engineering projects.

Term Work:

The term-work shall comprise of the neatly written report of the practicals and assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems and/or questions on each modules/ sub-modules and contents thereof, further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report and the assignments. The final certification and the

acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments;and further minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments: 12 Marks
- Practical: 08 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.
75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. PWD handbook, Engineering Geology, Government of Maharashtra.
2. Textbook of Engineering Geology, *R. B. Gupte*, PVG Prakashan.
3. Geology of India, *D. H. Wadia.*
4. Geology of India and Burma, *M. S. Krishnan*.
5. Textbook of Engineering geology, *N., Chenna, Kesavulu.*
6. Geology for Civil Engineering*: A. C. McLean, C. D. Gribble, George Aleen and Unwin* London.
7. Textbook of Engineering Geology*: P. K. Mukerjee,* Asia.

Semester VIII

Subject Code	Subject Name	Credits
CE-E804	Elective-II: Geographical Information System	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

GIS is a core subject which provides power of mapping to civil engineers. GIS lets us visualize, question, analyze and interpret date to understand relationships, patterns and trends. In this subject, the students get acquainted with the detailed study of GIS. Data models of spatial and non-spatial information are also explained. An overview on digitizing, editing and structuring of map data is also provided for error detection, correction and appropriate topology creation. Digital Elevation Models (DEM) and their needs are also incorporated along with the applications of Remote Sensing and GIS.

Objectives

- To Install GIS software and getting familiar with its user interface.
- To digitize, edit and structure map data.
- To represent spatial data model.
- To view data.
- To label the features.

- To use geo-processing tools.
- To enable data conversion.
- To import and export data.
- To apply the techniques of remote sensing and GIS for forest resource Management, Agriculture and Soil Management, Water Resource Management and Disaster Management.

Detailed Syllabus

Module	Contents	Periods
I.	IntroductiontoGIS:Definition,sourcesofdata,typesofdata,conceptof spaceandtimeinGIS,spatialinformationtheory,historyofGIS,elements ofGIS,objectivesofGIS,hardwareandsoftwarerequirementsofGIS, applicationofGIS	09
II.	Datamodelsofspatialinformation:Layersandcoverage,conceptualmodel s ofspatialinformation,representationofspatialdatamodelsincomputer: rasterandvectormodels,comparativeoverviewbetweenrasterandvector models	11
III.	Datamodelsofnon-spatialinformation:Databasemanagementsystems, hierarchical structure, networkstructure,relationalstructure	07
IV.	Digitizing,EditingandStructuringofmapdata:Digitizing: manual,semi-automaticandautomatic,editing:errordetectionandcorrection,tolerances , topologycreation.attributemap generation	10
V.	DigitalElevationModel:NeedofDEM,VariousstructuresofDEM:line, TIN, grid.	08
VI.	ApplicationofRemotesensingandGIS:Forestresourcemanagement, agricultureandsoilmanagement,waterresourcemanagement,landuseand landsuitability.disaster management	07

Contribution to Outcomes

On completion of this course, the students shall be able to

- Install and Use GIS software.

- Project the Maps and view data to interpret the results.
- Create Spatial data models.
- Use Geo-processing tool.
- Convert the data.
- Import and Export data.
- Layout a Map using GIS software.

Theory examination:

1. The question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** and will have question/s on the theoretical portion covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided equally and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt **anythree** questions out of remaining five questions.
5. Total **four** questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work.

List of Practical: (At least ten to be performed)

1. InstallationofGISsoftware and gettingFamiliarizedwithGISmenuandTools
2. MapProjections and Map Digitization.
3. Geo-Referencing.
4. CreatingVectordata and CreatingRasterdata/ data layers.
5. Creatingattribute table.
6. Measurements: length and area.
7. Dataviewing basedonSingleSymbol, Graduated Symbol.
8. DataviewingonContinuouscolor and unique value.
9. Labelingthefeatures.
10. Selection tool and Geo-processingtool(Buffer,Clip,intersectanddifference).
11. Coordinatecapture- tosavein notepad.
12. Joininglayersbasedoncommonfield.

13. Dataconversion (raster to vector), polygon to polyline.
14. Convertpolygontopolyline.
15. AddGraphic overlay to a vector layer.
16. Importandexportdata and MapLayout.

Term work:

The term-work shall comprise of the neatly written report of the practicals performed and the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least three problems and/or questions on each modules/ sub-modules and contents thereof, further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded for the various components depending upon its quality. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments;and further, minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments: 10 Marks
- Practicals: 10 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. GeographicInformationSystemsandScience (2nd Ed.):*Longley,PaulA., MichaelF.Goodchild,DavidJ.Maguire,DavidW.Rhind*,JohnWileyandSons,New York, 2005.
2. ModelingOurWorld:TheESRIGuideto GeodatabaseDesign:*Zeiler,M.*, ESRIPress, Redlands,California, 1999.
3. GIS,SpatialAnalysisandModeling:*Maguire,D.,M.Batty*,and*M. Goodchild*, ESRI Press, 2005.

4. Introduction to GeographicInformationSystems:*Kang-TsungChang*,TataMc GrawHill.
5. AdvancedSurveying(TotalStation,GISandRemoteSensing) (1st Ed.): *SatheeshGopi,R.Sathikumar,N. Madhu*,2007.

Semester VIII

Subject Code	Subject Name	Credits
CE-E804	Elective II- Water Resources Engineering and Management	5

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practicals	Tutorials	Theory	Practicals	Tutorials	Total
4	2	-	4	1	-	5

Evaluation Scheme

Theory					Termwork/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3	25	-	25	150

Rationale

The knowledge of this subject is essential to understand facts, concepts of water resources project planning, environmental impact assessment, flood estimation and control measures. This course will provide the students the knowledge of planning, design, and operation of water resources systems using mathematical optimization methods and models. The student will learn to apply basic economic analysis (engineering economic and microeconomic analysis) and operations research techniques (linear, nonlinear and dynamic programming, and combinatorial optimization) to various surface water resource allocation problems.

Objectives

1. To know about objectives of Water resources project planning, investigations and data requirement.
2. To understand Water resources system design, development, assessment and environment impact assessment.
3. To evaluate Engineering economy in flood control projects.

4. To Model watershed hydrology using different techniques.
5. To understand requirements of multipurpose project developmental issues like hydro-electric power development, inland water transportation and watershed management.

Detailed Syllabus

Module	Sub -Modules/Contents	Periods
I	**Water resources project planning** Investigations in project planning, planning data requirement and collection, levels or planning and objectives, project formulation and evaluation, multipurpose project planning, Drawbacks in planning, system approach in water resources planning.	9
II	**Water resources development and environment** Objects of water resources development. water resources system design, Water resources assessment, augmentation of water resources, Economics of water resources development, Integrated and conjunctive use of water development, Irrigation and water management, Constraints in irrigation development, National water policy, Environmental planning, Environmental impact assessment, measurement of ElA, status of EIA in India.	13
III	**Engineering economy in flood control projects**	10
	Flood estimation and flood control measures, flood forecasting and warning, effect of urbanization on runoff, peak flow methods in urban area, Flood routing through reservoirs and channels, discounting formulae, discounting methods, economies of flood control, estimating flood damages, estimating flood control benefits, reservoir sedimentation and control.	

IV	**Modelling watershed hydrology** Hydrologic processes, rainfall-runoff measurement and analysis, Hydrographs and IUH, Mathematical models in hydrology, Nash and clark model, Generalised watershed simulation models, GIS tool in watershed management, probability and stochastic models, frequency analysis, Regression and correlation, optimisation techniques for water resources projects by linear programming, non-linear programming and dynamic programming, mathematical models for large scale multipurpose projects, different case studies.	13
V	**Multipurpose developmental issues** Hydro-electric power development and power sector, inland water transportation, micro-level planning, watershed management. Rainwater harvesting, cloud seeding, cost-benefit considerations in water resources planning, River basin management.	7

Contribution to outcomes

On successful completion of this course, students shall be able to:

1. Know about Investigations required in water resources project planning, formulation and its evaluation.
2. Assess economics of water resources development, Integrated and conjunctive use of water development and water management.
3. Estimate flood, its control measures, flood forecasting techniques, warning system and its benefits.
4. Model watershed hydrology by different techniques along with applications of optimization techniques for water resources projects.
5. Understand cost-benefit considerations in water resources project planning.

Theory examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.

3. The remaining **five** questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately further; and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:-

The oral Examination shall be based upon the entire syllabus and the term work.

Term work:-

The term-work shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and/or questions on each modules/ sub-modules and contents thereof, further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report and the assignments. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments;and further, minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Water Resources Engineering: *Ralph A Wurbs, Weseley P. James*, Prentice Hall. India
2. Economics of Water Resources Planning: *James,L. D., Leo,R. R.*, Mc GrawHill
3. Elements of Water Resources Engineering: *K N Duggal and P Soni*, New Age International Publishers
4. Environmental Impact Assessment: *Larry W. Canter*, Mc Graw Hill, 1997
5. Introduction to Hydrology: *Warren Viessman, Jr.* and *Gary L. Lewis*, Pearson Education, 2007.
6. Hydrology- Principles, Analysis Design*: H.M. Raghunath*, New Age International Publishers

Semester VIII

Subject Code	Subject Name	Credits
CE-E804	Elective-II: Bridge Design and Engineering	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

In transportation system roads and railways routes are require to be constructed in difficult terrains, where requirement of bridges are essential to connect the inaccessible routes. In this subject, students will be well acquainted with the types of bridges and their selection based on the specific needs. The civil engineering profession is much concerned with design of different types of structures, in which design of bridge structure is very important. This subject deals with analysis and design of different types of bridges for IRC loads along with substructure (foundation, Pier, abutments) with various constructions methods.

Objectives

The course aims at:

1. Selection of suitable type of bridge according to the site condition.
2. IRC loadings, load distribution and railway loading.

3. Design of bridge superstructure and substructures.
4. Different types of bridge foundations.
5. Erection of bridge super structure.

Detailed Syllabus

Module	Sub- Modules/ Contents	Periods
I.	**Introduction:** Types of Bridges, Selection of suitable type of bridge, aesthetics, economic span.	08
II.	**Design Loads and their Distribution:** IRC loads, analysis of deck slab and IRC loads, Load distribution among longitudinal beams of a bridge, railway loading.	11
III.	**Design of Superstructure:** Design of balanced cantilever concrete bridge, design of prestressed concrete bridge, design of lattice girder railway bridge, introduction to design of RC Arch bridges and box bridges.	16
IV.	**Design of Substructure:** Different types of foundations, their choice and methods of construction, design of well foundation, design of piers and abutments, various types of bearings and their suitability.	14
V.	**Construction Methods :** Erection of bridge superstructure, cantilever construction.	03

Contribution to Outcomes

On successful completion of the course, the student shall be able to:

1. Select the suitable type of bridge according to the site condition.
2. Understand IRC loads, distribution of these loads among longitudinal beams of a bridge.
3. Design of balanced cantilever concrete bridge, prestressed concrete bridge, lattice girder Railway Bridge, RC Arch bridges and box bridges.

4. Design different types of foundations, piers and abutments, their methods of construction,
5. Understand various types of bearings and their suitability, erection of bridge superstructure.

Theory Examination:-

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work.

Term work:

The termwork shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and/or questions on each modules/ sub-modules and contents thereof, further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work. The final certification and the acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments;and further, minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.
75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Design of Bridges: *Raju N. K.*, Oxford and IDH.
2. Bridge Engineering: *Ponnuswamy S.*, Tata Mc Graw Hill.
3. Concrete Bridge Practice: *Raina V. K.*, Tata Mc Graw Hill.
4. Essentials of Bridge Engineering: *Victor D.J*, Oxford and IDH.
5. Design of Bridge Superstructures: *T.R. Jagdeesh* and*M.A. Jayaram*, Prentice Hall India Private Ltd., New Delhi.

Semester VIII

Subject Code	Subject Name	Credits
CE-E804	Elective-II: Environmental Impact and Assessment and Audit	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

Environmental impact assessment is the formal process used to predict the environmental consequences (positive or negative) of a plan, policy, program, or project prior to the decision to move forward with the proposed action. An impact assessment may propose measures to adjust impacts to acceptable levels or to investigate new technological solutions. This subject covers the study of environmental assessment process,environmental auditing and provisions of various environmental acts of India.

Objectives

1. To use of EIA for various projects
2. To monitor and mitigation of Impacts
3. To perform EIA for various projects

4. To perform Environmental Auditing process

5. To learn laws related to EIA and auditing in India

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	Environmental impact assessment What is it, Environmental attitudes, Brief history of EIA, Significance of EIA, Role of EIA in planning and decision making process, objectives of EIA.	07
II.	Environmental assessment process Assessment methodology , Socioeconomic impact assessment, Air quality impact analysis, Noise impact analysis, Energy impact analysis, Water quality impact analysis, Vegetation and wild life impact analysis, Cumulative impact assessment, Ecological impact assessment, Risk assessment.	14
III.	Environmental Impact Assessment Basic concept behind EIS, Stages in EIS production: Screening, scoping, prediction, evaluation, reducing impact, monitoring, conclusions, typical EIS outline,	07
IV.	Rapid EIA	06
V.	Environmental Auditing Definition, aims and objectives, audit principles, incentives to undertake audit, partial environmental audits, stages of implementing environmental audits, scope of audit	06
VI.	ProvisionsofvariousenvironmentalactsofIndia	06
VII.	CaseStudies	06

Contribution to Outcomes

The students shall be able to:

1. Evaluate the need to EIA

2. Carry out an EIA for a project

3. Understand the laws and where they can be applied in Indian Context

Theory examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work consisting of the assignments.

Term work:

The term-work shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and/or questions on each modules/ sub-modules and contents thereof, further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report and the assignments. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments;and further, minimumpassing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.
75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Corporate Environmental Management: Welford R, University Press
2. Environmental Assessment: *Jain R K*, Mc-Graw Hill
3. Environmental Impact Assessment: *Harry W Conter*, Mc-Graw Hill
4. Environmental Impact Assessment – Handbook: *John G Rau* and *D C Wooren*, Mc-GrawHill.

Semester VIII

Subject Code	Subject Name	Credits
CE-E804	Elective-II: Appraisal and Implementation of Infrastructure Project	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

This course is intended to make students aware of appraisal criteria needed for Civil engineering project. Through this course, student must learn about feasibility studies, Project report preparation etc. to decide the viability of the project.The professional construction engineering practice will be rendered meaningless if student do not grasp the knowledge of financial analysis. This course shall be helpful to students in studying all the economic aspects of Infrastructure projects.

Objectives

- To understand the basic study as well as feasibility studies of Infrastructure projects.
- To learn various appraisals for deciding the worthwhileness of the projects.

- To make students acquainted with the important tools like break even analysis, S.W.O.T analysis.
- To know about economic analysis of the projects.

Detailed Syllabus

Module	Sub- Modules/Contents	Periods
I.	**Construction Projects and Report Preparation:** 1.1 Infrastructure projects and its classification. 1.2 Project Formulation and phases involved in it. 1.3 Feasibility studies, SWOT analysis. 1.4 Preparation of Project report	09
II.	**Projects Appraisal:** 2.1 Project Development Cycle 2.2 What is appraisal? Need of appraisal etc. 2.3 Steps of appraisal.	06
III.	**Market Appraisal:** 3.1 Demand analysis, forecasting demand etc. 3.2 Sources of information, Market Survey 3.3 Uncertainties in demand forecasting	06
IV.	**Technical Appraisal** 4.1 Technical Viability 4.2 Location, Land, Building etc. 4.3 Size of plant, Technology, Machinery, raw materials etc. 4.4 Energy requirements, Water supply, effluent disposal etc.	05
V.	**Managerial Appraisal :** 5.1 Assessment of entrepreneurs, Organizational structure 5.2 Managerial requirements of project. 5.3 Chief Executive, Board of Directors etc.	07
VI.	**Financial Analysis and Economic appraisal:** 6.1Cost of project, Profitability, Break Even Analysis etc. 6.2 Economic appraisal: Urgency, Payback period, Avg. Rate of return,	12

	Net Present Value, Internal rate of return, Benefit cost ratio, Cost of Capital etc.	
VII.	**Project Implementation :** 7.1 Agencies involved in Implementation. 7.2 Methods of implementation like Built, operate and Transfer its Variants like B.O.O, B.O.OT, B.L.T etc.	04
VIII.	**Project Financing:** 8.1 Types and Sources of finance (Local, National and International) 8.2 Project financing Issues.	03

Contribution to Outcomes

On successful completion of the course, it is expected that:

- The students shall be able to understand about the infrastructure projects and implementation methods.
- The students shall be able to know how to prepare project report and detailings about theproject.
- The students shall be able to understand and apply various appraisal criteria's for deciding the worthwhileness of the project.
- The course shall inculcate the managerial skills and knowledge of financial aspects among the students which will be helpful for them in future during the implementation of projects.

Theory examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.

5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:

The oral Examination will be based upon the entire syllabus and the term work.

Term work:

The term-work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and/or questions on each modules/ sub-modules and contents thereof, further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report and the assignments. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments;and further, minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Project Preparation, Appraisal, Budgeting, and Implementation: *Prasanna Chandra*, Tata McGraw Hill.

Semester VIII

Subject Code	Subject Name	Credits
CE-E804	Elective-II: Disaster Management	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

Disasters, natural or man-made result in untold misery on the human beings and adverse effects on the ecology. Thus our ability to manage and mitigate disaster assumes paramount importance. Disaster management is understood as the managerial function charged with creating the framework, within which communities reduce vulnerability to hazards and cope with disasters.The function of disaster managers is to evaluate risk and exposure, create response plans and ensure response capacity after an event. The response capacity to disaster becomes complete when the community, with specific reference to youth is involved in the entire disaster management cycle.Youth constitute a vibrant, constructive force of a nation and more so in India, where it is emerging as a leading nation in the percentage of population in the age group of 13-35. This course is intended to teach students the management skills to be applied during such disasters.

Objectives

- To increase the knowledge and understanding of the disaster phenomenon, its different contextual aspects, impacts and public health consequences.
- To increase the knowledge and understanding of the International Strategy for Disaster Reduction (UN-ISDR) and to increase skills and abilities for implementing the Disaster Risk Reduction (DRR) Strategy.
- To ensure skills and abilities to analyze potential effects of disasters and of the strategies and methods to deliver public health response to avert these effects.
- To ensure skills and ability to design, implement and evaluate research on disasters.

Detailed Syllabus

Module	Sub - Modules/Contents	Periods
I.	**Introduction to Disasters** 1.1 Definitions and terminologies — hazard, risk, accident, disaster vulnerability 1.2 Natures and extent of disasters, natural calamities such as earthquake, floods, drought volcanoes, forest, coasts hazards, landslides etc. Manmade disasters such as chemical and industrial hazards, nuclear hazards, fire hazards etc. 1.3 Disaster Management – Financing relief, expenditure, legal aspects, rescue operations. Casual management, risk management, disaster management. 1.4 Significance of disaster management and role of civil engineers in it	15
II.	**Emergency Management Program:** 2.1 Administrative setup and organization. 2.2 Hazard analysis, training of personnel, information management, emergency facilities and equipment necessary public awareness creation 2.3 Preparation and execution of the emergency management program	12

III.	**Disaster Relief Teams:** 3.1 Various organizations registered with Government and NGO's working for disaster relief- 3.2 Challenges faced by organizations. 3.3 Methods of assessment of impact of disasters such as photogrammetric methods, media survey, ground data collection	12
IV.	**Resources Management and Allocation :** 4.1 International adopted practices for disaster mitigation. 4.2 Rules and regulations, Monitoring aspects of disaster mitigations programs. 4.3 International Strategy for Disaster Reduction (UN-ISDR) 4.4 Disaster Risk Reduction (DRR) Strategy.	13

Contribution to Outcomes

On successful completion of the course, the students shall be able to:

1. Demonstrate knowledge and understanding of the role of Public Health in disaster situations, including both a broad command of the field and a deeper knowledge of specific areas, together with insight into current research and development work and to demonstrate deeper methodological knowledge related to their chosen study track:
2. Integrate knowledge and to analyse, evaluate and manage the different public health aspects of disaster events at a local and global levels, even when limited information is available.
3. Describe, analyze and evaluate the environmental, social, cultural, economic, legal and organizational aspects influencing vulnerabilities and capacities to face disasters.
4. Work theoretically and practically in the processes of disaster management (disaster risk reduction, response, and recovery) and relate their interconnections, particularly in the field of the Public Health aspects of the disasters.
5. Manage the Public Health aspects of the disasters.
6. Obtain, analyze, and communicate information on risks, relief needs and lessons learned from earlier disasters in order to formulate strategies for mitigation in future scenarios with the ability to clearly present and discuss their conclusions and the knowledge and arguments behind them.

7. Design and perform research on the different aspects of the emergencies and disaster events while demonstrating insight into the potential and limitations of science, its role in society and people's responsibility for how it is used.
8. Analyze and evaluate research work on the field of emergencies and disaster while demonstrating insight into the potential and limitations of science, its role in society and people's responsibility for how it is used.

Theory examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory**whichwill have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately further; and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work.

Term Work:

The term-work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and/or questions on each modules/ sub-modules and contents thereof, further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon its quality. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments and the minimum passing marks to be obtained by

the students. The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Manual Natural Disaster Management in India, *Gupta, M. C.*, NIDM, New Delhi
2. Encyclopedia of Disaster Management, Vol. I, II and III, *Goyal, S. L.*, Deep and Deep, New Delhi
3. Disaster Management Act 2005, Govt. of India
4. Publications of NDMA on Various Templates and Guidelines for Disaster Management

Reference Books:

1. An Introduction to Disaster Management –Natural Disasters and Man Made Hazards, *S.Vaidyanathan*, Ikon Books
2. Construction Engineering and Management – *Seetharaman*.
3. NICMAR Publications
4. Different sites on internet on Disaster Management
5. Project Management – *K Nagarajan* – New Age International Ltd.
6. Disaster Management Handbook by *Jack Pinkowski* – CRC Press (Taylor and Francis group)
7. RedR Handbook for Disaster Management

Semester VIII

Subject Code	Subject Name	Credits
CE-E804	Elective-II: Pavement Design and Construction	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

The pavements are classified according to mode of transportation (highway and airways) and structural behaviour (flexible and rigid). The design of any pavement warrants the proper analysis thereof. The course deals with the various methods of the analyses and design of pavements. The evaluation of the pavements on routine basis and subsequent maintenance is essential to avoid the distresses in pavements. The course also covers the various distresses likely to take place in the pavements and various methods of evaluating the existing pavements. The distressed pavement needs either strengthening or rehabilitation depending upon the distresses the pavement has undergone. For the proper working and maintenance of the pavement, the concept of pavement management system has emerged. The course also covers these aspects. It also gives major thrust on the low volume roads and construction of concrete roads.

Objectives

1. To introduce the different types of pavements depending upon the mode of transportation using it and further, depending upon the structural behavior.
2. To understand the concept of consideration of wheel loads, axle loads, wheel-axle configuration and allied aspects as a pre-requisite in the analysis and design of the pavement.
3. To study the various types of structural responses (stresses and deformations) inducing the pavements due to wheel load and other climatic variations.
4. To study the various methods of analysis and design of the pavements and its sub-sequent applications to the various types of pavements.
5. To study the different types of distresses in pavement, evaluation of the existing pavements using different methods and rehabilitation of the distressed pavements.
6. To study the construction of the concrete roads and low volume roads.
7. To study the quality control and quality assurance in the road construction and introduce pavement management system.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	Pavement structure and functional attributes, factor affecting pavement design, types of wheel loads for highways and airports, development of design method for highway and airport pavements.	05
II.	Stresses in flexible pavements, 1-layer, 2-layer, 3-layers theories, EWLF,ESWL Stresses in Rigid pavement: load and temperature stresses, combined stresses.	10
III.	Flexible Pavement Design Airport pavement: Corps of Engineer's method, FAA method CDOT method, Asphalt institute method. Highway Pavement: Empirical methods using no soil strength criteria, empirical method based on soil strength criteria: CBR method as specified by IRC, Road note 29 methods, AASHTO method,	08

	Asphalt institute method. Fatigue and rutting as a failure criterion.	
IV.	Rigid Pavement Design: Airport pavements: PCA methods, corps of Engineer's method, FAA method. Joints and reinforcement requirement. Highway pavement: Current British procedure, IRC method.	06
V.	Evaluation and strengthening: flexible and rigid pavement distresses, condition and evaluation surveys, present serviceability index, roughness measurement, Benkaleman beam deflections, design of overlays, skid resistance and measurement.	07
VI.	Concrete road construction: Mix design, concrete strength, size of aggregates, gradation, and workability, preparation of base form work, placing of reinforcement, compaction, and finishing, curing, joints.	03
VII.	Low Cost Roads (Rural Areas) Classification of low cost roads, construction of low cost roads, stabilization of subgrade, base and its advantages, construction of granular base courses, macadam surface, macadam bases, low cost materials and methods used for highway construction, suitability of different types of roads under different situation. Soils.	03
VIII	Road making machinery Role of labour versus machinery, in road construction, earth work machinery, rock excavation machinery, aggregate transportation and watering equipment, wet mix WMM Plant, Asphalt plant, (computerized), drum mix, Continuous batch mix, compaction equipment, bituminous equipment, storage, heating and spraying equipment, hot mix plants, cold mix plants, paver, finisher, concrete road making machinery, equipment usage rates, factors affecting usage rate	05
IX	Quality control (QC) and Quality assurance (QA) during construction of various pavements, importance, process control and end product control, statistical methods in quality control, control charts, frequency of testing etc.	03
X	Introduction to pavement management systems.	02

Contribution to Outcomes

On successful completion of the course, the students shall be able to:

- Understand the structural actions involved in the pavement due to different types of load acting thereon and the various methods of analysis of pavements.
- Understand the applications of the analysis in the design of pavements using different methods of pavement design.
- Know the different types of distresses occurring in the existing pavements and carry out the structural and functional evaluation of the pavements.
- Apply the knowledge of evaluation in pre-empting the failure and to arrive upon the methodology of the rehabilitation of pavements.
- Understand the various aspects of the construction of concrete roads and low volume roads.
- Understand the pavement management system and quality control and assurance criteria and subsequently, its application in the highway construction.

Theory Examination:-

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:-

The oral examination shall be based upon the entire syllabus and the term work.

Term work:

The term-work shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least three problems and/ or questions on each modules/ sub-modules and contents thereof, further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon its quality of the term work. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments;and further, minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Principles and Practice of Highway Engineering: *L.R.Kadiyali*, Khanna publications.
2. Highway Engineering: *Khanna S.K. and Justo* C.E.G. Nem Chand (Revised 10th Edition, 2014)
3. Principles, Practice and Design of Highway Engineering (Including Airport Pavements): *Sharma, S.K.*, S. Chand Technical Publications (3rd Revised Edition, 2013)
4. Pavement Analysis and Design: *Yang H. Huang*, Prentice Hall, New Jersey, 1993
5. Pavement Design: *Yoder* and *Witzech*, McGraw-Hill, 1982.
6. The Design and Performance of Road Pavements: *Croney, David et al*, McGraw Hill.

Semester VIII

Subject Code	Subject Name	Credits
CE-E804	Elective-II: Advanced Design of Steel Structures	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

There are various types of the civil engineering structures which are subjected to various types of loading and their combination. Most of the structures are made of steel.These structures are designed by working stress method and limit state method. The design method of different component that are given in the syllabus are based on limit state method and working state method.

Objectives

1. To understand the analysis and design concept of round tubular structures
2. To understand the design concept of different type of steel water tank
3. To understand the design concept of lattice tower and steel chimney
4. To understand the design concept of gantry girder

5. To develop clear understanding of theconcepts and practical knowledge of modern Civil Engineering techniques for design of steel structures.
6. Use of various relevant IS codes for designing steel structures.

Detailed Syllabus

Module	Sub – Modules / Contents	Periods
I	**Introduction to Steel Structure** Introduction to type of steel, mechanical properties of Structural steel, advantages of steel as structural material, design philosophies of Working Stress Method (WSM) and Limit state method	03
II	**Moment Resistant Beam End Connections :** Design of moment resistant bolted and welded beam end connections by limit state method	05
III	**Round Tubular Structural Members :** Properties of steel tubes, design of tension member and compression members, design of welded connections, design of flexural members, analysis and design of tubular trusses including purlins and supports	06
IV	**Elevated Steel Tanks and Stacks :** Loads acting on tanks including wind and earthquake, design of circular tanks with hemispherical and conical bottom, supporting ring beam, staging for circular tanks including design of columns and foundation, design of rectangular steel tanks including design of staging, columns and foundation.	14
V	**Gantry Girder :** Loads acting on gantry girder, Analysis of gantry girder, design of gantry girder by limit state method.	07
VI	**Lattice Tower :** Different configuration of lattice towers, loads acting on lattice towers, Analysis of lattice tower, design of lattice tower including welded or riveted connections for members by limit state method.	09

VII	**Steel Chimney :** Forces acting on chimney, design of self-supporting welded and bolted chimney and components including design of foundation.	08

Contribution to Outcomes

On completion of this course, the students shall be able to understand the analysis and design of gantry girder by limit state method. They shall be able to analysis and design steel chimney, lattice tower, tubular truss and water tank.The students are expected to be able to independently design steel structures using relevant IS codes.

Theory Examination:-

1. Question paper will comprise of **six** question; each carrying 20 marks.
2. The **first** question will be compulsory and will have short question havingweightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt **any three** questions out of remaining five questions.
5. Total **four** questions need to be attempted

Oral Examination:

The oral examination shall be based upon the entire syllabus and the term work.

Term Work:

The term-work shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least three problems and/or questions on each modules/ sub-modules and contents thereof, further. In addition to this, the term work shall consist of a design report and detailed drawings on three projects as indicated below:

1. Roofing system including details of supports using tubular section
2. Design of elevated circular tank with conical bottom or rectangular steel tank.

3. Design of lattice tower or steel chimney.

The drawing will be drawn in pencil only on minimum of A-1 (imperial) size drawing sheets.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded for various components depending upon its quality. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments;and the minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 10 Marks
- Design Report: 10 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1 Design of Steel Structures : *N Subramanian,* Oxford- University Press

2 Design of Steel Structures: Punamia, *A. K. Jain and Arun Kumar Jain*, Laxmi Publication

3 Design of Steel Structures: *Dayaratnam,* Wheeler Publication, New Delhi.

4 Design of steel structures: *Krishnamachar, B.S.*and*Ajitha Sinha D.*

Reference Books:

1. Design of Steel Structures: *Mac. Ginely T.*
2. Design of Steel Structures: *Kazimi, S. M.* and *Jindal, R. S.*, Prentice Hall of India.
3. Design of Steel Structures: *Breslar, Lin* and *Scalzi*, John Willey, New York.
4. Design of Steel Structures: *Arya* and *Ajmani*, New chand and Bros.
5. Relevant IS codes, BIS Publication, New Delhi
6. Steel structures, Controlling behavior through design: *Englekirk, R.,* Wiley

7. LRFD Steel Design : *William T. Segui*, PWS Publishing
8. Design of Steel Structures: *Edwin H. Gaylord*, *Charles N. Gaylord* and *James*, Stallmeyer, McGraw-Hill
7. Design of Steel Structures, Vol I and II: *Ramchandran*, Standard Book House, New Delhi.
8. Design of Steel Structures: *Dayaratnam*, Wheeler Publication, New Delhi
9. Design of Steel Structures: *Breslar, Lin* and *Scalzi*, John Willey, New York.
10. Structural Steel Work: *Reynolds, T. J., Kent L.E. and Lazenby, D.W.*, English University Press.
11. Comprehensive Design of Steel Structures: *Punmia, A.K. Jain* and *Arun Kumar Jain*, Laxmi Publications Pvt. Ltd.
12. Design of Steel Structures: *Sayal, I. C.*and *Salinder Singh*, Standard Publishers and Distributors.

Semester VIII

Subject Code	Subject Name	Credits
CE-E804	Elective-II: Earthquake Engineering	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

Earthquake engineering is the science of the performance of buildings and structures when subjected to seismic loading. It also assists analyzing the interaction between civil infrastructure and the ground, including the consequences of earthquakes on structures. One of the most important aims of earthquake engineering is the proper design and construction of buildings in accordance with building codes, so as to minimize damage due to earthquakes. It is the earthquake engineer who ensures proper design of buildings so they will resist damage due to earthquakes, but at the same time not be unnecessarily expensive.

Objectives

- To study the importance of the earthquake engineering
- To study the different types of dynamic loads, concept of damping, and analysis of SDOF system subjected to different types of dynamic loads.

- To calculate frequency and mode shapes for the MDOF system, analysis of MDOF system subjected to different types of dynamic loads.
- To study the causes of earthquake, types of earthquakes, seismic waves, structure of earth, and measurement of earthquake magnitude and intensity.
- To study the concept of Response Spectrum, ground motion parameters, characteristics of response spectrum, and various methods to construct response spectrum.
- To analyze the structure subjected to ground motion as per codal provisions of IS:1893-2002 and calculation of earthquake loads/forces. Importance of ductility in earthquake resistant design of structure and codal provision of IS: 13920.
- To perform the basic experiments in structural dynamics on SDOF and MDOF system.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	**Introduction:** Definitions of basic problems in dynamics, static v/s dynamic loads, different types of dynamic loads, undamped vibration of SDOF system, natural frequency and periods of vibration, damping in structure. Response to periodic loads, response to general dynamic load, response of structure subject to round motion, use of Fourier series for periodic forces.	12
II.	**MDOF systems:** Direct determination of frequencies and mode shapes, orthogonality principle, approximate methods for determination of frequencies and mode shapes. Forced vibration of MDOF system, modal analysis, applications to multistoried rigid frames subject to lateral dynamic loads including ground motion.	08

III.	**Seismological Background:** Seismicity of a region, earthquake faults and waves, structure of earth, plate tectonics, elastic-rebound theory of earthquake, intensity and magnitude of earthquake, measurement of ground motion, seismogram, earthquake frequency , local site effects, seismotectonics and Seismicity of India.	06
IV.	**Characterization of Ground Motion:** Earthquake response spectra, factors influencing response spectra, design response spectra for elastic systems, peak ground acceleration, response spectrum shapes, deformation, pseudo-velocity, pseudo-acceleration response spectra. Peak structural response from the response spectrum, response spectrum characteristics, construction site specific response spectra.	08
V.	**Deterministic Earthquake Response:** Types of earthquake excitation, lumped SDOF elastic systems. translational excitation, lumped MDOF elastic systems, translational excitation, time history analysis, multistoried buildings with symmetric plans, multi storied buildings with un symmetric plans, torsional response of symmetric plan building, distributed - parameter elastic systems, translational excitation, combining maximum modal responses using mean square response of a sin le mode, SRSS and CQC combination of modal responses.	06
VI.	**I. S. Code Method of Seismic Analysis:** Seismic co-efficient method and its limitation, response spectrum method, IS 1893-2002 provisions for seismic analysis of buildings and water towers, seismic evaluation and retrofitting, types of structural system used in building to resist earthquake loads.	06
VII	Review of damages during past earthquakes and remedial measures, seismic design considerations, allowable ductility demand, ductility capacity, reinforcement detailing for members and joints as per IS 13920.	06

Contribution to Outcomes

- The students are expected to understand the difference between static and dynamic analysis, types of dynamic loads, concept of damping.
- The students are expected to evaluate the response of the structures subjected to different types of dynamic loads.
- The students are expected to understand earthquake phenomenon, concept of response spectrum, application of structural dynamics in the evaluation of structural response to Earthquake excitation and their codal provisions.
- The students are expected to carry out Seismic analysis of structure.

Theory Examination:-

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:-

The oral Examination shall be based upon the entire syllabus and the term work.

Term work:-

The term-work shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problemsand/or questions on each modules/ sub-modules and contents thereof, further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon its quality. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments;and further, minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

- Structural Dynamics-An Introduction to Computer Methods: *Roy R. Craig*.
- Dynamics of Structures: *Anil K. Chopra*, Prentice Hall, India.
- Dynamics of Structures: *Cloguh* and *Penzien*, Tata McGraw Hill
- Structural Dynamics: *John M, Biggs*, Tata McGraw Hill
- Fundamentals of Earthquake Engineering: *N. M. Newmarks* and *E. Rosenblueth*, Prentice Hall.
- Earthquake Design Practice for Building: *D. Key, Thomas Telford*, London, 1988.
- Earthquake Engineering: *R. L. Wiegel*, 2nd Edition, Prentice Hall, London, 1989.
- Design of Multistoried Buildings for Earthquake Ground Motions: *J. A. Blume*, Portland Cement Association, Chicago, 1961.
- Proceedings on World Conference on Earthquake Engineering: 1956-2000.
- Earthquake Resistant Design of Structures: *Pankaj Agarwal, Manish Shrikhande*, Prentice Hall, India, 2006.
- I. S. codes No. 1893, 4326, 13920. (All latest codes)

Semester VIII

Subject Code	Subject Name	Credits
CE-E804	Elective-II: Soil Dynamics	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

In basic geotechnical engineering course generally various static loads are considered in the theories and analysis of soil. But practically many geotechnical applications require the knowledge of the behaviour and properties/response of soil as a material which is subjected to various types of dynamic or cyclic time-dependent loadings. Some of the structures which are subjected to dynamic loadings are machine foundations, shallow and deep foundations, retaining structures, slopes, sub grade soil below railway, pavement, runway etc. This course provides the fundamental theoretical and computational aspects of dynamics for some important geotechnical problems and structures.

Objectives

- To study fundamental concepts of vibrations, degrees of freedom and damping systems.

- To study phenomena like liquefaction and their effects.
- Tostudy principals of machine foundation design and dynamic earth pressure theories on retaining wall.
- To learn test methods of evaluating dynamic properties of soil.

Detailed Syllabus

Module	**Sub- Modules/Contents**	**Periods**
I.	Vibration of elementary system, degree of freedom, analysis of system with one degree of freedom, spring-mass system, harmonic vibration, uniform circular motion natural frequency, free and forced vibrations with and without damping, type of damping	10
II.	Wave propagation in elastic rods, in an elastic infinite medium and in semi elastic half space, wave generated by surface footing.	05
III.	Liquefaction of soils, criterion and factors affecting liquefaction of soil, laboratory and field studies on liquefaction, liquefaction studies in oscillatory simple shear, evaluation of liquefaction potentials, liquefaction of clay.	10
IV.	Principles of machine foundation design, criteria for satisfactory machine foundation, degree of freedom of a block foundation analysis of vertical and sliding vibration of a machine foundation, mass of soil participating in vibration.	06
V.	Vibration isolation and screening methods, improvement of distressed machine foundation.	07
VI.	Field and laboratory tests for evaluation of dynamic properties of soil under vertical vibration coefficient of elastic uniform shear, spring constant damping modulus of elasticity typical values of soils.	07
VII.	Basics of dynamic earth pressure on retaining walls: conventional gravity type, reinforced soils, distribution of pressure, point of application of the resultant, simple examples.	07

Contribution to outcomes

On successful completion of the course, the students are expected to:

- Acquire the knowledge of concepts, principles and applications of soil under dynamic loading.
- Develop an ability to design with reference to code provisions and solve the practical soil problems subjected to vibrations.
- Provide an impetus to new developments in related dynamic topics.

Theory Examination:-

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Laboratory Test

It is recommended to conduct block foundation tests.

Oral Examination:-

The oral examination will be based on the entire syllabus.

Term Work:

Each student shall prepare a project report covering the selection of design parameters, design analysis including drawing on any aspect of soil dynamics included in the syllabus. The project report referred above along with the assignments will form a part of the term work.The assignments shall be given covering the entire syllabus in such a way that the

students would attempt at least four problems and/or questions on each modules/ sub-modules and contents thereof, further. The report on the block vibration tests, if conducted, shall also form a part of the term work.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded for various components of the term work depending upon its quality. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments, proper compilation of the project report and that of experiments/ practical, if conducted;and further, minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended books:

1. Soil Dynamics: *Shamsher Prakash*, McGraw-Hill book company
2. Principles of Soil Dynamics: *Braja, M. Das*, PWS-Kent Publishing Company
3. Dynamics of Bases and Foundations: *Barkan, D. D.*, McGraw- Hill Book company
4. Relevant IS codes

Semester VIII

Subject Code	Subject Name	Credits
CE-E804	Elective-II: Building Services	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

The building services are based on engineering principles that are applied to the construction of buildings and the built environment. In many respects, building services are responsible for the artificial environment in which we live and work and associated with that the environmental condition of our planet. Building service systems are complex and typically are a major source of cost and potential coordination problems in building construction. Fundamental knowledge of how mechanical, electrical, plumbing and other systems work and interact is fundamental to the construction professional. This course provide an introduction to building service systems which includes Study the design, interfaces, and specifications of various building services in building construction.

Objectives

- To introduce students to concepts of building services and its applications.

- To understand design concept of various machinery like lift, escalators, vibrators, concrete mixers etc. and utility services in building like plumbing system, electrical system, fire safety installation etc.
- To introduce concept of green building which includes various energy efficient building services?

Detailed Syllabus

Module	Sub- Modules/Contents	Periods
I.	**Machineries:**	06
	1.1 Lifts and Escalators - Special features required for physically handicapped and elderly - conveyors - Vibrators - Concrete mixers - DC/AC motors - Generators - Laboratory services - Gas , Water, air and electricity - Hot water boilers- pumps	
II.	**Plumbing Systems in Building:**	09
	2.1 Plumbing Services:- Water Distribution system - Material for service pipes - Service connection - Size of service pipe - Water meter - valves storage tanks **2.2 Drainage system :-** Pipe and traps - system of plumbing - House drainage plans - septic tanks- soak pit	
III.	**Electrical systems and Illumination Design in Buildings:**	12
	3.1 Electrical systems in buildings: Basics of electricity - Single / Three phase supply - Protective devices in electrical installations - Earthing for safety -Types of Earthing - ISI specifications - Types of wires, wiring systems and their choice - Planning electrical wiring for building - Main and distribution boards - Transformers and switch gears - Layout of substations **3.2 Principles of Illumination Design:** Visual task - Factors affecting visual task - Modern theory of light and colour - Synthesis of Light - Additive and Subtractive synthesis of colour - Luminous flux - candela - solid angle illumination - utilization factor - Depreciation factor - MSCP - MHCP - Lans of illumination - Classification of lighting - Artificial lights sources - spectral energy distribution - Luminous efficiency -	

	Colour temperature - Colour rendering. **3.3 Design of Modern lighting:** Lighting for stores, offices, school, hospitals and house lighting. Elementary idea of special features required and minimum level of illumination required for physically handicapped and elderly in building types.	
IV.	**Refrigeration Principles and Applications:**	09
	4.1 Thermodynamics - Heat - temperature, measurement transfer - change of state - sensible heat - Latent heat of fusion, evaporation, sublimation - saturation temperature - super heated vapour - sub cooled liquid - pressure temperature relationship for liquid **4.2 Refrigerants and air conditioners** - Vapour compression cycle - compressor - Evaporators- Refrigerants control devices - Electric motors - starters - Air handling units- cooling towers - Window type and packed air conditioners - chilled water plant - Fan coil systems - water piping - cooling load - Air conditioning systems for different types of building - Protection against fire to be caused by A.C. systems.	
V.	**Fire Safety Services**	06
	5.1 Fire Safety Installation: Causes of fire in building - safety regulation - NBC - Planning considerations in building like non-combustible materials, construction, staircases and lift lobbies, fire escapes and A.C. system. Special features required for physically handicapped and elderly in building types - Heat and smoke detectors - Fire alarm system, snorkel Ladder - Fire Lighting pump and water storage - Dry and wet riser - Automatic sprinklers	
VI.	**Rain Water Harvesting**	06
	6.1Rain Water Harvesting Water Audit of India, Concept of rain water harvesting, Methodologies for Percolation / recharge bore pit, Percolation / recharge bore well, Percolation/ recharge well cum bore pit, Harvesting rooftop rainwater, Harvesting driveway runoff. National water harvesters network (NWHN) and some case studies.	
VII.	**Green Building**	04
	7.1. Introduction to Green Building: Need for a green building, planning and design of green buildings, obstacles,	

	materials used in green building technology, rating system (According to LEED- INDIA)	

Contribution to Outcomes

On successful completion of the course, it is expected to enable the students to:

- Understand the importance and installation of utility services.
- Understand drawbacks if all service lines are not installed properly or used faulty material.
- Choose appropriate systems and integrate the same in to the building construction projects.

Theory examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work consisting of the assignments.

Term work:

The term-work shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problemsand/or questionson each modules/ sub-modules and contents thereof, further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon its quality. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments;and further, minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Heat Pumps and Electric Heating: *E. R. Ambrose*, John and Wiley and Sons, Inc., New York, 1968.
2. Handbook for Building Engineers in Metric Systems, NBC, New Delhi, 1968.
3. Philips Lighting in Architectural Design, McGraw-Hill, New York, 1964.
4. The Lighting of Buildings: *R. G. Hopkinson and J. D. Kay*, Faber and Faber, London, 1969.
5. Air-conditioning and Refrigeration: *William H. Severns* and *Julian R. Fellows*, John Wiley and Sons, London, 1988.
6. Air-conditioning and Energy Conservation: *A.F.C. Sherratt*, The Architectural Press, London, 1980.
7. National Building Code.
8. Building Construction: *Dr. B. C. Punmia, Ashol K Jain*, A.K Jain
9. Construction Engineering and Management: *S. Seetharaman*, Umesh Publicatins, Delhi.
10. Water supply and Sanitory Installations: *A. C. Panchdhari*, New Age International Publication, Delhi
11. Fire Safety in Building: *V. K. Jain*, New Age International Publication, Delhi

12. Green Remodeling: *David Johnston*.
13. Green Building , Project Planning and Cost Estimation: *R. S. Means*
14. LEED – INDIA (Abridged Reference guide for Core and Shell, Version 1.0).

Semester VIII

Subject Code	Subject Name	Credits
CE-804	Elective II- Design of Hydraulic Structures	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practicals	Tutorials	Theory	Practicals	Tutorials	Total
4	2	-	4	1	-	5

Evaluation Scheme

Theory					Termwork/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3	25	-	25	150

Rationale

This subject provides necessary knowledge about planning, design and constructions of important hydraulic structures like dams, reservoirs, weirs, cross drainage woks and canal structures. It also provides basic knowledge to design various regulation structures like spillways, energy dissipation works, canal structuresand canal regulation works. This subject is also useful to gain the knowledge with respect to facts, concepts, principles and procedures related to hydraulic structures so that students can effectively plan and execute various types of hydraulic structures.

Objectives

1. To study planning of reservoir and selection criteria for gravity dam.
2. To study various types of dams including planning and design.
3. To study the design of earth and rock fill dams.
4. To study spillways and energy dissipaters and flood control works.

5. To study design details of surplus weir, barrages, canal drop, canal regulator, cross drainage works.

Detailed Syllabus

Module	Sub Modules/Contents	Periods
I.	**Reservoir Planning and Management:** Reservoir – types, storage capacity of reservoir, storage zones, designing reservoir capacity, flow duration curves, mass curves of inflow and outflow, reservoir losses, reservoir sedimentation, silt control, selection of type of dam, selection of site of dam, preliminary and final investigations of dam sites.	4
II.	**Gravity Dams:** Definition, typical cross section, forces acting on gravity dam, modes of failure and structural stability analysis, profile of dam- elementary and practical profile, low and high gravity dam, design consideration and fixing of section of dam, methods of design, construction of galleries in dams, types of joints, temperature control in concrete dams, foundation treatment..	12
III.	**Arch and Buttress Dams:** Definition and types of arch dams, forces acting on arch darn, design of arch dams, types of buttress dams.	4
IV.	**Earth and Rock Fill Dams:** Types of earth dams, method of construction, causes and failures of earth dams, design criteria, selecting suitable preliminary section, seepage line for different conditions and its location, seepage control through embankment and through foundations, Swedish circle method with pore pressure, details of construction and maintenance, types of rock fill dams, stability analysis, advantages.	10

V	**Spillways and Flood Control Works:** Introduction, location of spillway, design consideration of main spillway, controlled and uncontrolled spillway, types of spillways, design principles of ogee spillway. Chute spillway. Siphon spillway and shaft spillway, energy dissipation below overflow and other types of spillways, design of bucket type energy dissipater and stilling basin, flood mitigation reservoirs. Crest gates, types, advantages, design of radial gate, outlet works through dams, intake structures.	12
VI	**Miscellaneous Topics:** Design of small bridges and culverts, data collection, high flood discharge, linear waterway calculation, scour depth, causeways and culverts, principles of hydraulic design of causeways and culverts, design details of surplus weir, flush escape, direct sluice, canal drops, canal regulators, diversion head works: component parts, functions, weirs and barrages, Blighs Creep theory, Lanes weighed theory. Cross drainage (CD) works: Types of CD works	10

Contribution to outcomes

On successful completion of this course, the student shall be able to:

1. Select the site for dam with preliminary and final investigations, fix storage capacity, analyze reservoir losses, and estimate sedimentation in reservoirs.
2. Analyze forces acting on gravity dam its failure and carry out stability analysis of gravity dams.
3. Understand forces on an arch and buttress dams and its design.
4. Understand details of construction and maintenance of earth fill and rock fill dams including stability analysis criteria.
5. Understand design principles of spillways, energy dissipation works and flood control works.
6. Design small bridges and culverts and its principles of hydraulic design.

Theory examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.

2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately further; and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:-

The oral Examination shall be based upon the entire syllabus and the term work.

Term Work:

The term-work shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and/or questionson each modules/ sub-modules and contents thereof, further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report and the assignments. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments;and further, minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Irrigation Engineering and Hydraulic Structures:*S. K. Ukarande*, Ane's Books Pvt. Ltd. (Abridged Edition 2015), ISBN 9789383656899.
2. Irrigation and Water Power Engineering: *B.C. Punmia*, *Pande B.B. Lal*, *A.K Jain*. Laxmi Publications Pvt, Ltd. New Delhi
3. Irrigation Water Resources and Water Power Engineering: *P.N. Modi*, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
4. Irrigation Engineering and Hydraulics Structures: *S. K. Garg*, Khanna Publishers. Delhi.
5. Design of Irrigation Structures: *S. K. Sharma*, S. Chand and Co.
6. Theory and Design of Irrigation Structures: *R. S. Varshney and R. C. Gupta*, Nem Chand
7. Engineering for Dams, Vol. I to III: *Crager, Justin* and *Hinds*, John Wiley
8. Design of Small Dams: USBR
9. Hydro Power Structures: *R. S. Varshney*, Nem Chand and Bross, Roorkee
10. ConcreteDams*: R. S. Varshney*, Oxford and IBH Publishing Co.

Semester VIII

Subject Code	Subject Name	Credits
CE-E804	Elective-II: Industrial Waste Treatment	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

This subject deals with sampling, manufacturing process and treatment of different industrial waste. Industrial waste waters are generally much more polluted than the domestic or even commercial wastewaters. Such industrial wastewaters cannot always be treated easily by the normal methods of treating domestic wastewaters, and certain specially designed methods. In order to achieve this aim, it is generally always necessary, and advantageous to isolate and remove the troubling pollutants from the wastewaters, before subjecting them to usual treatment processes. Thus Wastewater treatment is closely related to the standards and/or expectations set for the effluent quality. Wastewater treatment processes are designed to achieve improvements in the quality of the wastewater.

Objectives

- To study different characteristics of liquid waste generated from different industries.

- To study the effect of disposal of liquid waste into natural water course, municipal sewer and on land
- To study general treatment of industrial wastes like neutralization, equalization and segregation.
- To study the conventional aerobic and anaerobic biological treatment methods

Detailed Syllabus

Module	**Sub- Modules/Contents**	**Periods**
I.	General: Liquid wastes from industries – their volumes and characteristics, Effect of disposal into natural water courses, Municipal sewers and on land, River standards and effluent standards.	04
II.	Sampling and analysis of industrial wastes, Treatability study, good housekeeping, bioassay test, population equivalence.	04
III.	Stream sanitation: Effects of industrial wastes on self-purification of streams and fish life, Statement and significance of the parameters of Streeter and Phelp's equation and BOD equations, Deoxygenating and reaeration , Oxygen sag and numericals based on this.	08
IV.	General treatment of industrial wastes: Neutralization, equalization, segregation. Modification of conventional aerobic and anaerobic biological treatment methods. Dewatering and disposal of sludges – floatation, vacuum filtration, centrifugation, filter press and membrane filters.	08
V.	Detailed consideration of wastes produced from following industries: Manufacturing processes normally followed , Volume and effects of raw and treated effluent on streams, sewers, characteristics of effluents and land Treatment methods, reuse-recovery 1)Textiles: cotton 2)Pulp and paper:- Sulphate process 3)Electroplating 4)Dairy 5)Sugar-sugarcane	18

	6)Distilleries 7) Tanneries 8) Refineries	
VI.	Provision of various acts pertaining to industrial wastes / effluents, introduction to environmental impact assessment and environmental audit.	06
VII.	Common Effluent Treatment Plants (CETPs): Location, Need, Design, Operation and Maintenance Problems and Economical aspects.	04

Contribution to outcomes

On completion of this course, the students shall have an ability to understand the industrial waste sources, effects and its treatment. The students shall understand the various methods of disposal of industrial waste. They shall further have an understanding of the nature and characteristics of industrial waste and regulatory requirements regarding industrial waste treatment and lastly, they will have an ability to plan industrial waste minimization.

Theory Examination:-

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately further; and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work.

Site Visit/ Field Visit:

The students will visit any industrial/hazardous/municipal solid waste comprising source, characterization, transportation, recycles, treatment and disposal.

Term Work:

The term-work shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and/or questions on each modules/ sub-modules and contents thereof, further. In addition to the assignments, each student shall prepare a report on visit to the site mentioned in the preceding section.

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon its quality. The final certification and acceptance of term work warrants the satisfactory completion of the assignments,proper compilation of the report on the site visit; andfurther, minimum passing marks to be obtained by the student.

The following weightage of marks shall be given for different components of the term work:

1. Tutorial and Assignments: 16 Marks
2. Report on the site visit : 04 Marks
3. Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Waste Water Treatment: *Rao* and *Datta*, Oxford and IBH Publishing Co.
2. Environmental Pollution and Control in Chemical Process Industries: *Bhatia, S. C.*, Khanna Publication.
3. Industrial Water Pollution Control: *Eckenfelder Jr, W. W.*, Mc Graw Hill.

4. Industrial Water Pollution Management: *Gurnham, E. F*., John Wiley.
5. Biological Waste Treatment: *Eckenfelder* and *Connor*, Pergamon Press.
6. Theories and Practices of Industrial Waste Treatment: *Addisoon Wesley*.
7. Pollution Control in Process Industries: Mahajan, S. P., Tata McGraw Hill.
8. Industrial Waste: *Rudolfs, W.(Ed)*, L E C Publishers Inc.
9. The Treatment of Industrial Wastes: *Besselievre, E. D*., Mcgraw Hill.
10. Industrial Waste Disposal: *Ross, R. D. (Ed),* Reinhld Bok Croporation.

Semester VIII

Subject Code	Subject Name	Credits
CE-E804	Elective-II: Transportation Planning and Economics	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

This subject will impart complete knowledge of Transport Planning, Management of Transportation techniques and concepts, which will give the complete perspective with respect to Transportation Modeling, advanced/soft computing techniques for expert systems related with transportation. The students will study in detail with respect to Economic Evaluation of all Civil Engineering Projects, especially related with Transportation projects. Knowledge also gained in this subject related with the important concepts for Mass Rapid Transit systems for urban transportation.

Objectives

1. To study all the land-use transport models used in the transportation planning.
2. To understand the travel-forecasting principles and techniques in planning.

3. To study and understand all the important economic evaluation techniques related with Tansportation/Highway projects.
4. To gain the complete knowledge of mass rapid transit systems used in urban transportation.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	Transportation Planning and management: General Travel Forecasting Principles and techniques, Generalized demand, price and capacity relationship applied to travel forecasting, Practical problems of forecasting travel. Introduction to the process of urban transport planning. Travel demand forecasting: Trip generation analysis, trip classification, multiple regression analysis, category analysis, trip distribution analysis: introduction, methods of trip distribution, uniform and average factor method, Fratar method, Furness method, the gravity model and its calibration, Intervening and competing opportunities model, linear programming approach to trip distribution. Modal split analysis: introduction, Modal split analysis: Probit analysis, Logit analysis and Discriminant analysis, modal split models with behavioral basis. Traffic Assignment: purpose of traffic assignment, traffic flow characteristics, Assignment techniques: All or nothing assignment, Multiple route assignment, Capacity restraint assignment, Diversion curves. Rout building algorithms. Land-use transport models: Introduction, selection of Land-use transport models, The Lowry model, Grain – Lowry model, Applications of Lowry model. Introduction to advanced/soft computational techniques for transportation planning like Expert Systems, Neural Networks, Fuzzy Logic, Genetic Algorithm, Simulated Annealing, Hybrid systems etc.	24

II.	Transport Economics: Economic evaluation of highway schemes, need for economic evaluation, cost and benefits of transportation projects, basic principles of economic evaluation, Net present value method, benefit/cost ratio method, internal rate of return method. Vehicle operating costs, Value of travel time saving, Accident costs and road pricing.	09
III.	Public Transportation Introduction to various mass transportation systems, Classification of mass transit modes: Street transit or surface transit, Semi rapid transit, Rapid transit or mass rapid transit System, Special transit systems: magnetic levitation, monorails, water borne transport, Automated Guided Transit, Detailed capacity assessment of some selected technologies: Conventional bus on bus bays, Light rail transit, Rail Rapid Transit, Regional rail Transit or Suburban Railway, Suitability of Transit Systems for different travel demand for Indian Cities, Suitability of Transit Systems for Indian Cities of Different Population sizes and forms, Influence of other factors in selection of Mass Transit Systems, Transit System Operations: Introduction, Route Development, Stop location and stopping policy, Schedule development, Capacity of transit systems. Future of Public transportation.	19

Contribution to Outcomes

On successful completion of the course work, students will get complete knowledge and will clearly understand all the concepts for Urban Transportation Planning, which may include Multiple Regression Analysis etc. They are expected to gain all the knowledge necessary regarding Methods available for Economic Evaluation like Benefit/Cost ratio, Rate of Return,

Net Present Value method etc. They shall be able to understand and plan the Transit Systems with respect to Mass Transportation for Urban areas, which ultimately relieve the congestion problems faced by citizens in all the busy cities.

Theory Examination:-

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work.

Term work:

The term-work shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and/or questionson each modules/ sub-modules and contents thereof, further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon its quality. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments and the minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:-

1. Traffic Engineering and Transport Planning: *L.R. Kadiyali,* Khanna publishers Delhi.
2. Principles of Traffic Engineering: *G.J. Pingnataro*, Mc Graw-Hill, 1970.
3. Traffic System Analysis for Engineering and Planners: *Wohl* and *Martin*, Mc Graw Hill, 1983.
4. Introduction to Urban Transport Systems, Planning: *B.G. Hutchinson*, McGraw-Hill, 1970.
5. Economics of Transportation: Fair and Williams, *Harper*and *Brothers*, Publishers, New York.
6. Economic Analysis for Highway: *Winfrey, Robley*, International Textbook Co., Pennsylvania, USA, 1969.
7. Public Transportation Planning Operation and Management: *Gray* and *Hoel*, Prentice Hall Publication.
8. Principles of Transportation Engineering: *Partha Chakroborty* and *Animesh Das*, Prentice Hall (India).

Semester VIII

Subject Code	Subject Name	Credits
CE-E804	Elective-II: Advanced Repairs and Rehabilitation of Structures	05

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

The success of the repair and rehabilitation project depends on the specific plans designed for it. It is vital to evaluate the condition of the concrete in the structure and relating the condition of the concrete to the underplaying causes. Further, it is important to select an appropriate repair material and method for any deficiency found, while using selected materials and methods to repair or rehabilitate the structure. It is also important for civil engineers to focus on the maintenance of structures and prepare investigation reports for repair and rehabilitation of structures. The buildings and infrastructural works are subjected to the severe environmental conditions. This badly damages the concrete, making repair and rehabilitation imperative. So, there are enormous employment opportunities in the field of Repair and Rehabilitation in India. This course has, therefore, relevance in the curriculum so that the students can be made competent in this area. The course deals with the structural strengthening, specialized repairs, use of composite materials, seismic retrofitting and

maintenance of structures post-repair. The repair and rehabilitation of heritage structures is as important as any other building. The course caters for the rehabilitation of heritage structures. The knowledge acquired by the students through this course would help them to master the required skills in the domain of repair andrehabilitation.

Objectives

- To study the need for strengthening of structures.
- To be familiar with the various methods of strengthening of columns, beams, walls, footings, slabs, etc.
- To get acquainted with the specialized repairs for the buildings and infrastructural works.
- To know the process of retrofitting of the structures using composite materials.
- To acquire the technical knowhow in the area of seismic retrofitting.
- To get introduced to the concept of repairing and maintaining the heritage structures.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	**Introduction:** Need for strengthening due to various reasons such as ageing, natural calamities, increase of load, change of function and design, construction errors	05
II.	**Structural Strengthening:** Strengthening and retrofitting of columns, beams, walls, footings and slabs, piers of concrete structures by jacketing, external post-tensioning, replacing or adding reinforcement, plate bonding, textile reinforced concrete	11
III.	**Specialized Repairs:** Electro chemical repair using re-alkalization and chloride extraction techniques, Specialized repairs for chemical disruption, fire, marine exposure etc, Repair of damaged structures of water retaining structures, hydraulic structures, Pavements and Runways, Tunnels,	11

	Bridges, Piers and Flyovers, Parking Garages, Underwater repair, Masonary Repair, Repair and Restoration of Heritage Structures	
IV.	**Retrofitting by Composite Materials:** Fiber reinforced concrete, Ultra-high performance fibre reinforced concrete (UHPFRC), Fiber reinforced composites, Carbon fibre reinforced polymer (CFRP), Fibre wrapping (Carbon, Aramide, Glass)	10
V.	**Seismic Retrofitting:** Seismic strengthening of existing RC structures, Use of FRP for retrofitting of damaged structures	08
VI.	**Post-Repair Maintenance of Structures:** Protection and Maintenance schedule against environmental distress to all those structures	04
VII.	Special care in repair and rehabilitation of heritage structures	03

Contribution to Outcomes

The students should acquire desired learning outcomes in cognitive, psychomotor and affective domain and thereby demonstrate the following outcomes:

- Assess the structural health and take a decision whether it needs the strengthening or not.
- Implement the various methods for strengthening columns, beams, slabs, footing, etc. in the field.
- Have a thorough understanding of the special repair materials and techniques.
- Retrofit the damaged structures using composite materials like UHPFRC, CFRP, etc.
- Understand the importance of the seismic retrofitting and employ the methods for the affected structures.
- Carry out the repair of the structures of heritage importance and maintain the same.

Theory examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately further; and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:-

The oral Examination shall be based upon the entire syllabus and the term work.

Term work:-

The term-work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and/or questionson each modules/ sub-modules and contents thereof, further.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report and the assignments. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments and the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1. Concrete Repair and Maintenance: *Peter H .Emmons* and *Gajanan M. Sabnis*, Galgotia Publication.
2. Repairs and Rehabilitation-Compilation from Indian Concrete Journal-ACC Publication.
3. Guide to Concrete Repair and Protection, HB84-2006, A joint publication of Australia Concrete Repair Association, CSIRO and Standards Australia.
4. CPWD hand book on Repairs and Rehabilitation of RCC buildings published by DG (Works), CPWD, Government of India (Nirman Bhawan), http://www.cpwd.gov.in/handbook.pdf
5. Guide to Concrete Repair, *Glenn Smoak*, US Department of the Interior Bureau of Reclamation, Technical Service Center, http://books.google.co.in
6. Management of Deteriorating Concrete Structures: *George Somerville*, Taylor and Francis Publication
7. Concrete Building Pathology: *Susan Macdonald*, Blackwell Publishing.
8. Testing of Concrete in Structures*: John H. Bungey, Stephen G. Millard and Michael G. Grantham*, Taylor and Francis Publication.
9. Durability of concrete and cement composites: *C.L.Page* and *M.M. Page*,Wood Head Publishing.
10. Concrete Repair, Rehabilitation and Retrofitting: *M. Alexander, H. D. Beushausen, F. Dehn* and *P. Moyo*, Taylor and Francis Publication.
11. Concrete Repair Manual, Volume I and II, Published jointly by ACI, BRE, Concrete Society, ICRI

Semester VIII

Subject Code	Subject Name	Credits
CE-E804	Elective II: Geo-synthetics and Reinforced Structures	5

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
04	02	--	04	01	--	05

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03	25	--	25	150

Rationale

The course introduces the students to the different types of geosynthetics, their manufacturing technique, testing methods and their applications in different types of civil engineering projects. Detailed design techniques and construction methods will also be covered in the course.

Objectives

To study the:

- types of geosynthetics.
- manufacturing techniques.
- physical, mechanical and hydraulic properties.
- reinforced soil retaining walls and slopes.
- foundations on reinforced soil.
- drainage and filtration applications of geosynthetics.

- pavements with geosynthetics.
- scope for use of geosynthetics in landfills.

Detailed Syllabus

Module	Sub - Modules/Contents	Periods
I.	**Introduction:** 1. Definition of geosynthetics. The terminology includes natural fibre materials such as coir, jute and hemp. 2. Historical background of geosynthetics. 3. Basic functions of geosynthetics and relevance to the environment. 4. Different types of geosynthetics (nonwoven and woven geotextiles, geogrids, geonets etc) and their exclusive functions and applications. 5. Pros and cons of geosynthetics in various functions and applications.	03
II.	**Polymers and Resins:** 1. Polymersfor geotextiles- Basis of polymers and resins, classification and types, brief manufacturing (PP/PE/PET (Polyester)/PA (Nylon) etc.), property comparison (physical, mechanical and weatherability etc.) and applications, influence of UV rays and stabilization. a. Environmental implications of use of these materials, recyclability and life cycle analysis. 2. Geosynthetic types and their manufacturing techniques: i. Geosynthetic types: Geotextiles, geogrids (knitted, woven, extruded), geonets, geomembranes, geosynthetics clay liners, geopipe, geofoam, geocomposites and geocells. ii. Filter type, yarn types and mechanical properties:Manmade and natural (jute/coir), monofilament, multifilament, staple fiber yarn, flat tape yarn and fibrillated tape yarn, stress-strain curves and linear density of yarns. iii. Geotextile types and their mechanical and functional properties: woven fabrics, nonwoven fabrics- staple fibre, spun bonded, thermal bonded; knitted and braided fabrics, functional properties	05

	of different fabrics.	
III.	**Testing Methods for Geosynthetics:** 1. Distinction between codes and standards, and guidelines. 2. The concept of quality assurance and quality control in geosynthetics. 3. Various international bodies that have come up with testing codes, standards and guidelines (BIS, ASTM, ISO, etc.). What is followed in India and why? 4. A brief on testing techniques(index and performance tests) for each of the following parameters and their application based significances: **a.**Basic physical properties including (but not limited to): i. Constituents of the material ii. Unit weight iii. Thickness, etc. iv. Apparent Opening Size **b.** Mechanical properties including i.Various strength characteristics, including significance of peak strengths, residual strengths as applicable ii. Elongations at break for tensile strengths iii. Tension module iv. Fatigue resistance v. Seam strengths vi. Puncture resistance vii. Tear resistance viii. Wetting and drying stability ix. Burst strength **c.**Connection tests for reinforced soil walls (RSW) **d.**Direct shear box i. Modified direct shear box ii. ASTM type **e.**Pull-out tests for RSW **f.**In-soil strength test	06

	g. Hydraulic properties i.Permittivity ii.Transmissivity **h.**Tests related to various reduction factors in design i. Installation damage ii. Durability from environmental considerations (chemical and biological) iii. Durability from exposure to UV considerations iv. Creep, including the conventional concept of time-temperature superposition and the Stepped Isothermal Method (SIM)	
IV.	**Reinforced Soil Retaining Walls and Slopes:** 1. Elements of a reinforced soil wall and function of each element, selection of each element, limit state approach, design principles, external and internal stability, codal provisions, FHWA and BS 8006, construction of RS walls, causes of failures, numerical example 2. Reinforced soil slopes, differences in design, modes of failure, example of a reinforced slope (desirable to use a software for design calculations).	13
V.	**Applications in Foundations:** Foundations on reinforced granular soils: reinforcement, failure mode (Binquet and Lee's approach), forces in reinforcement ties.	05
VI.	**Drainage and Filtration Applications of Geosynthetics** 1. Different filtration requirements, flow in plane of geosynthetics, flow cross plane of geosynthetics, apparent opening size, filter criteria, filtration in different types of soils and criteria for selection of geotextiles, estimation of flow of water in retaining walls, pavements, etc., and criteria selection of geosynthetics. 2. Erosion control, coastal protection, river bank protection, various methods for control.	04
VII.	**Geosynthetics in Pavements:** 1. Geosynthetics in unpaved roads – Giroud and Noiray approach	07

	(1981). 2. Geosynthetics in paved roads – Milligan, Houlbsy and others approach (1989-90). 3. Examples on unpaved and paved roads. 4. Reflective cracking applications. 5. Use in flexible pavements layers.	
VIII.	**Geosynthetics in Environmental Engineering and Landfills:** 1. Type of landfills, their functions and related environmental issues a. Municipal garbage landfills b. Construction debris fills c. Industrial landfills d. Ash ponds, slag dumps, etc. e. Ore tailings, such as copper, zinc, aluminum ores f. Specialty waste landfills including for toxic and bio-hazardous sold materials g. River and harbor dredging fills h. Radioactive waste dumps 2. The physical and chemical characteristics of solids, liquids (leachates) and gases generated by such landfills over time including toxicity, pH etc. 3. Identify the various components of landfills and the scope for use of geosynthetics and geocomposites for each of such functions.These could include but not be limited to: a. Slope stabilization including use of reinforced soil b. Providing an impervious blanket and its protection, containment systems c. Filtration d. Separation of various layers e. Erosion protection f. Reinforcement of above geosynthetics systems g. Chemical reaction of material of geosynthetics with the solid, liquid and gaseous products of the land fill, deterioration of various systems with time.	05

	4. Leachate collection systems 5. Design engineering of various systems	

Contribution to outcomes

This course will enable the students to recognize the major geosynthetics applications and their significance. They will be able to recognize the fundamental mechanism and principles in practical applications. They develop the knowledge of problem solving, analysis and design.

Theory examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately further; and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:-

The oral Examination shall be based upon the entire syllabus and the term work.

Term work:-

The term-work shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems and/or questions on each modules/ sub-modules and contents thereof, further. Following guidelines shall be resorted to while giving the assignments to the students.

Assignments:

- Pictures/sketches of various types of geosynthetics.

- Illustrate the practical applications of geosynthetics highlighting each of the basic functions.
- Essays on select testing procedures along with hand drawn sketches, highlighting the significance of such tests.
- Provide a case study and analysis and design of the entire landfill.

Tutorials:

- Physically show and explain the various documents of BIS, ASTM, ISO, etc.
- Take up simple design problems for various systems of landfills.
- Software modules- Geoslope, etc.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded for the various components depending upon its quality. The final certification and the acceptance of the term-work warrant the satisfactory and the appropriate completion of the assignments; and further, minimum passing marks to be obtained by the students.

The following weightage of marks shall be given for different components of the term work.

- Assignments : 20 Marks
- Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books (All latest edition):

1. Engineering Principles of Ground Modifications: *Manfred R. Hausmann*, Mcgraw Hill International.
2. Engineering with Geosynthetics, *Venkatappa Rao G*. and *SuryanarayanaRaju*, GVS, Tata McGraw Hill Publishing Co. Ltd.
3. Designing with Geosynthetics, *Koerner, R. M*., Prentice Hall, NJ.

4. Designing in Geosynthetics, *Ingold*.

References:

1. ASTM and Indian Standards on Geotextiles.
2. BS and FHWA Codes.
3. ASCE Journals.
4. Handbook on “Geosynthetics Case Studies of ITTA Members”- ITTA, Mumbai.
5. Handbook of Geotextiles- BTRA.

Semester VIII

Subject Code	Subject Name	Credits
CE-P805	Project – Part II	04

Teaching Scheme

Contact Hours	Credits Assigned
02 Hr Per Project Group	04

Evaluation Scheme

Term Work/ Oral		Total
TW	OR	
50	50	100

After completion of the work at the end of Semester VIII, the student shall compile the report in a standard format and written in the systematic manner and chapter wise.

The student shall adhere to the following scheme of chapterization while compiling the final report in general. The Guide/ Supervisor shall ensure the student has written the Dissertation Report in appropriate language (grammatically correct).

1. **Introduction:** The student shall give the introduction to the theme of the subject chosen as a Project/ Dissertation, give further current state of art related to the theme (i.e., brief review of literature), broad problem definition and scope of the work. The student shall also state at the end of this chapter the scheme of chapterization included in his/ her Dissertation.
2. **Theoretical Aspects/ Review of Literature:** The student is expected to highlight the various theoretical aspects pertaining to the topic chosen, literature (updated) available related to the various aspects of the topic chosen citing the research work carried out by the earlier researchers and summarize the findings of the literature. The student may state the precise the problem definition. If felt necessary, these two

aspects, i.e., theoretical aspects and review of literature can be compiled as separate chapters.

3. **Formulation/ Methodology/ Experimental Work:** In this chapter, the student is expected to explain the methodology for pursuing their work. In case of analytical work, students may give the formulation along with validation for assessment of accuracy of the numerical procedure being used/ proposed by them. In respect of experimental work, the students may outline the experimental set up/ procedure. In case of the work in which either approach is involved, the students may appropriately provide the methodology to cover either approach. This chapter may be supported by the Data Collection if the work involves the Collection of the Data and its subsequent processing.
4. **Analysis/ Results and Discussion:** The studentsare expected to present the results emerging from the analytical/ theoretical/ experimental study/ studies being pursued by them. The results shall be discussed properly. The results may be compared with the results published by the earlier researchers if the work being pursued by the students warrants the same. The students may indicate the broad conclusions/ inferences at the end.
5. **Summary and Conclusions:** Based on the results discussed in the previous chapter, the students shall give in the systematic manner the conclusions/ inferences emerged from the study and summarize it properly. The students shall indicate the scope of the future work which can be extended by any other students in the future. The students may point out the limitation/s left out in the work pursued by them while carrying out the work contained in the Dissertation.
6. **References:** The students shall at the end give the list of the references in the appropriate manner. This part should not be treated as a Chapter. For referencing style, student may refer any standard journal of national and international repute.
7. **Publication/s:** The student shall give the list of the technical/ research papers published/ accepted for publication in the referred journal/ conference proceedings. This part should not be treated as a Chapter.

Project Stage- II should be assessed based on following points:

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution

- Relevance to the specialization or current Research / Industrial trends
- Clarity of objective and scope
- Methodology for carrying out the work defined as a Problem Statement (Formulation in respect of the analytical studies/ Experimental Work / Combination thereof depending upon the nature of the work involved)
- Quality of work attempted
- Presentation of the results along with the validation of results or part thereof.
- Quality of Written Report and Oral Presentation
- Publication of the technical/ research paper by the student in a conference of National/ International repute. Publication of paper in a referred/ peer reviewed journal is highly preferred.

Project Stage- II shall be assessed through a presentation jointly by the Internal Examiner (Guide/ Supervisor) and External Examiner appointed by the University of Mumbai