As per letter No. AA/ICD/20·780· dt. 12/12

UNIVERSITY OF MUMBAI
No. UG/44 of 2018-19

~~Again~~ Revised syllabus as per letter No. AAU/ICD/2018-19/890 dt. 15.2.19.

CIRCULAR:-

Attention of the Principals of the affiliated Colleges and Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/248 of 2010, dated 12th August, 2010 relating to syllabus of the Bachelor of Engineering (B.E.) degree course.

They are hereby informed that the recommendations made by the Board of Studies in Civil Engineering at its meeting held on 9th April, 2018 have been accepted by the Academic Council at its meeting held on 5th May, 2018 **vide** item No. 4.55 and that in accordance therewith, the revised syllabus as per the (CBCS) for the T.E. in Civil Engineering (Sem - V & VI) has been brought into force with effect from the academic year 2018-19, accordingly. (The same is available on the University's website www.mu.ac.in).

(Dr. Dinesh Kamble)
I/c REGISTRAR

MUMBAI – 400 032
25th June, 2018

To

The Principals of the affiliated Colleges & Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.55/05/05/2018

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No. UG/44 -A of 2018 MUMBAI-400 032 25th June, 2018

Copy forwarded with Compliments for information to:-

1) The I/c Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Civil Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Co-Ordinator, University Computerization Centre,

(Dr. Dinesh Kamble)
I/c REGISTRAR

Dean, Faculty of Science and Technology

Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and 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 (PEOs) and give freedom to affiliated Institutes to add few (PEOs). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and 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 and developed curriculum accordingly. In addition to outcome-based education, semester-based credit and grading system is also introduced to ensure quality of engineering education. Choice based Credit and 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 and 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 and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scales to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc. Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017- 18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande

Dean(I/c) Faculty of Science and Technology,

Member - Academic Council,

University of Mumbai, Mumbai

Chairman

Preamble:

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and 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 and 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 the philosophy of outcome-based education in the process of curriculum development. As the Chairman, Board of Studies in Civil Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by more than 40 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Civil Engineering. The Program Educational Objectives finalized for the undergraduate program in Civil Engineering are listed below; 1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals 2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems 3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process 4. To prepare the Learner for a successful career in Indian and Multinational Organisations In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of outcome-based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr. S. K. Ukarande

Chairman, Board of Studies in Civil Engineering,

University of Mumbai

University of Mumbai

Scheme of Instructions and Examination

Second Year Engineering (Civil Engineering)

(With effect from 2017- 2018)

(Semester-III)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CE-C301	Applied Mathematics -III*	4	-	1	4	-	1	5
CE-C302	Surveying- I	4	2	-	4	1	-	5
CE-C303	Strength of Materials	4	2	-	4	1	-	5
CE-C304	Engineering Geology	3	2	-	3	1	-	4
CE-C305	Fluid Mechanics-I	3	2	-	3	1	-	4
Total		**18**	**8**	**1**	**18**	**4**	**1**	**23**

Subject Code	Subject Name	Examination Scheme							
		Theory					TW	Oral & Practical	Total
		Internal Assessment			End Sem Exam	Exam Duration			
		Test1	Test2	Avg					
CE-C301	Applied Mathematics- III	20	20	20	80	3	25	-	125
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	Engineering Geology	20	20	20	80	3	25	25	150
CE-C305	Fluid Mechanics -I	20	20	20	80	3	25	25	150
Total		--	--	**100**	**400**	-	**125**	**100**	**725**

*Common with Mechanical/ Automobile/ Mechatronics

** For the course 'Surveying-I (CE-C 302)", the oral examination will be conducted in conjunction with practical/s

University of Mumbai

Scheme of Instructions and Examination

Second Year Engineering (Civil Engineering)

(With effect from 2017- 2018)

(Semester -IV)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CE-C401	Applied Mathematics-IV*	4	-	1	4	-	1	5
CE-C402	Surveying-II	3	3	-	3	1.5	-	4.5
CE-C403	Structural Analysis-I	4	2	-	4	1	-	5
CE-C404	Building Design & Drawing	2	3	-	2	1.5	-	3.5
CE-C405	Building Materials & Construction Technology	4	2	-	4	1	-	5
CE-C406	Fluid Mechanics-II	3	2	-	3	1	-	4
Total		**20**	**12**	**1**	**20**	**6**	**1**	**27**

Subject Code	Subject Name	Examination Scheme							
		Theory					TW	Oral & Practical	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test2	Avg.					
CE-C401	Applied Mathematics- IV*	20	20	20	80	3	25	--	125
CE-C402	Surveying-II	20	20	20	80	3	50	25**	175
CE-C403	Structural Analysis-I	20	20	20	80	3	25	25	150
CE-C404	Building Design & Drawing	20	20	20	80	4	25	25@	150
CE-C405	Building Materials & Construction Technology	20	20	20	80	3	25	25	150
CE-C406	Fluid Mechanics-II	20	20	20	80	3	25	25	150
Total		--	--	**120**	**480**	--	**175**	125	**900**

* Common with Mechanical/ Automobile/ Mechatronics

** For the course 'Surveying-II (CE-C 402), the oral examination will be conducted in conjunction with practical/s

@ For the course 'Building Design and Drawing (CE-C 404)', the oral examination shall be conducted in conjunction with the sketching examination.

University of Mumbai

Scheme of Instructions and Examination

Third Year Engineering (Civil Engineering)

(With effect from 2018- 2019)

(Semester -V)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs.	Tut.	Theory	Practs.	Tut.	Total
CE-C501	Structural Analysis – II	4	2	--	4	1	--	5
CE-C502	Geotechnical Engineering – I	3	2	--	3	1	--	4
CE-C503	Applied Hydraulics	3	2	--	3	1	--	4
CE-C504	Environmental Engineering -I	3	2	--	3	1	--	4
CE-C505	Transportation Engineering – I	3	2	--	3	1	--	4
CE-DLO506X	Department Level Optional Course – I	3	2	--	3	1	--	4
CE-C507	Business and Communication Ethics	--	4#	--	--	2	--	2
Total		**19**	**16**		**19**	**8**	**-**	**27**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Practs.	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 Engineering – I	20	20	20	80	3	25	--	25	150
CE-C503	Applied Hydraulics	20	20	20	80	3	25	--	25	150
CE-C504	Environmental Engineering -I	20	20	20	80	3	25	--	25	150
CE-C505	Transportation Engineering – I	20	20	20	80	3	25	--	25	150
CE-DLO506X	Department Level Optional Course -I	20	20	20	80	3	25	--	25	150
CE-C507	Business and Communication Ethics	--	--	--	--	--	50*	--	--	50
Total		**--**	**--**	**120**	**480**	**--**	**200**	**--**	**150**	**950**

University of Mumbai

Scheme of Instructions and Examination

Third Year Engineering (Civil Engineering)

(With effect from 2018- 2019)

(Semester -VI)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Practs	Tut.	Total
CE-C601	Geotechnical Engineering. – II	3	2	--	3	1	--	4
CE-C602	Design and Drawing of Steel Structures	4	2	--	4	1	--	5
CE-C603	Transportation Engineering. – II	3	2	--	3	1	--	4
CE-C604	Environmental Engineering. – II	3	2	--	3	1	--	4
CE-C605	Water Resource Engineering –I	3	2	--	3	1	--	4
CE-DLO606X	Department Level Optional Course – II	3	2	--	3	1	--	4
CE-C607	Software Applications in Civil Engineering	--	2	--	--	1	--	1
Total		**19**	**14**	**--**	**19**	**7**	**--**	**26**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (InHrs.)				
		Test1	Test2	Avg						
CE-C601	Geotechnical Engineering-II	20	20	20	80	3	25	--	25	150
CE-C602	Design and Drawing of Steel Structures	20	20	20	80	4	25	--	25@	150
CE-C603	Transportation Engineering- II	20	20	20	80	3	25	--	--	125
CE-C604	Environmental Engineering-II	20	20	20	80	3	25	--	25	150
CE-C605	Water Resource Engineering-I	20	20	20	80	3	25	--	25	150
CE-DLO606X	Department Level Optional Course-II	20	20	20	80	3	25	--	25	150
CE-C607	Software Applications in Civil Engineering	--	--	--	--	--	25		25	50
Total		**120**	**120**	**120**	**480**		**175**	**--**	**150**	**925**

For the course 'Business and Communication Ethics (CE- C507), although 04 (Four) clock hours are mentioned under the head of Practical, 02 (Two) clock hours out of these 04 (Four) clock hours may be utilized as the Theory at the Institute/ College Level so as to enable the instructor (teacher) to impart the theoretical aspects of the said course. Accordingly, the provision may be made in the Time Table.

* Further, the oral examination in respect of the course 'Business and Communication Ethics (CE-C 507)' will be an internal oral and will be conducted in conjunction with seminar/ presentation.

@ For the course, Design and Drawing of Steel Structures (CE-C 602), the oral examination will be conducted in conjunction with sketching.

Department Level Optional Course –I	**Department Level Optional Course- II**
CE-DLO5061: Advanced Surveying	CE-DLO6061: Advanced Construction Equipment
CE-DLO5062: Advanced Concrete Technology	CE-DLO6062: Traffic Engineering and Management
CE-DLO5063: Building Services and Repairs	CE-DLO6063: Ground Improvement Techniques
CE-DLO5064: Advanced Structural Mechanics	CE-DLO6064: Advanced Structural Analysis

University of Mumbai

Scheme of Instructions and Examination

Fourth Year Engineering (Civil Engineering)

(With effect from 2019-2020)

(Semester -VII)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs.	Tut.	Theory	Pract.	Tut.	Total
CE-C701	Quantity Survey Estimation and Valuation	4	2	--	4	1	-	5
CE-C702	Theory of Reinforced Concrete Structures	4	2	--	4	1	--	5
CE-C703	Water Resource Engineering -II	3	2	--	3	1	-	4
CE-DLO704X	Department Level Optional Course-III	3	2	--	3	1	--	4
ILO701X	Institute Level Optional Course-I	3	--		3	--		3
CE-C705	Project – Part I	--	6	--	--	3	--	3
Total		**17**	**14**	**--**	**17**	**7**	**--**	**24**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (InHrs.)				
		Test1	Test 2	Avg						
CE-C701	Quantity Survey Estimation and Valuation	20	20	20	80	4	25	--	25	150
CE-C702	Theory of Reinforced Concrete Structures	20	20	20	80	3	25	--	25	150
CE-C703	Water Resource Engineering-II	20	20	20	80	3	25	--	25	150
CE-DLO704X	Department Level Optional Course-III	20	20	20	80	3	25	--	25	150
ILO701X	Institute Level Optional Course I	20	20	20	80	3	--	--	-	100
CE-P705	Project – Part I	--	--	--	--	--	50	--	25@	75
Total		**100**	**100**	**100**	**400**		**150**	**--**	**125**	**775**

@ For Project Part-I (CE-P 706), the oral examination shall be based on the presentation/ seminar before the board of internal examiners to be appointed by the Head of the concerned Department.

University of Mumbai

Scheme of Instructions and Examination

Fourth Year Engineering (Civil Engineering)

(With effect from 2019-2020)

(Semester- VIII)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practs	Tut.	Theory	Practs	Tut	Total
CE-C801	Design and Drawing of Reinforced Concrete Structures	4	--	2	4	--	1	5
CE-C802	Construction Management	4	--	2	4	--	1	5
CE-DLO803X	Department Level Optional Course- IV	4	2	--	4	1	--	5
ILO802X	Institute Level Optional Course- II	3	--	1	3	--	1	4
CE-C804	Project – Part II	--	12	--	--	6	--	6
Total		**15**	**14**	**5**	**15**	**7**	**3**	**25**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (In Hrs.)				
		Test1	Test 2	Avg						
CE-C801	Design and Drawing of Reinforced Concrete Structures	20	20	20	80	4	25	--	25	150
CE-C802	Construction Management	20	20	20	80	3	25	--	25	150
CE-DLO803X	Department Level Optional Course-IV	20	20	20	80	3	25	--	25	150
ILO802X	Institute Level Optional Course II	20	20	20	80	3	25	--	--	100
CE-P 804	Project – Part II	--	--	--			50	--	50#	100
Total		**80**	**80**	**80**	**320**		**150**		**125**	**650**

The oral examination for the Project- Part II (CE-P 806) shall be based on the presentation/ seminar to be delivered by the projectee/s before the board of examiners. The board of internal examiners will comprise of the internal examiners and the external examiners to be approved by the University from the pool of eligible examiners.

Guidelines for Project, i.e., Dissertation (Part-I and II)

(i) Students can form groups with minimum of 2 (Two) students and not more than 4 (Four) students.
(ii) Faculty load: In Semester VII: 01 (One) clock hour per week per project group and in Semester VIII: 02 (Two) clock hours per week per project group.
(iii) Each faculty member shall be permitted to guide maximum 04 (Four) project groups.

Department Level Optional Course – III (Semester – VII)	**Department Level Optional Course – IV** (Semester – VIII)
CE-DLO7041: Pre-stressed Concrete CE-DLO7042: Solid Waste management CE-DLO7043: Pavement Sub-grade and Materials CE-DLO7044: Structural Dynamics CE-DLO7045: Application of GIS and Remote Sensing CE-DLO7046: Foundation Analysis and Design CE-DLO7047: Applied Hydrology and Flood Control	CE-DLO8031: Advanced Design of Steel Structures CE-DLO8032: Industrial Waste Treatment CE-DLO8033: Pavement Design and Construction CE-DLO8034: Bridge Engineering and Design CE-DLO8035: Appraisal and Implementation of Infrastructure Projects CE-DLO8036: Soil Dynamics CE-DLO8037: Design of Hydraulic Structures

Institute Level Optional Course – I (Semester –VII)	**Institute Level Optional Course – II** (Semester – VIII)
ILO7011: Product Lifecycle Management ILO7012: Reliability Engineering ILO7013: Management Information Systems ILO7014: Design of Experiments ILO7015: Operations Research ILO7016: Cyber Security and Laws ILO7017: Disaster Management and Mitigation Measures ILO7018: Energy Audit and Management ILO7019: Development Engineering	ILO8021: Project Management ILO8022: Finance Management ILO8023: Entrepreneurship Development and Management ILO8024: Human Resources Management ILO8025: Professional Ethics and Corporate Social Responsibility (CSR) ILO8026: Research Methodology ILO8027: Intellectual Property Rights and Patenting ILO8028: Digital Business Management ILO8029: Environment Management

Semester-V

Semester V

Subject Code	Subject Name	Credits
CEC501	**Structural Analysis-II**	**5**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
4	2	-	**4**	1	-	**5**

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	3 Hrs.	25	-	25	150

Rationale

There are various types of components in civil engineering structures, which are subjected to different types of loading or combinations thereof. The knowledge gained in the courses such as Engineering Mechanics, Strength of Materials and Structural Analysis -I is extended in this course. The scope of the course is to evaluate the response in the form of shear forces, bending moments, axial forces, and displacement parameters in various statically indeterminate structures such as beams, rigid and pin jointed frames. The course involves the concept of the displacement and flexibility approach for analysing the indeterminate structures. The course also involves the analysis of the indeterminate structures using the concept of plastic analysis and approximate analysis.

Objectives

- To revise the various concepts involved in the analyses of the structures studied in the course Structural Analysis-I.
- To analyze the statically determinate structures with reference to the variation in the temperature.
- To understand the concept of static and kinematic indeterminacy (degrees of freedom) of the structures such as beams & rigid pin jointed frames.
- To understand the concepts/ broad methods, sub-methods involved in the analysis of indeterminate structures.
- To apply various methods for analyzing the indeterminate structures to evaluate the response of such structures in the form of bending moment, shear force, axial force etc.
- To study the analyses of frame by approximate method.

Detailed Syllabus			
Module	**Sub Modules/Contents**		**Periods**
1.	**General**		**04**
	Types of structures occurring in practice, their classification. Stable and unstable structures, static and kinematic determinacy and indeterminacy of structure. Symmetric structures, symmetrical & anti-symmetrical loads, distinction between linear and non-linear behaviors of material and geometric non-linearity. Two hinged arches: Introduction, classification and structural behavior (no numerical).		
2.	**Deflection of statically determinate structures**		**04**
	Introduction to the concept of complimentary energy, absolute & relative deflection caused by loads, temperature changes settlement of supports, application to beams, pin jointed frames, rigid jointed frames.		
3.	**Analysis of indeterminate structures by Force Method**		**14**
	3.1	Application of the Clapeyron's Theorem of Three Moments. Castigliano's theorem of least work Fixed Beams	
	3.2	Flexibility coefficients and their use in formulation of compatibility equations. Application to propped cantilevers, fixed beams, continuous beam and rigid jointed frames.	
	3.3	Application of flexibility method to simple pin jointed frames including effect of lack of fit for members.	
4.	**Analysis of indeterminate structures by Displacement Methods**		**18**
	4.1	Direct stiffness method: Stiffness coefficients for prismatic members, their use for formulation of equilibrium equations. Application to indeterminate beams & simple rigid jointed frames with inclined member but having only one translation degree of freedom.	
	4.2	Slope deflection method: Development of slope deflection equation, their use for formulation of equilibrium equations. Application to indeterminate beams & simple	

		rigid jointed frames with inclined member but having only one translation degree of freedom including the effect of settlement of supports.	
	4.3	Moment distribution method: Stiffness factor, distribution factor, Application to indeterminate beams & simple rigid jointed frames, having only one translation degree of freedom including the effect of settlement of supports.	
	4.4	Kani's Method: Fundamental equation of Kani's Method, application to simple beams and frames with single storey having two bays	
5.	**Plastic analysis of Steel structures**		**06**
	5.1	Introduction to plastic analysis, Concept of plastic hinge, plastic moment carrying capacity, shape factor.	
	5.2	Determination of collapse load for single and multiple span beams.	
6.	**Approximate Method for Analysis of Building Frames**		**06**
	6.1	Approximate method for gravity loads: Substitute frame method and equivalent frames.	
	6.2	Approximate method for lateral loads: Portal and cantilever method.	
		Total	**52**

Contribution to Outcomes

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

- Understand the behavior of various statically indeterminate structures subjected to static loads and variation in temperature.
- Analyze the structures using displacement parameters to find out the internal forces such as axial force, shear force, bending moment, twisting moments, etc. for beams, 2D portal frames with various loads and boundary conditions, which becomes the basis for structural design.
- Contrast between the concept of force and displacement methods of analysis of indeterminate structures. Also, the elastic curve in beams and frames under the action of loads.
- Understand the concept of plastic hinge, plastic moment carrying capacity, shape factor and collapse load for single and multiple span beams.
- Find out the approximate dimensions of beams and columns using the approximate method for giving the input in design software. The knowledge gained in this subject shall also be useful for

application in the structural design in later years and also useful in the civil engineering field for the analysis purpose.

- Demonstrate the ability to extend the knowledge gained in this subject for their higher years UG Programme subjects such as Advanced Structural Analysis and Advanced Structural Mechanics in which they will be dealing with the indeterminate structures.

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 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 consisting of the tutorials and assignments.

Term Work:

The term work shall comprise of neatly written report based on tutorials and assignments. The term work shall cover the entire syllabus in such a way that the students would attempt at least four problems on each sub-modules and contents thereof.

At least twenty solved problem have to be validated by using available computer software.

Or

At least ten solved problem (validated by using available computer software) and Analysis of (G+2) portal frame with minimum three bays.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded depending upon the quality of the term work. Final certification, acceptance of term work warrants a satisfactorily appropriate completion of assignments 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: 5 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: C.S. Reddy, Tata McGraw Hill New Delhi.
2. Structural analysis: A Matrix Approach, Pandit and Gupta, Tata McGraw Hill publications.
3. Mechanics of Structures: Vol-I: S. B. Junnarkar and H.J. Shah, Charotar Publishers, Anand.
4. Analysis of Structures: Vol. I and II, Vazirani and Ratwani
5. Basic Structural Analysis: K.U. Muthu, Azmi Ibrahim, I K International publishing house, Pvt. ltd.
6. Theory of Structures: S. Ramamrutham, Dhanpatrai and Sons, Delhi
7. Comprehensive structural analysis (Vol. I and II), Vaidyanathan R., Laxmi publications
8. Structural Analysis: Bhavikatti, Vikas publisher house Pvt, ltd.
9. Structural Analysis: Devdas Menon, Narosa Publishing House.
10. Structural Analysis: L.S. Negi and R.S. Jangid, Tata Mc-Graw Hill India
11. Fundamentals of Structural Analysis: Sujit Kumar Roy and Subrota Chakrabarty, S. Chand Publications.
12. Structural analysis: Mohandas and Bhargab Mohan, Prentice hall international
13. Structural analysis: T. S. Thandavmoorthy, Oxford University Press

Reference Books:

1. Structural Analysis: Hibbler, Pentice Hall International.
2. Structural Analysis: Chajes, ElBS London.
3. Theory of Structures: Timoshenko and Young, Tata McGraw Hill New Delhi.
4. Element of Structural Analysis: Norries and Wilbur, McGraw Hill.
5. Structural Analysis: Laursen H.I, McGraw Hill Publishing Co.
6. Structural theorem and their application: B.G. Neal, Pergaman Press.
7. Structural Analysis: Kassimali, TWS Publications
8. Fundamentals of Structural analysis: K.M. Leet, C.M. Uang and A.M. Gilbert, Tata McGraw Hill New Delhi.
9. Elementary theory of Structures: Heish, Prentice Hall

Semester V

Subject Code	Subject Name	Credits
CEC502	Geotechnical Engineering-I	4

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

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	3 Hrs.	25	-	**25**	**150**

Rationale

All civil engineering structures rest on ground i.e. supported by soil and rock. Rock is rarely occurring and hence mostly the supporting medium is soil. Hence the stability of structure depends on the stability of supporting medium. Therefore, geotechnical analysis is required to be carried out. Geotechnical analysis depends on the basics of physical properties which are useful for determining the strength, compressibility, drainage etc. The soil mechanics is the basic tool for geotechnical engineering which is the specialized section of civil engineering. Soil is also used as construction material to make various civil structures, viz., dams, embankment etc. Thus, it is very essential to understand various concepts involved in this course of Geotechnical Engineering-I

Objectives

- To study the types of soil and relationships involving the weight, volume and other parameters of soil.
- To study the index properties of soil which is measure of the engineering properties and classify the soil based on different classification systems.
- To study the properties of soil related to flow of water.
- To study the concept of total stress, neutral stress & effective stress in soil.
- To understand the load deformation concept through compaction process.
- To understand the techniques of soil exploration, assessing the subsoil conditions & engineering properties of various strata along with presentation of report.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Introduction to Geotechnical Engineering, Basic Definitions & Relationships**		**07**
	1.1	Definitions: Rocks, Soil, origin & mode of formation and type of soil obtained, soil mechanics, rock mechanics, soil engineering, geotechnical engineering	
	1.2	Scope of soil engineering: Importance of field exploration and characterization	
	1.3	Cohesionless & cohesive soils	
	1.4	Soil as three-phase & two-phase system in terms of weight, volume, void ratio, porosity	
	1.5	Weight-volume relationship: water content, void ratio, porosity, degree of saturation, air voids, air content, different unit weights, specific gravity of solids, and mass, absolute specific gravity.	
	1.6	Relationship between: different unit weights with void ratio, degree of saturation, specific gravity; different unit weights with porosity, void ratio, water content; different unit weights with water content, unit weights air voids.	
	1.7	Mention different methods to find water content, specific gravity, unit weight of soil (Detailed description to be covered during practical)	
2.	**Plasticity Characteristics of soils**		**06**
	2.1	Plasticity of soil: Definition of plasticity of soil, reason of plasticity, consistency of soil, explanation about idea set by Atterberg in defining the three states of soil, definition & determination of liquid limit, plastic limit, shrinkage limit.	
	2.2	Definitions of shrinkage parameters; plasticity index, shrinkage index, liquidity index, consistency index, flow index, toughness index, activity, sensitivity and thixotropy of soils. Use of consistency limits	
	2.3	Explanation about clay minerals e.g. montmorillonite, illite, and kaolinite; their formation and role in producing the plastic behavior in soil	

3.	**Classification of soils**		**06**
	3.1	Necessity of soil classification, Indian standard particle size classification, Indian standard soil classification system as per IS: 1498, boundary classification	
	3.2	Mechanical sieve analysis: wet & dry sieve analysis, combined sieve & sedimentation analysis, Stokes's law, hydrometer method of analysis, relation between percent finer and hydrometer reading. Limitation of sedimentation analysis, particle size distribution curve/gradation curve and its use	
	3.3	Relative density	
4.	**Permeability of soils & seepage analysis**		**10**
	4.1	Introduction about ground water flow: water table, types of aquifers, types of soil water, explanation of surface tension with capillary rise in small diameter tubes, capillary rise in soils	
	4.2	Definition of hydraulic head, hydraulic gradient, Darcy's law, laminar flow through soil, validity of Darcy's law.	
	4.3	Definition of permeability of soil, numerical values for different types of soils, determination of coefficient of permeability of soil in lab using constant head and variable head methods. Determination of in-situ permeability with pumping out and pumping in test. Permeability from indirect methods e.g. empirical equation & from consolidation data	
	4.4	Permeability of stratified soil deposits	
	4.5	Definition of seepage and its importance for the study of analysis & design of hydraulic structures. Derivation of Laplace equation for two-dimensional flow, its analytical solution representation by stream & potential function; Graphical representation by flow net, definition of flow line, equipotential lines, flow channel, field, characteristics of flow net, use of flow net	
	4.6	Solution of Laplace equation by other methods e. g. numerical methods	
5.	**Effective stress principle**		**03**
	5.1	Definition of geostatic stresses, vertical stress/total stress, neutral stress/pore water pressure, effective stress.	
	5.2	Effect of water table fluctuations, surcharge, capillary action, seepage	

		pressure on effective stress; quick sand condition.	
6.	**Compaction of soils & soil exploration**		**07**
	6.1	Theory of compaction, determination of Optimum Moisture Content (OMC) & Maximum Dry Density (MDD) in laboratory by conducting the light and heavy compaction test.	
	6.2	Factors affecting the compaction, effect of compaction on properties of soil, relative compaction	
	6.3	Necessity of soil exploration, methods of investigation, methods of boring, types of soil samples, soil samples sampling, number and spacing of bore holes, depth of bore holes.	
	6.4	Penetrometers tests: SPT, SCPT, and DCPT.	
	6.5	Representation of data with borehole logs.	
		Total	**39**

Contribution to Outcomes

With the completion of this course, the students will be able to:

- Understand the soil types, index and engineering properties and relationship between various unit weights & other parameters.
- Classify the soil with a view towards assessing the suitability of a given soil for use; either to use if to support a structure (e.g. embankment) or to construct a structure therein (e.g. foundation)
- Understand the use of geosynthetics in soil to improve soil properties.
- Evaluate the compaction characteristics in laboratory & field and hence interpret the results with compaction specifications.
- Interpret soil boring data for foundation design.
- Conduct laboratory experiments to collect, analyze, interpret and present the data

Theory Examination:

1. Question paper will comprise of **six** questions: each having 20 marks.
2. The **first** question will be **compulsory** will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The **remaining 5** questions will be based on all the modules of entire syllabus. For this module shall be divided proportionately further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module 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 5** 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 report of experiments performed in the laboratory and assignment.

List of Experiments/Practical: (At least 8 to be performed)

1. Determination of natural moisture content using oven drying method

Following other methods to find moisture content shall be explained briefly:

a) Pycnometer method
b) Sand bath method
c) Alcohol method
d) Torsional balance method
e) Radio activity method
f) Moisture meter

2. Specific gravity of soil grains by density bottle method or pycnometer method
3. Field density using core cutter method
4. Field density using sand replacement method
5. Field identification of fine grained soils
6. Grain size distribution by sieve analysis
7. Grain size distribution by hydrometer analysis
8. Determination of liquid & plastic limit
9. Determination of shrinkage limit
10. Liquid limit by cone penetrometer method
11. Permeability using constant head method
12. Permeability using falling head method
13. Compaction test, IS light compaction test/ Standard Proctor test
14. Compaction test, IS heavy compaction test/ Modified Proctor test
15. Relative density test

Term Work:

a) The term work shall be comprised of the neatly written report based on the experiments performed in the laboratory 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 on each modules/ sub-module content thereof further.

b) One assignment should be given on Geosynthetics. The teacher is expected to deliver extra lectures on geosynthetics for the entire class, thereby conveying the importance of the same to the students. The questions related to this concept shall not be asked in the theory examination. However, it shall be treated as a part of term work submission. It shall preferably cover the following points:

- Definition of geosynthetics, types of geosynthetics: geotextiles, geogrids, geo cells, geomembranes, geo composites; types of geotextiles: woven and non-woven etc.; physical properties: apparent opening size (AOS), specific gravity, mass per unit area, thickness; basic hydraulic properties: permittivity, transmissivity of geotextile
- Filter design criteria for graded soil & geotextile filters

Distribution of Term-work Marks

The marks of the term work shall be judiciously awarded depending upon the quality of the term work, assignments, and experiment reports. The final certification acceptance of term work warrants the satisfactory and appropriate completion of assignments 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 Experiments : 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. Soil Engineering in Theory and Practice; *Alam Singh*, CBS Publishers Distributors, New Delhi
2. Soil Mechanics and Foundation Engineering: *V. N. S. Murthy*; Saitech Publications
3. Soil Mechanics and Foundation Engineering: *K. R. Arora*; Standard Publishers and Distributors, New Delhi

4. Soil Mechanics and Foundations: *Dr. B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain*; Laxmi Publications, New Delhi
5. Geotechnical Engineering: *C. Venkat Ramaiah*; New Age International
6. Fundamentals of Soil Engineering; *D. W. Taylor*, John Wiley & Sons.
7. An Introduction to Geotechnical Engineering: *R. D. Holtz*, Prentice Hall, New Jersey
8. Soil Mechanics: *R. F. Craig*, Champion & Hall
9. Soil Mechanics: *T. W. Lambe, R. V. Whitman*, John Wiley & Sons.
10. Designing with Geosynthetics: *R. M. Koerner*, Prentice Hall, New Jersey.
11. An Introduction to soil reinforcement geosynthetics: *G. L. Sivakumar Babu*, Universities Press.
12. Relevant Indian Standard Specifications Codes, BIS Publications, New Delhi.

Semester V

Subject Code	Subject Name	Credits
CEC503	**Applied Hydraulics**	**4**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

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	3 Hrs.	25	-	25	**150**

Rationale

The knowledge of this course is essential to understand facts, concepts and design parameters of dynamics of fluid flow, application of momentum equation in lawn sprinklers and pipe bends, dimensional analysis and impact of jets. Further it helps to understand the design aspects, components, function and uses of centrifugal pump, turbines and design of open channels and flow through open channels.

Objectives

- To introduce the concept of dynamics of fluid flow and dimensional analysis
- To study hydraulic machines like centrifugal pumps, reciprocating pumps and turbines.
- To study the mathematical techniques used in research work for design conducting model tests.
- To impart the dynamic behavior of the fluid flow analyzed by the Newton's second law of motion.
- To understand the uniform and non-uniform flow through open channels.
- To study design of open channel and understand concept of surface profile with hydraulic jump.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
1.	**Dynamics of Fluid Flow**	**04**
	Momentum principle (applications: pipe bends), moment of momentum equation (applications: sprinkler).	

2.	**Dimensional Analysis:**		**05**
	Dimensional homogeneity, Buckingham's π theorem, Reyleigh's method, dimensionless numbers and their significance, Model (or similarity) laws, application of model laws: Reynold's model law, Froude's model law, scale effect in models.		
3.	**Impact of Jets:**		**07**
	Introduction, force exerted on stationary flat plate: held normal to jet, held inclined to jet, hinged plates, curved plate: Stationary and Moving, symmetrical and unsymmetrical (Jet striking at Centre and jet striking tangentially at one end).		
4.	**Hydraulic Turbines:**		**11**
	General layout of hydro-electric plant, heads, efficiencies of turbine, classification, working of Pelton Wheel Turbine, Reaction Turbine, Francis Turbine, Kaplan Turbine and draft tube theory, specific speed, unit quantities, Characteristic curves, Cavitation.		
5.	**Centrifugal pumps:**		**03**
	Work done, heads, efficiencies, Minimum speed: series parallel operation, Multistage pumps, specific speed, model testing, priming, characteristic curves, cavitations. Brief introduction to reciprocating pump.		
6.	**Flow through open channels**		**09**
	6.1	Uniform Flow: Flow through open channel: Definition, types of channels, Types of flows in channels, Prismatic, non-prismatic channels, Uniform flow: steady flow and unsteady flow, laminar and turbulent flow, subcritical flow, supercritical flow, Chezy's formula, Manning's formula, hydraulically efficient channel cross-section (most economical section).	
	6.2	Non-Uniform Flow: Specific energy and specific energy curve, Specific force, Hydraulic jump and standing wave. Gradually varied flow, equation for gradually varied flow, back water curve and afflux, Introduction to surface profiles.	
		Total	**39**

Contribution to Outcomes

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

- Apply the concepts of fluid dynamics to solve pipe bend and sprinkler problems.
- Analyze dimensional problems and explain model laws.
- Explain the working and functions of Francis, Kaplan and Pelton wheel turbines.
- Explain the basic concepts of open channel hydraulics and measure discharge through open channels.
- Identify the occurrence of hydraulic jump and its parameters
- Explain uniform flow, non-uniform flow and establish mathematical relationships.

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 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 examinations shall be based on the entire syllabus, the report of the experiments conducted by the students including assignments.

List of Experiments (Any six):

1. Impact of jet on flat plate/inclined plate/curved plate.
2. Performance of Pelton wheel- full gate opening.
3. Performance of Centrifugal pumps.
4. Performance of Kaplan turbine.
5. Performance of Francis turbine.
6. Determination of Chezy's roughness factor.
7. Study of gradually varied flow.

8. Study of hydraulic jump and its characteristics.
9. Calibration of Venturi-flume/Standing wave flume.

Term Work:

The term work shall comprise of the neatly written report based on the afore-mentioned experiments and assignments. The assignments shall comprise of the minimum 20 problems covering the entire syllabus divided properly module wise.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 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. Hydraulics and Fluid mechanics: *Dr. P.N. Modi* and *Dr. S.M. Seth*, Standard Book House, Delhi.
2. Theory and Application of Fluid Mechanics: *K. Subramanya*, Tata McGraw hill publishing company, New Delhi.
3. Fluid Mechanics: *A.K Jain*, Khanna Publishers.
4. Fluid Mechanics and Hydraulics: *S.K. Ukarande*, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538
5. Fluid Mechanics and Fluid Pressure Engineering*: D.S. Kumar, F.K. Kataria* and sons 6. Fluid Mechanics: *R.K. Bansal*, Laxmi Publications (P) Ltd.
6. Flow in Open Channels: *K. Subramanya*; Tata Mc-Graw Hill Publishing House Pvt. Ltd.
7. Irrigation and Water Power Engineering: *B. C. Purnnia*.; Standard Publishers, New Delhi.

Reference Books:

1. Fluid Mechanics: *Frank M. White*, Tata Mc-Graw Hill International Edition.
2. Fluid Mechanics: *Streeter White Bedford*, Tata Mc-Graw International Edition.
3. Fluid Mechanics with Engineering Applications: *R.L. Daugherty, J.B. Franzini, E.J. Finnemore,* Tata Mc-Graw Hill, New Delhi.
4. Hydraulics: James F. Cruise, *Vijay P.Singh and Mohsen M. Sherif*, CENGAGE Learning India (Pvt.) Ltd.
5. Introduction to Fluid Mechanics: *Edward J. Shaughnessy, Ira M. Katz, James P. Schaffer.* Oxford Higher Education.

Semester V

Subject Code	Subject Name	Credits
CEC504	**Environmental Engineering-I**	**4**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

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	3 Hrs.	**25**	**-**	**25**	**150**

Rationale

Environmental engineering is important for all human endeavours not simply about construction within the environment. This course lays emphasis on the practical application of knowledge, while at the same time recognizing the importance of theoretical knowledge in developing the intellectual capacity of the engineer. Knowledge of this course is useful for planning, designing, execution monitoring water supply sanitary schemes for the towns/cities. The scope of the course is to also solve the issues related to air and noise pollution.

Objectives

- To prepare students who can accomplish planning, design and construction of water systems and related infrastructural facilities.
- To provide the necessary knowledge on quality of water, concepts in the field of water supply and treatment.
- To impart necessary skill for the design and operation of water treatment plants.
- To introduce new developments in the field of water treatment and to inculcate the students with sound theoretical knowledge in engineering sciences as well as in research consultancy skills.
- To give a practical oriented knowledge so that they can give the practical solutions to environmental problems in the society and also to provide basic understanding of air pollution and monitoring.
- To impart positive responsive vocational attitudes, initiative creative thinking in their mission as an Engineers. Also provide the basic understanding of noise pollution.

Detailed Syllabus

Module		Sub Modules / Contents	Periods
1		**Water Supply and Distribution of Water**	03
		Water resources, Water supply systems, distribution systems of water, types of intake structure, water demand.	
2		**Quality of Water**	04
		Wholesomeness and palatability, physical, chemical, Biological standards, Treatment of water, drinking water standards, environmental chemistry, Eutrophication, Primary, Secondary and Tertiary treatment of water. Typical water treatment flow diagram.	
3	3.1	**Aeration and Sedimentation**	04
		Aeration, Types of Aeration systems, Theory and factors affecting efficiency of sedimentation, design of sedimentation tank and tube settlers.	
	3.2	**Coagulation and flocculation**	06
		Mechanisms, common coagulations, rapid mixing and flocculating devices, Jar test, coagulant aids – PAC.	
	3.3	**Filtration**	05
		Classification, slow and rapid sand filters, dual media filters, under drainage system, mode of action, cleaning, limitations, operational difficulties, performance, basic design consideration, head loss in filters and numerical on head loss, pressure filters: construction and operation.	
	3.4	**Water Softening**	02
		Lime soda and base exchange methods, Principle reactions, design considerations, sludge disposal.	
	3.5	**Disinfection**	03
		Chlorination, chemistry of chlorination, kinetics of disinfection, chlorine demand, free and combined chlorine, break point chlorination, super chlorination, de-chlorination, chlorine residual, uses of iodine, ozone, ultra violet rays and chlorine dioxide as disinfectants, well water disinfection	

	3.6	**Advanced and Miscellaneous Treatments**	03
		Reverse Osmosis, Activated carbon, Membrane filtration, Removal of Iron and Manganese, taste, odour and colour, principles and methods, de-fluoridation.	
4	**4.1**	**Building Water supply**	02
		Introduction – Per Capita Supply, Determination of storage capacity, Service connection from main, water meter.	
	4.2	**Sanitary Fixtures**	
		Sanitary Fixtures and fittings: Introduction, classification of fixtures, soil fixtures, bathroom accessories, special accessories, fittings	
5		**Rainwater Harvesting**	02
		Need for rainwater harvesting, Annual potential, Collection of rain water for direct use or ground water recharge, Roof-top rain water harvesting	
6	**6.1**	**Air Pollution**	03
		Air-Composition and properties of air, Quantification of air pollutants, Monitoring of air pollutants, Air pollution- Occupational hazards, Urban air pollution-automobile pollution, Air quality standards, Control measures for Air pollution, construction and limitations	
	6.2	**Noise**	02
		Basic concept, measurement and various control methods. Thermal pollution.	

Contribution to Outcomes

After completion of the course the student will be able to:

- Understand the water supply system, its components and water demand by various consumers.
- Understand and analyze the quality of water and will be able to conduct the quality control test on samples.
- Understand the different processes in the water treatment facility.
- Design the different units of treatment for water treatment plants.
- Understand the components of building water supply system, storage and rain water harvesting.

- Understand the problems of air and noise pollution. Besides, they will 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** and it will consist of short questions will have 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 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: (Any eight to be performed)

1. Determination of pH of water.
2. Determination of Alkalinity of water.
3. Determination of Hardness of water.
4. Determination of Turbidity of water.
5. Determination of Optimum dose of coagulant by using Jar Test Apparatus.
6. Determination of Dissolved Oxygen of Water.
7. Determination of Residual chlorine in water.
8. Determination of chlorides in water.
9. Most Probable Number.
10. High Volume Sampler.
11. Determination of Level Equivalent of Noise.

Site Visit:

The students should visit the Water 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.

Mini Project: (Any one)

A mini project shall comprise of

1. Design a basic plumbing system for water supply for residential/commercial building.

2. A case study for any existing structure.
3. Model making.
4. Software based design of water distribution system.

Term Work:

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

Oral Examination:

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

Distribution of the 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 acceptance of term work warrants the satisfactory performance of the experiments by the student, properly compiled report thereof 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.

- Assignments & Experiments: 05 Marks
- Internal Oral examination based on Experiments and Assignments: 05Marks
- Mini Project: 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. Water Supply and Sanitary Engineering: S.K. Hussain, Oxford & IBH Publication, New Delhi.
2. Manual on Water Supply and Treatment, (latest Ed.): Ministry of Urban Development, New Delhi
3. Plumbing Engineering Theory and Practice: S.M. Patil, Seema Publication, Mumbai.
4. Water Supply and Sewage: E.W. Steel, McGraw Hill, New York.
5. Water Supply and Sewage: T.J. McGhee, McGraw Hill, New York.

6. CPHEEO Manual on Water Supply and Treatment.
7. Water Supply Engineering: P.N. Modi, Rajsons Publication.
8. Water Supply Engineering: S. K. Garg, Khanna Publication.
9. Environmental Engineering (Vol. II)- Sewage Disposal and Air Pollution Engineering: S. K. Garg, Khanna Publication
10. Introduction to Environmental Engineering: Vesilind, PWS Publishing company.
11. Water supply and pollution control: J.W. Clark, W. Veisman, M.J. Hammer, International textbook company.
12. Relevant Indian standard specifications.
13. Environmental Pollution: Gilbert Masters.
14. Basic Environmental Engineering: J.A. Nathanson, Prentice Hall of India.
15. Environmental Engineering: Sincero And Sincero.
16. Air pollution: *M. N Rao.,* Tata Mc Graw Hill, New Delhi.

Semester V

Subject Code	Subject Name	Credits
CEC505	Transportation Engineering-I	4

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

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 Hrs.	25	-	25	150

Rationale

Transportation contributes to the economical, industrial, social and cultural development of any country. The adequacy of transportation system of a country indicates its economic and social development. Three basic modes of transportation include land, water and air. The land mode further gives rise to highways and railways. The highways owing to its flexibility in catering door-to- door service forms one of the important modes. This course deals with the investigation, planning, design, construction and maintenance of highways for urban and rural areas. This course also deals with the planning, operation and control of the traffic.

Objectives

- To give insight of the development in the field of highway engineering, right from inception up to construction and maintenance and to familiarize the students with different surveys required to be carried out for the implementation of the highway project.
- To enable the students to understand the phase of engineering which deals with the planning and geometrics design of streets, highways, abutting land and with traffic operations thereon w.r.t. safe, convenient and economic transportation of people and goods.
- To enable the students to understand the properties of the different materials to be used in the construction of highways and other allied structures, characterize the materials and evaluate their suitability;
- To understand the principle of soil stabilization along with its significance and different types of stabilization techniques; and also, to study the concept of reinforced soil in the construction of highway and allied structures.

- To enable the students to understand the classification and behaviour of different types of pavements, factors to be considered in the design of pavements, approaches for designing the different types of pavements using various design methodologies
- To study the various methods of construction of different types of pavements including semi-rigid pavements and composite pavements, to study the different types of distresses in pavements, evaluation of existing pavements and methods to strengthen the distressed pavements, low volume and low-cost road and also to understand the significance of the drainage in the field of highway engineering including different methods of providing the drainage in the highways.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Highway Planning and Development/ Highway Alignment and Surveys**		**03**
	1.1	Classification of roads based on the different criteria; brief history of road developments in India; present status of roads development programme in India, including different programmes being executed by various agencies.	
	1.2	Highway alignment, basic requirement of ideal alignment, factors governing highway alignment.	
	1.3	Different types of surveys for Highway location survey, map study, reconnaissance, topographic surveys, highway alignment in hilly area, drawing report preparation.	
2.	**Geometric Design of Highway**		**07**
	2.1	Terrain classification, vehicular characteristics, highway cross section elements, salient dimensions, clearances, width of carriage way, shoulders, medians, width of road way, right of way, camber along with its profile (IRC Standards).	
	2.2	Design speed, sight distance, perception time, break reaction time, analysis of safe sight distance, analysis of overtaking sight distance, intersection sight distance.	
	2.3	Horizontal curves: design of super elevation, its provisions, minimum radius of horizontal curves, widening of pavement, transition curves.	
	2.4	Gradients: Different types of gradients (maximum, minimum, ruling, exceptional) grade compensation in curves, vertical curves: design factors, comfort sight distance, summit curve, valley curve.	

3.	**Traffic Engineering**		**05**
	3.1	Different Traffic Studies: Speed Studies (Spot Speed, Speed and Delay Studies), Traffic Volume, Parking Studies, Significance/ applications of these studies; different methods of conducting traffic studies, Methods of the presentation of data.	
	3.2	Introduction to relationship between Speed, density and volume; Capacity: Different types and factors affecting the capacity, concept of Passenger Car Units (PCU) and Level of Service (LoS).	
	3.3	Introduction to different types of Traffic Control Devices: Traffic signs, signals (no design), road marking.	
	3.4	Different types of intersections: At grade and grade separated; grade separated interchanges; rotary intersections.	
4.	**Highway Materials**		**06**
	4.1	Subgrade materials: desirable properties, modulus of elasticity, modulus of subgrade reaction, classification of subgrade soils, different strengths, various tests to be conducted to evaluate the suitability of the soil as the highway material.	
	4.2	Sub-base material: desirable properties, different tests to be conducted on aggregate, requirement of aggregate for different types of pavements.	
	4.3	Bituminous materials: types of bituminous material, test on bituminous material, desirable properties, grade of bitumen.	
	4.4	Soil Stabilization: Significance; principle of soil stabilization; different methods of soil stabilization, use of Geosynthetics in highways and allied structures.	
5	**Highway Pavement Design**		**09**
	5.1	Types of pavements: Flexible, Rigid, Semi-Rigid and composite; comparison between them vis-à-vis based on the structural behavior and other parameters; Factors affecting design of pavements including traffic factors (Design wheel load, equivalent single wheel load, equivalent wheel load factor/VDF)	
	5.2	Flexible pavement: Various approaches of designing the pavement and methods falling under each category (theoretical, semi-theoretical or	

		semi-empirical, empirical, mechanistic empirical and methods based on road performance); Overview of the method prescribed by IRC along with the modifications incorporated therein time to time (IRC: 37- 1970, 1984, 2001 and 2012); Design of the pavement using IRC: 37- 2001 and IRC: 37- 2012 with a more emphasis on latest IRC Code); Introduction to the design of low volume flexible pavement (IRC: SP 72- 2007/2015 and IRC: 77-2008).	
	5.3	Rigid Pavements: Introduction to the different types of rigid pavements (plain jointed, plain jointed reinforce, continuous reinforced, fiber reinforced, roller compacted concrete); Analysis of the stresses to be developed in the pavement (wheel load, warping and frictional); critical combination of the loading; Overview of the various approaches (Analytical, Empirical and Mechanistic empirical) of designing the pavements and methods falling under the respective category; overview of the methods prescribed by IRC along with modifications incorporated therein time to time (IRC: 58-1974, 58-1988; 58-2002 and 58-2015); Design of plain jointed rigid pavements (IRC: 58- 2002 and IRC: 58- IRC: 58- 2015 with more emphasis on IRC: 58-2015) including design of joints; Introduction to the design of low volume rigid pavement using (IRC: SP- 62-2004 and IRC: SP- 62-2014)	
6.	**Highway Construction/ Drainage/ Rehabilitation and maintenance**		**09**
	6.1	Construction of different types of roads: Introduction to the water bound macadam (WBM), wet mix macadam (WMM), bituminous pavements, plain jointed cement concrete pavements and along with various joints (as per IRC/ MORTH specifications), jointed reinforced, continuously reinforced; fiber reinforced, roller compacted concrete pavements.	

	6.2	Pavement failure: Classification of distresses in pavements (functional and structural); different types of distresses in flexible and rigid pavements along with the causes and remedial measures; various types of maintenance pavements; evaluation of pavements: functional and non-destructive evaluation of pavement, various equipment used in evaluation of pavements along with their principles (Profilometer, bump integrator, Benkelman beam, lacroixdeflectograph, falling weight deflectometer) and utility in the evaluation.	
	6.3	Strengthening of existing pavement: Objective of strengthening, different types of overlay, design of flexible overlays on flexible pavement using effective thickness approach, and deflection approach resorting to Benkelman Beam method (IRC: 81-1981) and Mechanistic Empirical approach using deflection (IRC: 81-1997); Introduction to the design of other types of overlays.	
	6.4	Highway drainage: Necessity/ Significance, mode of ingress of water in highway structure, Different methods of drainage- surface and subsurface drainage inkling for the roads in hilly areas.	

Contribution to the Outcomes

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

- To get an insight of the development in all the fields of highway engineering and familiarized with different surveys required to be carried out for the implementation of the highway project; to understand the phase of engineering which deals with the planning and geometrics design of streets, highways and abutting land in the context of safe and convenient traffic operations thereon.
- To know the required properties of the different materials to be used in the construction of highways and other allied structures, to understand characterization of the materials and to evaluate their suitability; understand the principle of soil stabilization, utilization of geosynthetics in the construction of highway and allied structures
- To understand the classification of different types of pavements, factors to be considered in the design of pavements, approaches for designing the different types of pavements and can the flexible and rigid pavements be using IRC Specifications.

- To get an insight into the methods of construction of different types of pavements; along with the importance of highway drainage and various methods of providing the drainage; also, to understand the elements of bridge engineering.
- To illustrate different distresses in the pavements, evaluate the pavements in terms of its functional and structural adequacy and arrive upon the rehabilitation measures.
- To explain methods to strengthen the distressed pavements, low volume and low-cost road and also to understand the significance of the drainage in the field of highway engineering including different methods of providing the drainage in the highways.

Theory Examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which the short questions will have 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 contents thereof.
4. There can be **an internal choice** either in the main question or sub-question to accommodate the contents of all the modules.
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 examinations shall be based on the entire syllabus the report of the experiments conducted by the students including assignments and the Traffic Survey Report.

List of Practical:

Although it is recommended that 12 experiments are desirable, at least nine should be performed.

1. Impact test on aggregates
2. Abrasion test on aggregates
3. Crushing test on aggregates
4. Shape test on aggregates
5. Soundness test
6. Polished stone value test

7. Stripping value or bitumen adhesion test (water sensitivity)
8. Penetration test on bitumen
9. Ductility test on bitumen
10. Softening point test on bitumen
11. Viscosity test on bitumen
12. Flash point and fire point test on bitumen
13. Marshall stability test on the bituminous mix
14. CBR test on subgrade soil material (Laboratory or Field)
15. Plate bearing test on subgrade soil

Term Work:

The term-work shall comprise of the neatly written report based on the afore-mentioned experiments and the assignments. There shall be at least 10 assignments which will comprise of numerical problems and lay-out sketches, covering the entire syllabus divided properly module wise. In addition to this, the students shall conduct any one of the traffic surveys and will prepare a detail report thereof. This report shall also form a component 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 the quality of the term work. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 08 Marks
- Assignments: 08 Marks
- Traffic Study Report: 04 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. Highway Engineering: *Khanna, S.K., Justo, C. E. G. and Veeraraghavan A*; NemChand and Bros., Roorkee (Revised 10th Edition)
2. Principles and Practice of Highway Engineering: *Kadiyali, L. R.*; Khanna Publishers, Delhi
3. A Text Book of Highway and Traffic Engineering: *Saxena, Subhash Chandra*; CBS Publishers and Distributors (2014)

4. A Text Book of Highway Engineering: *Sriniwasakumar, R*.; University Press, Hyderabad (First Published in 2011; Reprinted in 2013)
5. Transportation Engineering (Vol.-I)- Highway Engineering: *Venkatramaiah, C.*; University Press, Hyderabad (2016).
6. Principles of Transportation and Highway Engineering, *Rao, G.V.;* Tata McGraw Hill Publishing House Pvt. Ltd., New Delhi.
7. Principles, Practice and Design of Highway Engineering (Including Airport Engineering): *Sharma, S.K.;* S. Chand and Company Pvt. Ltd., New Delhi.
8. Principles of Transportation Engineering: *Chakraborty, Partha and Das, Animesh*; Prentice Hall India Learning Pvt. Ltd., New Delhi (Eighth Printing: January 2013).

Reference Books:

1. Transportation Engineering and Planning: *Papacostas, C.S. and Prevedouros, P.D.*; Prentice Hall India Learning Pvt. Ltd., New Delhi.
2. Transportation Engineering: *Khisty, C.J. and Lall, Kent, B.;* Prentice Hall India Learning Pvt. Ltd., New Delhi.
3. Traffic Engineering and Transport Planning: *Kadiyali, L.R.*, Khanna Publishers, Delhi
4. Pavement Design: *Srinivasakumar, R*; University press, Hyderabad (First Published 2013; Reprinted in 2015).
5. Highway Material and Pavement Testing*: Khanna, S.K., Justo, C.E.G. and Veeraragavan, A.;*Nem Chand and Bros., Roorkee, India.

Additional Reading

Relevant specifications of Bureau of Indian Standards for Highway Material Testing, Indian Roads Congress (IRC) and Ministry of Road Transport and Highways (MoRTH) w.r.t. Planning related aspects in the context of Highway Geometrics/ Traffic Planning/ Pavement Design and Highway Construction)

Note: Some of the recent specifications may not have been incorporated in few books. For this, titles of multiple books are given in the list of the Recommended Books. The latest editions shall be used. In addition to this, relevant specifications/ codes shall be referred to.

Semester V

Subject Code	Subject Name	Credits
CE-DLO5061	Department Level Optional Course – I: Advanced Surveying	4

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

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 Hrs.	25	-	25	150

Rationale

This is an advanced course which is intended to teach students about applications of modern surveying instruments with their principle and uses in surveying for different civil engineering works. Student should get exposed to the concept of Total Station, G.P.S., G.I.S. and Remote Sensing techniques. To make the students acquainted with the field problems, various groups of students not less than 2 and more than 4 should be formed, and they will research on use of various Geospatial tools for tackling problems based on any one stream viz., disaster management, construction management, project management, town planning, urban planning management and policy, water resources, utility mapping, land resource management etc.

Objectives

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

- Use Total Station & GPS for desired requirements in surveying.
- Establish surveying control to determine required accuracy using Total Station, GPS, GIS and remote sensing.
- Stake out the designed data by using modern high precision surveying instruments.
- Generate and utilize field surveying data and incorporate design data using specialized software.
- Critically evaluate the use of advance positioning instrument for surveying and setting out.
- Apply GIS for solving civil engineering problems.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1	**Modern Surveying Equipment**		**3**
	1.1	Introduction.	
	1.2	Electronic Distance Measuring Instrument (EDMI), Use of lasers in Surveying	
	1.3	Electronic Theodolite, Total Station and Scan Station	
2	**Global Positioning System**		**8**
	2.1	Basics of GPS, Positioning using satellites, GPS principles, GPS receivers, GPS principles	
	2.2	GPS errors and accuracy Error sources in GPS observations Satellite geometry and accuracy measures	
	2.3	GPS measurements techniques, GPS algorithms/Navigational solutions Other satellite navigation systems and GPS modernization	
	2.4	Civil engineering application of GPS	
3	**Photogrammetry**		**6**
	3.1	Introduction to geometry of vertical photographs Geometry of tilted photographs, photogrammetric terms; Applications; Type of photographs; perspective geometry of vertical and tilted photographs, heights and tilt distortions;	
	3.2	Flight planning; Stereoscopy, base lining, floating marks, parallax equation and stereo measurements for height determination, Developments in photogrammetry: analogue, analytical and digital methods, photogrammetric instruments.	
	3.3	Civil engineering application of photogrammetry	
4	**Remote Sensing**		**10**
	4.1	Introduction: Physical basis of remote sensing- Electro-magnetic radiation (EMR)-nature, nomenclature and radiation laws; Interaction in atmospheric nature, its effects in various wavelength regions, atmospheric windows;	

		interaction at ground surface- soils and rocks, vegetation, water, etc.; Physical basis of remote sensing (Radiometry)	
	4.2	Geometric basis of interaction, Platform and sensors, Terrestrial, aerial and space platforms; Orbital characteristics of space platforms, sun and geo-synchronous; Sensor systems radiometers, optomechanical and push broom sensor; Resolution- spectral, spatial, radiometric and temporal; Data products from various air and spaceborne sensors- aerial photographs, LiDAR, Landsat, SPOT, IRS, ERS, IKONOS, etc. Image interpretation- Elements of interpretation; Manual and digital interpretation; Field verification	
	4.3	Remote sensing: Image Interpretation, Introduction to image processing techniques, Image enhancement, Information extraction	
	4.4	Civil engineering application of Remote Sensing	
5	**Geographical Information System**		**8**
	5.1	Introduction to GIS, its hardware and software components Geographical data in computer: Data structures for GIS, Components of GIS- data acquisition, spatial and attribute data, pre-processing, storage and management; Data structures- raster and vector data; GIS analysis functions; Errors and corrections; Data presentation and generation of thematic maps. Introduction to QGIS software	
	5.2	GIS manipulation, query running, analysis and modelling, Errors and corrections	
	5.3	Civil Engineering Application of GIS	
6	**Hydrographic Survey**		**4**
	6.1	Introduction, Organizations, National and International Maritime Hydrography, Hydrographic survey Methods, Lead lines, sounding poles, and single-beam, echo sounders	
	6.2	Civil Engineering Application of Hydrographic Survey	

Contribution to Outcomes

On completion of the course, the students will be able to:

- Select appropriate methods and instruments in surveying, based on accuracy and precision required, sophistication, availability of resources, economics and duration of project.
- Appreciate the superiority and leverage of using modern methods in surveying over conventional ones.
- Employ modern surveying methods, for solving complex surveying problems
- Apply different advance surveying methodologies to carry out large scale survey works as modern instruments have largely changed the approach to survey works with the principles being same.
- Collect and manipulate data using GIS for simplifying data management and also reducing labour.
- The knowledge of limits of accuracy will be obtained by making measurements with various surveying equipment employed in practice.

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 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 solved.

Oral Examination:

The oral examination shall be based on the entire syllabus, the projects performed and practical conducted. It will include a practical exam (10 marks), before proceeding for viva (15 marks)

List of Practical:

1. Determination of co-ordinates of profile by GPS and length of profile.
2. Profile Leveling (Open Traverse) by Total Station and print output by using any software interface
3. Navigation of existing co-ordinates by GPS
4. Digitization work by any GIS software, like QGIS, ArcGIS, Gram++, etc.
5. Setting out a foundation plan of RC structure in the field using Total Station.

6. Mini Project on GIS using various software

Term work: It shall consist of the following:

1. **Mini Project** forming a group not less than 2 and more than 4 based on use of Geospatial tools for tackling problems on any one stream viz., disaster management, construction management, project management, town planning, urban planning management and policy, water resources, utility mapping, land resource management etc.
2. Presentation on any one modern tool
3. Practical write up, clearly stating aims, objectives, sketches, observations, results and subsequent discussion of results
4. The assignments shall comprise at least one assignment on each module.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory and field work by the student, appropriate completion of the assignments.

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

- Mini-project: 05 Marks
- Report of the Experiments: 05 Marks
- Assignments: 05 Marks
- Presentation: 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 Study Materials

(A) Recommended Books:

1. Higher surveying: *A.M. Chandra*, New Age International publishers.

2. Higher surveying: *B.C. Punimia, Ashok Join, Arun K. Jain,* Laxmi Publications(P), Ltd.

3. Geographic Information System and Science: *Longley, Paul A., Michael F. Goodchild, David J. Maguuire, David W. Rhind*, John Wiley and Sons, New York (2nd Ed.), 2005

4. Modeling Our World: The ESRI Guide to Geodata base Design: *Zeiler, M*. ESRI Press, Redlands, California, 1999.

5. GIS, Spatial Analysis, and Modeling: Maguire, *D., M. Batty, and M. Goodchild* 2005. ESRI Press (070.212.05842005)

6. Global Positioning System: Signals, Measurements, and Performance, *Pratap Misra and Per Enge*(2nd Ed.), 2006.

7. Remote Sensing Principles and Interpretation*: Floyd, F. Sabins, Jr:, Freeman* and Co., San Franscisco,1978.

8. A Remote Sensing Perspective: Introductory Digital Image Processing: *John, R. Jensen*, Prentice Hall.

9. Imaging Radar for Resource Survey: Remote Sensing Applications: *W. Travelt*, Chapman and Hall.

10. Remote Sensing and GIS, *B Bhatia*, Oxford University Press, New Delhi.

11. Remote sensing and Image interpretation, *T.M Lilles, R.W Kiefer and J.W Chipman*, 5th edition, John Wiley and Sons India

12. Concepts and Techniques of Geographic Information Systems, *Lo, C.P. & Yeung A.K.W.*, Prentice Hall of India, New Delhi, 2002

13.Remote Sensing and Geographical Information Systems, *M. Anji Reddy*, B.S. Publications, Hyderabad, 2001

(B) Web Materials:

1. http://nptel.ac.in/courses/105104100/1

2. http://www.surveyofindia.gov.in/

3. http://www.iism.nic.in/

4. http://bhuvan.nrsc.gov.in/bhuvan_links.php

5. http://igrmaharashtra.gov.in/#

Semester V

Subject Code	Subject Name	Credits
CE-DLO 5062	Department Level Optional Course-I: Advanced Concrete Technology	4

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

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 Hrs.	25	-	25	150

Rationale

Basic concept of concrete technology is essential for civil engineering students to execute the civil engineering projects as per the standard laid down time to time. The concrete technology is the backbone of infrastructure of civil engineering field. The students must know various concreting operations and testing operations during and after construction. It is expected to know the properties of materials, especially concrete and to maintain quality in construction projects. The civil engineering students ought to know the selection of materials, its mix proportioning, mixing, placing, compacting, curing and finishing.

Objectives

This course mainly aims to develop the knowledge about properties/ design and testing of advanced cement concrete.

Expected Outcome: Upon completion of this course, the student will be able to

- Know the various materials and properties in concrete.
- Understand the various properties of special concrete
- Understand the Mix design by different methods.
- Get a thorough knowledge of Fibre Reinforced Concrete.
- Know the different procedures for testing concrete.
- Understand the concept of durability and cracking in concrete.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Properties of Concrete:**		5
	1.1	Cement and its types: general, hydration of cement, water requirement for hydration, alkali aggregate reaction. Aggregate: grading curves of aggregates.	
	1.2	Concrete: properties of fresh concrete, w/c ratio, w/b ratio, gel space ratio, maturity concept, aggregate cement bond strength, curing and its method.	
2.	**Special Concrete:**		5
	Light weight concrete, ultra-light weight concrete, vacuum concrete, mass concrete, waste material-based concrete, shotcreting, guniting, sulphur concrete and sulphur infiltrated concrete, jet cement concrete (ultra-rapid hardening), gap graded concrete, no fines concrete, high strength concrete, high performance concrete.		
3.	**Concrete Mix Design:**		9
	3.1	Design of concrete mixes by IS code method - ACI method - Road Note No: 4 methods.	
	3.2	Design of high strength concrete mixes, design of light weight aggregate concrete mixes, design of fly-ash cement concrete mixes, design of high density concrete mixes.	
4.	**Fibre Reinforced Concrete:**		6
	Historical development of fibre reinforced concrete, properties of metallic fibre, polymeric fibres, carbon fibres, glass fibres and naturally occurring fibres. Interaction between fibres and matrix (uncracked and cracked matrix), basic concepts and mechanical properties: tension and bending.		
5.	**Testing of Concrete:**		8
	5.1	Properties of hardened FRC, behaviors under compression, tension and flexure of steel fibres and polymeric fibres.	

	5.2	Advanced non-destructive testing methods: ground penetration radar, probe penetration, pull out test, break off maturity method, stress wave propagation method, electrical/ magnetic methods, nuclear methods and infrared thermography, core test.	
6.	**Durability of Concrete:**		**6**
	Durability, Transport mechanism of fluids and gases in concrete, cracking in concrete - corrosion and carbonation induced cracking, Alkali Aggregate Reaction, degradation by freeze and thaw, chloride attack, sulphate and sea water attack (marine conditions). Hot and cold weather concreting.		
		Total	**39**

Contribution to Outcomes

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

- Know the various materials and properties in concrete.
- Understand the Mix design by different methods.
- Understand the various properties of special concrete.
- Get a thorough knowledge of Fibre Reinforced Concrete.
- Know the different procedures for testing concrete.
- Understand the concept of durability of concrete.

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 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 on the entire syllabus and experiments performed in the laboratory.

List of Practical (Any Eight to be performed):

1. Mix design in laboratory by ACI Method.
2. Mix design in laboratory by Road Note 4.
3. Chemical Admixture (Superplasticiser) optimization by Mini Slump and Marsh cone.
4. Concrete- Slump, Slump retention by Slump cone.
5. Split and Modulus of rupture of concrete.
6. Permeability test on concrete.
7. Rapid chloride penetration test
8. Tests on polymer modified concrete/mortar.
9. Tests on fiber-reinforced concrete.
10. Nondestructive testing of concrete- some applications (hammer, ultrasonic etc.).
11. Carbonation test on concrete.
12. Pull out/ pull off test on concrete.

Term Work: It shall consist of the following:

1. Neatly written report of afore mentioned experiments (at least eight)
2. Presentation on any emerging trend in concrete technology.
3. At least one assignment on each module.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments.

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

- Report of the Experiments: 10 Marks
- Assignments: 05 Marks
- Presentation: 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 Study Materials

(A) Recommended Books:

1. Concrete Technology: A. R. Shanthakumar, Oxford University Press, New Delhi, 2007.
2. Concrete Technology Theory and Practice: Shetty M.S., S. Chand.
3. Properties of concrete: Neville, Isaac Pitman, London.
4. Relevant I.S. codes: Bureau of Indian standard.
5. Special Publication of ACI on Polymer concrete and FRC.
6. Proceedings of International Conferences on Polymer Concrete and FRC.
7. Concrete Technology: Gambhir M.L., Tata McGraw Hill, New Delhi.
8. Concrete Technology: Neville A.M. & Brooks. J. J., ELBS-Longman, Pearson Education Ltd.
9. Chemistry of Cement and Concrete: F.M. Lue, Edward Arnold, 3rd Edition, 1970.
10. Concrete Technology: D.F. Orchardi, Wiley, 1962.
11. Tentative Guidelines for cement concrete mix design for pavements (IRC: 44-1976): Indian Road Congress, New Delhi.
12. Concrete mix proportioning-guidelines (IS 10262:2009).
13. Concrete- Microstructures, Properties and Materials: P. Kumar Mehta and Paulo J. M. Monteiro, Indian Edition, Indian Concrete Institute, Chennai, 1999.
14. Concrete Mixture Proportioning- A Scientific Approach: De Larrard F., E&FN Spon, London, 1999.
15. Fibre Reinforced Cementitious Composites: ArnonBentur and Sidney Mindess, Modern Concrete Technology Series, Tylor and Francis.

(B) Web Materials:

1. www.theconcreteportal.com
2. www.concrete.org

Semester V

Subject Code	Subject Name	Credits
CE-DLO 5063	Department Level Optional Course-I: Building Services & Repairs	4

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

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 Hrs.	25	-	25	150

Rationale

Building service systems are complex. They are typically a major source of cost & potential coordination problems in building construction. Fundamental knowledge of how mechanical, electrical, plumbing & other systems work & interact is important to the construction professional. This course provides an introduction to building service systems which include the study of design, interfaces & specifications of various building services in building construction 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 &functional values. Moreover; it facilitates extending the building life & ensures the safety of dwellers. Usually, the structures do perform well for about 50 years after the construction & thereafter, the deterioration begins. Insufficient maintenance & lack of repairs may lead to the limited life span of the structure. However, the regular maintenance & 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. 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. Fire safety is to be studied in order to safeguard the building from fire damage.

Objectives

- To understand the concepts of building services & its applications.
- To understand design concepts of various machineries like lift, escalators, vibrators, concrete mixers, etc. & utility services in building like plumbing system, electrical system, etc.

- To get familiar with the causes of distress of concrete structures, seepage & leakage in concrete structures & the effect on steel corrosion.
- To study the condition survey, evaluation and assessment of damage through the visual inspection & 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. and implement the steel corrosion protection methods in the field.
- To study the fire safety of the structures.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Machineries**		**05**
	Lifts & Escalators- Special features required for physically handicapped & elderly, Conveyors, Vibrators, Concrete mixers, DC/AC motors, Generators, Laboratory services, Gas, Water, air & electricity, Hot water boilers and pumps		
2.	**Plumbing Systems & Fire safety in Building**		**08**
	2.1	Plumbing Services: Water Distribution system, Material for service pipes, Service connection, Size of service pipe, Water meter, valves and storage tanks.	
	2.2	Drainage system: Pipe and traps, system of plumbing, House drainage plans, septic tanks and soak pit.	
	2.3	Fire Safety Installation: Causes of fire in building - safety regulation - NBC - Planning considerations in building like non-combustible materials, construction, staircases and lift lobbies, fire escapes and A.C. system. Special features required for physically handicapped and elderly in building types - Heat and smoke detectors - Fire alarm system, snorkel Ladder - Fire Lighting pump and water storage - Dry and wet riser - Automatic sprinklers	

3.	**Electrical systems & Illumination Design in Buildings**		**07**
	3.1	Electrical systems in buildings: Basics of electricity - Single / Three phase supply, Protective devices in electrical installations, earthing for safety, Types of Earthing, ISI specifications, Types of wires, wiring systems &their choice, Planning electrical wiring for building, Main &distribution boards, Transformers & switch gears, Layout of substations	
	3.2	Principles of Illumination Design: Visual task, Factors affecting visual task, Modern theory of light &colour, Synthesis of Light, Additive & Subtractive synthesis of colour, Luminous flux, candela, solid angle illumination, utilization factor, Depreciation factor, MSCP, MHCP, Lens of illumination, Classification of lighting, Artificial lights sources, spectral energy distribution, Luminous efficiency, colour temperature, colour rendering.	
	3.3	Design of Modern lighting: Lighting for stores, offices, school, hospitals and house lighting. Elementary idea of special features required and minimum level of illumination required for physically handicapped and elderly in building types.	
4.	**Deterioration of Concrete Structures**		**05**
	4.1	Causes of deterioration of concrete structures, effects of climate, moisture, temperature, chemical, wear, erosion & loading on serviceability & durability. Design& construction errors.	
	4.2	Causes of seepage & leakage in concrete structures. Formation of cracks including those due to corrosion.	
5.	**Condition Survey, Evaluation & Damage Assessment**		**05**
	5.1	Diagnostic methods & analysis.	
	5.2	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, Concrete endoscopy & thermal imaging, pull-off test & pull-out test.	
6.	**Materials & Repair Methodologies, Protection of Concrete Structures & Rebar Corrosion Protection**		**09**

	6.1	Repair analysis & design.	
	6.2	Repair materials and their desired properties.	
	6.3	Methodologies for crack and patch repair: polymer modified mortar, polymer modified concrete, polymer concrete	
	6.4	Injection grouting, shotcrete, joints and sealants, rebar corrosion crack repair 10.5	
	6.5	Protective materials and their properties for moisture barrier systems.	
	6.6	Above grade and below grade water-proofing of concrete structures.	
	6.7	Systems like integral, crystalline, coatings, membranes, etc.	
	6.8	Thermal protection coatings.	
	6.9	Methods of corrosion protection, corrosion inhibitors	
	6.10	Corrosion resistant steels, cathodic protection	
	6.11	Pre-packed zinc sacrificial anode, Snap-on zinc mesh anode CP system.	
		Total	**39**

Contribution to Outcomes

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

- Understand the importance & installation of utility services.
- Understand the drawbacks of all the service lines are not installed properly or if materials used are faulty.
- Choose appropriate systems & integrate the same into the building construction projects.
- Assess the structural health of the buildings & infrastructural works and also Inspect & evaluate the damaged structures.
- Implement the techniques for repairing the concrete structures and also decide whether or not the structure should be dismantled, if it is deteriorated beyond repair.
- Employ the methods of steel protection in the field.
- Understand the damage caused by fire & exercise due care for fire safety.

Theory examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory.** It will have short questions, each carrying 4 to 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 options within 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 & the term work consisting of the assignments& experiments.

List of Practicals:

1. Carbonation test by spraying phenolphthalein
2. Non -destructive testing of concrete structures by Rebound hammer.
3. Non -destructive testing of concrete structures by UPV meter.
4. Outdoor exposure test to measure weathering of coating
5. Test for flexibility of coating by applying on a tin sheet
6. Test for effectiveness by measuring water absorption of coating applied on a card board.

Condition Survey:

The students will carry out the condition survey of any damaged structure by visual observations& 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 & 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 & 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 & contents thereof further. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 08 Marks
- Assignments: 08 Marks
- Report on the Condition Survey: 04 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. National Building Code.
6. Building Construction: *Dr. B. C. Punmia, Ashok K Jain*, A.K Jain
7. Construction Engineering and Management: *S. Seetharaman*, Umesh Publications, Delhi.
8. Water supply and Sanitory Installations: *A. C. Panchdhari*, New Age International Publication, Delhi
9. Concrete Repair and Maintenance: *Peter H. Emmons and Gajanan M. Sabnis*, Galgotia Publication.
10. Repairs and Rehabilitation-Compilation from Indian Concrete Journal-ACC Publication.
11. Guide to Concrete Repair and Protection, HB84-2006, A joint publication of Australia Concrete Repair Association, CSIRO and Standards Australia.
12. 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.
13. Guide to Concrete Repair, *Glenn Smoak*, US Department of the Interior Bureau of Reclamation, Technical Service Center, http://books.google.co.in.
14. Management of Deteriorating Concrete Structures: *George Somerville*, Taylor and Francis Publication.
15. Concrete Building Pathology: *Susan Macdonald*, Blackwell Publishing.

16. Testing of Concrete in Structures: *John H. Bungey*, *Stephen G. Millard and Michael G. Grantham*, Taylor and Francis Publication.
17. Durability of concrete and Cement Composites: *Page, C.L.*and Page*, M.M.,* Woodhead Publishers
18. Fire Safety in Building: V. K. Jain, New Age International Publication, Delhi

Semester V

Subject Code	Subject Name	Credits
CE-DLO 5064	Department Level Optional Course-I: **Advanced Structural Mechanics**	**4**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

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 Hrs.	25	-	25	150

Rationale

The structures are subjected to various types of loading/ forces. These are axial force, shear force, bending moment, etc. This course enables the students with the knowledge in conformity with analysis of behaviour of structural members under different types of loading. The course facilitates in imparting theoretical concepts and physical understanding, which in turn will help in solving structural mechanics problems, mostly involving beams & thin-walled structures under different loading conditions.

Objectives

- To understand the concept of shear centre& evaluate the shear centre for symmetrical & un-symmetrical thin walled sections.
- To understand the concept &behavior of beams resting on elastic foundation.
- To study the behavior of beams curved in plan.
- To understand the concept of different theories of failure in regards of materials.
- To study the behavior of deep beams using different theories available for the analysis of different sections.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1	**Shear centre:**		5
	Shear Centre for symmetrical & unsymmetrical (about both axes) thin walled open sections.		
2	**Bending of beams with large initial curvature:**		8
	2.1	Bending of beams with large initial curvature, loaded in their plane of curvature.	
	2.2	Application to analysis of hooks, circular closed rings, chain links with straight length & semi-circular ends.	
3	**Beams on elastic foundation:**		8
	3.1	Analysis of beams of infinite length subjected to concentrated force/moment & semi-infinite length subjected to concentrated load/moment at one end.	
	3.2	Semi-infinite beam hinged at one end (origin) & subjected to UDL throughout.	
4	**Beams curved in plan:**		5
	4.1	Analysis of beams loaded perpendicular to their own plane.	
	4.2	Simply supported, fixed & continuous beams.	
5	**Theories of Failure:**		7
	5.1	Maximum principal stress theory, Maximum principal strain theory, Maximum shear stress theory.	
	5.2	Maximum total strain energy theory.	
6	**Analysis of deep beams:**		6
	6.1	Determination of deflection	
	6.2	Determination of shear correction factor for various sections: rectangular solid & hollow section, circular solid & hollow section & I-section	
	6.3	Stress concentration, stress concentration factor.	
		Total	**39**

Contribution to Outcomes

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

- Understand the concept of shear centre for thin walled open sections.
- Study the behavior of beam resting on elastic foundation with various loading conditions.
- Analyze the beam curved in plan for different support conditions.
- Understand the concept of different theories of failure in different sections.
- Determine deflection, shear correction factor for different sections like solid & hollow sections.

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 option within 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 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.

Oral Examination:

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

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., Preentice Hall, New Delhi.
8. Beams on Elastic Foundation: Heteny M. 9. Strength of Materials: Subramanian, Oxford University Press.

Semester V

Subject Code	Subject Name	Credits
CE507	**Business and Communication Ethics**	**2**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
-	**4#**	-	**-**	**2**	-	2

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
-	-	-	-	-	50	-	-	50

Rationale

Ethical issues of **Business Communication** are the process by which individuals exchange information between other individuals or groups of people. Throughout the process, effective communicators try as clearly and accurately to convey their thoughts, intentions and, objectives to their receiver. This course is very important for aspiring Civil Engineers as the industry suffers major delays due to miscommunication between various parties to the contract.

Objectives

- To inculcate professional and ethical attitude.
- To enhance effective communication and interpersonal skills.
- To build multidisciplinary approach towards all life tasks.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1	**Report Writing**		**05**
	1.1	Objectives of Report Writing	
	1.2	Language and Style in a report	
	1.3	Types: Informative and Interpretative (Analytical, Survey and Feasibility) and Formats of reports (Memo, Letter, Short and Long Report)	

2	**Technical Writing**		**03**
	2.1	Technical Paper Writing (ASCE Format)	
	2.2	Proposal Writing	
3	**Introduction to Interpersonal Skills**		**09**
	3.1	Emotional Intelligence	
	3.2	Leadership and Motivation	
	3.3	Team Building	
	3.4	Assertiveness	
	3.5	Conflict Resolution and Negotiation Skills	
	3.6	Time Management	
	3.7	Decision Making	
4	**Meetings & Documentations**		**02**
	4.1	Strategies for conducting effective meetings	
	4.2	Notice, Agenda and Minutes of a meeting	
	4.3	Business meeting etiquettes	
5	**Introduction to Corporate Ethics**		**02**
	5.1	Professional and work ethics (responsible use of social media - Facebook, WA, Twitter etc.)	
	5.2	Introduction to Intellectual Property Rights	
	5.3	Ethical codes of conduct in business and corporate activities(Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	
6	**Employment Skills**		**07**
	6.1	Group Discussion	
	6.2	Resume Writing	
	6.3	Interview Skills	
	6.4	Presentation Skills	
	6.5	Statement of Purpose	
		Total	**28**

Contribution to Outcomes

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

- Design a technical document using precise language, suitable vocabulary and apt style.
- Develop the life skills/ interpersonal skills to progress professionally by building stronger relationships.
- Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
- Apply the traits of a suitable candidate for a job/higher education, upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
- Deliver formal presentations effectively implementing the verbal and non-verbal skills.

Term Work:

The term-work shall comprise of the neatly written report based on the Assignments, Project Report Presentation and Group Discussion. The assignments shall be given according to the list given below

List of Assignments:

1. Report Writing (Theory)
2. Technical Proposal
3. Technical Paper Writing (Paraphrasing a published IEEE Technical Paper)
4. Interpersonal Skills (Group activities and Role plays)
5. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
6. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
7. Corporate ethics (Case studies, Role plays)
8. Writing Resume and Statement of Purpose

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. Term work will consist of all assignments from the list. The distribution of marks for term
Work will be as follows:

- Book Report: 10 Marks
- Assignments:10 Marks
- Project Report Presentation: 15 Marks
- Group Discussion: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. Fred Luthans, *"Organizational Behavior",* McGraw Hill, edition
2. Lesiker and Petit, *"Report Writing for Business",* McGraw Hill, edition
3. Huckin and Olsen, *"Technical Writing and Professional Communication",* McGraw Hill
4. Wallace and Masters, *"Personal Development for Life and Work",* Thomson Learning, 12th edition
5. Heta Murphy, *"Effective Business Communication",* Mc Graw Hill, edition
6. Sharma R.C. and Krishna Mohan, *"Business Correspondence and Report Writing",* Tata McGraw-Hill Education
7. Ghosh, B. N., *"Managing Soft Skills for Personality Development",* Tata McGraw Hill.
8. Lehman, Dufrene, Sinha, "BCOM", Cengage Learning, 2nd edition
9. Bell, Smith, "Management Communication" Wiley India Edition, 3rd edition.
10. Dr. Alex, K., "Soft Skills", S Chand and Company
11. Subramaniam, R., "Professional Ethics" Oxford University Press.
12. Robbins Stephens P., "Organizational Behavior", Pearson Education
13. https://grad.ucla.edu/asis/agep/advsopstem.pdf

Semester VI

Semester VI

Subject Code	Subject Name	Credits
CEC601	**Geotechnical Engineering-II**	**5**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	**3**	1	-	**4**

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	3 Hrs.	25	**-**	**25**	**150**

Rationale

Basic knowledge of analysis and design of foundations is very important for all civil engineers; and more so for geotechnical and structural engineers. Soil testing (both field and lab tests) and its analysis are not only compulsory prerequisites for the analysis, design and construction of any major structure but also holds lucrative business and job opportunities in the field of civil engineering. Immense research opportunities are also available in this field.

Objectives

- Students will gain knowledge of consolidation theory.
- Students will evaluate the shear strength characteristics of the soil. Moreover, they would apply the knowledge for solving the related problems.
- Students will analyze stability of slopes, comprehend lateral earth pressure theories and apply them in stability analysis of retaining walls.
- Students will analyze and design shallow as well as deep foundations.
- Students will gain knowledge of underground conduits and braced cuts.
- Students will gain knowledge of ground improvement techniques.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1	**Consolidation of soils**		**04**
	1.1	Compressibility & settlement, comparison between compaction & consolidation, concept of excess pore water pressure, initial, primary secondary consolidation, spring analogy for primary consolidation, consolidation test results, coefficient of compressibility, coefficient of volume change, compression, expansion recompression indices, normally over consolidated soils.	
	1.2	Terzhaghi's theory of consolidation- assumptions, coefficient of vertical consolidation, distribution of hydrostatic excess pore water pressure with depth & time, time factor, relationship between time factor degree of consolidation, determination of coefficient of vertical consolidation, pre-consolidation pressure.	
	1.3	Final settlements of a soil deposit in the field, time settlement curve, field consolidation curve.	
2	**Shear strength**		**05**
	2.1	Introduction, three dimensional state of stress in soil mass, principal stresses in soil, shear failure in soils- frictional cohesive strength, general shear stress-strain curves in soil definition of failure, graphical method of determination of stresses on a plane inclined to the principal planes through Mohr's circle, important characteristics of Mohr's circle.	
	2.2	Mohr-Coulomb theory- shear strength parameters; Mohr-Coulomb failure criterion- relation between major minor principle stresses, total & effective stress analysis.	
	2.3	Different types of shear tests drainage conditions; Direct shear test, Triaxial compression test (UU, CU CD), Unconfined compression test, Vane shear test; comparison between direct & triaxial tests, interpretation of test results of direct shear & triaxial shear tests stress-strain curves Mohr failure envelopes	
	2.4	Determination of shear strength of soil with geosynthetics- pull out test: ASTM procedure for finding shear strength of soil-geosynthetic system.	

3.	**Stability of Slopes**		**04**
	3.1	Introduction: Types of slopes, types of slope failures, factors of safety	
	3.2	Stability analysis of infinite slopes in i) cohesionless soil and ii) cohesive soil under a) dry condition, b) submerged condition and c) steady seepage along the slope	
	3.3	Stability analysis of finite slopes: i) Culmann's method, ii) Swedish slip circle method, iii) friction circle method and iv) Taylor's stability number	
4.	**Lateral Earth Pressure Theories and Stability of Retaining Walls**		**10**
	4.1	Introduction to Lateral Earth Pressure Theories: Concept of lateral earth pressure based on vertical and horizontal stresses, different types of lateral earth pressure	
	4.2	Rankine's earth pressure theory: i) assumptions, ii) active and passive states in cohesionless soil: effect of submergence, effect of uniform surcharge, effect of inclined surcharge iii) active and passive states in cohesive soil	
	4.3	Coulomb's wedge theory: i) assumptions, ii) active and passive states in cohesionless soil, iii) active and passive states in cohesive soil	
	4.4	Rehbann's Graphical Method (no proof)	
	4.5	Culmann's Graphical Method (no proof)	
	4.6	Introduction to retaining walls: types of retaining walls, stability checks for retaining walls	
	4.7	Stability analysis of gravity retaining walls	
	4.8	Stability analysis of cantilever retaining walls	
5.	**Shallow Foundations**		**10**
	5.1	Introduction: types of shallow foundations, definitions of different bearing capacities	
	5.2	Theoretical methods of determining bearing capacity of shallow foundations: i) Terzaghi's theory: assumptions, zones of failure, modes of failure, ultimate bearing capacity equations for general and local shear failure, factors influencing bearing capacity: shape of footing and water table, limitations of Terzaghi's theory ii) Vesic's theory: bearing capacity equation	

		iii) I.S. Code Method: bearing capacity equation	
	5.3	Field methods of determining bearing capacity of shallow foundations: i) standard penetration test and ii) plate load test	
6.	**Pile Foundations**		**6**
	6.1	Introduction to pile foundations: types of pile foundations, necessity of pile foundations	
	6.2	Theoretical methods of determining load carrying capacity of pile foundations: i) static formulae and ii) dynamic formulae	
	6.3	Field method of determining load capacity of pile foundations: pile load test	
	6.4	Group action of piles, settlement of pile groups, negative skin friction	
		Total	**39**

Contribution to Outcomes

- Students will be able to evaluate the consolidation parameters for the soil.
- Students will be able to calculate the shear strength parameters for the soil.
- Students will be able to calculate the factors of safety of different types of slopes under various soil conditions, analyze the stability of slopes, calculate lateral earth pressures and analyse the stability of retaining walls.
- Students will be able to calculate bearing capacity of shallow foundations using theoretical and field methods, calculate load bearing capacity of individual as well as group of pile foundations and their settlement using theoretical and field methods
- Students will be able to explain conduits and calculate the load carried by the struts of a braced cut under various soil conditions.
- Students will be able to explain ground improvement techniques.

Theory Examination

1. Question paper will consist of total **6** questions; each carrying 20 marks.
2. Only **4** questions (out of 6) need to be attempted.
3. Question no. **1** will be **compulsory.**

4. Any **3** out of the remaining **5** questions need to be attempted.

5. In question paper, weightage of each module maybe approximately proportional to the number of lecture hours assigned to it in the syllabus.

Oral Examination:

The oral examination shall be based upon the entire syllabus

Term Work:

Although it is recommended that 7 experiments are desirable, at least 5 should be performed.

1. Determination of pre-consolidation pressure coefficient of consolidation from one dimensional consolidation test.
2. Determination of shear parameters form unconsolidated undrained tri-axial compression test
3. Determination of shear parameters from direct shear test
4. Determination of cohesion from unconfined compression test
5. Determination of CBR value from CBR test
6. Determination of shear strength of soft clays from vane shear test.
7. Determination of swelling pressure of clays

Assignments:

a) Assignments should contain at least 15 numerical problems covering the entire syllabus.

b) One assignment shall be given on GROUND IMPROVEMENT TECHNIQUES. The teacher is expected to deliver extra lectures on the topic, thereby imparting the knowledge to the students, about the concept of ground improvement. The questions related to ground improvement techniques shall **NOT** be asked in the theory examination. However, it shall be treated as a part of term work submission. It shall preferably cover the following points:

- Reinforced earth: Design of reinforced earth wall
- Geotextiles: definition, types, functions and use in civil engineering

- Introduction to stone columns and prefabricated vertical drains

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

- Report of the Experiments: 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. Soil Mechanics and Foundations: Dr. B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain; Laxmi Publications
2. Soil Mechanics and Foundation Engineering: K. R. Arora; Standard Publishers and Distributors
3. Soil Mechanics and Foundation Engineering: V. N. S. Murthy; Saitech Publications
4. Geotechnical Engineering: C. Venkatramaiah; New Age International
5. Soil Engineering in Theory and Practice: Alam Singh; CBS Publishers Distributors
6. Designing with Geosynthetics: R. M. Koerner; Prentice Hall, New Jersey
7. An Introduction to Soil Reinforcement Geosynthetics: G. L. Sivakumar Babu; Universities Press
8. Theoretical Soil Mechanics: K. Terzaghi; John Wiley and Sons
9. Fundamentals of Soil Engineering: D. W. Taylor; John Wiley and Sons.
10. Relevant Indian Standard Specifications Code: BIS Publications, New Delhi

Semester VI

Subject Code	Subject Name	Credits
CEC602	**Design and Drawing of Steel Structures**	**5**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
4	2	-	**4**	1	-	**5**

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 Hrs.	25	---	25@	150

Rationale

Steel structures are preferred due to their higher strength, speed of construction and aesthetic view. Civil engineers must have knowledge of designing and detailing of steel structures to make structures safe and serviceable during its life span. IS code specifying the use of Limit State design philosophy for design of steel structures and its various components. This course is designed to provide basic knowledge of design and detailing of steel structures.

Objectives

- To make students familiar with behavior of steel structure and their components under the action of various loads.
- To train the students for effective use of IS codes, design tables and aids in analyzing and designing the steel structures by limit state method.
- To equip students with aspects required for designing tension member, compression members and column bases.
- To equip students with aspects required for designing beams and welded plate girder
- To help students design connections in steel members
- To aid students in designing steel trusses.

Detailed Syllabus

Module	Sub Modules/Contents		Periods
1.	**Introduction**		04
	Types of steel structures, Properties of Structural Steel, Indian Standard Specifications and Sections, Design Requirements & Design Process, Advantages and limitations of WSM, Introduction to Limit State Design, partial safety factors for load and resistance, design load combinations, section classification such as plastic, compact, semi-compact and slender.		
2.	**Design of tension members**		06
	Introduction, types of tension members, net area calculation. Design strength due to yielding, rupture and block shear. Design of tension members with welded and bolted end connection using single angle section & double angle section.		
3.	**Design of compression members and column bases**		15
	3.1	Introduction, types of compression members, classification of cross sections, types of buckling, effective length of column and slenderness ratio, buckling curves, design of compression members as struts using single angle sections & double angle section.	
	3.2	Design of axially loaded column using rolled steel sections, design of built up column, laced and battened Columns.	
	3.3	Design of slab bases & gusseted base.	
4.	**Design of beams and welded plate girder**		13
	4.1	Design strength in bending, effective length, Lateral torsion buckling behavior of unrestrained beams, design of single rolled section with or without flange plates, design strength of laterally supported beams, low and high shear, design strength of laterally unsupported beams, web buckling, web crippling, shear lag effect and deflection. Design of angle section purlin.	
	4.2	Design of welded plate girder: proportioning of web and flanges, flange plate curtailment, stiffeners and connections	
5.	**Design of connections**		07
	Design of bolted and welded beam to beam and beam to column connections.		

	Framed, stiffened and unstiffened seat, bracket connections.	
6.	**Design of truss**	**07**
	Design of determinate truss. Calculation of dead load, live load and wind load acting on truss. Load combinations and calculation of internal forces. Design and detailing of members. Support detailing.	
	Total	**52**

Contribution to Outcomes

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

- Explain the Limit State Design philosophy as applied to steel structures.
- Predict the behavior and design members subjected to axial compression, tension and their connection.
- Predict the behavior and design members subjected to bending, shear and their connection
- Calculate loading for a truss and design the complete truss.
- Demonstrate ability to follow IS codes, design tables and aids in analysis and design steel structures.
- Analyze and design the commercial steel structures and prepare drawing with complete detailing.

Theory examination:

1. Question paper will comprise of five questions. First question will **carry 32** marks and remaining four will carry **16 marks** each. The **first** question will be **compulsory.** From remaining four questions any **three** questions can be answered. Total **four** questions need be attempted.
2. The **first** question will be based on **any one** of design projects from following.

a) Design of Truss.

b) Design of flooring system.

3. The next four questions will be based on remaining modules of syllabus. The weightage of the marks shall be judiciously awarded in proportion to the importance of the module and number of hours allotted for the module. There can be an internal choice in various questions/ sub-questions in order to accommodate the questions on all the topics/ sub-topics.
4. For each question, the drawings will carry 20% weight of respective question. Drawings of questions **shall be drawn on half imperial drawing sheet** during the examination. The drawings of remaining questions may be drawn on drawing sheet or answer book.

5. All relevant IS codes will be allowed during examination.

Oral Examination:

The oral examination shall be conducted in conjunction with the sketching examination and it will be based upon the entire syllabus and the term work consisting of the assignments, projects including drawing sheets.

Term Work:

The Term work shall consist of following:

1. Design Report including detail drawings on any of the two projects as listed below:
   a) Design of truss (internal forces to be calculated by analytical method/graphical method/using any software)
   b) Flooring system including beam, column, column base and connections.
   c) Welded plate girder.

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

2. Neatly drawn minimum 15 sketches showing structural detailing based on entire syllabus(in sketchbook).
3. Neatly written assignments covering the syllabus. (At least four problems on each modules and contents thereof)
4. One site visit report (The report should contain structural details with sketches).viz. Industrial structure, Railway Structures, Workshops etc.

Distribution of the 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 acceptance of term work warrants the satisfactory and appropriate completion of the design report, drawing work and assignments and minimum passing marks obtained by student. The following weightage of marks shall be given for different components of the term work.

- Design Report: 05 Marks
- Drawing sheets: 10 marks
- Assignments: 05 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, the following guidelines should be resorted to: 75%-80%: 03 marks; 81%-90%: 04 marks; 91%-100%: 05 marks

Recommended Books:

1. Design of Steel Structure by N. Subramanian, Oxford University Press, New Delhi.
2. Limit state design of steel structures by S. K. Duggal, McGraw Hill Education(India) Pvt. Limited, New Delhi.
3. Design of steel structure by Limit State Method as per IS: 800- 2007 by Bhavikatti S. S., I.K. International Publishing House, New Delhi
4. Design of Steel Structures by K. S. Sai Ram, Pearson Education, New Delhi.
5. Limit state design of steel structures as per IS 800/2007. by S. Kanthimathinathan. I.K. International Publishing House, New Delhi.
6. Relevant Indian Specifications, Bureau of Indian Standards, New Delhi

Semester VI

Subject Code	Subject Name	Credits
CEC603	**Transportation Engineering-II**	**4**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	1	-	4

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 Hrs.	25	-	-	125

Rationale

Transportation contributes to the economical, industrial, social cultural development of any country. The adequacy of transportation system of a country indicates its economic social development. Three basic modes of transportation include land, water and air. The land mode further includes highways railways. This course is developed so as to impart the basic principles behind railway engineering, airport engineering water transportation engineering in respect of their various types of materials used, function of component parts, methods of construction, planning principles, aspects of supervision maintenance.

Objectives

- To enable the students to study the various elements pertaining to air transportation, water transportation, railway transportation. To study the various components of railway track, materials used functions of component parts.
- To study the various imaginary surfaces of an airport, geometric standards, runway taxiway lighting.
- To study the various parking system, holding apron, hangars drainage system.
- To study the various modes of water transportation, types of breakwater, harbours and port facilities equipment.
- To study the various aspects of jetties, wharves, piers, dolphins, fenders buoyancy etc.
- To study the fundamental concepts of bridge engineering

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	General Introduction: Role of transportation in Society, objectives of transportation system, different types of modes, planning coordination of different modes for Indian conditions.		10
	Railway Engineering		
	1.1	Railways for urban transportation-Engineering surveys for track alignment-Obligatory Points-Conventional and modern methods (eg. Remote sensing, GIS)	
	1.2	Permanent way-track components their functions, sleeper – functions types, sleeper density, ballast functions different ballast materials.	
	1.3	Rails: coning of wheels, tilting of rails, rail cross sections, wear, creep of rails, rail fastenings.	
	1.4	Yards: details of different types of railway yards their functions.	
	1.5	Construction and maintenance of railway track, methods of construction, material requirements, maintenance of tracks, traffic operations.	
	1.6	Modernization of track and railway station for high speed trains, Mono rails and Metro rails.	
	1.7	Permanent way-track components their functions, sleeper – functions types, sleeper density, ballast functions, different ballast materials.	
2.	**Geometric Design of Railway and Traffic Control**		08
	2.1	Geometrics: gradients, transition curves, widening of gauge on curves, Cant deficiency.	
	2.2	Points crossing: design of turnouts, description of track junctions, different types of track junctions.	
	2.3	Signaling interlocking: classification of signals, interlocking of signals points, control of train movement.	

3.	**Airport Engineering**		**08**
	3.1	Aircraft component, their functions, aircraft characteristics and their influence on airport planning.	
	3.2	Airport planning: topographical geographical features, existing airport in vicinity, air traffic characteristics, development of new airports, factors affecting airport site selection.	
	3.3	Airport obstruction: zoning laws, classification of obstructions, imaginary surfaces, approach zones, turning zones.	
	3.4	Airport layout: runway orientation, wind rose diagrams, basic runway length, corrections for runway length, airport classification, geometric design, airport capacity, runway configuration, taxiway design, geometric standards, exit taxiways, holding aprons, location of terminal buildings, aircraft hangers parking.	
	3.5	Airport marking and lighting marking, lighting of runways, taxiway, approach other areas.	
	3.6	Terminal area & airport layout: terminal area, planning of terminal buildings, apron: size of gate position, number of gate position, aircraft parking system, hanger, general planning considerations, blast considerations.	
4.	**Air Traffic Control**		**06**
	4.1	Air traffic control aids, en-route aids, landing aids.	
	4.2	Airport drainage: requirement of airport drainage, design data, surface drainage design.	
	4.3	Airport airside capacity delay: runway capacity delays, practical hourly capacity, practical annual capacity, computation of runway system, runway gate capacity, taxiway capacity,	
	4.4	Air traffic forecasting in aviation: forecasting methods, forecasting requirement applications.	
5.	**Water Transportation**		**03**
	Introduction of water transportation system, harbors docks, port facilities.		
6.	**Bridge Engineering**		**04**
	Bridge Engineering: Importance, Investigations, Site Selection, Different terms related with Bridges; Waterway, Afflux, Economic span, Scour depth,		

	Different types of bridges: Superstructures and sub-structures, Different loadings for design of bridges, Design requirements for high speed trains	
	Total	**39**

Contribution to Outcomes

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

- Understand the various systems of railway, airport, water transportation and the components of p-way and its construction, yards, modernization of railway track.
- Apply the concept of geometric design of railway track and railway traffic control.
- Understand airport planning, obstructions and orientation of runway.
- Apply the concept of geometric design of runway, taxiway, etc. and the knowledge of various signaling system for air traffic control.
- Understand the system of water transportation, types of breakwater, harbours and port facilities equipment
- Understand the basic idea about the bridge engineering.

Theory Examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which the short questions will have 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 and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
4. There can be an **internal** choice in various questions/ sub-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 four problems on each modules/ sub-module content thereof further. There shall be theory questions as well.

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 experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments 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. A Course of Railway Engineering: *Saxena, S. C. and Arora, S. P.*; Dhanpat Rai Sons, New Delhi.
2. Airport Planning Design: *Khanna, S.K., Arora, M.G.and Jain, J.J.; Nemchand Bros., Roorkee.*
3. Docks and Harbour Engineering: *Bindra, S. P.*; Dhanpat Rai and Sons, New Delhi.
4. Principles and Practice of Bridge Engineering: *Bindra, S.P.;*Dhanpat Rai and Sons, New Delhi.
5. Harbour, Dock and Tunnel Engineering: *Shrinivas, R.;*Charotar Publishing House, Anand
6. A Text Book on Highway Engineering Airports: Sehgal, S. E. and Bhanot, K. L., S. Chand and Co. Ltd., New Delhi
7. Airport Engineering: *Rao, G. V.,* Tata Mc-Graw Hill India Publishing House, New Delhi

Reference Books:

1. Indian Railway Track: *Agarwal, M. M.,*Suchdeva Press New Delhi.
2. Planning Design of Airport: *HoronjeffMckelrey*, Tata Mc-Graw Hill India Publishing House, New Delhi.
3. Design and Construction of Ports and Marine Structures: Quinn, A. D., Tata Mc-Graw Hill India Publishing House
4. Bridge Engineering: Victor, D. J., Tata Mc-Graw Hill Publishing House Pvt. Ltd., New Delhi
5. Bridge Engineering: *Bindra, S. P.*, Dhanpatrai and Sons, New Delhi

Semester VI

Subject Code	Subject Name	Credits
CE-C604	Environmental Engineering – II	**04**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	**02**	**--**	**03**	**01**	**--**	**04**

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

Environment has gained increasing importance in the relation with the principles of public health engineering, design of waste water collection and treatment systems; and develops 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 and solid waste management. The course lays emphasis on complete update of the knowledge of these processes related to design of treatment plant.

Objectives

- To understand and explain the role of sanitation and its relation to public health and environment.
- To provide knowledge of wastewater collection system, characteristics of wastewater.
- To provide students the necessary knowledge and concepts of advancements/emerging techniques of treatment in physical, chemical and biological treatment processes. To provide students prerequisite knowledge necessary for higher studies and research in the field of wastewater treatment.
- To study the appropriate treatment, reclamation and resource recovery and re-use at both centralized and decentralized levels. Also, to study self-purification in nature.
- To develop rational approaches towards sustainable wastewater management via sludge recovery and treatments.
- To provide necessary skill for understanding and operation of solid waste management facilities.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Sewage Generation, Collection and Conveyance**		**10**
	1.1	**Introduction**: Need for sewerage system, Domestic sewage, Industrial waste and Storm Water, 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	
	1.2	**House drainage and Environmental sanitation** **Plumbing:** basic principles, Plumbing regulations, preliminary data for design, Preparation and submission of plans, Systems of Plumbing, anti-siphonic and vent pipes.	
	1.3	**Conveyance of sewage** 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: Pumping station components	
2.	**Characterization and Primary Treatment of sewage**		**07**
	2.1	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. Primary treatment: Screening, Grit removal, Oil and Grease removal, settling tank.	
3.	**Conventional Biological treatments**		**11**
	3.1	**Secondary Treatment Methods** Trickling filter- Principle, Process description and Operational problems and Design. Activated sludge process (ASP) - Principle, Process description, Recirculation of sludge, Operational problems, Sludge volume index and	

		Design of ASP. Aerated lagoons- Process description and Design, Rotating Biological contractors, Stabilization Ponds, UASB.	
	3.2	**Constructed Wetland** Wetland and aquatic treatment systems; Types, application, Treatment Free water surface and subsurface constructed wetlands, Other aquatic treatment systems- Root zone technology, Duckweed ponds	
	3.3	**Septic Tank and Soak Pit** –Operation, suitability and Design. Concepts of advances in wastewater treatment. Imhoff Tank On-site treatment: Meaning of decentralized treatment.	
4.	**Reclamation and Reuse of Waste water**		**05**
	4.1	Tertiary and Grey water treatment, recycling and reuse of wastewater.	
	4.2	**Self-Purification of Natural Water Bodies** Oxygen economy, Sewage farming. Disposal of treated effluent Disposal of Raw and treated sewage on land and water, standards for disposal. Stream pollution: Self-purification, DO sag curve.	
5.	**Sludge Treatment and Disposal**		**03**
	5.1	Thickening, Dewatering, Sludge Digestion: Principles of anaerobic digestion, quantity and characterization of sludge, design of sludge digestion tanks. Disposal- disposal of digested sludge, drying beds.	
6.	**Municipal Solid Waste Management**		**03**
	6.1	Solid waste: Sources, Types, generation and collection, storage, handling, transportation, processing, treatment and disposal methods Introduction to Hazardous wastes, E-wastes and Plastic wastes.	
		Total	**39**

Contribution to Outcomes

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. The students shall be able to design the treatment facilities

and assess the guidelines for disposing of waste. They shall be able to formulate approaches to treat waste water in most effective manner.

After the completion of the course the student should be able to:

- Explain wastewater collection systems in buildings and municipal areas and to determine the quantity of wastewater and storm water production. Also, gain the knowledge of the construction of new sewer line and importance of sewer appurtenances.
- Explain and analyze the characteristics of wastewater and design the primary treatment for wastewater
- Explain on-site treatment methods and solve Analyze and design wastewater treatment systems (ASP, Aerated lagoon and Oxidation ponds).
- Identify and apply proper treatment for reclamation and reuse of wastewater and disposal.
- Explain sludge characteristics and processing methods.
- To provide knowledge of solid waste collection system, characteristics of solid waste and to identify hazardous waste. Study related to plastic waste management will be studied.

Theory examination:

1. Question paper will comprise of **Six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which the short questions will have 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 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:(Any eight to be performed)

1. Determination of pH of sewage.
2. Determination of Chlorides.
3. Determination of Total Solids, suspended solids, dissolved solids, volatile solids.
4. Determination of Oil and Grease in waste water.
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. Plumbing demonstration of accessories, fittings and fixtures.
10. Solid waste: Determination of pH.
11. Solid waste: Determination of moisture content.

Term work:

The term-work shall comprise of the neatly written report based on the experiments performed in the laboratory along with the assignments. A brief report on the visit to sewage treatment plant shall also form a part of the term work.

Site Visit:

The student should visit to 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.

Mini Project :(Any one)

1. Identify sewer network of a particular area and study the case.
2. Collect the sample from municipal or industrial wastewater, test the parameters and suggest the treatment.
3. Identify the sewerage treatment facility in your area and suggest modification, innovation with design.
4. Identify plumbing system. Enlist sewer appurtenances and system requirement for row house or apartment.
5. A case study related to solid waste management or any waste minimization technique.
6. Model making in form of prototype with respect to sewage treatment or solid waste management.
7. Design of sewage treatment plant using software.

Distribution of the 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 acceptance of term work warrants the satisfactory performance of the experiments by the student, properly compiled report thereof 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.

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

- Internal Oral examination based on Experiments and Assignments: 10 Marks

- Mini Project: 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

Oral Examination

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

Recommended Books

1. Wastewater Engineering Treatment, Disposal, Refuse: Metcalf and Eddy, T.M.H. Edition, New Delhi, 1995.
2. Manual on Wastewater Treatment 3rd Ed. Pub: CPH and Env. Engg. Organization, Ministry of Urban Development, Govt. of India, New Delhi, 1991.
3. Environmental Engineering: *Peavy, H.S., RoweD.R., Tchobanoglous G.*; 1991, Tata-Mcgraw Hill.
4. Environmental Engineering Vol II- Sewage Disposal and Air Pollution Engineering: *S. K. Garg,* Khanna Publishers New Delhi.
5. Water supply and sanitary Engineering: *Hussain S. K.,* Oxford and IBH Publication, New Delhi.
6. Plumbing Engineering, Theory and Practice: *Patil S. M.,* Seema Publication, Mumbai.
7. CPHEEO Manual on Sewage and Treatment.
8. Environmental Engineering: *B. C. Punmia*, Laxmi Publications, New Delhi.
9. Relevant Indian standard specifications and BIS publications.
10. Solid waste management in developing countries: A.D. Bhide and B.B. Sundaresan.
11. Integrated solid waste management, Tchobanoglous, Theissen and Vigil, McGraw Hill Publication.
12. Manual on Municipal Solid Waste Management: Ministry of urban development, New Delhi.
13. Water Supply and Sewerage: *E.W. Steel.*
14. Introduction to Environmental Engineering, *Vesilind*, PWS Publishing Company 2000.
15. Introduction to Environmental Engineering: P. *AarneVesilind*, *Susan M. Morgan*, Thompson.
16. Wastewater Treatment- Concepts and Design Approach: G. L. Karia and R. A. Christian.

Semester VI

Subject Code	Subject Name	Credits
CEC605	Water Resources Engineering-I	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	2	-	3	**1**	-	4

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	3	25	-	25	150

Rationale

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 of rainfall 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 various irrigation methods based on crop water requirements, hydrologic processes, estimation of storage capacity of reservoir and hydraulics of wells.

Objectives

- To study various types of irrigation projects.
- To study and understand the various techniques and methods of irrigation.
- To understand the irrigation requirements of crops.
- To calculate storage capacity of reservoirs.
- To study the elements of hydrologic cycle and calculate catchment yield.
- To study the hydraulics of wells and ground water exploration methods.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
1.	**Introduction:**	**6**
	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.	
2.	**Irrigation methods and management**	**6**
	Types of irrigation: surface irrigation, subsurface irrigation; lift irrigation, bandhara irrigation, percolation tanks. Techniques of water distribution: free flooding, border flooding, check flooding, basin flooding, furrow irrigation method, micro irrigation, sprinkler irrigation, drip irrigation. Irrigation scheduling, participatory irrigation management.	
3.	**Water requirement of crops:**	**7**
	Crops and crop seasons in India, cropping pattern, duty and delta, quality of irrigation water, soil water relationship, soil characteristics significance from irrigation considerations, root zone soil water, infiltration, consumptive use, irrigation requirement, frequency of irrigation, water requirement and capacity of canal and reservoir, assessment of irrigation water, water conservation, rain water harvesting.	
4.	**Hydrology**	**8**
	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, complex hydrograph.	
5.	**Ground water and well hydraulics:**	**6**
	Ground water resources, occurrence of ground water, well irrigation. Well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifer, aquifer tests, design of water wells.	
6.	**Investigation and reservoir planning**	**6**
	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, evaporation loss, estimation and controlling methods of evaporation.	
	Total	**39**

Contribution to Outcomes

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

- Classify various types of irrigation projects
- Explain different irrigation methods and effective use of water resources.
- Calculate the crop water requirements and irrigation requirement.
- Derive hydrographs and calculate runoff of a catchment area.
- Explain the steady state and unsteady state conditions of any aquifer and design water wells.
- Estimate the capacity of a reservoir for different purposes.

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 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 solved.

Oral Examination:

The oral examinations shall be based on the entire syllabus including term work.

Term Work:

The term work shall comprise of the neatly written assignment/tutorials based on above modules. The assignment shall be covering the entire syllabus in such way that the student would attempt at-least three questions including numerical if any, on each module.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance in tutorials and appropriate completion of the assignments.

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 and Water Power Engineering: *B.C. Punmia, Pande B.B. Lal, A.K Jain*. Laxmi Publications Pvt, Ltd. New Delhi.
2. Irrigation Water Resources and Water Power Engineering: *P.N. Modi*, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
3. Irrigation Engineering and Hydraulic Structures: *S.K. Ukarande,* Ane Books Pvt. Ltd.ISBN, 9789383656899.
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.
10. Concrete *Dams: R. S. Varshney*, Oxford and IBH Publishing Co.

Semester VI

Subject Code	Subject Name	Credits
CE-DLO6061	Department Level Optional Course-II-Advanced Construction Equipment	**04**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	**2**	**-**	03	01	**-**	04

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**	**3 Hrs.**	**25**	**-**	**25**	**150**

Rationale

Machines have revolutionised every sphere of human being's life. Engineering constructions also have seen a drastic reformation due to introduction of various construction equipment and techniques. This course provides an extensive overview of advanced equipment used in construction industry and also discusses certain methods used to construct facilities using modern equipment. It further exposes the student to different kinds of civil engineering structures which they are supposed to construct in the field and makes them aware with the equipment required for the same. The impact of use of equipment on human resource as well as how equipment will help in making optimum utilization of resources is also given a thought.

Objectives

- To illustrate the characteristics and complexities involved in large civil engineering projects.
- To classify various construction equipment
- To elaborate the various advanced equipment used on, below or above ground/water.
- To discuss about the various non-conventional construction techniques which make use of these advanced equipment.
- To discuss the utility of modern formworks systems over conventional systems.
- To select appropriate equipment and techniques in construction for large and heavy engineering projects on the basis of suitability, availability, productivity, output, initial and operation cost, savings in time and other resources etc.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Introduction**		**06**
	Study of Different categories of construction equipment used conventionally with reference to available types and their capacities, operations and factors affecting their performance.		
	1.1	Earthmoving and other hauling equipment	
	1.2	Drilling and blasting equipment.	
	1.3	Pile driving equipment.	
	1.4	Pumping equipment (for water as well as concrete), Applications of Air compressor.	
	1.5	Dewatering techniques for trenches, tunnels.	
	1.6	Stone crushing equipment.	
2.	**Equipment for Underground and Underwater tunneling.**		**09**
	Various purposes for which tunneling may be carried out, Basic terms related to tunneling, Conventional methods of carrying out tunneling in different types of soils/rocks. Modern methods of tunneling and detailed study of following equipment/techniques in this regard:		
	2.1	Jumbo – used for drilling and blasting.	
	2.2	Vertical shaft sinking machine (VSM).	
	2.3	Tunnel Boring machine (TBM), Micro tunneling.	
	2.4	New Austrian tunneling method (NATM).	
	2.5	Cut & cover method, Top to bottom construction.	
	2.6	Tunnel lining trolley.	
3.	**Modern formwork systems**		**06**
	3.1	Difference in conventional and modern systems of formwork Mivan, Doka shuttering along with their advantages and disadvantages.	
	3.2	Modular shuttering, Slip and jump form, Tower cranes and the benefits they offer for high rise construction.	
	3.3	Prefabricated housing systems, Difficulties faced in the installation and operation of all these systems.	
	Equipment for construction of underground utilities, road construction		

4.	**and bridges/flyovers**		**06**
	4.1	Pipeline insertion system, use of ground penetrating radar (GPR) for locating underground utilities.	
	4.2	Construction of roads using paver machines.	
	4.3	Methods of construction for bridges/flyovers and the processes/equipment required thereof, Incremental launching method and balanced cantilever method with reference to the recent infrastructure developed in the local and global context.	
5.	**Equipment/ techniques for setting up of power generation structures.**		**06**
	5.1	Hydropower station.	
	5.2	Thermal power station.	
	5.3	Solar power station.	
	5.4	Atomic power generation.	
	5.5	Installation and operation of wind mills.	
	5.6	Installation and operation of underground power transmission lines as well as overhead transmission towers.	
6.	**Equipment for construction of transporting facilities**		**06**
	4.4	Construction of railway lines using track laying machine. Methods, techniques and equipment involved in the construction of Metro, mono and maglev trains. Special requirements of the permanent way in each case.	
	4.5	Equipment required for construction and operation of an airport and sea port.	
		Total	**39**

Contribution to Outcomes

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

- Understand the use/applications of various conventional construction equipment and select the best out of them for a particular site requirement.
- Know modern methods/equipment used for underground as well as underwater tunnelling.
- Compare conventional and modern methods of formwork on the basis of productivity, reuse value, ease of erection and dismantling, flexibility offered and overall cost.

- Understand the techniques involved and the equipment required thereof for construction of various transporting facilities.
- Gain knowledge about the setting up of different kinds of the power generating structures.
- Select proper equipment for construction of transporting facilities based on requirements.

Theory Examination:

1. Question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory which the short questions will have 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 (One for each module) and site visits (minimum 2). The assignments shall be given covering the entire syllabus and preferably different questions can be given to different group of students so that they themselves will create the question bank and answers for the same.

This course should be taught through maximum site visits and demonstration of the working processes and equipment through animations/videos to make the delivery most effective. The difference between conventional and modern method of carrying out a construction process should be clearly known to the students. Site visits to various ongoing infra projects especially in Mumbai Metropolitan region (MMR) can be of great help to the students. The site visits should be planned in such a way so that maximum equipment/techniques can be seen actually by the students. The report on site visit shall also form a part of the term work.

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: 10 Marks
- Report on Site Visits: 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/Study material:

1. Construction Equipment & Planning, Purifoy, R.L & Ledbetter, McGraw Hill
2. Construction Equipment & it's Management, Sharma, S. C. Khanna Publishers
3. Tunnel Engineering Handbook, Thomas R. Kuesel, Elwyn H. King, John O. Bickel, Springer
4. Practical tunnel construction, Gary B. Hemphill, Wiley Publishers
5. Construction Technology for Tall Buildings, Michael Yit Lin Chew, World Scientific
6. The prefabricated home, Colin Davies, Reaktion Books.
7. Literature/specifications/downloadable videos available on Doka and Mivan shuttering websites.
8. Accelerated Bridge Construction: Best Practices and Techniques, Mohiuddin Ali Khan, BH Elsevier
9. Design and Construction of Nuclear Power Plants, RüdigerMeiswinkel, Julian Meyer, Jürgen Schnell Wiley Publishers

Semester VI

Subject Code	Subject Name	Credits
CE-DLO6062	Department Level Optional Course-II-Traffic Engineering and Management	**04**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	02	-	03	01	-	04

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**	**3 Hrs.**	**25**	**-**	**25**	**150**

Rationale

Transportation Planning is a backbone of the urban planning or town planning. It constitutes the important part of any urban or town system. Traffic Engineering follows the Transportation Planning and is the specialized branch of the Highway Engineering which deals with the improvement of traffic performance on road network and terminals through systematic traffic studies, scientific analysis and engineering applications. Traffic Engineering includes the planning and geometric design on one hand and regulation and control on the other. It, therefore, deals with the application of scientific principles, tools, techniques and findings for safe, rapid, economical and efficient movement of people and vehicles.

Objectives

- To understand the concepts of traffic characteristics, traffic surveys to be conducted for planning any transportation network or judging the adequacy of the existing one; and further, the application of various statistical tools to the analysis of the large data base emerging out of extensive traffic surveys and transportation and traffic planning.
- To understand the concept of various features of the highway geometrics and infrastructures, their necessity, pros and cons, design or planning principles and subsequently, to design / plan the features such as channelization, island, speed change lanes and parking facility.
- To understand the concept of highway capacity and such other components such as Passenger Car Unit and Level of Service affecting the Capacity; and Speed- Flow- Density Relationship and various theories describing these relationships.

- To understand the importance of Highway Safety and implementation of Traffic System Management (TSM) Measures and subsequent to study the various Traffic Control Devices and aspects of Highway Lighting.
- To study the various components of the Transportation Planning process, their importance and various approaches/ methods/ models to be resorted to for each of these components.
- To understand the concept of economic evaluation of any of the transportation projects, its significance, various aspects associated with the evaluation; and various methods of economic evaluation.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Traffic Engineering**		**08**
	1.1	**Traffic Characteristics/ Characteristics of the Users of the Transportation System** Introduction to the Road User and the Vehicle; Road Users' (Human) Characteristics affecting their behavior; Vehicular Characteristics; Power Performance of Vehicles.	
	1.2	**Traffic Studies/ Surveys** Introduction to Spot Speed (space and time mean speed); Speed and Delay Studies (different types of delays, overall/ journey speed, running speed, journey time, running time); Traffic Volume Studies; Vehicle Occupancy Studies; Parking Studies; Accident Studies. Significance/ Objectives/ Necessity/ Application of the afore-mentioned studies; Methods of conducting these studies along with pros and cons (merits and drawbacks) of each of methods; Analysis Methodologies; Different methods of the Interpretation / Presentations of the Results.	
	1.3	**Application of Statistical Methods in the Traffic Engineering** Different Statistical Methods; Basic Concepts of the Terminologies pertaining to statistical methods; Poisson's, Binomial and Normal Distribution, Sampling theory and Significance Testing, Regression (Linear and Multiple) and Correlation	

2.	**Highway Geometrics and Parking System**		**07**
	2.1	Different Terms involved in Highway Geometrics; Types of Intersections (At grade and grade separated) and its further bifurcations/ classification along with merits and drawbacks; Conflict points and Conflict Area at Intersections; Flaring of Intersections; Principles behind designing the intersections. Channelization: Significance, Different types of islands within the layout of the road network and intersection or junctions. Speed Change Lanes; Rotary intersection: Merits and Demerits; Necessity; Different Types; Design Principle; Design of the Rotary.	
	2.2	Traffic and parking problems; different types of parking facilities (on street and off street along with further bifurcations therein); Truck Terminals; Long distance Bus Terminals.	
3.	**Highway Capacity and Introduction to Theory of Traffic Flow**		**04**
	Capacity; Difference between Capacity and Volume; Passenger Car Unit (PCU); Concept of Level of Service; Different Types of Capacities and Factors affecting the Capacity. Speed- flow-Density Relationships; Introduction to the Lighthill and Whitham's Theory; Car Following Theory and Queuing Theory		
4.	**Highway Safety/ Traffic System Management/ Lighting**		**07**
	4.1	Factors responsible for the accident; Preventive Measures; Traffic Management Measures and its implications on traffic flow and accident prevention Brief Introduction to the Highway Lighting: Importance; Principle of Visibility at Night; Factors influencing Night Visibility; Design Factors; Important Definitions; Law of Illumination; Discernment by Artificial Lighting; Mounting Height; Spacing; Lantern Arrangements; Types of Lamps; Lighting of Some Important Highway Structures; Design of Highway Lighting Systems.	
	4.2	**Traffic Control Devices (Signs, Signals and Marking)** Significance; Advantages and Drawbacks; Principles of TCDs; Different Types of Traffic Signs; Different Types of Traffic Signals; Terms	

		involved in Signals; Co-ordinated Control of Signals and Types of Co-ordinated Signal System; Various Approaches of Designing the Signals (determination of optimal cycle time and signal setting for an intersection with fixed time signals); Area Traffic Control and Delay at Signalized Intersections.	
5.	**Transportation Planning**		**07**
	Introduction to the process of urban transport planning. Trip Generation: Introduction; Factors affecting Traffic Generation and Attraction Rates; Multiple Regression Analysis, Category Analysis Trip Distribution: Importance; Different Methods of Trip Distribution, Uniform and Average Factor Method, Fratar Method, Furness Method, Gravity model, Opportunities Model. Traffic Assignment: Purpose; General Principles; Assignment Techniques (All or Nothing Assignment, Multiple Route Assignment, Capacity restraint assignment, Diversion Curves). Modal Split: General Considerations; Factors affecting Modal Split; Modal Split in the Transportation Planning Process Land Use Transport Models: Introduction; Selection of Land Use Transport Models; Lowry Derivative Models; Garin Lowery Model		
6.	**Transport Economics**		**06**
	Economic Evaluation of Transportation Projects; Necessity; Cost and Benefits of Transportation Projects, Basic Principles of Economic Evaluation, Interest Rate; Costs (Vehicle Operating; Time; Accident); Benefits (Direct and Indirect); Different Methods of Economic Evaluation (Benefit- Cost Ratio Method, First Year Rate of Return Method; Net present Value Method; Internal rate of Return Method); Comparison of the Various Methods of Evaluation vis-a-vis.		
		Total	**39**

Contribution to Outcomes

After successful completion of the course the students shall be able to

- Understand different characteristics of the road users and vehicles from their consideration and view point in the traffic engineering and transportation planning.
- Conduct different traffic surveys, analyzing the data collected as a part of such studies and interpreting it with the help of the different statistical models.
- Explain the concepts of PCU and LoS, their implication in determination of the capacity using Speed-Flow-Density relationships.
- Discuss the aspects associated with highway safety and different TSM measures.
- Discuss transportation planning and ascertain the financial viability of any transportation network in the inception stage itself.
- Plan the various features of highway geometrics and transportation infrastructure constituents to ensure safe, rapid, economical and efficient of the traffic.

Theory Examination:

1. The question paper will comprise of six questions; each carrying 20 marks.
2. All the 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.
3. There can be an option within various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics and to give justice to all the contents of the entire syllabus.
4. The **first** question will be **compulsory**. 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 prepared by the student and appropriately certified by the course instructor/ teacher concerned.

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: 10 Marks
- Report of the Traffic Surveys: 10 Marks
- Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, the 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: Pignataro, G. J., McGraw-Hill
3. Traffic System Analysis for Engineering and Planners: Wohl and Martin, Mc-Graw Hill
4. Highway Engineering: Khanna, S.K.; Justo, C.E.G. and Veeraraghavan, A.; Nemchand and Bros., Roorkee (10th Revised Edition)
5. Principles of Transportation Engineering: ParthaChakroborty and Animesh Das, Prentice Hall (India).
6. Highway Engineering and Traffic Engineering: Saxena, Subhash C.; C.B.S. Publishers
7. Transportation Engineering (Vol.-I): Venkatramaiah, C.; University Press, Hyderabad
8. Principles, Practice and Design of Highway Engineering: Sharma, S.K.; S Chand and Co. Pvt. Ltd., Delhi
9. Highway Engineering: Sriniwaskumar, R.; University Press, Hyderabad
10. Traffic Flow Theory and Control: Drew, D. R., Mc-GrawHill, New York

11. Transportation Engineering and Planning: Papacostas, C. S., Prevedouros, P. D., PHI Learning Pvt. Ltd.
12. Transportation Engineering: Khisty, C.J. and Lall, K.B.; PHI Learning Pvt. Ltd.
13. Introduction to Urban Transport Systems, Planning: Hutchinson, B.G.; McGraw-Hill.
14. Economics of Transportation: Fair and Williams, Harper and Brothers, Publishers, New York.
15. Highway Capacity Manual, Transportation Research Board, National Research Council, Washington D.C.
16. Relevant IRC Codes amended time to time.

Semester VI

Subject Code	Subject Name	Credits
CE-DLO6063	Department Level Optional Course-II: Ground Improvement Techniques	**04**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	02	-	03	01	-	04

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**	**3 Hrs.**	**25**	**-**	**25**	**150**

Rationale

A geotechnical engineer often needs to design new structures or repair the structures on or in problematic soils in engineering practices. The types of soil at construction sites are not always totally favorable for supporting civil engineering structure such as buildings, bridges, highways, tunnels, retaining walls, dams, offshore structures and many more. Soil needs to be treated using ground improvement techniques to enhance the soil strength. Similarly, specific types of soil improvement techniques are required in the case of expansive soils and collapsible soil and in the case of earthquake prone areas. For both cases, the knowledge of Ground Improvement is required as ground improvement is an important to for a Geotechnical Engineer. This course will deal with different ground improvement techniques along with principles, design issues and construction procedures.

Objectives

- To enable students to identify problematic soils and their associated issues.
- To make the student understand for different ground improvement methods adopted for improving the properties of in-situ and remoulded soils.
- To make the student learn the concepts, purpose, methods and effects of soil stabilization.
- To make the student learn the concepts, purpose and effects of grouting.
- To provide the concepts of the reinforced earth and soil nailing to the students in conventional retaining walls.
- To enable the students to know ground anchors that can be used to improve the engineering performance of soils both in static and seismic condition

Detailed Syllabus

Module	Sub Modules/Contents	Periods
1.	**Introduction**	04
	Need for Ground Improvement, Different types of problematic soils, classification of ground improvement techniques, Emerging trends in ground Improvement techniques, economic considerations and suitability.	
2.	**Compaction and Consolidation**	07
	Methods of compaction, Shallow compaction, Deep compaction techniques: Vibro-floatation, Blasting, Dynamic consolidation, pre-compression; accelerated consolidation by sand drains, free strain and equal strain cases, design of sand drain layout.	
3.	**Stabilization of Soil**	05
	Methods of stabilization, mechanical stabilization: lime, cement, lime, fly-ash, bitumen, chemicals and polymer stabilization, stabilization by electro-osmosis.	
4.	**Grouting**	06
	Grouting technology, Grout materials, physical and chemical properties, strength, Rheological aspects of coarse and fine grouts, penetrability and performance aspect of coarse and fine grouts, Various application of grouting.	
5	**Stone Columns**	08
	Application, layout feature, procedures of installation, vibro float and rammed stone column, unit cell concept, load transfer mechanism, settlement in stone column, methods of improving the effectiveness of stone column, Design for stone column layout.	
6.	**Reinforced Earth and Anchors**	09
	Necessity of reinforced earth, theory of reinforced earth, materials and method, application, design of reinforced earth, characteristics of reinforced earth masses; introduction to soil nailing and ground anchors; Capacity of shallow horizontal and vertical strip anchors by using Mononobe-Okabe method.	
	Total	39

Contribution to Outcomes

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

- Identify problematic soils and their associated issues.
- Study the various ground improvement techniques and propose suitable remedial techniques and design.
- Select appropriate soil improvement technique based on the soil type and application.
- Design grouting for various engineering applications in the field.
- Design stone column layout
- Design the geotechnical structures with the pseudo-static method under seismic condition

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 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 consisting of the assignments.

Term Work:

The term work shall comprise of neatly written report based on assignments. The term work shall cover the entire syllabus in such a way that the students would attempt conceptual theory part from each module. Further, groups of students (having maximum four students) shall be formed who shall analyse and design any **three** with different data from the following:

1. Design of sand layout in soft compressible clay deposit for required (accelerated) rate of consolidation.
2. Analysis of Horizontal or Vertical strip anchor by using Mononobe-Okabe Method to find the seismic capacity.
3. Design of a reinforced earth retaining wall.
4. Analysis and design of skirted stone columns.

Distribution of the 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 acceptance of term work warrants the satisfactory and appropriate completion of the assignments. Final certification, acceptance of term work warrants a satisfactorily appropriate completion of assignments 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
- Report on Analysis and Design: 10 Marks
- Attendance: 5 Marks

Further, while giving weightage of marks on the attendance, the following guidelines should be resorted to:

- 75%-80%: 03 marks; 81%-90%: 04 marks; 91%-100%: 05 marks

Recommended Books:

1. Ground Improvement Techniques: P.P. Raj, Prentice Hall of India, (2005).
2. Engineering Principles of Ground Modification: M.R. Housmann, McGraw Hill, (1990).
3. Foundation Engineering Manual: N. V. Nayak, (2015).
4. IS15284 (Part 1): Design and Construction for Ground Improvement–Guidelines: (Stone Column), Bureau of Indian Standards, New Delhi, (2003).
5. Ground Improvement Techniques: Nihar Ranjan Patro, Vikas Publishing House (P) Limited, (2012).
6. Geotechnical Earthquake Engineering: S. L. Kramer, Pearson, (2013).
7. Earth Anchors: B. M. Das, Elsevier, (2012).

Reference books:

1. Constructional and Geotechnical Methods in Foundation Engineering: R.M. Koerner, McGraw Hill, (1985).
2. Design and Construction of Stone Column: FHWA Report No. Rd 83/026, (1983)

3. Principles of Foundation Engineering: B. M. Das, 7th edition, Cengage Learning, (2013).

4. Designing with Geosynthetics: R.M.Koerner,4thEdition,Prentice Hall, Jersey, (1999)

Semester VI

Subject Code	Subject Name	Credits
CE-DLO6064	Department Level Optional Course-II: Advanced Structural Analysis	**04**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	02	-	03	01	-	04

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

Rationale

There are various types of the civil engineering structures which are subjected to various types of loading and their combination. Most of the structures are indeterminate. There are various advances in methods to analysed these structures. The methods of analysis which are given in the syllabus are based on computer software.

Objectives

- To analyze the statically indeterminate portal frame.
- To study the methods and evaluating rotation and displacement parameters in complete frame using various methods.
- To analyze the symmetrical frame with symmetrical and anti-symmetrical loading.
- To understand the concept of analyze of non-prismatic frame and beam.
- To understand the concept of Influence lines for statically indeterminate beams.
- To understand in depth the stiffness matrix method of analysis, which is the basis of all compute-based software methods used in practice; finite element method, concepts thereof, different elements to be used along with various shape functions and solution methodology.

Detailed Syllabus

Module	Sub-Modules / Contents		Periods
1.	**Introduction to Stiffness Method in Matrix form**		**10**
	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.	
2.	**Conventional Form of Stiffness Method, Modified Moment Distribution Method**		**07**
	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.	
3.	**Flexibility Method in Matrix form**		**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.	

4.	**Conventional Form of Flexibility Method**		**07**
	4.1	Elastic Centre Method and its application to rectangular box, and rigid jointed portal frames.	
	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.	
5.	**Influence Line Diagrams for Indeterminate Structures**		**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.		
6.	**Introduction to Finite Element Method**		**06**
	6.1	Brief History of the Development; Advantages & Disadvantages of Finite Element Method.	
	6.2	Different elements (1-D, 2-D, 3-D, CST Elements); Shape Functions & Interpolation Polynomials for two nodded bar and beam elements; Stiffness Matrix for the basic Bar & Beam Element, Solution Methodology.	
		Total	**39**

Contribution to Outcomes

The students will be able to

- Understand the Stiffness Matrix method and will be able to analyze various types of structures by this method understand the conventional 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.
- Demonstrate the ability to extend the knowledge gained in this subject for their higher years UG program courses, in which they will be dealing with the indeterminate structures.
- Understand the concepts of the finite element method toward solving the problem, different elements and shape functions (displacement functions) to extend the application to the short problems.

Theory Examination:

1. Question paper will comprise of six questions; 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 consisting of the assignments.

Term Work:

The term work shall comprise of neatly written report based on tutorials and assignments. The term work shall cover the entire syllabus in such a way that the students would attempt at least four problems on each sub-modules and contents thereof.

At least twenty solved problem have to be validated by using available computer software.

Or

At least ten solved problem (validated by using available computer software) and analysis of (G+2) portal frame with minimum three bays.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded depending upon the quality of the term work. Final certification, acceptance of term work warrants a satisfactorily appropriate completion of assignments 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: 5 marks

Further, while giving weightage of marks on the attendance, the following guidelines should be resorted to: 75%-80%: 03 marks; 81%-90%: 04 marks; 91%-100%: 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. Sructural Analysis: L. S. Negi & R. S. Jangid, Tata McGraw hill.
6. Structural Analysis Vol. I and Vol. II: Pandit and Gupta, Tata McGraw hill.
7. Analysis of Structures: V.N.Vazirani and M.M.Ratwani Khanna Publishers.
8. Finite Element Analysis: S.S. Bhavikatti, New Age International Publication

Reference Books:

1. Matrix Method in structural Analysis: Livesley R. K. Pergamon Press, London.
2. Elementary Structural Analysis: Wilber, M MethodGraw 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. Finite Element Analysis: S. Rajasekaran, S. CHAND & COMPANY PVT. LTD
7. Finite Element Method with application in Engineering Y.M.Desai, T. I. Eldho and A.H, Shah PEARSON
8. Finite Element Method: Daryl L. Logan, THOMSON
9. Matrix Structural Analysis: William McGuire, Richard H. Gallagher, Ronaid D. Ziemian, Wiley India Pvt. Ltd.

Semester VI

Subject Code	Subject Name	Credits
CEC607	**Software Applications in Civil Engineering**	1

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
-	2	-	-	1	-	1

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
-	-	-	-	-	**25**		25	**50**

Rationale

With the advancements in software and technology, a significant revolution in Civil Engineering field has taken place. Software reduces all the extensive work, specifically through the introduction of programs and applications. Lately, software development has effectively contributed in various Civil Engineering disciplines. It provides engineers with the ability to perform variety of complex calculations, modelling, drafting, design practices and analytical processes with utmost ease. Further these software packages have wide capabilities and help engineers to analyze, design, plan and monitor projects, which earlier was a cumbersome job. Civil Engineering students need to learn all skill sets and demonstrate the practical applications to Engineering problems. Hence this course covers the study of various types of software packages and their application in Civil Engineering fields.

Objectives

Students are introduced to:

- All kinds of software packages available in various fields of civil engineering.
- Proficiency in applications of these software packages.
- Practical use of software results and their validation by relating them with analytical results by conventional methods.

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**General**		**02**
	1.1	Importance and need of software for modeling, analysis and design in Civil Engineering field, Advantages and limitations of software, causes for errors, validation of software results. Failures due to errors in modeling, data entry and interpretation of software results.	
2.	**Software application in various disciplines of Civil Engineering:** Learning and practice of any one software from at least any 4 domain from 14 domain (2.1 to 2.14)		**24**
	2.1	**Drafting and drawing**: AutoCAD, Civil 3D, Auto plotter, Design and detailing of same using AutoCAD Beams (simply supported, continuous etc), Slabs (one way, two way), Columns, Portal frame, Truss	
	2.2	**building information modelling**: Revit and archicad, tekla , Navisworks, Trimble, AECOsim Building designer , Sketchup	
	2.3	**Numerical Analysis and Mathematical operations:** MATLAB Scilab	
	2.4	**Structural Analysis and Design:** STAAD Pro, ETABS, SAP 2000, SAFE, MIDAS.	
	2.5	**Finite Element Analysis**: ANSYS, ABAQUS, NISA	
	2.6	**Project Management:** Primavera, MS Project	
	2.7	**Geotechnical Engineering: Geo** studio, PLAXIS	
	2.8	**Quantity Surveying:** QS red, CCS Candy	
	2.9	**Environmental Engineering:** Storm CAD, EPANET, Sewer CAD	
	2.10	**Remote Sensing and Geographical Information System:** QGIS, GRAM++, Arc GIS	
	2.11	**Transportation Engineering:** MX Road, HDM, Road estimator	
	2.12	**Hydraulics and Water Resources Engineering**: Water Gems, Water CAD, Flow Master, Culvert Master, Nero solution, Discipulus, HEC-RAS, Arc SWAT, Hydrology: HEC, HMS	
	2.13	Different Open source software used for specific problems	

	2.14	**MS Excel:** Conduct concrete mix design for M40 grade concrete. or any exercise of Civil Engineering domain.	
		Total	**26**

Note: Course Owner is free to add and teach any latest additional software which is relevant to Civil Engineering Field and not listed in above curriculum.

Contribution to Outcome

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

- Use the software in various disciplines of Civil Engineering
- Apply the software in to provide solutions to field problems.
- Validate the software results using judgment about range of answers.
- Identify theappropriate software application based on the field of Civil Engineering
- Apply equivalentopen source software based on thecase ofCivil Engineering specific problems.
- Integrate different softwares and their results for specific problems of Civil Engineering.

Term Work

A group of 3-4 students will prepare and give detailed power point presentation on any one software. Presentation should cover salient features, capability of software and should contain some applications from field.

The term work shall comprise of:

- At least hands-on working on one Software from any fourdomain listed above and preparing report of the same.
- Presentation Report on any one software.
- Open Source Software report (optional)

Distribution of the 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 acceptance of term work warrants the satisfactory and appropriate completion of the design report/ 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:

- Software Report: 16 marks
- Presentation: 4 marks
- Attendance: 5 marks

Further, while giving weight age of marks on the attendance, the following guidelines should be resorted to: 75%-80%: 03 marks; 81%-90%: 04 marks; 91%-100%: 05 marks

Recommended reading:

1. Software manuals.
2. Refereed Journal papers on Software applications.
3. NPTEL course like " MATLAB programming for numerical computation by Dr.NiketKaisare from IIT Madras and so on for other softwares.