

# **UNIVERSITY OF MUMBAI**



## **Bachelor of Engineering**

**Civil Engineering (Final Year – Sem.VII&VIII), Revised course**

**(REV- 2012) from Academic Year 2015 -16,**

**Under**

## **FACULTY OF TECHNOLOGY**

(As per Semester Based Credit Grading System)

# Preface

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) give freedom to affiliated Institutes to add few (PEO's) courseobjectives course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, developed curriculum accordingly. In addition to outcome based education, semester based credit grading system is also introduced to ensure quality of engineering education.

Semester based Credit Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Credit grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year Final Year Engineering in the academic years 2014-2015, 2015-2016, respectively.

**Dr. S. K. Ukarande**  
**Dean,**  
**Faculty of Technology,**  
**Member - Management Council, Senate, Academic Council**  
**University of Mumbai, Mumbai**

## **Preamble**

The engineering education in India in general is expanding in manifolds. Now, the challenge is to ensure its quality to the stakeholders along with the expansion. To meet this challenge, the issue of quality needs to be addressed, debated taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education reflects the fact that in achieving recognition, the institution or program of study is committed open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I am happy to state here that, Program Educational Objectives were finalized in a meeting where syllabus committee members were also present. The Program Educational Objectives finalized for undergraduate program in civil Engineering are as follows:

1. To prepare Learner's with a sound foundation in the mathematical, scientific engineering fundamentals
2. To prepare Learner's to use effectively modern tools to solve real life problems
3. To prepare Learner's for successful career in Indian Multinational Organisations to excel in Postgraduate studies
4. To encourage motivate Learner's for self-learning
5. To inculcate professional ethical attitude, good leadership qualities commitment to social responsibilities in the Learner's

In addition to above each institute is free to add few (2 to 3) more Program Educational Objectives of their own. In addition to Program Educational Objectives, course objectives expected course outcomes from learner's point of view are also included in the curriculum for each course of undergraduate program to support the philosophy of outcome based education. I believe strongly that small step taken in right direction will definitely help in providing quality education to the stakeholders.

**Dr. S. K. Ukarande**

**Chairman, Board of studies in Civil Engineering**

**University of Mumbai, Mumbai**

**University of Mumbai**  
**Scheme of Instructions and Examination**  
**Second Year Engineering (Civil Engineering)**  
**(With effect from 2013-2014)**  
**Semester III**

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned					
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total		
CE-C301	Applied Mathematics III *	4	--	--	4	--	--	4		
CE-C302	Surveying – I	3	2	--	3	1	--	4		
CE-C303	Strength of Materials	4	2	--	4	1	--	5		
CE-C304	Building Materials Construction	3	2	--	3	1	--	4		
CE-C305	Engineering Geology	3	2	--	3	1	--	4		
CE-C306	Fluid Mechanics – I	3	2	--	3	1		4		
CE-C307	Database Information Retrieval System*	--	4‡	--	--	2	--	2		
Total		20	14	--	20	7	--	27		
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-C301	Applied Mathematics III *	20	20	20	80	3	--	--	--	100
CE-C302	Surveying – I	20	20	20	80	3	25	--	25	150
CE-C303	Strength of Materials	20	20	20	80	3	25	--	25	150
CE-C304	Building Materials Construction	20	20	20	80	3	25	--	25	150
CE-C305	Engineering Geology	20	20	20	80	3	25	--	25	150
CE-C306	Fluid Mechanics – I	20	20	20	80	3	25	--	--	125
CE-C307	Database Information Retrieval System*	--	--	--	--	--	25	25		50
Total		120	120	120	480	--	150	25	100	875

‡ For the subject 'Database Information Retrieval System' although 4 (Four) clock hours are mentioned under the head of Practical, 2 (Two) clock hours out of these 4 (Four) clock hours may be utilized as the Theory at the Institute/ College level to impart the theoretical aspects of the said subject; accordingly, provision may be made in the Time Table. \*Course common for Civil, Mechanical, Automobile and Production Engineering.

**Semester IV**

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned					
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total		
CE-C401	Applied Mathematics – IV	4	--	--	4	--	--	4		
CE-C402	Surveying – II	3	3	--	3	1.5	--	4.5		
CE-C403	Structural Analysis – I	5	2		5	1	--	6		
CE-C404	Building Design and Drawing – I	2	3	--	2	1.5	--	3.5		
CE-C405	Concrete Technology	3	2	--	3	1	--	4		
CE-C406	Fluid Mechanics – II	3	2	--	3	1	--	4		
Total		20	12	--	20	6	7	26		
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-C401	Applied Mathematics – IV	20	20	20	80	3	--	--	--	100
CE-C402	Surveying – II	20	20	20	80	3	25	--	25*	150
CE-C403	Structural Analysis – I	20	20	20	80	3	25	--	25	150
CE-C404	Building Design and Drawing – I	20	20	20	80	4	25	--	25 <sup>#</sup>	150
CE-C405	Concrete Technology	20	20	20	80	3	25	--	25	150
CE-C406	Fluid Mechanics – II	20	20	20	80	3	25	--	25	150
Total		120	120	120	480	--	125	--	125	850

\*Oral & Practical    <sup>#</sup> Oral & Sketching

**University of Mumbai**  
**Scheme of Instructions and Examination**  
**Third Year Engineering (Civil Engineering)**  
**(With effect from 2014-2015)**  
**Semester V**

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned					
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total		
CE-C501	Structural Analysis – II	4	2	--	4	1		5		
CE-C502	Geotechnical Engg.– I	4	2	--	4	1	--	5		
CE-C503	Building Design and Drawing – II	1	4*	--	1	2	--	3		
CE-C504	Applied Hydraulics – I	4	2		4	1	--	5		
CE-C505	Transportation Engg. – I	4	2	--	4	1	--	5		
CE-C506	Business and Communication Ethics	-	4†	-	-	2		2		
Total		17	16	--	17	8		25		
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-C501	Structural Analysis – II	20	20	20	80	3	25	--	25	150
CE-C502	Geotechnical Engg. – I	20	20	20	80	3	25	--	25	150
CE-C503	Building Design and Drawing – II	20	20	20	80	4	25	--	25 <sup>#</sup>	150
CE-C504	Applied Hydraulics – I	20	20	20	80	3	25	--	--	125
CE-C505	Transportation Engg. – I	20	20	20	80	3	25	--	--	125
CE-C506	Business and Communication Ethics	--	--	--	--	-	25	--	25 <sup>**</sup>	50
Total		100	100	100	400	-	150	-	100	750

<sup>#</sup> **Oral and Sketching**

**\*\*Oral and Presentation**

\* For Building Design Drawing- II, although 4 (Four) clock hours are mentioned under the head of Practicals, 1 (One) clock hour out of these 4 (Four) clock hours may be utilized as the Theory at the College/ Institute level accordingly, provision may be made in the Time Table.

† For Presentation Communication Technique, although 4 clock hours are mentioned under the head of Practicals, 2 (Two) clock hours out of these 4 (Four) clock hours may be utilized as the Theory at the Institute/ College level accordingly, provision may be made in the Time Table.

**Semester VI**

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned					
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total		
CE-C601	Geotechnical Engg. – II	4	2	--	4	1	--	5		
CE-C602	Design and Drawing of Steel Structures	4	2	--	4	1	--	5		
CE-C603	Applied Hydraulics – II	3	2	--	3	1	--	4		
CE-C604	Transportation Engg. – II	4	2	--	4	1	--	5		
CE-C605	Environmental Engg – I	3	2	--	3	1	--	4		
CE-C606	Theory of Reinforced Prestressed Concrete	4	2	--	4	1	--	5		
Total		22	12	--	22	6	--	28		
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-C601	Geotechnical Engg. – II	20	20	20	80	3	25	--	25	150
CE-C602	Design and Drawing of Steel Structures	20	20	20	80	4	25	--	25 <sup>@</sup>	150
CE-C603	Applied Hydraulics – II	20	20	20	80	3	25	--	25	150
CE-C604	Transportation Engg. – II	20	20	20	80	3	25	--	25	150
CE-C605	Environmental Engg. – I	20	20	20	80	3	25	--	--	125
CE-C606	Theory of Reinforced and Prestressed Concrete	20	20	20	80	3	25	--	25	150
Total		120	120	120	480		150		125	875

<sup>@</sup>Oral and Sketching

**University of Mumbai**  
**Scheme of Instruction and Examination**  
**Fourth Year Engineering (Civil Engineering)**  
**(With effect from 2015-2016)**  
**Semester VII**

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned					
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total		
CE-C701	Limit State Method for Reinforced Concrete Structures	4	2	--	4	1	--	5		
CE-C702	Quantity Survey Estimation and Valuation	4	2	--	4	1	--	5		
CE-C703	Irrigation Engineering	4	2	--	4	1	--	5		
CE-C704	Environmental Engineering – II	4	2	--	4	1	--	5		
CE-E705	Elective – I	4	2	--	4	1	--	5		
CE-P706	Project – Part I	--	4	--	--	2	--	2		
Total		20	14	--	20	7	--	27		
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-C701	Limit State Method for Reinforced Concrete Structures	20	20	20	80	3	25	--	--	125
CE-C702	Quantity Survey Estimation and Valuation	20	20	20	80	4	25	--	25	150
CE-C703	Irrigation Engineering	20	20	20	80	3	25	--	25	150
CE-C704	Environmental Engineering – II	20	20	20	80	3	25	--	25	150
CE-E705	Elective – I	20	20	20	80	3	25	--	25	150
CE-P706	Project – Part I	--	--	--	--	--	50	--	25 <sup>@</sup>	75
Total		100	100	100	400	--	175	--	125	800

<sup>@</sup> Seminar on Project (Internal)



**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 <sup>#</sup>	100
Total		80	80	80	320		150	--	150	700

<sup>#</sup> 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

<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE–C701	Limit State Method for Reinforced Concrete Structure	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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	--	--	125

<b>Rationale</b>
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The limit state method (LSM) is based on the statistical probability which provides the rational solution to the design problem. The philosophy lies behind LSM uses multiple safety factors format which attempts to provide adequate safety at the ultimate load as well as adequate serviceability at service load by considering all possible limit states. The ultimate load method (ULM) proportions the structural element in such a way that the elements withstand the ultimate load, which is obtained by enhancing the service load by some factor referred to as the load factor, for giving a desired margin of safety. The ULM, thus, ensures safety but disregards the serviceability aspects, whereas the LSM ensures the safety at the ultimate load and serviceability at the working load rendering the structure fit for its intended use. The subject involves the application of limit state method in the analysis and design of various elements of the civil engineering structures such as beams, column, slab and footing. The application of the concept of Ultimate Load Method in the limited extent, i.e., for the flexural members like beams also forms a part of the course.

## Objectives

1. To develop the clear understanding amongst the students of the concepts of the design of reinforced concrete structure using ULM and LSM.
2. To study the various clauses of IS: 456-2000 and its significance in the RCC design.
3. To apply the concepts of ULM in the analysis and design of beams.
4. To apply the concepts of LSM in the analysis and design of beams, slabs, columns and footings.

## Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
<b>I.</b>	<b>Ultimate Load Method:</b> Brief introduction to fundamentals of ultimate strength theory: curved stress distribution, compressive stress block, simplified rectangular stress block as per Whitney's approach, ultimate moment of resistance of singly reinforced section and doubly reinforced sections.	05
<b>II.</b>	<b>Limit State Method :</b> Introduction to limit state method of design as per IS 456 (latest edition): concepts of probability and reliability, characteristic loads, characteristic strength, partial safety factors for loads and materials, introduction to various limit states.	04
<b>III.</b>	<b>Limit State of Collapse – Flexure:</b> Limit state of collapse in flexure, shear and Limit state of serviceability in deflection and cracking, design of singly and doubly reinforced rectangular and T sections for flexure, design of members in shear and bond, design of beam subjected to bending and torsion. Requirements governing reinforcement detailing.	17
<b>IV.</b>	<b>Design of Slabs:</b> Design of one way and two way slabs	07
<b>V.</b>	<b>Limit State of Collapse – Compression:</b> Limit state of collapse compression for short and slender column. Members subjected to combined axial and uni-axial as well as biaxial	08

	bending. Development of interactive curves and their use in column design.	
<b>VI.</b>	<b>Design of Foundations:</b> Isolated square and rectangular footings subjected to axial load and moments. Design of combined rectangular pad footings, slab beam type footing and strap footing.	11

<b>Contribution to Outcomes</b>
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On successful completion of the course, the student shall be able to:

1. Understand the pros and cons of the ULM and LSM vis-à-vis Working Stress method (WSM), covered in Semester VI.
2. Understand the various clauses specified in IS: 456-2000 for designing structural members with the safety and economy.
3. Understand the application and effectiveness of the LSM to the considerable extent along with the application of ULM in the limited extent.

**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.

**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 three problems and/ or questions on each modules/ sub-modules or 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. Design of Reinforced Concrete Structures: *Dayaratnam, P*; Oxford and IBH.
2. Limit State Design – Reinforced Concrete: *Jain A. K*, Nemchand and Bros., Roorkee
3. Limit State Design – Reinforced Concrete: *Shah and Karve*, Structure Publications, Pune.
4. Ultimate Strength Design for Structural Concrete: *Arthur, P. D.and Ramakrishnan, V.*, Wheeler and Co. Pvt. Ltd.
5. Limit State Theory of Reinforced Concrete Design: *Huges, B. P.*, Pitman.
6. Reinforced Concrete: *Warner, R. F., Rangan, B. C.and Hall, A. S.*, Pitman.
7. Reinforced Concrete: *H.J. Shah*, Charotar Publishers, Anand.
8. Fundamentals of Reinforced Concrete: *Sinha and Roy*, S. Chand and Co. Ltd.
9. Illustrated Reinforced Concrete Design: *Dr. V. L. Shah and Dr. S. R. Karve*, Structure Publications, Pune.
10. Reinforced Concrete Design: *Wang, C. K., Salmon, C. G., and Pincheira, J. A*,

John Wiley(2007), 7<sup>th</sup> Edition.

11. Reinforced Concrete Fundamentals: *Ferguson, P. M., Breen, J. E., and Jirsa, J. O.*, John Wiley andSons (1988) 5<sup>th</sup> Edition.
12. RCC Design (WSM and LSM): *Punmia, B. C.,Jain, A. K., and Jain, Arun, K.*, Laxmi Publications.
13. Limit State Design of Reinforced Concrete (as per IS: 456-2000): *Punmia, B. C., Jain, A. K., and Jain, Arun, K.*,Laxmi Publications.
14. Design and RCC structural Elements (RCC Vol-I): *Bhavikatti, S. S.*,New Age International Publications.

<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-C702	Quantity Survey Estimation and Valuation	05

### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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	

<b>Rationale</b>
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Any structure, i.e., building, bridge, dam etc. consists of various building materials. Due to rise in the cost of materials, the structure has to be designed so that it is safe, serviceable and economical. Without proper design and estimation, it may lead to the increase in cost of construction and it further affects the economical aspect of the structure. A prior knowledge of various building materials is required for the construction and it controls the cost of the structure, save wastage of labour-hours and eventually helps in giving the correct amount required and quantity of various materials required. It also helps in scheduling of men, materials and machine to be used in the project at stages. The scope of the subject includes estimating, costing, analysis of rates, specification, valuation, tender and contracts etc.

<b>Objectives</b>
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- To read, understand and interpret plans, sections, detailed drawings and specifications for a construction project.



- To study the various methods of detailed and approximate estimates.
- To emphasize the importance of relevant IS: 1200- 1964 codes and relevant Indian Standard specifications, taking out quantities from the given requirements of the work, and drafting specifications.
- To conduct a material and labour survey to understand the current market rates for the various materials required for construction and the different categories of labour required.
- To perform the rate analysis for various items: standard and non-standard and the use of DSR in this process.
- To study the process of tendering and its various stages, various types of contracts, its suitability and validity as per the Indian Contract Act of 1872 and draft various clauses and conditions of a contract.
- To study the arbitration process.
- To study assessment of the value of a property.

### Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
<b>I.</b>	<b>Estimates:</b> Various types, their relative importance, factors to be considered, 14 complete set of Estimate. Approximate estimates: importance, purpose, different methods. Use of CBRI Equations for the same. Methods of preparation of estimates for projects such as: i) Building R.C.C., Load bearing ii) Road iii) Cross drainage work iv) Factory shed including steel truss	18
<b>II.</b>	<b>Measurements for various items:</b> Use of relevant Indian Standard Specifications for the same, taking out quantities from the given requirements of the work, comparison of different alternatives, Bar bending schedules, Mass haul Diagrams	06
<b>III.</b>	<b>Material survey:</b> Approximate estimates of requirement of various materials for	05

	building works, percentage breakup of the cost, cost sensitive index, market survey of basic materials	
<b>IV.</b>	<b>Specifications:</b> Types, requirements and importance, detailing of specifications for various items	03
<b>V.</b>	<b>Rate analysis:</b> Purpose, importance and necessity of the same, factors affecting, task work.	06
<b>VI.</b>	<b>Tender:</b> Preparation of tender documents, importance of inviting tenders, contract types, relative merits, prequalification. general and special conditions, termination of contracts, extra work and items, penalty and liquidated charges, Settlement of disputes, R.A. Bill and Final Bill, Payment of advance , insurance, claims, price variation, etc.	06
<b>VII.</b>	<b>Valuation:</b> Different terms used the role of a valuer, purpose and necessity of the same. Capitalized Value, Years purchase, sinking fund, depreciation, types of values, Purpose of valuation. Different methods of valuation for 1. open plots. 2. open plots with existing residential and commercial structures 3. lease hold properties Use of valuation tables and formulae	08

### Contribution to Outcomes

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

- Read, understand and interpret plans, sections, detailed drawings and specifications for a construction project.
- Prepare approximate and detailed estimates based on the quantity survey of the available general and detailed drawings.
- Draft specifications, make bar bending schedules and draw mass haul diagrams.

- Have knowledge about the current market rates for labour and material required for construction, perform rate analysis and compare with DSR.
- Draft tenders, prepare valid contract documents.
- Understand the process of arbitration.
- Understand the role of a valuer and assess the value of a property.

### **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 or 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 on the entire syllabus and the term work.

### **Term Work:**

The term work shall consist of the following:

1. An approximate estimate of a multistoried building by approximate method.
2. Detailed estimate of any **four** of the following with the required material survey for the same.
  - a) a single storeyed building (RCC)
  - b) a bridge with minimum 2 spans
  - c) a factory building
  - d) a road work
  - e) a cross drainage work
  - f) a load bearing structure

3. Valuation report in a standard format of the Government/ Private company/Firm.
4. Assignments on rate analysis, market survey, specifications and simple estimates.
5. Detailed estimate of a minor structure.
6. Bar bending schedule.

The use of quantity survey software and the use of worksheets / databases while solving some of the afore-mentioned assignments is desirable.

### **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. Estimating, Costing Specifications and Valuation: *Chakraborty, M.*, Kolkata.
2. Building and Engineering Contracts: *Patil, B. S.*, University Press, Hyderabad.
3. Estimating and costing: *Datta, B. N.*, UBS Publications
4. Relevant Indian Standard Specifications, BIS Publications
5. World Bank approved contract documents

<b>Semester VII</b>
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Subject Code	Subject Name	Credits
CE-C703	Irrigation Engineering	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

<b>Rationale</b>
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India is an agricultural country where majority of population lives in villages so agricultural industry is the backbone of Indian economy. Being a tropical country with large temporal and spatial variation of rainfall and availability only for three to four months irrigation is strongly needed in India. To satisfy this need enhancing the irrigation facilities in the country is required. This subject provides necessary knowledge about survey for investigation, hydrology for calculation of yield from rainfall, designing the storage capacity, planning design and constructions of important irrigation structures like dams, weirs, cross drainage works and canal structures. This subject is also useful to the students with respect to facts, concepts, principles and procedures related to irrigation structures so that they can effectively plan and execute these structures.

<b>Objectives</b>
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1. To collect the data for irrigation system.
2. To calculate the yield from catchments.

3. To calculate the capacity of Canals.
4. To calculate the storage capacity of reservoirs.
5. To find out and fix the control levels of reservoirs.
6. To decide the section of Dams, Weirs and Barrages.
7. To classify the Canals and design the Canals.
8. To classify different irrigation systems.

### Detailed Syllabus

Module	Sub- Module/Content	Periods
<b>I</b>	<b>Introduction:</b> Definition of irrigation, water resources in India, development of irrigation in India, need of irrigation in India, Benefits of irrigation, ill effects of irrigation, irrigation systems: major, medium and minor irrigation projects, command area development, impact of irrigation on environment, national water policy.	4
<b>II</b>	<b>Water requirement of crops:</b> Crops and crop seasons in India, cropping pattern, duty and delta. Quality of irrigation water. Soil water relationship: soil characteristics significant from irrigation considerations, root zone soil water, infiltration, consumptive use, irrigation requirement, frequency of irrigation. Methods of applying water to the fields: surface, sub-surface, micro irrigation: sprinkler irrigation, drip irrigation.	8
<b>III</b>	<b>Hydrology:</b> Hydrologic cycle, Precipitation: Types of precipitations, measurement of rainfall by rain gauges, stream flow measurement, runoff, factors affecting runoff, computation of runoff, yield of the catchment runoff hydrograph, runoff computations, flood discharge and calculations, unit hydrograph, application of unit hydrograph, methods of deriving unit hydrograph, S-hydrograph.	9

<b>IV</b>	<b>Ground water and well hydraulics:</b> Ground water resources, occurrence of ground water, methods of ground water exploration, well irrigation. Well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifer, aquifer tests, design of water wells.	7
<b>V</b>	<b>Investigation and reservoir planning</b> Selection of site for reservoir, zones of storage reservoir, capacity elevation and area elevation curve of reservoir site, control levels, fixation of control levels, reservoir sedimentation, methods of control of sedimentation.	4
<b>VI</b>	<b>Dams:</b> Introduction, classification. Gravity dams: forces acting on gravity dam, modes of failure, stability analysis. Design, galleries, joints. Keys, water seals. Earth and rock-fill dams: types, causes of failure, seepage analysis, stability analysis, design, rock-fill dams. Arch and buttress dams: types. Spillways and types of spillways, other energy dissipating devices: types.	12
<b>VII</b>	<b>Distribution systems:</b> Canal systems, alignment of canals, canal losses, estimation of design discharge. Bandhara Irrigation. Canal outlets: non-modular, semi-modular and modular outlets. Waterlogging: causes, effects and remedial measures. Lining of canals: economics of lining. Drainage of irrigated land: necessity, methods, Canal regulation works. Cross drainage works and its types.	8

### Contribution to Outcomes

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

1. Calculate the demand of water required for agricultural land
2. Understand basic requirements of irrigation and how can they be managed
3. Apply their knowledge on ground water, well hydraulics to estimate the safe yield and ground water potential
4. Perform analysis and design of various Irrigation systems including hydraulic structures
5. Carry out design of water resources projects independently.

**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, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module or 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 will 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 sub-modules and contents thereof further.

**Distribution of the Term Work Marks:**

The marks of the term work shall be judiciously awarded depending upon its quality. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the report of the assignments; and the minimum passing marks to be obtained by the student. 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 Water Resources and Water Power Engineering: *P.N. Modi*, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
2. Irrigation Engineering and Hydraulic Structures: *S. K. Ukarande*, Ane's Books Pvt. Ltd. (Abridged Edition 2015), ISBN 9789383656899
3. Irrigation and Water Power Engineering: *B.C. Punmia, Pande, B.B. Lal, A.K Jain*. Laxmi Publications Pvt, Ltd. New Delhi.
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 and Bros., Roorkee
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 Bros. Roorkee
10. Concrete Dams: *R. S. Varshney*, Oxford and IBH Publishing Co.

<b>Semester VII</b>
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Subject Code	Subject Name	Credits
CE-C704	Environmental Engineering - II	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	

<b>Rationale</b>
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Every civil engineer must be acquainted with the principles of public health engineering, design of waste water collection and treatment systems; and develop rational approaches towards sustainable waste management via appropriate treatment and reuse. The course deals with the overall features and study of treatment of sewage processes. The course lays emphasis on complete update of the knowledge of these processes related to design of treatment plant.

<b>Objectives</b>
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- To understand and explain the role of sanitation in the urban water cycle and its relation to public health and environment.
- To develop rational approaches towards sustainable wastewater management via pollution prevention.

- To understand the relevant physical, chemical and biological processes and their mutual relationships within various sanitation components.
- To contribute to the development of innovative approaches to the provision of adequate and sustainable sanitation services in the country.
- To study the appropriate treatment, Reclamation and resource recovery and re-use at both centralized and decentralized levels.

### Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
<b>I.</b>	<b>Sewage Generation, Collection and Conveyance</b>	12
	<b>Introduction :</b> Need for sewerage system, Domestic sewage, Industrial waste and Storm Water- Quantification and design. Definitions: sewage, sullage, sewerage, Conservancy and water carriage system Systems of sewerage and their layouts : Separate, Combined and partially combined system, Merits and demerits ,Patterns of sewerage layout, Quantity of sewage, dry weather flow	
	<b>Conveyance of sewage:</b> Sewer: Shapes and materials of sewers, open drains, Design of sewers: SEWER SIZE, Determination of velocity of flow using empirical formulae, limiting velocities. Laying and testing of sewers Sewer joints, Sewer appurtenances, Ventilation of sewers. Construction and Maintenance of sewers. Pumping of sewage: Types, selection of pumps, Pumping station	
<b>II.</b>	<b>Primary Treatment of sewage:</b> Need for Analysis, Characteristics of sewage: Composition, Biochemical characteristics, aerobic decomposition, anaerobic decomposition, Sampling of sewage, Analysis of sewage. Treatment processes: Objective, methods of treatment, flow sheets showing Preliminary, Primary, Secondary and Tertiary treatment.	10

	Screens, Grit chamber, Primary and secondary clarifier. Design of primary treatment units.	
<b>III.</b>	<p><b>Secondary treatment methods:</b></p> <p>Principles, Trickling filter, Activated sludge process, recirculation, hydraulic design of trickling filter and activated sludge process, Sludge volume index, Operational problems in trickling filter and activated sludge process, Aerated lagoons, Rotating Biological contractors, Stabilization Ponds, UASB . Design of secondary treatment units</p> <p><b>Sludge treatment and disposal:</b></p> <p>Sludge Digestion: Principles of anaerobic digestion, quantity and characterization of sludge, design of sludge digestion tanks, disposal of digested sludge, drying beds.</p> <p><b>Sewage disposal :</b></p> <p>Discharge of Raw and treated sewage on land and water, standards for disposal.</p> <p><b>Self-purification of natural water bodies:</b></p> <p>Oxygen economy, Numericals on BOD, Sewage farming. Disposal of treated effluent</p>	16
<b>IV.</b>	<p><b>Reclamation and Reuse of Waste water :</b></p> <p>Tertiary treatment for removal of residual organics, removal of nutrients, recycling and reuse of wastewater.</p>	04
<b>V.</b>	<p><b>House drainage and Environmental sanitation</b></p> <p><b>Plumbing :</b> basic principles, Plumbing regulations, preliminary data for design, Preparation and submission of plans, Plumbing fixtures , materials used for plumbing system, systems of plumbing, antisiphonic and vent pipes.</p> <p><b>Low cost sanitation:</b> Septic tanks, Imhoff tanks- Principles, Operation and suitability, Design.</p>	06
<b>VI.</b>	<p><b>Environmental Pollution:</b> Air-Composition and properties of air, Quantification of air pollutants, Monitoring of air pollutants, Air pollution- Occupational hazards, Urban air pollution automobile pollution, Chemistry of combustion, Automobile engines, quality of</p>	04

	fuel, operating conditions and interrelationship. Air quality standards, Control measures for Air pollution, construction and limitations, <b>Noise</b> -Basic concept, measurement and various control methods. Thermal pollution.	
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<b>Contribution to Outcomes</b>
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Having completed this course the students shall ensure the safe handling and treatment of wastewater and sewage. The students shall be able to conduct quality control tests on samples obtained from sewer water, soil, nearby rivers and groundwater. Further, the students shall be able to design the treatment facilities and assess the guidelines for disposing of waste. Lastly, they shall be able to formulate approaches to treat waste water in most effective manner.

**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, 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.

**List of Practical** (*At least eight to be performed*)

1. Measurement of Noise level
2. Determination of chlorides
3. Determination of pH of sewage
4. Determination of Total Solids, suspended solids, dissolved solids, volatile solids
5. Determination of Dissolved oxygen
6. Determination of Bio chemical Oxygen Demand of sewage sample
7. Determination of Chemical Oxygen Demand of sewage sample
8. To find Sludge Volume Index (SVI) of sewage sample.

9. Measurement of air quality standard by High volume sampler
10. Plumbing demonstration of accessories, fittings and fixtures.

**Site Visit:**

The students will visit the Sewage Treatment Plant in the nearby vicinity or in the city and prepare detailed report thereof. This report will form a part of the term work.

**Oral Examination:-**

Oral examination will be based on entire syllabus and the term work.

**Term Work:**

The term-work shall comprise of the neatly written report based on the experiments performed in the laboratory and the 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. A detailed report on the visit to sewage treatment plant will also be submitted as a part of the term work.

**Distribution of the 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 performance of the experiments by the student, properly compiled report thereof along with the assignments and the report on the site visit; and the 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. Report of the Experiments: 08 Marks
2. Assignments: 08
3. Report on the visit to Sewage Treatment Plant : 04 Marks
4. 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

Demonstration of available software for design of sewage treatment plant and sewer network is to be done.

**Recommended Books:**

1. Environmental Engineering (Vol. II): *Garg, S. K.*, Khanna Publishers, New Delhi.
2. Water supply and Sanitary Engineering: *Hussain, S. K.*, Oxford and IBH Publication, New Delhi.
3. Plumbing Engineering, Theory and Practice: *Patil, S. M.*, Seema Publications, Mumbai.
4. Environmental Engineering: *Punmia, B. C.*, Laxmi Publications, New Delhi
5. Air pollution: *Rao, M. N.*, Tata Mc-Graw Hill Publishers, New Delhi
6. Environmental Engineering: *Peavy, H. S., Rowe D. R. and Tchobanoglous G.*; Tata-Mcgraw Hill, 1991.
7. Wastewater Engineering Treatment, Disposal, Refuse: *Metcalf and Eddy*, Tata McGraw Hill Publishers, New Delhi, 1995.
8. Water Supply and Sewerage: *Steel, E.W.*
9. Introduction to Environmental Engineering: *P. Aarne Vesilind*, PWS Publishing Company, 2000
10. Introduction to Environmental Engineering : *P. Aarne Vesilind, Susan M. Morgan, Thompson /Brooks/Cole*; Second Edition 2008
11. Manual on Wastewater Treatment: CPH and Env. Engg. Organization (3<sup>rd</sup> Ed.), Ministry of Urban Development, Govt. of India, New Delhi, 1991.
12. CPHEEO Manual on Sewage and Treatment
13. Relevant Indian Standard Specifications

<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-E705	Elective-I: Advanced Surveying	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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

<b>Rationale</b>
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This is an advanced course dealing in modern surveying instruments such as Total Station, Electronic Theodolite and Electronic Distance Measuring (EDM) Instruments. This subject also includes the study of GPS (Global Positioning System) for navigation and positioning including the applications of GIS (Geographic Information System). Detailed study of Photogrammetry and its geometrical considerations are taken into account. Advanced surveying also includes Remote Sensing and image interpretation techniques along with field astronomy and hydrographic surveying.

<b>Objectives</b>
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- To study traversing using Total Station.
- To establish Waypoints/ Networks using GPS receivers.
- To demonstrate GIS software
- To Measure the Relief Displacement using Mirror Stereoscope.



## Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
<b>I.</b>	<b>Modern Surveying Equipment:</b> Data and equipment needed for engineering projects. Review of traditional surveying equipment. Changing scene in surveying and mapping, maps substitutes, use and advantage of modern surveying equipment in project. Modern surveying electronic equipment, their principles, construction, working and use - Electronic Theodolite, E.D.M. Instruments - Distomat, Total station. Application of lasers in distance and angular measurements. Introduction of electronic navigation and position fixing. Different systems and their characteristics.	09
<b>II.</b>	<b>Global Positioning System:</b> Introduction to navigation and positioning, Geodesy; geospatial reference systems, overview of GPS; GPS segments, 2D and 3D positioning, GPS error sources and handling, GPS applications.	06
<b>III.</b>	<b>Geographic Information System:</b> Geographic Information System (GIS) - Definition of GIS, Geographical concepts and terminology, Components of GIS, Data acquisition, Raster and vector formats, scanners and digitizers. Advantages of GPS and GIS in the storage of thematic information extracted from remotely sensed images.	08
<b>IV.</b>	<b>Photogrammetry:</b> Definition of photogrammetric terms, geometry of aerial and terrestrial photographs, aerial camera and photo theodolite, scales of photographs, tilt and height displacements, stereoscopic vision and stereoscopes, height determination from parallax measurements, flight planning, maps and map substitutes and their uses.	08

<b>V.</b>	<b>RemoteSensing:</b> Introductionand definitionofremotesensingterms,remote sensingsystem,principlesofremotesensing,InteractionofEMR, Fundamentals of aerial photography, platforms and orbits, sensors, data products, principles of visual interpretation, principles and uses; thermal remotesensitize, microwave remotesensing.	08
<b>VI.</b>	<b>ImageInterpretation:</b> Principles of interpretation of aerial and satellite images, equipments and aids required for interpretation, ground truth- collection and verification, advantages of multi date and multi band images, digital image processing; introduction, image enhancement techniques, digital image classification.	07
<b>VII.</b>	<b>FieldAstronomy:</b> Terms, coordinate systems, hour angle, right declination, altitude, and azimuth: study of astronomical charts, deter latitude and bearing by observation on the sun and pole star, time, standard time, local time, universal time, equation of time.	03
<b>VIII.</b>	<b>HydrographicSurveying:</b> Uses, Method of hydrographic surveys, mean sea- level, tide gauges, sounding equipments, location of soundings, the capacity of reservoir, stream gauging	03

### Contribution to Outcomes

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

1. Use modern surveying instruments.
2. Use GPS receivers.
3. Demonstrate GIS software.
4. Use Mirror Stereoscope.

### 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 the practical performed either in the laboratory or on the field as well as 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 term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on the practical performed and assignments. The final certification and acceptance of 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.

- Report of the Practical/ Field Studies : 10 Marks
- Assignments : 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. Highersurveying:*A.M.Chandra*, NewAgeInternationalpublishers.
2. Highersurveying:*B.C.Punimia,AshokJoin,ArunK.Jain*, LaxmiPublications(P), Ltd.
3. Geographic Information System and Science: *Longley, Paul A., Michael F. Goodchild, David J. Maguire, David W. Rhind*, John Wiley and Sons, New York (2<sup>nd</sup> Ed.), 2005
4. ModelingOurWorld:TheESRIGuidetoGeodatabaseDesign:*Zeiler,M*.ESRI Press,Redlands,California, 1999.
5. GIS,SpatialAnalysis,andModeling:Maguire,*D.,M.Batty,andM.Goodchild*.2005. ESRIPress(070.212.05842005)
6. GlobalPositioningSystem:Signals,Measurements,andPerformance,*PratapMisraandPerr Enge*(2<sup>nd</sup> Ed.), 2006.
7. RemoteSensingPrinciplesand Interpretation: *Floyd,F.Sabins,Jr.,FreemanandCo.*,San Fransisco,1978.
8. RemoteSensingandImageInterpretation:*LillesandandKiefer*.,JohnWiley,1987.
9. A Remote Sensing Perspective: Introductory Digital Image Processing:*John,R. Jensen*, PrenticeHall.
10. ImagingRadarforResource Survey:Remote SensingApplications:*W.Travelt*,Chapman andHall.

<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-E705	Elective-I: Rock Mechanics	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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

<b>Rationale</b>
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There are several structures such as foundations, dams, rock slopes, tunnel, hydroelectric and energy generating plants, mines, etc. which are built directly on or in rock masses. The design of structures depends on the rock mass properties and the interaction between the rock and the structure. This demands the study of mechanics applied to rocks and engineering activity involving rocks. The course is an interdisciplinary course with applications in geology and geophysics, mining, petroleum and geotechnical engineering.

<b>Objectives</b>
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1. To study the structural geology and classification of rock masses
2. To study the stress distribution and stress - strain behaviour of rocks
3. To study bearing capacity of rocks
4. To study the stability of rock slopes and openings in rocks

5. To study the rock bolting and grouting.

**Detailed Syllabus**

<b>Module</b>	<b>Sub-Modules/ Contents</b>	<b>Periods</b>
<b>I.</b>	<b>Structural Geology of Rocks:</b> Introduction	04
<b>II.</b>	Subsurface Investigations in Rocks and Engineering Characteristics of Rock Masses	04
<b>III.</b>	<b>Engineering Classification of Rocks and Rock Masses:</b> Classification of intact rocks, rock mass classifications {rock quality designation, rock structural rating, geomechanics classification (RMR)}, strength and modulus from classifications, classification based on strength and modulus, geo-engineering classification, Deere and Miller's Engineering Classification.	06
<b>IV.</b>	<b>Stress Distribution in Rocks:</b> Field and Laboratory Tests on Rocks	07
<b>V.</b>	<b>Strength, Modulus and Stress-Strain Responses of Rocks:</b> Factors influencing rock responses, strength criteria for isotropic intact rocks, modulus of isotropic intact rocks with confining pressure, uni-axial compressive strength of intact anisotropic rocks, strength due to induced anisotropy in rocks, compressive strength and modulus from SPT, stress- strain models (constitutive models, elastic stress-strain model, elasto-plastic stress-strain model, equivalent material concept), influence of intermediate principal stress.	07
<b>VI.</b>	<b>Bearing Capacity of Rocks:</b> Estimation of bearing capacity (foundation on intact rock, heavily fractured rock, UBC with Hoek-Brown criterion, foundation on slope), stress distribution in rocks, factor of safety, strengthening measures (concrete shear keys, bored concrete piles, tensioned cable anchors, concrete block at toe), settlement in rocks (from joint factor, for horizontal joints, from field tests).	07
<b>VII</b>	<b>Stability of Rock Slopes:</b>	06

	Modes of failure, rotational failure, plane failure, wedge method of analysis, buckling failure, toppling failure, improvement of slope stability and protection.	
<b>VIII</b>	<b>Opening in Rocks:</b> Introduction to theory of elasticity, lined and unlined tunnels, pressure tunnels and tunnels for other purposes.	06
<b>IX</b>	<b>Rock Bolting and Grouting:</b> Grouting in rocks, objectives, contact grouting, consolidation grouting, process of grouting, grout requirement, types of grout, stage grouting, grout curtain.  Rock bolts, rock bolt types and applications, theory of rock bolting, rock anchors, modes of failure, uplift capacity.	05

### Contribution to Outcomes

On successful completion of the course, the students shall develop an ability to identify, formulate and solve rock associated problems. They are further expected to acquire the knowledge about the latest trends and methodologies for understanding rock mechanics and engineering.

#### 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 the 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 term-work shall be judiciously awarded depending upon the quality of the term work. 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. Fundamentals of Rock Mechanics: *J. C. Jaeger and N. G. W. Cook*, Oxford Press.
2. Rock Mechanics and Design of Structures on Rock: *Obert, Leon and W. I. Duvall*.
3. Rock Mechanics in Engineering Practice: *K. G. Stagg and O. C. Zienkiewicz*, John Willey and Sons, New York.
4. Rock Mechanics – Vol. I and II: *Jumukis*, Trans Tech Publication, USA.



<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-E705	Elective-I: Applied Hydrology and Flood Control	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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

<b>Rationale</b>
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This subject deals with the various processes involved in hydrological cycle and provides in depth understanding of the theories and concepts of surface, subsurface and ground water hydrology. It also explains the application of hydrographs, unit hydrographs and further describes various techniques of estimating stream flows.

<b>Objectives</b>
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1. To study the various processes involved in the hydrological cycle.
2. To study the Measurement of rainfall, computation of average rainfall, various water losses etc.
3. To study the hydrograph and unit hydrographs, applications of unit hydrograph concept.
4. To study various flood control methods, estimate design flood, and flood routing.

5. To study the concepts of ground water movement, steady and unsteady flow towards fully penetrating wells and well yields.

<b>Detailed Syllabus</b>
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Module	Sub-Modules/ Contents	Periods
<b>I.</b>	<b>Introduction:</b> Hydrological cycle, scope of hydrology, water budget equation, sources of data.	2
<b>II.</b>	<b>Precipitation:</b> Measurement of precipitation, network of rain gauges and their adequacy in a catchment, methods of computing average rainfall, hyetograph and mass curve of rainfall, adjustment of missing data, station year method and double mass curve analysis, Depth-Area - Duration relationship, Intensity-Duration -Frequency relationship, Probable Maximum Precipitation.	5
<b>III.</b>	<b>Abstractions from Precipitation:</b> Evaporation and transpiration, evapotranspiration, interception, depression storage, infiltration and infiltration indices, determination of water losses.	3
<b>IV.</b>	<b>Stream Flow Measurement:</b> Measurement stream-flow by direct and indirect methods, measurement of stage and velocity, area-velocity method, stage-discharge relationships, current meter method, pitot tube method, slope-area method, rating curve method, dilution technique, electro-magnetic method, ultrasonic method.	6
<b>V.</b>	<b>Runoff:</b> Catchment, watershed and drainage basins, Factors affecting runoff, rainfall-runoff relationship, runoff estimation, droughts.	4
<b>VI.</b>	<b>Hydrograph Analysis:</b> Characteristics, base <i>flow</i> separation, unit hydrograph, S-hydrograph, complex hydrograph, synthetic hydrograph, dimensionless unit hydrograph, Instantaneous unit hydrograph.	14

<b>VII.</b>	<b>Floods:</b> Estimation, envelope curves, flood frequency studies, probability and stochastic methods, estimation of design flood, flood control methods, Limitations, risk-reliability and safety factor.	5
<b>VIII.</b>	<b>Flood Routing:</b> Reservoir routing, channel routing.	5
<b>IX.</b>	<b>Ground Water Hydrology:</b> Yield , transmissibility, Darcy's law, Dupuit's theory of unconfined flow, steady flow towards fully penetrating wells (confined and unconfined).Unsteady flow towards wells: Jacob's curve and other methods, use of well Function, pumping tests for aquifer characteristics, methods of recharge.	8

#### Contribution to Outcomes

On completion of this course, student shall have a good understanding of the:

- principles of hydrologic cycle and water budgeting
- measurement and analysis of precipitation and water losses
- rainfall-Runoff relationships, runoff estimation and stream gauging techniques
- hydrographs and unit hydrographs, application of unit hydrographs
- steady and unsteady flow towards well, aquifer characteristics and yields from wells.

#### 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.
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 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 sub-modules and contents thereof further.

**Distribution of Term Work Marks:**

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of 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. Engineering Hydrology: *K. Subramanya*, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
2. Irrigation Engineering and Hydraulic Structures: *S. K. Ukarande*, Ane's Books Pvt. Ltd. (Abridged Edition 2015), ISBN 9789383656899
3. Hydrology: *H. M. Raghunath*, New Age International Publishers, New Delhi
4. Irrigation and Water Power Engineering: *Dr. B.C. Punmia* and *Dr. Pande, B.B.Lal*, Laxmi Publications Pvt. Ltd. New Delhi.
5. Irrigation Engineering and Hydraulics Structures: *S. K. Garg*, Khanna Publishers. Delhi
6. Irrigation Water Resources and Water Power Engineering: *Dr. P.N. Modi*, Standard BookHouse. Delhi.
7. Elementary Hydrology: *V. P. Singh*, Prentice Hall
8. Engineering Hydrology: Principles and practice: *V. M. Ponce*, Prentice Hall

<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-E705	Elective-I: Solid Waste Management	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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

<b>Rationale</b>
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This course will be of interest to those who wishes to understand the principles and techniques of solid waste management, including the legislative, environmental, economic and social drivers. The course also provides the opportunity to visit recycling facilities and disposal sites to better understand links between theory and practice. This subject deals with control of generation, storage and collection, transfer, processing and disposal of solid waste in a manner in which it benefits-public health economics, conservation aesthetics and other environmental considerations.

<b>Objectives</b>
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- To understand the implications of the production, resource management and environmental impact of solid waste management.

- To understand the components of solid waste management infrastructure systems to minimize the above effects.
- To be aware of the significance of recycling, reuse and reclamation of solid wastes.
- To be familiar with relationships between inappropriate waste management practices and impacts on water, soil and sediment quality.
- To fully appreciate the current practices available and implement the systems available in solid waste management.
- To be capable of carrying out an assessment of the relationships between environmental guidelines, human activities and environmental quality of impacted soils and water.
- To study the different storage and collection method of the solid waste management.

<b>Detailed Syllabus</b>
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Module	Sub-Modules/Contents	Periods
<b>1.</b>	<b>Introducing Municipal Solid Waste Management</b> Overview: problems and issues of solid waste management - Need for solid waste management-Functional elements such as waste generation, storage, collection, transfer and transport, processing, recovery and disposal in the management of solid waste.	05
<b>2.</b>	<b>Generation and Characteristics of Waste</b> Sources, Types, composition, quantity, sampling and characteristics of waste, factors affecting generation of solid wastes.	04
<b>3.</b>	<b>Waste Collection, Storage and Transport</b> Collection and storage of municipal solid waste; Methods of collection - House to House collection - Type of vehicles-Manpower requirement-collection routes; on site storage methods-materials used for containers-Reduction of solid waste at source-on site segregation of solid waste-Recycling and Reuse Need for transfer and transport; transfer station-selection of location, operation and maintenance; transportation Methods-manual, Mechanical methods with or without compaction, economy in transportation of waste optimization of transportation routes.	10

<b>4.</b>	<b>Waste Processing Techniques</b> Processing techniques-biological and chemical conversion technologies – composting and its methods, vermicomposting, mechanical composting, In vessel composting, incineration, pyrolysis, gasification.	07
<b>5.</b>	<b>Disposal of Solid Waste</b> Segregation, reduction at source, recovery and recycle; dumping of solid waste-sanitary waste- sanitary landfills-site selection-design and operation of sanitary landfill-secure landfills-landfill bioreactors-leachate and landfill gas management-landfill closure and environmental monitoring-landfill remediation; Municipal solid waste in Indian conditions, legal aspects of solid waste disposal.	12
<b>6.</b>	<b>Industrial Solid Waste</b> Waste products during manufacturing and packing, operation of pollution control facilities, generation, minimization at source, recycling, disposal.	04
<b>7.</b>	<b>Hazardous Waste</b> Definition, sources, hazardous characteristics, management, Treatment and disposal, mutagenesis, carcinogenesis, Toxicity testing.	04
<b>8.</b>	<b>Biomedical Waste</b> Definition, sources, classification, collection, segregation, treatment and disposal.	04
<b>9.</b>	<b>Electronic Waste</b> Waste characteristics, generation, collection, transport and disposal.	02

<b>Contribution to outcomes</b>
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On completion of this course, the students shall be able to understand the various methods of disposal of solid waste. They shall have the better understanding of the nature and characteristics of solid waste and regulatory requirements regarding solid waste management and further they shall have an ability to plan waste minimization. Besides, they shall be prepared to contribute practical solutions to environmental problems in our society.

**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.
5. Total **four** questions need to be attempted.

**Oral Examination:**

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

**Site Visit:**

Each student shall visit any site involving industrial/hazardous/municipal solid waste comprising source, characterization, transportation, recycles, treatment and disposal. The detailed report prepared on such visit will also form a part of 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 two problems and/ or questions on each modules/ sub-modules and contents thereof further. A detailed report prepared on the site visit as mentioned in the aforementioned section will also be submitted along with the assignments.

**Distribution of Term Work Marks:**

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory completion of the assignments and the report on the site visit; and the 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: 16Marks
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

Demonstration of available software for design of sewage treatment plant and sewer network is to be done.

**Recommended Books:-**

1. Integrated Solid Waste Management: *Techobanglous, Thisen, and Vigil*, McGraw Hill International.
2. Hazardous Waste Management: *Lagrega, Buckingham, and Evans*, McGraw Hill International.
3. Solid Waste Management in Developing Countries: *Bhide, A. D.*, Nagpur publications.
4. Environmental Pollution Control Engineering: *Rao, C. S.*, Wiley Eastern, Manual of solid waste of management, CPHEEO.
5. E-Waste: Implications, Regulations, and Management in India and Current Global Best Practices, *Rakesh Johri*, The Energy and Resources Institute.
6. Biomedical Waste Management in India: *Jugal Kishore and Ingle, G. K.*, Century Publications.

<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-E705	Elective-I: System Approach in Civil Engineering	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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

<b>Rationale</b>
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Use of advanced analytical techniques to improve decision making is the need of the hour in Civil Engineering, considering the present scenario. Systems approach is also known as operations research, management science or industrial engineering. People with skills in systems approach hold jobs in decision support, business analytics, marketing analysis and logistics planning in civil engineering projects. This course is indeed required by the civil engineering professionals, as it makes sense to make the best use of available resources. Today's global markets and instant communications mean that customers expect high-quality products and services when they need them, where they need them. The organizations, whether public or private, need to provide these products and services as effectively and efficiently as possible. This requires careful planning and analysis – the hallmarks of good systems approach. This is usually based on process modelling, analysis of options or business analytics. This course helps a civil engineer to arrive at proper scheduling, facility planning, forecasting, managing and marketing their projects

## Objectives

1. To develop the skill for problem formulation amongst the students so as to enable them understand various components for formulating a problem
2. To develop decision making, especially, under uncertain scenario, risks, etc.
3. To enable the students formulate LPP, NLP, distribution queuing models, assignment and transportation models, games theory, replacement models and other such optimization techniques and should be able to analyze them.

## Detailed Syllabus

Module	Sub- Modules/Contents	Periods
<b>I</b>	<b>Concept of Systems Approach:</b> 1.1 System, boundaries of system, goals and objectives, optimality, 1.2 Mathematical models, objective function and constraints, 1.3 Problem solving mechanism, types of problems, modeling/problem formulation, 1.4 Sub-optimization, solution techniques, 1.5 Sensitivity Analysis	07
<b>II</b>	<b>Decision Theory:</b> 2.1 Classification of decision situations, decision tables and decision tree, 2.2 criteria for decision making under certain, uncertain and risk conditions, 2.3 Utility theory	07
<b>III</b>	<b>Time Series Analysis::</b> 3.1 Variations in time series, 3.2 Trend analysis: method of moving averages 3.3 Method of least squares	06

<b>IV</b>	<b>Linear Programming:</b> 5.1 Formulation of Linear optimization models, Civil engineering applications. 5.2 Simplex method, special cases in simplex method, 5.3 Method of Big M, Two phase method, duality, sensitivity analysis General nature of problem, formulation of problems 5.4 Graphical nature and formulation of problem, method of solution, 5.5 Sensitivity analysis	08
<b>V</b>	<b>Non-Linear Programming:</b> 4.1: Single variable unconstrained optimization –Local and Global optima, Uni-modal Function 4.2 Sequential Search Techniques: Dichotomous, Fibonacci, Golden Section methods.	05
<b>VI</b>	<b>Distribution Models:</b> 6.1 Transportation problems and its variants 6.2 Assignment problems and its variants 6.3 Games Theory	07
<b>VII</b>	<b>Queuing, Sequencing and Replacement Models:</b> 7.1 Queuing Theory, queue discipline, Simulation 7.2 Sequencing model – n jobs through 2, 3 and M machines 7.3 Replacement Models	06
<b>VIII</b>	<b>Dynamic Programming:</b> 8.1 Multi stage decision processes, Principle of optimality, Recursive equation, Application of D.P. 8.2 Decision theory	06

#### Contribution to Outcomes

On successful completion of the course, the students shall be able to solve various civil engineering problems by formulating them into linear and non-linear programmes. Further, they are expected to be able to analyze and take appropriate decisions by applying transportation, assignment, sequencing making, replacement models to the specific problems. They are also expected to apply dynamic programming, games theory and other such optimization approaches to civil engineering problems.

**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 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 term-work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of 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

**Reference Books:**

1. Operations Research : *Hamdy A.Taha*
2. Engineering Optimization—Theory and Practice:*Rao.S. S.*, Wiley.
3. Engineering Optimization—Methods and Applications: *Ravindran Philips*,Wiley
4. Operations Research:*Sharma, J. K.*
5. Quantitative Techniques in Management:*Vohra, N. D.*
6. Principles of Construction Management:*Pilcher, R.*
7. Operations Management: *Buffa, E. S.*
8. Principles of Operations Management: *Wangner, H. M.*
9. Principles of Operation Research: *Wagner*, Prentice Hall.
10. Operation Research:*Hira and Gupta, S.Chand*
11. Operations Research: Principles and Practice: *RavindravPhilip and Solberg*,Wiley,India

## Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: Risk and Value 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

Many risks and uncertainties are associated with civil engineering projects. As these projects are directly applicable and beneficial to the society, one needs to carry out all such projects with great care by applying risk management in practices. At the same time, one needs to maintain the value right from the conception stage of the project. This course is indeed required by the civil engineering professionals as it makes sense to identify the risks involved and manage risks through the management system. This course helps the civil engineer to get acquainted with value engineering approach, function analysis, etc.

## Objectives

1. To understand the types of risks involved in civil engineering/ construction projects.
2. To enable the students develop the skills of managing the risks.
3. To prepare value engineering job plan.

4. To make the students understand the basic concept of function analysis for achieving the value.
5. To impart to the students the knowledge of the life cycle costing of the civil engineering/ construction projects.

<b>Detailed Syllabus</b>
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Module	Sub- Modules/Contents	Periods
<b>I.</b>	<b>Risks</b> Definition, Types of risks; Uncertainties in projects.	03
<b>II.</b>	<b>Risks associated with construction</b> Risks related to resources- Time, Money, Technology, Manpower etc.; Risks related to agencies- Client, Contractor etc.; Decision making in construction.	05
<b>III.</b>	<b>Risk Management Systems:</b> Risk identification, sources of risks.; Classification of risks, Impact and consequences of risks; Risk qualification and risk analysis; Risk response, retention, reduction, transfer and avoidance	07
<b>IV.</b>	<b>Value Engineering:</b> Definition: Value, Value Engineering, Value Analysis; Value Management; Habits, attitudes and roadblocks and their relation to value Engineering.	07
<b>V.</b>	<b>Value Engineering Job Plan:</b> Definition: Value Engineering Job Plan, Various versions of plan; Phases involved in Job Plan.	04
<b>VI.</b>	<b>Function Analysis:</b> Function and its role in achieving value; Function in terms of its cost and worth; Graphical functional analysis; Function analysis system technique.	06
<b>VII.</b>	<b>Creative Thinking:</b> Definition: Creative Thinking; Creative People and their characteristics; Creative Processes, Creative sessions etc.	06



<b>VIII.</b>	<b>Life Cycle Costing :</b> Definition, Purpose and implications; Economic Principles for L.C.C.; Types of life cycle costs.	05
<b>IX.</b>	<b>Energy :</b> Energy resources and consumption; Energy embodiment of construction materials; Factors affecting energy consumption; Impact of maintenance on energy saving.	07
<b>X.</b>	Integrated approach to value and risk management.	02

<b>Contribution to Outcomes</b>
---------------------------------

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

1. Identify the risks associated with the projects and apply risk management systems.
2. Understand the value approach clearly and apply the measures for achieving the value.
3. Prepare value engineering job plan.
4. Know about the creative thinking, creative people which will be very much helpful for them in future.
5. Understand the effective consumption of valuable energy.

**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 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 TermWork Marks:**

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of 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. Value Engineering: L.W. Zimmerman, *Hart, G.D.* (CBS publishers and distributors.)
2. Value andRisk Management: *Dallas, M.F.* (Blackwell publishing.)
3. Risk Management andConstruction: *Flagnan, R.andNorman, G.*(Blackwell Scientific)
4. Value Engineering in the Construction Industry – *Dell’Isola, A.J.*(Construction publication company)

<b>Semester VII</b>
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Subject Code	Subject Name	Credits
CE – C 705	Advanced Structural Analysis	6

#### 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	Test	Average						
20	20	20	80	03	25		25	

<b>Rationale</b>
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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 indeterminate. There are various advanced method to analyze these structure. The methods of analysis which are given in the syllabus are amenable to computer software.

<b>Objectives</b>
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- To analyze the statically indeterminate portal frame.
- To study the various methods for evaluating rotation and displacement parameters in complete frame.
- To analyze the symmetrical frame with symmetrical and anti-symmetrical loading.
- To understand the concept of analysis of non-prismatic frame and beam.
- To understand the concept of influence lines with respect to statically indeterminate beams.

- To understand the concept of plastic analysis with respect to the simple portal frame.
- To understand thoroughly the stiffness matrix method of analysis which is the basis of all computerbasedsoftware methods used in practice.

### Detailed Syllabus

Module	Sub – Modules / Contents		Periods
<b>I.</b>	<b>1. Introduction to stiffness Method in Matrix Form :</b>		15
	1.1	Basic concepts of stiffness coefficients, member stiffness matrix for beam, member stiffness matrix for plane truss, member stiffness matrix for rigid jointed plane frame, member stiffness matrix for plane grid and of space frame.	
	1.2	Properties of stiffness matrix, co-ordinate transformation matrix, stiffness matrix in local and global co-ordinate axes system, assemblage of structural stiffness matrix and application of boundary conditions.	
	1.3	Joint loads, Equivalent joint loads, method of solution for displacements and computation of internal forces in members	
	1.4	Application of stiffness method to beams, pin jointed trusses, rigid jointed plane frames and simple plane grid structures.	
<b>II.</b>	<b>2. Conventional Form of stiffness Method, Modified Moment Distribution Method, Kani's Method :</b>		10
	2.1	Symmetrical structure, Symmetric and anti-symmetric loads, Modification of stiffness and carryover factors for symmetric and anti-symmetric loads both for sway and non-sway cases for frames with different support conditions. Application to frames involving side sways	
	2.2	Fundamental equation of Kani's method, frames with side sway and without sway.	
<b>III.</b>	<b>3. Flexibility Method in Matrix Form :</b>		04
	3.1	Review of concepts of flexibility coefficients, Flexibility member matrix for beam, member flexibility matrix for plane truss, member flexibility matrix for rigid jointed plane frame, member	

		flexibility matrix for plane grid and of space frame.	
	3.2	Selection of primary structure, concepts of flexibility matrix, compatibility equation, solution for redundant forces, computational of internal forces, and joint displacement. Application to pin jointed trusses and rigid jointed plane frames for different loading including the effect of settlement of support, temperature changes and elastic supports	
IV.	<b>4. Conventional Form of Flexibility Method :</b>		10
	4.1	Elastic Center Method and its application to rectangular box, rigid jointed portal frames and fixed arches.	
	4.2	Column Analogy Method and its application to analysis of non-prismatic beams, simple rectangular frames, determination of stiffness coefficients and carry over factors for non-prismatic beam members	
V.	<b>5. Influence Line Diagrams for Indeterminate Structures</b>		05
	Muller Breslau’s Principle for drawing influence line diagrams for statically indeterminate structures. Influence Lines Diagrams for propped cantilevers, fixed beams and continuous beams.		
VI.	<b>6. Approximate Method for Analysis of Building Frames :</b>		05
	6.1	Approximate method for gravity loads: Substitute frame method and equivalent frames.	
	6.2	Approximate method for lateral loads: Portal and cantilever method.	
VII.	<b>7. Plastic Analysis of Steel Structures :</b>		03
	Application to single bay single storey rectangular frames		

### Contribution to Outcomes

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

- Understand the stiffness matrix method and to analyze various types of structures using this method.
- Understand the conventional and approximate methods of analysis.

- Understand the methodology involved in commercially available computer software for analysis which are based on stiffness matrix method
- Obtain the response of the indeterminate beams under the action of moving loads.
- Evaluate the displacement/ deflection in frames under the action of loads

### **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 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 term-work shall be judiciously awarded depending upon the quality of the term work including 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. Basic Structural Analysis: *Reddy C. S.*, Tata McGraw hill.
2. Analysis of Framed Structures : *Gere and Weaver*, East-West Press
3. Analytical Methods in Structural Analysis: *S. A. Raz* , New Age Int Publishers
4. Modern Method in Structural Analysis: *Dr. B. N. Thadani and Dr. J. P. Desai*, Weinall Book Corporation.
5. Structural Analysis: *L. S. Negi and R. S. Jangid*, Tata McGraw hill.
6. Structural Analysis Vol. I and Vol. II: *Pandit and Gupta*, Tata McGraw Hill.
7. Fundamentals of Structural Mechanics and Analysis: *Gambhir, M.L.*, Prentice Hall India (PHI) Learning Pvt. Ltd.
8. Structural Analysis Vol.II: *Vaidyanathan, R. and Perumal, P.*, Laxmi Publications
9. Fundamentals of Structural Analysis: *Roy, Sujit Kumar and Chakrabarty, Subrata, S.* Chand and Co. Ltd., New Delhi
10. Structural Analysis: *T.S. Thandavamoorthy*, Oxford Higher Education

### **Reference Books:**

1. Matrix Method in Structural Analysis: *Livesley R. K.* Pergamon Press, London.
2. Elementary Structural Analysis: *Wilber*, McGraw Hill, New York.
3. Plastic Method of Structural Analysis: *B. G. Neal*, Chapman and Hall, London.
4. Intermediate Structural Analysis : *Wang C. K.*, Tata McGraw hill
5. Matrix Method of Structural Analysis: *Dr. A. S. Meghre, S. K. Deshmukh*, Charotar Publishing House.
6. Structures: *Schodek, D.L. and Bechthold, Martin*, Prestice Hall India Learning Pvt. Ltd.
7. Matrix Analysis of Structures: *P. K. Singh*, Cengage Learning.

<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-E705	Elective-I: Advanced Structural Mechanics	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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

<b>Rationale</b>
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There are different types of structures subjected to various types of loading/ forces such as axial, shear, bending and torsion. This course equips the students to analyze the behavior of structural members under different types of loading. This course also aimed at imparting certain theoretical foundation and physical understanding to solve structural mechanics problems mostly involving beams and thin-walled structures under different loading conditions.

<b>Objectives</b>
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1. To understand the concept of the shear centre and evaluation of the shear centre for symmetrical and non-symmetrical thin walled sections.
2. To understand the concept and behavior of beams resting on elastic foundation.
3. To study the behavior of beams curved in plan.



4. To understand the concept of different theories of failure with respect to materials.
5. To study the behavior of deep beams using different theories available for the analysis of different sections.
6. To introduce the concept of torsion theories for solid section.

<b>Detailed Syllabus</b>
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Modules	Sub-Modules/ Contents	Periods
<b>I.</b>	Shear Centre for symmetrical and non-symmetrical (about both axes) thin walled open sections.	07
<b>II.</b>	Bending of beams with large initial curvature loaded in their plane of curvature. Application to analysis of hooks, circular closed rings, chain links with straight length and semi-circular ends.	08
<b>III.</b>	Beams on elastic foundation: Analysis of beams of infinite length subjected to concentrated force/moment and semi-infinite length subjected to concentrated load/moment at one end. Semi-infinite beam hinged at one end (origin) and subjected to UDL throughout.	08
<b>IV.</b>	Beams curved in plan: Analysis of beams loaded perpendicular to their own plane, simply supported, fixed and continuous beams.	07
<b>V.</b>	Theories of Failure: Maximum principal stress theory, Maximum principal strain theory, Maximum shear stress theory, maximum total strain energy theory.	08
<b>VI.</b>	Analysis of deep beams: Determination of deflection. Determination of shear correction factor for various sections rectangular solid and hollow section and circular solid and hollow section and I-section	06
<b>VII.</b>	Torsion in non-circular solid section rectangle, triangular and hexagon section.	08

<b>Contribution to Outcomes</b>
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On successful completion of the course, the student shall be able to:

1. Understand the concept of shear centre for thin walled open sections.

2. Study the behavior of beam resting on elastic foundation with various loading conditions.
3. Analyze the beam curved in plan for different support conditions.
4. Understand the concept of different theories of failure in different sections.
5. Determine deflection, shear correction factor for different sections like solid and hollow sections.
6. Understand the concept of torsion in non-circular solid section.

### **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 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 term-work shall be judiciously awarded depending upon the quality of the term work. 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. Mechanics of Materials: *Popov, E.P.* Prentice Hall of India Pvt. Ltd.
2. Mechanics of Materials: *James Gere, M.*, Thomson Brooks.
3. Mechanics of Materials: *Beer, F.P., E. Russell Jhonston and John T. DeWolf*, TMH, New Delhi.
4. Advanced Mechanics of Materials: *Arthur P. Boresi and Omar M. Sidebottom*, Wiley and Sons.
5. Advanced Mechanics of Materials: *Arthur P. Boresi and Richard Schmidt*, John Wiley and sons.
6. Strength of Material Part I and Part II: *Timoshenko*, McGraw Hill, New York.
7. Mechanics of Solids: *Shames, I and Pitarresi, J. M.*, Prentice Hall, New Delhi.
8. Beams on Elastic Foundation: *Heteny M.*
9. Strength of Materials: *Subramanian*, Oxford University Press.

<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-E705	Elective-I: Structural Dynamics	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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

<b>Rationale</b>
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The civil engineering structures are mostly designed for only static gravitational loads. However, in actual practice the structures may be subjected to dynamic loads due to wind, vibrations, impacts, explosion, shocks and earthquake forces apart from the static loads. This subject involves the basic understanding of the analysis of structures subjected to such type of loading.

<b>Objectives</b>
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- To expose the students to understand the basic theory of structural dynamics, structural behavior under vibratory load and the effect of damping.
- To study the difference between static load and different types of dynamic loads.
- To study the free vibration analysis of SDOF systems, concept of damping and dynamic analysis of SDOF system subjected to different dynamic loads.

- To study the dynamic degrees of freedom and calculation of the frequencies and mode shapes for lumped mass for discrete MDOF systems,
- To study the modal analysis of MDOF systems and analysis of systems with distributed mass for continuous system.
- To study the random vibrations, probabilistic theory, random process and related parameters.
- To study the stochastic response analysis of linear SDOF systems.

### Detailed Syllabus

Module	Sub-Modules/Contents	Period
<b>I</b>	<b>Introduction:</b> Introduction to structural dynamics, definition of basic problem in dynamics, static v/s dynamic loads, different types of dynamic load	02
<b>II</b>	<b>Single Degree of Freedom (SDOF) Systems:</b> Undamped vibration of SDOF system, natural frequency and period of vibration, damping in structures, viscous damping and coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, Logarithmic decrement. Forced vibration, response to harmonic forces, periodic loading, dynamic load factors, response of structure subjected to general dynamic load, Duhamel's integral, numerical evaluation of dynamics response of SDOF systems subjected to different types of dynamic loads. Introduction to frequency domain analysis, response of structure in frequency domain subjected to general periodic and non-periodic / impulsive forces of short duration, use of complex frequency response function. Use of Fourier Series for periodic forces, introduction to vibration isolation. Distributed mass system idealized as SDOF system, use of Rayleigh's method, response of SDOF system subjected to ground motion.	16

<b>III</b>	<b>Generalized Single-Degree of Freedom System:</b> Generalized properties, assemblages of rigid bodies, systems with distributed mass and elasticity, expressions for generalized system properties.	04
<b>IV</b>	<b>Lumped Mass Multi Degree of Freedom (MDOF) system:</b> Coupled and uncoupled systems, direct determination of frequencies of vibration and mode shapes, orthogonality principle, vibration of MDOF systems with initial conditions, approximate methods of determination of natural frequencies of vibration and mode shapes-vector iteration methods, energy methods and use of Lagrange's method in writing equations of motions. Decoupling of equations of motion, modal equation of motion, concept of modal mass and modal stiffness, forced vibration of MDOF system, modal analysis, and application to multi storey rigid frames subjected to lateral dynamic loads.	10
<b>V</b>	<b>Structure with Distributed Mass System:</b> Use of partial differential equation, free vibration analysis of single span beams with various boundary conditions, determination of frequencies of vibration and mode shapes, forced vibration of single span beams subjected to the action of specified dynamic loads.	05
<b>VI</b>	<b>Random Vibrations:</b> Probability theory: Single random variable, important averages of single random variable, two random variables, important averages of two variables, principal axis of joint probability density function, Rayleigh's probability density function. Random processes, stationary and ergodic processes, autocorrelation function, power spectral density function, relationship between power spectral and autocorrelation functions, power spectral density and autocorrelation functions for derivatives of processes, superposition of stationary processes, stationary Gaussian processes, stationary white noise, probability distribution for maxima and extreme values	09

<b>VII</b>	<b>Stochastic Response of Linear SDOF Systems:</b> Transfer functions, relationship between input and output autocorrelation functions, relationship between input and output power spectral density functions, response characteristics for narrowband systems	06
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<b>Contribution to Outcomes</b>
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The students are expected to understand the difference between static and dynamic loads and analysis. They are expected to evaluate the response of SDOF and MDOF systems to different types of dynamic loads including ground motions. They are also expected to understand the basics of random vibrations and the application of this concept to analyze Linear SDOF systems.

#### **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.

#### **List of experiments: (At least five to be performed)**

1. To find the time period of compound pendulum
2. To study instrumentations in structural dynamics

3. To find natural frequency of SDOF system
4. To find natural frequency of two DOF system
5. To find natural frequency of three DOF system
6. To observe liquefaction of soil
7. To observe phenomenon of vibration absorption

**Term Work:**

The term-work shall comprise of the neatly written report based on the practicals/ experiments performed either in the laboratory 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 term-work shall be judiciously awarded for various components depending upon the quality of the term work. 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.

- Report of the Practical: 10 Marks
- Assignments : 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:-**

- Structural Dynamics-An Introduction to Computer Methods: *Craig R.R.*, John Wiley and Sons.
- Dynamics of Structures: *Anil K. Chopra*, Prentice Hall India Pvt. Ltd.
- Dynamics of Structures: *CloguhandPenzein*, Tata Mc-Graw Hill Pvt. Ltd.
- Structural Dynamics:*John M. Biggs*, Tata Mc-Graw Hill.



<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-E705	Elective-I: Advanced Foundation Engineering	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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

<b>Rationale</b>
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In order to find the solution to field problems and design issues in wide range of geotechnical structures such as slopes, retaining walls, foundations etc., a detailed study on the theories and analysis methods is required. This course develops the capability and requisite skills of a student to problem solving in geotechnical application areas and with emphasis on indepth study exposes the student to dwell on further new developments.

<b>Objectives</b>
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- To study site investigation techniques and characterization of the soil
- To understand the one and three dimensional consolidation process and their practical applications
- To study stress paths and failure criteria
- To learn the different vertical stress theories

- To study the bearing capacity and settlement of shallow foundations
- To study the load carrying capacity of pile foundations
- To study different ground improvement methods

### Detailed Syllabus

Module	Sub-modules/ Contents	Periods
<b>I.</b>	<b>Site exploration and characterization</b> Purpose and scope, influence of soil conditions and type of foundations on exploratory programme, project assessment, phasing of site exploration. Open excavation and boring methods of exploration, types of samplers and their design features. Subsurface soundings- static, dynamic and geophysical methods. Planning of subsurface investigations, type and sequence of operations, lateral extent and depth of exploration, interpretation of field and laboratory data.	06
<b>II.</b>	<b>Consolidation</b> Terzaghi's one dimensional consolidation- derivation of equation (solution in detail need not be covered) Estimation of $C_c$ and $c_v$ from laboratory tests, estimation of preconsolidation pressure by various methods, field consolidation curves, prediction of field settlement, practical applications. Quasi-preconsolidation and secondary consolidation. Concept of three dimensional consolidation in cylindrical coordinates, theory of sand drain and prefabricated vertical drains.	10
<b>III.</b>	<b>Stress and strain behaviour of soil</b> Triaxial test – drained and undrained behaviour of sands and clays. Stress path, ideal, plastic and real soil behaviour, shear strength of sands and clays, failure criteria in soils- Mohr-Coulomb's criteria, modified cam clay model.	06
<b>IV.</b>	<b>Estimation of stresses</b> i. Boussinesq's theory, vertical stress due to concentrated load,	05

	<p>horizontal and shear stress due to concentrated load, isobar diagram, vertical stress distribution on horizontal plane, influence diagram, vertical stress distribution on vertical plane.</p> <p>ii. Vertical stress due to line load, vertical stress under strip load, maximum shear stress at points of under strip loads, vertical stress under a circular area, vertical stress under a corner of a rectangular area, Newmark's influence charts.</p> <p>iii. Westergard's theory.</p>	
<b>V.</b>	<p><b>Bearing capacity and settlement of shallow foundation</b></p> <p>Modes of failure, failure criteria- Terzahi concept, Vesic concept, IS code recommendations.</p> <p>Assumptions in estimation of ultimate loads, effect of shape, embedment of footing, eccentricity in loading, choice factor of safety.</p> <p>Compressibility (including critical rigidity index), settlement of foundations on sand- Schmertmann method.</p> <p>Evaluation of bearing capacity using plate load test and standard penetration test, Housel method.</p>	12
<b>VI.</b>	<p><b>Pile foundations</b></p> <p>Estimation of single pile capacity by static and dynamic methods, group capacity in sand and clay deposits, separation of skin friction and end bearing capacity.</p> <p>Settlement of single and group of piles.</p>	07
<b>VII</b>	<p><b>Ground improvement</b></p> <p>Improvement of deep cohesionless soils.</p> <p>Improvement in cohesive soils.</p> <p>Improvement of soil using additives such as fibres, chemicals, sustainable waste materials</p> <p>Concept of using geosynthetics, soil nailing to stabilize slopes and embankments</p> <p>Instrumentation- pore pressure gauges and settlement gauges and their applications.</p>	06

<b>Contribution to Outcomes</b>
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On successful completion of the course, the students shall have an:

1. Ability to identify, formulate and solve geotechnical engineering problems
2. Ability to design a suitable foundation system from economic and safe aspects
3. Awareness of the latest trends and instrumentation in ground improvement methods
4. Ability to relate easily to allied subjects such soil dynamics; advanced engineering geology, rock mechanics etc.

**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:**

Oral examination will be based on entire syllabus and the term work.

**List of Experiments:**

It is recommended to perform the following laboratory tests.

1. Unconsolidated Undrained, Consolidated Undrained and Consolidated Drained triaxial tests.
2. Direct box shear test on c- $\phi$  soils.

**Site / Field Visits:**

The students shall be taken to visit the sites where pile driving/SPT/CPT/plate load tests are carried being out. They will prepare a detailed report thereof which will be submitted along with the term work.

**Term work:**

The term-work shall comprise of the neatly written report based on the experiments performed in the laboratory 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 or contents thereof further. A project report covering the selection of soil parameters and design of shallow / pile foundations and ground improvements using stone columns and sand drains 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 the various components depending upon its quality. The final certification and acceptance of term work warrants the satisfactory performance of the experiments by the student, properly compiled report thereof along with the assignments and the report on the site visit; and the minimum passing marks to be obtained by the student. The following weightage of marks shall be given for different components of the term work.

Report of the experiments	: 05 Marks
Assignments	: 10 Marks
Report of Site Visit/ Field Visit	: 05 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 Mechanics and Foundation Engineering: *V. N. S. Murthy*, Saitech Publications
2. Soil Mechanics and Foundation Engineering: *K. R. Arora*, Standard Publishers and

Distributors, New Delhi.

3. Geotechnical Engineering: *C. Venkatramaiah*, New Age International.
4. Soil mechanics in Engineering Practice: *K. Terzaghi* and *R. B. Peck*, Wiley international edition.
5. Foundation Engineering Hand Book: *Winterkorn* and *Fang*, Galgotia publications.
6. Foundation Design Manual: *N. V. Nayak*, DhanpatRai publications (P) Ltd.
7. Principles of Foundation Engineering: *Braja M. Das*, PWS publishing.
8. Relevant Indian Standard Specifications and Codes, BIS Publications, New Delhi.

<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-E705	Elective-I: Ground Water Hydrology	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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

<b>Rationale</b>
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This subject deals with the basic principles of ground water flow and application of ground water engineering. It discusses the ground water availability, ground water flow, storage and yield of well. It also provides basic knowledge on ground water pollution, ground water management and ground water modeling.

<b>Objectives</b>
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- To understand the sources of ground water, aquifers, water occurrence and movement in different types of rocks.
- To understand the ground water potential theory, movement of ground water, evaluation of aquifer parameter.
- To study yield of well, the various types of wells, construction, maintenance, etc.

- To study the quality of ground water analysis and ground water pollution, recharge of ground water, etc.
- To study the ground water management and ground water modelling.

<b>Detailed Syllabus</b>
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Module	Sub-Modules / Contents	Periods
<b>I.</b>	<b>Introduction:</b> Ground water utilization and historical background, ground water in hydrologic cycle, ground water budget, ground water level fluctuations and environmental influence, literature/ data/ internet resources.	2
<b>II.</b>	<b>Occurrence and Movement of Ground Water:</b> <ul style="list-style-type: none"> <li>• Origin and age of ground water, rock properties affecting groundwater, groundwater column, zones of aeration and saturation, aquifers and their characteristics/classification, groundwater basins and springs.</li> <li>• Darcy's Law, permeability and its determination, Dupuit assumptions, heterogeneity and anisotropy.</li> <li>• Ground water flow rates and flow directions, general flow equations through porous media</li> </ul>	6
<b>III.</b>	<b>Advanced Well Hydraulics:</b> <ul style="list-style-type: none"> <li>• Steady /unsteady, uniform / radial flow to a well in a confined/ unconfined /leaky aquifer, well flow near aquifer boundaries/ for special conditions.</li> <li>• Partially penetrating/horizontal wells and multiple well systems, well completion/ development/ protection/ rehabilitation/ testing for yield</li> </ul>	12



<b>IV.</b>	<b>Pollution and Quality Analysis of Ground Water:</b> <ul style="list-style-type: none"> <li>• Municipal /industrial /agricultural /miscellaneous sources and causes of pollution, attenuation/underground distribution / potential evaluation of pollution.</li> <li>• Physical /chemical /biological analysis of groundwater quality, criteria and measures of ground water quality, ground water salinity and samples, graphical representations of ground water quality.</li> </ul>	6
<b>V.</b>	<b>Surface/ Sub-Surface Investigation of Ground Water:</b> <ul style="list-style-type: none"> <li>• Geological /geophysical exploration/ remote sensing / electric resistivity /seismic refraction based methods for surface investigation of groundwater, test drilling and ground water level measurement.</li> <li>• Sub-surface ground water investigation through geophysical / resistivity /spontaneous potential/radiation / temperature / caliper / fluid conductivity.</li> </ul>	6
<b>VI.</b>	<b>Artificial Ground Water Recharge:</b> <ul style="list-style-type: none"> <li>• Concept and methods of artificial ground water recharge, recharge mounds and induced recharge, wastewater recharge for reuse, water spreading.</li> </ul>	5
<b>VII.</b>	<b>Saline Water Intrusion in Aquifers:</b> <ul style="list-style-type: none"> <li>• Ghyben-Herzberg relation between fresh and saline waters, shape and structure of the fresh and saline water interface.</li> <li>• Upcoming of saline water, fresh-saline water relations on oceanic islands, seawater intrusion in Karst terrains, saline water intrusion control</li> </ul>	5

<b>VIII</b>	<b>Modeling and Management of Ground Water:</b> <ul style="list-style-type: none"> <li>• Ground water modeling through porous media/analog / electric analog / digital computer models.</li> <li>• Ground water basin management concept, hydrologic equilibrium equation, conjunctive use of surface and ground water, ground water basin investigations, data collection and field work, dynamic equilibrium in natural aquifers.</li> <li>• Management potential and safe yield of aquifers, stream-aquifer interaction.</li> </ul>	10
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### Contribution to Outcomes

On successful completion of this course, the students are expected to have a good understanding of:

- Porous medium properties that control ground water flow
- Ground water flow equations to confined and unconfined aquifers
- Pump test for determining the aquifer properties, yield of well, etc.
- Quality analysis of ground water, fresh-saline water relations and ground water pollution.
- Various surface and sub-surface investigations, conjunctive use of surface and ground water, ground water management, etc.

#### **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 sub-modules and contents thereof further.

### **Distribution of Term Work Marks:**

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. 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. Numerical Modeling of Coastal Aquifers: *S .K. Ukarande* and *A. K.Rastogi* ISBN-978-3-639-17552-3”
2. Numerical Groundwater Hydrology: *A.K Rastogi*, Penram International Publication, Mumbai-ISBN-798187972272
3. Groundwater Hydrology: *D. K. Todd* , John Wiley and sons
4. Hydrogeology: *Karanth K. R.*, TataMc-Graw Hill Publishing Company.
5. Groundwater: *Freeze, R.A. and Cherry, J.A* Prentice Hall, New Jersey

<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-E705	Elective-I: Pavement Subgrade and Materials	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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

<b>Rationale</b>
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Highway and airways mode of transportation contributes to the economical, industrial, social and cultural development of any country. For the design and construction of highway and airfield, it is imperative to know the properties of the materials such as soil, aggregates and bitumen used in the construction of pavements. The various tests are required to be conducted to evaluate the properties of these materials for the scientific design of the pavements and economic utilization of the different materials. The course also deals with the soil survey, stresses in soil and various ways and means of improving the soil and implementing techniques of improvement. The course also deals with the various surface and sub-surface drainage.

## Objectives

1. To give the students hands on experience on various material properties and testing procedures of pavement materials as per IRC standards.
2. To study the significance of the soil subgrade along with its functions.
3. To study the soil classification for highway engineering purpose as per different classification system.
4. To understand the concept of stresses in soil.
5. To enable the student to identify the basic deficiencies of various soil deposits and to arrive upon the various ways and means of improving the soil and implementing the techniques of improvement.
6. To understand the various system of drainage system.

## Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
<b>I.</b>	<b>Subgrade:</b> Functions, Importance of subgrade soil properties on pavement performance, subgrade soil classification for highway engineering purpose soils as per PRA system, revised PRA system, Bur mister system, Compaction system.	10
<b>II.</b>	Grading requirements for aggregate, selection of bases and sub-base material (including stabilized materials), selection of different grade of bitumen, types of bituminous surfaces, skid qualities, bituminous mix design, Marshall Stability test, design aspect of paving concrete. Experimental characteristics of road aggregate.	08
<b>III.</b>	<b>Soil Survey:</b> Soil Survey Procedure for Highway and Ground Water Investigation. Identification and Significance of soil Characteristics, effect of water in soil Swelling/shrinkage, cohesion, plasticity in soil. Soil Moisture movement- ground water, gravitational water, held water, soil suction.	08
<b>VI.</b>	<b>Stress in soil:</b> Theories of elastic and plastic behavior of soils, Methods of	10

	reducing settlement, estimation of rate of settlement due to consolidation in foundation of road embankment. Static and cyclic triaxial test on subgrade soils, resilient deformation, resilient strain, resilient modulus. CBR test, effect of lateral confinement on CBR and E value of Subgrade soil. Static and cyclic plate load test, estimation of modulus of subgrade reaction, correction for plate size, correction for worst moisture content.	
<b>V.</b>	<b>Ground Improvement Technique:</b> Different method of soil stabilization, use of geo-textile, geogrid and fibres in highway subgrade. Vertical sand drain: design criteria, construction and uses	08
<b>VI</b>	<b>Storm water Drainage:</b> General principles subsoil Drainage. Frost action soil: Frost susceptible soils, depth of frost penetration, and loss of strength during frost melting. Compaction of soils, field and laboratory method of soil compaction, equipment's used in field compaction. Design of surface and subsurface drainage system, pumping system, water body, holding ponds	08

### Contribution to Outcomes

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

- Understand the soil classification in accordance with various soil classify the system and evaluate the ability of the soil as a subgrade material.
- Understand the requirements and desirable properties of the various materials to be used in the construction of pavements.
- Understand the characterization of different paving materials along with the tests to be conducted on these materials.
- Know the various ground improvement methods.
- Know the different methods of drainage in highways and design the drainage systems.

**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 comprising of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems/ two questions on each modules/ sub-modules and contents thereof further.

**Distribution of Term Work Marks:**

The marks of term-work shall be judiciously awarded depending upon the quality of the term work which will comprise of the report on assignments. The final certification and acceptance of term-work warrants the satisfactory and the appropriate completion of the termwork; 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. Principles of Pavement Design, Second Edition, 1975: *Yoder, E.J.* , John Wiley and Sons, Inc., New York.
2. Concrete Roads: *HMSO*, Road Research Laboratory, London.
3. Highway Engineering: *Khanna, S.K., Justo, C.E.G. and Veeraragavan, A.*, Nem Chand and Brothers, Roorkee (10<sup>th</sup> Revised Edition, 2014)
4. Principles and Practices of Highway Engineering; *Dr. L. R. Kadiyali and Dr. N. B. Lal*, Khana Publishers, New Delhi.
5. Highway Engineering, *Sharma, S.K.*, S. Chand Technical Publishers, New Delhi (3<sup>rd</sup> Revised Edition, 2013).
6. Principles of Transportation and Highway Engineering: *Rao, G.V.* , Tata Mc-Graw Hill Publications, New Delhi



<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-E705	Elective-I: Air Pollution	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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

<b>Rationale</b>
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Air pollution is the introduction of particulates, biological molecules, or other harmful materials into the Earth's atmosphere, possibly causing disease, death to humans, damage to other living organisms such as food crops, or the natural or built environment. The atmosphere is a complex natural gaseous system that is essential to support life on planet Earth. Stratospheric ozone depletion due to air pollution has been recognized as a threat to human health as well as to the Earth's ecosystems. This course makes the students acquainted with the classification, sources and effects of air pollution, various methods; and equipment available for controlling it.

<b>Objectives</b>
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- To have the knowledge of mathematics, science and engineering to identify and to solve the problem of air pollution.

- To lay emphasis on the principles underlying the understanding of ambient air pollution, its sources and its effects.
- To give an exposure to the students of the air pollution problem in India.
- To have an introduction to sources of air pollution, basic meteorological processes and technology for air pollution control; and odor control.
- To understand the health problems, risk assessment and global atmospheric changes due to air pollution.
- To understand the reasons for environment degradation due to air pollution.

### Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
<b>I.</b>	Composition of dry ambient air Properties of air. Function of air, Definition of pollution. Classification of air pollutants. Units for Qualification of air pollution, History of air pollution, Global and national scope of the problem- general, urban, rural, specific.	06
<b>II.</b>	Sources of air pollution natural and man-made Major pollutants from different sources in Greater Bombay area (or any metropolis of Maharashtra), Emission factors.	05
<b>III.</b>	Effects of air and noise pollution on human health, plants, animals, properties and visibility, indoor air pollution and personal exposure to air pollution, simple numerical problems based on COH, CoHb	05
<b>IV.</b>	Meteorological aspects of air pollution Large scale wind circulation geotropic wind, gradient wind, cyclone, anticyclone, planetary boundary layer. Lapse rate, stability conditions, wind velocity profile, maximum mixing depth, topographic effects.	06
<b>V.</b>	Plum patterns, plum dispersion, Gaussian model for predicting concentration, downwind from a single source, diffusion coefficients, Turner's stability categories and graphs for dispersion estimates. Maximum ground level concentration, inversion effects, distance touching ground modification of Gaussian model to predict particulate dispersion, plume rise, modified Holland equation for small source. ASME equation for large source, Brigg's equation for buoyant plum	09

	rise, Brigg's equation for momentum plum rise.	
<b>VI.</b>	Methods and instruments for sampling and analysis of air for stack and ambient air monitoring.	05
<b>VII.</b>	Government of India: air pollution laws. Indian standards- emission and air quality standards.	04
<b>VIII.</b>	Control Devices Principles, operations and types, simple hoods and ducts. Settling chambers, cyclones, electrostatic precipitators (ESP), Filters, scrubbers, absorption towers and incinerators. Collection efficiencies for laminar and turbulent flows for settling chambers, particle cut size for cyclone, ESP Concept of frictional and overall efficiencies. Design criteria for filters, scrubbers, absorption towers and incinerators.	12

### Contribution to Outcomes

On completion of this course, the students are expected to understand the classification, sources, effects, various methods and equipment available for controlling air pollution. They are expected to have a better understanding of the nature and characteristics of air pollution and regulatory requirements regarding air pollution and further, they shall have an ability to plan air pollution control.

#### 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 on each sub-modules and contents thereof further.

**Distribution of Term Work Marks:**

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. 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. Air Pollution: *Henry Capeskins*, McGraw Hill publication.
2. Air Pollution: Part A- Analysis and Part B-Prevention and Control: *Ledbetter, J. O.*, Make Dekker Inc., New York.
3. Air Pollution: *Wark and Warner*, *Harper and Row*, New York.
4. Air Pollution Control Guidebook for Management: Edited by *Rossano, A.T.*, Environ Science Service Division. ERA Inc., USA
5. Air Pollution Control Theory: *Martin Crawford*, McGraw Hill publication.

6. Government of India's Publication of laws related to air pollution, Maharashtra Pollution Control Board's (MPCB) Publication of standards. Indian Standards relevant to Air Pollution Monitoring, Definitions, Standards.
7. Air Pollution: *Rao, M. N. and Rao, H. V. N.*, Tata McGraw Hill Publication, New Delhi.
8. Air Pollution Vol.1: *Tripathi, A. K.*, (editor) Ashish Publication House, New Delhi.
9. Air Pollution (Bio-pollutants in air): *Srivastava, A.K.*, Ashish Publication House, New Delhi.
10. Environmental Engineers Handbook Vol. II, Air pollution: *Liptak, B. G.*, (ed) Chilton Book Co .USA.
11. Air Pollution Handbook: *Magill, P. L.* et al., McGraw Hill publication.
12. Industrial Air Pollution Handbook: *Parker, A.*, Tata McGraw Hills Publication.

<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-E705	Elective-I: Prestressed Concrete	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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

<b>Rationale</b>
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Pre-stressed concrete combines high strength steel and high strength concrete in an active manner. Today, pre-stressed concrete is being used in the construction of wide range of structures. It helps an engineer to achieve a much economical section for carrying heavy loads over larger span lengths. Thus, the use pre-stressed concrete has become a standard practice for long span bridges. Building codes have been developed for the design and detailing of pre-stressed concrete. This course involves the study of various types of pre-stressing techniques in detail.

<b>Objectives</b>
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1. To bring the students to such a level so as to enable them to take the appropriate decision in respect of choice of prestressed section over R. C. C. as a civil engineer.

2. To make the student to be aware of such a highly mechanized technology in civil engineering construction.
3. To imbibe the culture of entrepreneurship in pre-cast and pre-stressed industry in mass housing, railway sleepers, electric transmission poles, etc.
4. To understand the basic design considerations in pre- stressed concrete structures in relation to its applications.
5. To employ and develop new techniques in rehabilitation of distressed structures like buildings, bridges and infrastructures.

<b>Detailed Syllabus</b>
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Module	Sub-Modules/ Contents	Periods
<b>I.</b>	<b>Introduction to Prestressed Concrete:</b> Basic concept and general principles, materials used and their properties, methods, techniques and systems of prestressing.	03
<b>II.</b>	<b>Analysis of Prestressed concrete sections:</b> Loading stages and computation of section properties, critical section under working load for pre tensioned and post tensioned members, stress method, load balancing method and internal resisting couple method, kern points, choice and efficiency of sections, cable profiles.	08
<b>III.</b>	<b>Loss of Prestress:</b> Loss of stresses due to elastic deformation of concrete, creep in concrete, creep in steel, shrinkage in concrete, relaxation in steel, anchorage slip and friction.	06
<b>IV.</b>	<b>Deflections of Prestressed Concrete Members:</b> Short time and long time deflection, deflection of uncracked sections, Uni-linear and bi-linear methods for cracked sections.	05
<b>V.</b>	<b>Design of Prestressed Concrete Sections for Flexure in Working Stress and Limit State Method:</b> General philosophy of design, permissible stresses in concrete and steel, suitability of section, safe cable zone, design of simply supported pretension and post tension slabs and beams using limit state method	10
<b>VI.</b>	<b>Design for shear:</b>	06

	Calculation of principle tension under working load, permissible principle tension, shear strength calculation under limit state of collapse for both sections cracked and uncracked in flexure.	
<b>VII.</b>	<b>End zone stresses in prestressed concrete members:</b> Pretension transfer bond, transmission length, end block of post-tensioned members.	06
<b>VIII.</b>	Introduction to application of prestressing to continuous beams and slabs, linear transformation and concordancy of cables.	08

<b>Contribution to Outcomes</b>
---------------------------------

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

1. To understand the concept of pre-stressing, behavior of the pre-stressed structures vis-à-vis that of the RCC structure.
2. To take the decision with respect to the choice of pre-stressed section over RCC.
3. To understand the application of these techniques in civil engineering construction, especially in mass housing, railway sleepers, transmission of poles, bridges, etc.
4. To analyze the various pre-stressed components of the structures and design 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 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.

#### **Site Visit/ Field Visit:**

The students shall visit the site where the construction of pre-cast and pre-stressed concrete is going on. The students shall prepare the detailed report thereof and submit as a part of the term work.

#### **Term Work:**

The term work shall consist of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least three problems/ questions on each modules/ sub-modules sub-modules and contents thereof further. The report of the field visit/ site visit shall also form a part of the term work.

#### **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 report of the field/ site visit; 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 : 15 Marks
- Report of the Field Visit/ Site Visit: 05 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. Prestressed Concrete: *N. Krishna Raju*, McGraw Hill, New York.
2. Prestressed Concrete: *N. Rajgopalan*, Narosa Publishing House.
3. Fundamentals of Prestressed Concrete: *Sinha, N.C. and S.K. Roy*, S.C. Chand and Company.

4. Prestressed Concrete Structures: *Dayaratnam, P.*, Oxford and IBH
5. Design of Prestressed Concrete Structures: *T.Y. Lin* and *N.H. Burns*, John Willey, New York.
6. Design of Prestressed Concrete: *Nilson Arthur*, McGraw Hill Book Company.
7. Prestressed Concrete Vol—I: *IY. Guyon*, Contractors Record, London.
8. Prestressed Concrete: *S. Ramamurtham*, Dhanpat Rai and Son's
9. Relevant latest IS codes.

<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-E705	Elective-I: Traffic Engineering and Control	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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

<b>Rationale</b>
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The complete knowledge of traffic engineering for urban and rural roads is essential for civil engineers, especially who are dealing with the transportation problems in day-to-day activities. This subject imparts the skills required in controlling the traffic on the busy roads. The complete concepts learning here may include planning, Design and implementation of traffic signals, islands, intersections, markings on the roads, network flow problems related with all the important aspects for complete control of traffic on all the important and busy roads.

<b>Objectives</b>
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1. To understand all the traffic characteristics.
2. To understand all the traffic surveys conducted for complete analysis of busy roads, which requires for effective traffic management.

3. To understand, to plan and design all the important elements on the roads like signals, junctions, islands for effective traffic engineering.
4. To understand the various network flow problems, which includes the traffic management skills.

<b>Detailed Syllabus</b>
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Module	Sub- Modules/Contents	Periods
<b>I</b>	<b>Traffic Engineering and Control :</b> Various traffic surveys and traffic studies: Speed, journey time and delay survey and studies, vehicle volume count classification and occupancy	10
<b>II</b>	<b>Origin-Destination surveys and Parking survey:</b> Origin-Destination Studies: Purpose, various methods of conducting O-D studies with pros and cons of each method, interpretation of the analysis results of O-D studies, utility Parking Survey: Purpose, different types of parking surveys, methods of conducting parking surveys and interpretation of the results.	04
<b>III</b>	<b>Statistical Methods for Traffic Engineering and their Applications:</b> Distributions, sampling theory and significance testing, regression and correlation.	05
<b>IV</b>	<b>Intersection Design:</b> Principles, various available alternatives, rotary design, mini round about, traffic signals: types of traffic signals, advantages, determination of optimal cycle time and signal setting for an intersection with fixed time signals, coordination of signals, types area traffic control, delay at signalized intersection.	07
<b>V</b>	<b>Accidents and Road Safety:</b> Accident cause, recording system, analysis and preventive measures, accident cost, alternative methodologies for calculation.	04
<b>VI</b>	<b>Traffic Management:</b> Various measures and their scope, relative merits and demerits.	03

<b>VII</b>	<b>Highway Capacity:</b> Passenger's car units, level of service, factor affecting capacity and level of service, influence of mixed traffic, capacity and level of service analysis.	03
<b>VIII</b>	<b>Highway Lighting:</b> Need for street lighting, important definitions, law of illumination, discernment by artificial lighting, mounting height, spacing, lantern arrangements, types of lamps, lighting of some important highway structures.	04
<b>IX</b>	<b>Traffic Signs and Markings:</b> General principle of traffic signing, types of traffic signs, design of signs, location and maintenance of signs, different types of road marking, marking design, marking maintenance, introduction to intelligent transportation systems.	04
<b>X</b>	<b>Theory of Traffic Flow:</b> Scope, definitions and basic relationship, review of flow density speed studies, hydrodynamic analogies, application of hydrodynamic analogy, Lighthill and Whitams theory, car-following theory and its application to traffic engineering, probabilistic description of traffic flow, an introduction to queuing theory as applied to traffic flow problems for study state conditions, fundamentals of traffic stimulation modeling.	05
<b>XI</b>	<b>Network Flow Problems and Entropy in Transportation:</b> Wardope principles of equilibrium, graph theoretic approach, network flows, minimum path trees, primal level solutions, introduction to entropy in transportation	03

### Contribution to Outcomes

After completion of the course work, the student are expected to understand the complete knowledge of traffic surveys, traffic characteristics and management skills related with various problems on busy roads. The students shall be in a commanding position to plan, design and implement the traffic signals, islands, markings, network flow characteristics

required in the transportation planning. The student is expected to get full knowledge related to all the modern techniques, various important methods for effective management of control of traffic on all the important and busy urban roads.

### **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 / questions on each sub-modules and contents thereof further. Apart from this, the students shall conduct at least three traffic surveys and shall prepare a detailed report of the analysis of these surveys. This report shall also form a part of the term work.

### **Distribution of the Term Work Marks:**

The marks of term work shall be judiciously awarded for various components 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 : 12 Marks
- Report of the Traffic Surveys: 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. Traffic Engineering and Transportation Planning: *Kadiyali L. R.*, Khanna Publishers, Delhi.
2. Principles of Traffic Engineering: *Pingnataro, G. J.*, McGraw-Hill
3. Traffic System Analysis for Engineering and Planners: *Wohl and Martin*, Mc-Graw Hill
4. Principles of Transportation Engineering: *Partha Chakroborty, Animesh Das*, Prentice Hall (India).
5. Traffic Flow Theory and Control: *Drew, D. R.*, Mc-GrawHill, New York
6. Highway Capacity Manual, Transportation Research Board, National Research Council, Washington D.C.
7. Transportation Engineering and Planning: *Papacostas, C. S., Prevedouros, P. D.*, PHI Learning Pvt. Ltd.
8. Principles, Practice and Design of Highway Engineering: *Dr. Sharma, S. K.*
9. Transportation Engineering: *C. Jotin Khisty and B. Kent Lall*, PHI Learning Pvt. Ltd.

<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-E705	Elective-I: Reinforced Concrete Repairs and Maintenance	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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

<b>Rationale</b>
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For an existing building to be in a good condition, so that it can continue to perform the intended functions, maintenance of the building plays a key role. Adequate maintenance improves aesthetic and functional values. Moreover; it facilitates extending the building life and ensures the safety of dwellers. Usually, the structures do perform well for about 50 years after the construction and thereafter, the deterioration begins. Insufficient maintenance and lack of repairs may lead to the limited life span of the structure. However, the regular maintenance and timely identification of deteriorated building elements for proper remedial measures may result in to the extension of life span of the structure up to 100 years also. Most of the modern structures built in India are becoming old as they have reached about 50 years of their age and are in the dire need of the repair and maintenance. Hence, there is a huge employment potential in conformity with the field of repair and maintenance. This course, therefore, finds its place in the curriculum such that the pupils can acquire the



competency in this area. The course deals with the building maintenance, special materials, concrete repair chemicals, strengthening of RCC members by underpinning, plate bonding, shoring, RC jacketing, etc. Technical knowhow and skills developed through this course may be helpful to preserve the historical buildings. Therefore, it is vital and imperative to get acquainted with the course for civil engineers.

### Objectives

- To get familiar with the causes of distress of concrete structures, seepage and leakage in concrete structures and the effect on steel corrosion.
- To study the condition survey, evaluation and assessment of damage through the visual inspection and various Non-Destructive Testing methods.
- To acquire the knowledge in connection with the special repair materials and crack repair methodologies to be applied in the field.
- To study the concrete protective materials, thermal protection coatings, etc.
- To implement the steel corrosion protection methods in the field.
- To know the various ways to maintain the reinforced concrete structures.

### Detailed Syllabus

Module	Sub-Modules/Contents		Periods
<b>I</b>	<b>Introduction</b>		08
	1.1	Causes of deterioration of concrete structures, effects of climate, moisture, temperature, chemical, wear, erosion and loading on serviceability and durability	
	1.2	Design and construction errors	
	1.3	Causes of seepage and leakage in concrete structures	
	1.4	Formation of cracks including those due to corrosion	
<b>II</b>	<b>Condition Survey, Evaluation and Damage Assessment</b>		12
	2.1	Diagnostic methods and analysis.	
	2.2	Destructive, semi-destructive and non-destructive methods: core test, carbonation test, chloride test, petrography, corrosion analysis, cover meter test, rebound hammer test, ultrasonic pulse velocity	

		test, and crack measurement techniques.	
	2.3	Concrete endoscopy and thermal imaging	
	2.4	Pull-off test and pull-out test	
<b>III</b>	<b>Materials and Repair Methodologies</b>		10
	3.1	Repair analysis and design	
	3.2	Repair materials and their desired properties	
	3.3	Methodologies for crack and patch repair: polymer modified mortar, polymer modified concrete, polymer concrete	
	3.4	Injection grouting, shotcreting, joints and sealants, rebar corrosion crack repair	
<b>IV</b>	<b>Protection of Concrete Structures</b>		08
	4.1	Protective materials and their properties for moisture barrier systems.	
	4.2	Above grade and below grade water-proofing of concrete structures.	
	4.3	Systems like integral, crystalline, coatings, membranes, etc.	
	4.4	Thermal protection coatings.	
<b>V</b>	<b>Rebar Corrosion Protection</b>		08
	5.1	Methods of corrosion protection, corrosion inhibitors	
	5.2	Corrosion resistant steels, cathodic protection	
	5.3	Pre-packed zinc sacrificial anode, Snap-on zinc mesh anode CP system	
<b>VI</b>	<b>Maintenance of Concrete Structures</b>		06
	6.1	Facets of maintenance	
	6.2	Planned preventive maintenance	
	6.3	Maintenance cycles	
	6.4	Statutory legislation and obligation	

### Contribution to Outcomes

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

- Assess the structural health of the buildings and infrastructural works.
- Inspect and evaluate the damaged structures.

- Implement the techniques for repairing the concrete structures.
- Employ the methods of steel protection in the field.
- Maintain the concrete structures in the working and safe condition.
- Be able to take the decision of dismantling the structure, if it is deteriorated beyond the repairing.

### 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.
5. Total **four** questions need to be attempted.

### Oral Examination:

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

### List of Practical:(At least six to be performed)

1. Rapid chloride penetration test
2. Carbonation test by spraying phenolphthalein
3. Non -destructive testing of concrete structures by Rebound hammer, UPV meter etc.
4. Corrosion analyzer by half-cell potential meter
5. Tests on polymer modified mortar/concrete and coating for adhesion by Pull-off test method
6. Outdoor exposure test to measure weathering of coating
7. Test for flexibility of coating by applying on a tin sheet
8. Test for effectiveness by measuring temperature difference of a thermal protection coating and concrete substrate on terrace
9. Test for effectiveness by measuring water absorption of coating applied on a cardboard

**Condition Survey:**

The students will carry out the condition survey of any damaged structures by visual observations, crack management and will prepare a detailed report thereof. This report will form a part of the term work.

**Term Work:**

The term-work shall comprise of the neatly written report based on the experiments/ practical performed and the assignments along with the detailed report on the condition survey.

**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 the term work warrants the satisfactory performance of the experiments/ practical by the student, properly compiled report thereof along with the assignments and the report on condition survey; and the minimum passing marks to be obtained by the student. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems/ questions on each sub-modules and contents thereof further.

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

1. Report of the Experiments: 08 Marks
2. Assignments: 08 Marks
3. Report on the Condition Survey : 04 Marks
4. 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: *Page, C.L. and Page, M.M.*, Woodhead Publishers

<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-E705	Elective-I: Advanced Computational Techniques	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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

<b>Rationale</b>
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With the dramatic increase in data generation and due to rapid technological developments, in fields including civil engineering the field of statistics has undergone a major change, as new and novel techniques of statistical modeling and advanced computational techniques are continually required. This subject includes the basic understanding of concepts like hypothesis testing, regression and correlation, linear programming and introduction of genetic algorithm

<b>Objectives</b>
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- To introduce different methods of statistics.
- To enhance the knowledge of probability theory and application in construction industry.
- To discuss about different methods of data collections and its analysis.
- To discuss the importance of Hypothesis testing and its application in civil engineering.

- To discuss application of ANOVA.
- To explain the application of linear programming problem and transportation problem in construction industry.

### Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
<b>I.</b>	<b>Review of Basic Statistics and Probability:</b> Probability Distributions, Theoretical: binomial, poisson, normal, exponential, hypergeometric, uniform	07
<b>II.</b>	<b>Sampling and Sampling Distributions</b> Probability and non-probability samples, sampling and non-sampling errors Sample size, sampling distributions: t, F and $\chi^2$ distributions.	05
<b>III.</b>	<b>Hypothesis Testing</b> Type I and II error, testing of mean, proportion, tests for equality of mean and variances of two populations, confidence interval, $\chi^2$ test for goodness of fit, ANOVA (one way classification), Non parametric tests: sign test, U test	08
<b>IV.</b>	<b>Correlation and Regression</b> Karl Pearson's and Rank Correlation coefficient, simple linear regression least squares method	06
<b>V.</b>	<b>Management Decision Making</b> System approach, decision making under uncertainty and risk: decision tables and decision tree.	08
<b>VI.</b>	<b>Linear Programming</b> Graphical solution, simplex method, dual, sensitivity analysis, transportation and assignment problems	10
<b>VII.</b>	<b>Introduction to Genetic Algorithms</b>	08

<b>Contribution to Outcomes</b>
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On successful completion of the course, the students shall have:

- Learnt different methods of statistics and its applications, different methods of data collection and presentation.
- Learnt about probability theory, application of Binomial distribution, Poisson distribution in civil engineering projects.
- An understanding of implementing the concept of linear programming problem and the transportation problem in getting the optimum solution for civil engineering problem.
- Understood the concept of hypothesis, significance level, type – I and type – II error in hypothesis.

**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 comprising of 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 sub-modules and contents thereof further.



**Distribution of the Term Work Marks:**

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. 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. Quantitative Techniques for Managerial Decisions: *Shrivastava, Shenoy and Sharma*, Wiley.
2. Research Methodology: *Kothari, C. R.*, Wiley Eastern
3. Methods in Social Research: *Goode, W. J. and Hatt, P. K.*, McGraw Hill
4. Handbook of Genetic Algorithms (1991): *Davis, L. D. and Melanie Mitchell*, Van Nostrand Reinham.
5. An Introduction to Genetic Algorithms (1998): *Melanie Mitchell*, Van Nostrand Reinham

<b>Semester VII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-P706	Project – Part I	02

#### **Teaching Scheme**

<b>Contact Hours</b>	<b>Credits Assigned</b>
01 Hr Per Project Group	02

#### **Evaluation Scheme**

<b>Term Work/ Oral</b>		<b>Total</b>
<b>TW</b>	<b>OR</b>	
50	25	75

The Project shall be based on thrust areas in Civil Engineering (Construction Engineering and Management; Structural Engineering, Geotechnical Engineering including Geology, Transportation Engineering, Hydraulics Engineering, Environmental Engineering, Remote Sensing, etc.) or interface problem of any of the diversified fields of the Civil Engineering Branch.

For this purpose, the students shall form a group of minimum two students and maximum four students. Further, each faculty shall be permitted to guide maximum four groups.

#### **Guidelines for Project- Part I:**

- Student should carry out the preliminary literature survey and subsequently, identify the problem in broad terms for the project and finalize/ settle it in consultation with Guide/ Supervisor.
- Pursuant to this, the student shall refer multiple literatures pertaining to the theme of the problem and understand the problem and define the problem in the precise terms.
- Student should attempt solution to the problem by analytical/simulation/experimental methods. The solution shall be validated with proper justification. The students shall compile the report in standard format.

- The work to be pursued as a part of the project shall be divided broadly in two parts, namely- Project Stage- I and Project Stage- II.
- The topic of the project should be such that it is a value addition for the existing knowledge in the field and has some worthwhile outcomes.

### **Guidelines for Assessment of Project Stage- I**

- Project Stage- I should be assessed based on following points
  1. Quality of Literature survey and Novelty in the problem
  2. Clarity of Problem definition and Feasibility of problem solution
  3. Relevance to the field
  4. Clarity of objective and scope
  5. 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)/ Data Collection, etc.
- Project Stage I should be assessed through a presentation by a panel of internal examiners appointed by the Head of the Department.

### 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.

<b>Detailed Syllabus</b>
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Module	Sub- Modules/ Contents	Periods
<b>I.</b>	<b>Design of Foundations:</b> Design of simple raft subjected to symmetrical loading using limit state method.	09
<b>II.</b>	<b>Design of Staircases:</b> Design of dog legged and open well type staircase using limit state method.	08
<b>III.</b>	<b>Comprehensive Design of the Building:</b> Complete design of residential, commercial or Industrial building including staircase and foundations using limit state method; Introduction to ductile design and detailing of structures.	12
<b>IV.</b>	<b>Design of Retaining Walls:</b> Design of cantilever and counter fort type retaining wall using limit state method.	09
<b>V.</b>	<b>Design of Water Tanks:</b> Circular and rectangular, at ground level, underground and overhead water tank both by IS coefficient and - approximate methods, including supporting 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.

<b>Contribution to Outcomes</b>
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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.



<b>Semester VIII</b>
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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

<b>Rationale</b>
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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.

<b>Objectives</b>
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- 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
<b>I</b>	<b>Construction equipment:</b>	05
	<b>1.1</b> 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.	
	<b>1.2</b> Study of equipments with reference to available types and their capacities, operations and factors affecting their performance:	05
	<b>1.2.1</b> 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	
	<b>1.2.2</b> 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
	<b>1.2.4</b> Pile driving equipment: types, pile driving hammers: single acting and double acting, differential acting hammers, hydraulic and	05

	diesel hammers, vibratory pile drivers	
	<b>1.2.5</b> Pumping equipment: reciprocating, diaphragm and centrifugal pumps, wellpoint system	02
	<b>1.2.6</b> Stone crushing equipment: jaw, gyratory and cone crushers, hammer mills, roll crushers, rod and ball crushers, aggregate screens and screening plants, portable plants	04
	<b>1.2.7</b> Air compressor	02
	<b>1.2.8</b> Equipment for moving materials: builder's hoists, forklifts, cranes, belt-conveyors, cableways, ropeways	02
<b>II</b>	<b>Tunneling:</b> 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 pumpcrete method, size, sampling distributions: $t$ , $F$ and $\chi^2$ distributions.	10
<b>III</b>	<b>Soil stabilization techniques:</b> sand drains, stone columns use of geotextiles and chemicals, diaphragm wall, rock anchors, foundation grouting	05
<b>IV</b>	<b>Concrete:</b> mass concreting, vacuum concrete, forms for concrete construction: slip forms, collapsible forms, forms for cantilevers	05
<b>V</b>	<b>Different types of cladding:</b> 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

<b>Semester VIII</b>
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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

<b>Rationale</b>
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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.

<b>Objectives</b>
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- 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.

<b>Detail Syllabus</b>
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Module	Sub- Modules/Contents	Periods
<b>I</b>	<b>Introduction to Construction Management:</b> 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
<b>II</b>	<b>Construction Projects:</b> 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
<b>III</b>	<b>Construction Project Planning and Scheduling:</b> 3.1 Stages of planning in the view of owner/Department as well as contractor. 3.2 W.B.S, Bar Charts. 3.3 Network-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

<b>IV</b>	<b>Resources Management and Allocation :</b> 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
<b>V</b>	<b>Project Monitoring and Cost Control :</b> 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
<b>VI</b>	<b>Safety and Health on Construction Sites</b> 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
<b>VII</b>	<b>Quality Control :</b> 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
<b>VIII</b>	<b>Construction Labors and Legislation :</b> 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



<b>Contribution to Outcomes</b>
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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 softwares like 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 and Management – *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
<b>I.</b>	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
<b>II.</b>	Excavation for heavy engineering projects: Excavation in various types of soils, selection of equipment, safety measures in excavation, drainage in excavation	06
<b>III.</b>	Concrete construction for heavy engineering projects: Selection of equipment for batching, mixing, transporting, placing and compacting for various types of jobs, safety measures during concreting, Special concretes and mortars: preplaced aggregate concrete, roller compacted concrete, grouting	06
<b>IV.</b>	Prefabricated construction: Planning for pre-casting, selection of equipment for fabrication, transport and erection, quality measures, safety measures during erection	06
<b>V.</b>	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
<b>VI.</b>	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	
<b>VII.</b>	Information related to special equipment and their applications to Off-shore construction, underground utility construction	06
<b>VIII.</b>	New materials and equipment for construction	05
<b>IX.</b>	Case studies of heavy construction projects	05

<b>Contribution to Outcomes</b>
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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.

<b>Detailed Syllabus</b>
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Module	Sub-Modules/ Contents	Periods
<b>I.</b>	<b>Introduction:</b> 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
<b>II.</b>	<b>Engineering Geology of Deccan trap basalts:</b> 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
<b>III.</b>	<b>Dams:</b> 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



	<p>alteration on engineering properties of rocks, deterioration of rock masses on exposure to atmosphere and suitable treatment for such rocks.</p> <p>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.</p> <p>Erosion of tail channel as a factor in selecting site for spillway causes of rapid erosion from side spillways, geological conditions leading to erosion.</p> <p>Case histories.</p>	
<b>IV.</b>	<p><b>Tunneling:</b></p> <p>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.</p> <p>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.</p> <p>Case histories.</p>	09
<b>V.</b>	<p><b>Bridges:</b></p> <p>Investigations for bridge foundations, computing SBC for bridge foundation based on nature and structure of rock, foundation settlements.</p> <p>Case histories.</p>	05

<b>VI.</b>	<b>Geology of soil formation:</b> 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
<b>VII.</b>	<b>Geophysical Investigations:</b> Seismic and electrical resistivity methods of explorations.	05
<b>VIII.</b>	<b>Construction Material:</b> Deccan trap basalts as construction Material. Use of compact basalt and amygdaloidal basalt as Rubble for masonry metal for concrete making.	05

<b>Contribution to Outcomes</b>
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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** 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.

### **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. Gupta*, 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.

<b>Semester VIII</b>
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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

<b>Rationale</b>
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GIS is a core subject which provides power of mapping to civil engineers. GIS lets us visualize, question, analyze and interpret data 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.

<b>Objectives</b>
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- 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
<b>I.</b>	Introduction to GIS: Definition, sources of data, types of data, concept of space and time in GIS, spatial information theory, history of GIS, elements of GIS, objectives of GIS, hardware and software requirements of GIS, application of GIS	09
<b>II.</b>	Data models of spatial information: Layers and coverage, conceptual models of spatial information, representation of spatial data models in computer: raster and vector models, comparative overview between raster and vector models	11
<b>III.</b>	Data models of non-spatial information: Database management systems, hierarchical structure, network structure, relational structure	07
<b>IV.</b>	Digitizing, Editing and Structuring of map data: Digitizing: manual, semi-automatic and automatic, editing: error detection and correction, tolerances, topology creation. attribute map generation	10
<b>V.</b>	Digital Elevation Model: Need of DEM, Various structures of DEM: line, TIN, grid.	08
<b>VI.</b>	Application of Remote sensing and GIS: Forest resource management, agriculture and soil management, water resource management, land use and land suitability. 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. Installation of GIS software and getting familiarized with GIS menu and Tools
2. Map Projections and Map Digitization.
3. Geo-Referencing.
4. Creating Vector data and Creating Raster data/ data layers.
5. Creating attribute table.
6. Measurements: length and area.
7. Data viewing based on Single Symbol, Graduated Symbol.
8. Data viewing on Continuous color and unique value.
9. Labeling the features.
10. Selection tool and Geo-processing tool (Buffer, Clip, intersect and difference).
11. Coordinate capture- to save in notepad.
12. Joining layers based on common field.

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
- Practical: 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 (2<sup>nd</sup> 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,andM. Goodchild*, ESRI Press, 2005.



4. Introduction to Geographic Information Systems: *Kang-Tsung Chang*, Tata Mc Graw Hill.
5. Advanced Surveying (Total Station, GIS and Remote Sensing) (1<sup>st</sup> Ed.):  
*Satheesh Gopi, R. Sathikumar, N. Madhu*, 2007.

<b>Semester VIII</b>
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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

<b>Rationale</b>
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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.

<b>Objectives</b>
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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.

<b>Detailed Syllabus</b>
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Module	Sub -Modules/Contents	Periods
<b>I</b>	<b>Water resources project planning</b> 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
<b>II</b>	<b>Water resources development and environment</b> 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 EIA, status of EIA in India.	13
<b>III</b>	<b>Engineering economy in flood control projects</b> 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.	10

<b>IV</b>	<b>Modelling watershed hydrology</b> 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
<b>V</b>	<b>Multipurpose developmental issues</b> 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

<b>Contribution to outcomes</b>
---------------------------------

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

<b>Semester VIII</b>
----------------------

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

<b>Rationale</b>
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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.

<b>Objectives</b>
-------------------

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.

<b>Detailed Syllabus</b>
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Module	Sub- Modules/ Contents	Periods
<b>I.</b>	<b>Introduction:</b> Types of Bridges, Selection of suitable type of bridge, aesthetics, economic span.	08
<b>II.</b>	<b>Design Loads and their Distribution:</b> IRC loads, analysis of deck slab and IRC loads, Load distribution among longitudinal beams of a bridge, railway loading.	11
<b>III.</b>	<b>Design of Superstructure:</b> 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
<b>IV.</b>	<b>Design of Substructure:</b> 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
<b>V.</b>	<b>Construction Methods :</b> Erection of bridge superstructure, cantilever construction.	03

<b>Contribution to Outcomes</b>
---------------------------------

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.

<b>Semester VIII</b>
----------------------

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

<b>Rationale</b>
------------------

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.

<b>Objectives</b>
-------------------

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
<b>I.</b>	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
<b>II.</b>	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
<b>III.</b>	Environmental Impact Assessment Basic concept behind EIS, Stages in EIS production: Screening, scoping, prediction, evaluation, reducing impact, monitoring, conclusions, typical EIS outline,	07
<b>IV.</b>	Rapid EIA	06
<b>V.</b>	Environmental Auditing Definition, aims and objectives, audit principles, incentives to undertake audit, partial environmental audits, stages of implementing environmental audits, scope of audit	06
<b>VI.</b>	Provisions of various environmental acts of India	06
<b>VII.</b>	Case Studies	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, 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. 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.

<b>Semester VIII</b>
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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

<b>Rationale</b>
------------------

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.

<b>Objectives</b>
-------------------

- 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
<b>I.</b>	<b>Construction Projects and Report Preparation:</b> 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
<b>II.</b>	<b>Projects Appraisal:</b> 2.1 Project Development Cycle 2.2 What is appraisal? Need of appraisal etc. 2.3 Steps of appraisal.	06
<b>III.</b>	<b>Market Appraisal:</b> 3.1 Demand analysis, forecasting demand etc. 3.2 Sources of information, Market Survey 3.3 Uncertainties in demand forecasting	06
<b>IV.</b>	<b>Technical Appraisal</b> 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
<b>V.</b>	<b>Managerial Appraisal :</b> 5.1 Assessment of entrepreneurs, Organizational structure 5.2 Managerial requirements of project. 5.3 Chief Executive, Board of Directors etc.	07
<b>VI.</b>	<b>Financial Analysis and Economic appraisal:</b> 6.1 Cost 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.	
<b>VII.</b>	<b>Project Implementation :</b> 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
<b>VIII.</b>	<b>Project Financing:</b> 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 the project.
- 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
<b>I.</b>	<b>Introduction to Disasters</b> 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
<b>II.</b>	<b>Emergency Management Program:</b> 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

<b>III.</b>	<b>Disaster Relief Teams:</b> 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
<b>IV.</b>	<b>Resources Management and Allocation :</b> 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

<b>Contribution to Outcomes</b>
---------------------------------

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** 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 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

<b>Semester VIII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-E804	Elective-II: Pavement Design and Construction	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practical</b>	<b>Tutorial</b>	<b>Theory</b>	<b>Practical</b>	<b>Tutorials</b>	<b>Total</b>
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

<b>Rationale</b>
------------------

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 subsequent 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
<b>I.</b>	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
<b>II.</b>	Stresses in flexible pavements, 1-layer, 2-layer, 3-layers theories, EWLF,ESWL Stresses in Rigid pavement: load and temperature stresses, combined stresses.	10
<b>III.</b>	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.	
<b>IV.</b>	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
<b>V.</b>	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
<b>VI.</b>	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
<b>VII.</b>	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
<b>VIII</b>	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
<b>IX</b>	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
<b>X</b>	Introduction to pavement management systems.	02

<b>Contribution to Outcomes</b>
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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 10<sup>th</sup> Edition, 2014)
3. Principles, Practice and Design of Highway Engineering (Including Airport Pavements): *Sharma, S.K.*, S. Chand Technical Publications (3<sup>rd</sup> 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.

<b>Semester VIII</b>
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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

<b>Rationale</b>
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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.

<b>Objectives</b>
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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 the concepts 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
<b>I</b>	<b>Introduction to Steel Structure</b> 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
<b>II</b>	<b>Moment Resistant Beam End Connections :</b> Design of moment resistant bolted and welded beam end connections by limit state method	05
<b>III</b>	<b>Round Tubular Structural Members :</b> 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
<b>IV</b>	<b>Elevated Steel Tanks and Stacks :</b> 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
<b>V</b>	<b>Gantry Girder :</b> Loads acting on gantry girder, Analysis of gantry girder, design of gantry girder by limit state method.	07
<b>VI</b>	<b>Lattice Tower :</b> 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

<b>VII</b>	<b>Steel Chimney :</b> Forces acting on chimney, design of self-supporting welded and bolted chimney and components including design of foundation.	08
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### 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 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 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 Wiley, 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.

<b>Semester VIII</b>
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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

<b>Rationale</b>
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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.

<b>Objectives</b>
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- 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
<b>I.</b>	<b>Introduction:</b> 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
<b>II.</b>	<b>MDOF systems:</b> 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

<b>III.</b>	<b>Seismological Background:</b> 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
<b>IV.</b>	<b>Characterization of Ground Motion:</b> 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
<b>V.</b>	<b>Deterministic Earthquake Response:</b> 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 single mode, SRSS and CQC combination of modal responses.	06
<b>VI.</b>	<b>I. S. Code Method of Seismic Analysis:</b> 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
<b>VII</b>	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

<b>Contribution to Outcomes</b>
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- 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 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 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)

<b>Semester VIII</b>
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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

<b>Rationale</b>
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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.

<b>Objectives</b>
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- To study fundamental concepts of vibrations, degrees of freedom and damping systems.

- To study phenomena like liquefaction and their effects.
- To study principles 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
<b>I.</b>	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
<b>II.</b>	Wave propagation in elastic rods, in an elastic infinite medium and in semi elastic half space, wave generated by surface footing.	05
<b>III.</b>	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
<b>IV.</b>	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
<b>V.</b>	Vibration isolation and screening methods, improvement of distressed machine foundation.	07
<b>VI.</b>	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
<b>VII.</b>	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



<b>Contribution to outcomes</b>
---------------------------------

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
<b>I.</b>	<b>Machineries:</b>	06
	<b>1.1 Lifts and Escalators</b> - 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	
<b>II.</b>	<b>Plumbing Systems in Building:</b>	09
	<b>2.1 Plumbing Services:-</b> Water Distribution system - Material for service pipes - Service connection - Size of service pipe - Water meter - valves storage tanks <b>2.2 Drainage system :-</b> Pipe and traps - system of plumbing - House drainage plans - septic tanks- soak pit	
<b>III.</b>	<b>Electrical systems and Illumination Design in Buildings:</b>	12
	<b>3.1 Electrical systems in buildings:</b> 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 <b>3.2 Principles of Illumination Design:</b> 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 - Lams of illumination - Classification of lighting - Artificial lights sources - spectral energy distribution - Luminous efficiency -	

	<p>Colour temperature - Colour rendering.</p> <p><b>3.3 Design of Modern lighting:</b></p> <p>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.</p>	
<b>IV.</b>	<p><b>Refrigeration Principles and Applications:</b></p> <p><b>4.1 Thermodynamics</b> - 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</p> <p><b>4.2 Refrigerants and air conditioners</b> - 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.</p>	09
<b>V.</b>	<p><b>Fire Safety Services</b></p> <p><b>5.1 Fire Safety Installation:</b></p> <p>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</p>	06
<b>VI.</b>	<p><b>Rain Water Harvesting</b></p> <p><b>6.1 Rain Water Harvesting</b></p> <p>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.</p>	06
<b>VII.</b>	<p><b>Green Building</b></p> <p><b>7.1. Introduction to Green Building:</b></p> <p>Need for a green building, planning and design of green buildings, obstacles,</p>	04

	materials used in green building technology, rating system (According to LEED- INDIA)	
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<b>Contribution to Outcomes</b>
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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 Publications, Delhi.
10. Water supply and Sanitary 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).



<b>Semester VIII</b>
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<b>Subject Code</b>	<b>Subject Name</b>	<b>Credits</b>
CE-804	Elective II- Design of Hydraulic Structures	05

#### **Teaching Scheme**

<b>Contact Hours</b>			<b>Credits Assigned</b>			
<b>Theory</b>	<b>Practicals</b>	<b>Tutorials</b>	<b>Theory</b>	<b>Practicals</b>	<b>Tutorials</b>	<b>Total</b>
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						

<b>Rationale</b>
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This subject provides necessary knowledge about planning, design and constructions of important hydraulic structures like dams, reservoirs, weirs, cross drainage works and canal structures. It also provides basic knowledge to design various regulation structures like spillways, energy dissipation works, canal structures and 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.

<b>Objectives</b>
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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
<b>I.</b>	<b>Reservoir Planning and Management:</b> 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
<b>II.</b>	<b>Gravity Dams:</b> 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
<b>III.</b>	<b>Arch and Buttress Dams:</b> Definition and types of arch dams, forces acting on arch dam, design of arch dams, types of buttress dams.	4
<b>IV.</b>	<b>Earth and Rock Fill Dams:</b> 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

<b>V</b>	<b>Spillways and Flood Control Works:</b> 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
<b>VI</b>	<b>Miscellaneous Topics:</b> 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

<b>Contribution to outcomes</b>
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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 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. 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. Concrete Dams: *R. S. Varshney*, Oxford and IBH Publishing Co.

<b>Semester VIII</b>
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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

<b>Rationale</b>
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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.

<b>Objectives</b>
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- 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
<b>I.</b>	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
<b>II.</b>	Sampling and analysis of industrial wastes, Treatability study, good housekeeping, bioassay test, population equivalence.	04
<b>III.</b>	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
<b>IV.</b>	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
<b>V.</b>	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	
<b>VI.</b>	Provision of various acts pertaining to industrial wastes / effluents, introduction to environmental impact assessment and environmental audit.	06
<b>VII.</b>	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; and further, 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 Croperation.

<b>Semester VIII</b>
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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

<b>Rationale</b>
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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.

<b>Objectives</b>
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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 Transportation/Highway projects.
4. To gain the complete knowledge of mass rapid transit systems used in urban transportation.

<b>Detailed Syllabus</b>
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Module	Sub-Modules/ Contents	Periods
<b>I.</b>	<p>Transportation Planning and management:</p> <p>General Travel Forecasting Principles and techniques, Generalized demand, price and capacity relationship applied to travel forecasting, Practical problems of forecasting travel.</p> <p>Introduction to the process of urban transport planning.</p> <p>Travel demand forecasting: Trip generation analysis, trip classification,</p> <p>multiple regression analysis, category analysis, trip distribution analysis:</p> <p>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.</p> <p>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.</p> <p>Land-use transport models: Introduction, selection of Land-use transport models, The Lowry model, Grain – Lowry model, Applications of Lowry model.</p> <p>Introduction to advanced/soft computational techniques for transportation planning like Expert Systems, Neural Networks, Fuzzy Logic, Genetic Algorithm, Simulated Annealing, Hybrid systems etc.</p>	24

<b>II.</b>	<p>Transport Economics:</p> <p>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.</p>	09
<b>III.</b>	<p>Public Transportation</p> <p>Introduction to various mass transportation systems,</p> <p>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,</p> <p>Detailed capacity assessment of some selected technologies: Conventional bus on bus bays, Light rail transit, Rail Rapid Transit, Regional rail Transit or Suburban Railway,</p> <p>Suitability of Transit Systems for different travel demand for Indian Cities,</p> <p>Suitability of Transit Systems for Indian Cities of Different Population sizes and forms, Influence of other factors in selection of Mass Transit Systems,</p> <p>Transit System Operations: Introduction, Route Development, Stop location and stopping policy, Schedule development, Capacity of transit systems.</p> <p>Future of Public transportation.</p>	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 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. 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).

<b>Semester VIII</b>
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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

<b>Rationale</b>
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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 and rehabilitation.

### 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
<b>I.</b>	<b>Introduction:</b> Need for strengthening due to various reasons such as ageing, natural calamities, increase of load, change of function and design, construction errors	05
<b>II.</b>	<b>Structural Strengthening:</b> 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
<b>III.</b>	<b>Specialized Repairs:</b> Electrochemical 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	
<b>IV.</b>	<b>Retrofitting by Composite Materials:</b> Fiber reinforced concrete, Ultra-high performance fibre reinforced concrete (UHPFRC), Fiber reinforced composites, Carbon fibre reinforced polymer (CFRP), Fibre wrapping (Carbon, Aramide, Glass)	10
<b>V.</b>	<b>Seismic Retrofitting:</b> Seismic strengthening of existing RC structures, Use of FRP for retrofitting of damaged structures	08
<b>VI.</b>	<b>Post-Repair Maintenance of Structures:</b> Protection and Maintenance schedule against environmental distress to all those structures	04
<b>VII.</b>	Special care in repair and rehabilitation of heritage structures	03

<b>Contribution to Outcomes</b>
---------------------------------

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 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 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

<b>Semester VIII</b>
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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

<b>Rationale</b>
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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.

<b>Objectives</b>
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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
<b>I.</b>	<b>Introduction:</b> <ol style="list-style-type: none"> <li>1. Definition of geosynthetics. The terminology includes natural fibre materials such as coir, jute and hemp.</li> <li>2. Historical background of geosynthetics.</li> <li>3. Basic functions of geosynthetics and relevance to the environment.</li> <li>4. Different types of geosynthetics (nonwoven and woven geotextiles, geogrids, geonets etc) and their exclusive functions and applications.</li> <li>5. Pros and cons of geosynthetics in various functions and applications.</li> </ol>	03
<b>II.</b>	<b>Polymers and Resins:</b> <ol style="list-style-type: none"> <li>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.               <ol style="list-style-type: none"> <li>a. Environmental implications of use of these materials, recyclability and life cycle analysis.</li> </ol> </li> <li>2. Geosynthetic types and their manufacturing techniques:               <ol style="list-style-type: none"> <li>i. Geosynthetic types: Geotextiles, geogrids (knitted, woven, extruded), geonets, geomembranes, geosynthetics clay liners, geopipe, geofoam, geocomposites and geocells.</li> <li>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.</li> <li>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</li> </ol> </li> </ol>	05

	of different fabrics.	
<b>III.</b>	<p><b>Testing Methods for Geosynthetics:</b></p> <ol style="list-style-type: none"> <li>1. Distinction between codes and standards, and guidelines.</li> <li>2. The concept of quality assurance and quality control in geosynthetics.</li> <li>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?</li> <li>4. A brief on testing techniques(index and performance tests) for each of the following parameters and their application based significances: <ul style="list-style-type: none"> <li><b>a.</b>Basic physical properties including (but not limited to): <ol style="list-style-type: none"> <li>i. Constituents of the material</li> <li>ii. Unit weight</li> <li>iii. Thickness, etc.</li> <li>iv. Apparent Opening Size</li> </ol> </li> <li><b>b.</b> Mechanical properties including <ol style="list-style-type: none"> <li>i.Various strength characteristics, including significance of peak strengths, residual strengths as applicable</li> <li>ii. Elongations at break for tensile strengths</li> <li>iii. Tension module</li> <li>iv. Fatigue resistance</li> <li>v. Seam strengths</li> <li>vi. Puncture resistance</li> <li>vii. Tear resistance</li> <li>viii. Wetting and drying stability</li> <li>ix. Burst strength</li> </ol> </li> <li><b>c.</b>Connection tests for reinforced soil walls (RSW)</li> <li><b>d.</b>Direct shear box <ol style="list-style-type: none"> <li>i. Modified direct shear box</li> <li>ii. ASTM type</li> </ol> </li> <li><b>e.</b>Pull-out tests for RSW</li> <li><b>f.</b>In-soil strength test</li> </ul> </li> </ol>	06

	<p><b>g.</b> Hydraulic properties</p> <p>i. Permittivity</p> <p>ii. Transmissivity</p> <p><b>h.</b> Tests related to various reduction factors in design</p> <p>i. Installation damage</p> <p>ii. Durability from environmental considerations (chemical and biological)</p> <p>iii. Durability from exposure to UV considerations</p> <p>iv. Creep, including the conventional concept of time-temperature superposition and the Stepped Isothermal Method (SIM)</p>	
<b>IV.</b>	<p><b>Reinforced Soil Retaining Walls and Slopes:</b></p> <ol style="list-style-type: none"> <li>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</li> <li>2. Reinforced soil slopes, differences in design, modes of failure, example of a reinforced slope (desirable to use a software for design calculations).</li> </ol>	13
<b>V.</b>	<p><b>Applications in Foundations:</b></p> <p>Foundations on reinforced granular soils: reinforcement, failure mode (Biquet and Lee's approach), forces in reinforcement ties.</p>	05
<b>VI.</b>	<p><b>Drainage and Filtration Applications of Geosynthetics</b></p> <ol style="list-style-type: none"> <li>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.</li> <li>2. Erosion control, coastal protection, river bank protection, various methods for control.</li> </ol>	04
<b>VII.</b>	<p><b>Geosynthetics in Pavements:</b></p> <ol style="list-style-type: none"> <li>1. Geosynthetics in unpaved roads – Giroud and Noiray approach</li> </ol>	07



	<p>(1981).</p> <ol style="list-style-type: none"> <li>2. Geosynthetics in paved roads – Milligan, Houlbsy and others approach (1989-90).</li> <li>3. Examples on unpaved and paved roads.</li> <li>4. Reflective cracking applications.</li> <li>5. Use in flexible pavements layers.</li> </ol>	
<b>VIII.</b>	<p><b>Geosynthetics in Environmental Engineering and Landfills:</b></p> <ol style="list-style-type: none"> <li>1. Type of landfills, their functions and related environmental issues <ol style="list-style-type: none"> <li>a. Municipal garbage landfills</li> <li>b. Construction debris fills</li> <li>c. Industrial landfills</li> <li>d. Ash ponds, slag dumps, etc.</li> <li>e. Ore tailings, such as copper, zinc, aluminum ores</li> <li>f. Specialty waste landfills including for toxic and bio-hazardous sold materials</li> <li>g. River and harbor dredging fills</li> <li>h. Radioactive waste dumps</li> </ol> </li> <li>2. The physical and chemical characteristics of solids, liquids (leachates) and gases generated by such landfills over time including toxicity, pH etc.</li> <li>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: <ol style="list-style-type: none"> <li>a. Slope stabilization including use of reinforced soil</li> <li>b. Providing an impervious blanket and its protection, containment systems</li> <li>c. Filtration</li> <li>d. Separation of various layers</li> <li>e. Erosion protection</li> <li>f. Reinforcement of above geosynthetics systems</li> <li>g. Chemical reaction of material of geosynthetics with the solid, liquid and gaseous products of the land fill, deterioration of various systems with time.</li> </ol> </li> </ol>	05

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

<b>Contribution to outcomes</b>
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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.

<b>Semester VIII</b>
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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 students are 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