AC. 11/5/2017

Item No. 4.177

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Civil Engineering (Second Year – Sem. III & IV)

Revised course (REV – 2016)

With Effect From Academic Year 2017 – 18

Under the

FACULTY OF TECHNOLOGY

(As per Semester Choice Based Credit and Grading System)

Preface

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

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

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 not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Credit grading based system was implemented for First Year of Engineering from the academic year 2016 – 2017. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2017 – 2018, for Third Year and Final Year Engineering in the academic years 2018 – 2019, 2019 – 2020, respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble

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

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

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

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

Dr. S. K. Ukarande
Chairman, Board of studies in Civil Engineering
University of Mumbai, Mumbai

University of Mumbai

Scheme of Instructions and Examination

Second Year Engineering (Civil Engineering)

(With effect from 2017 – 2018)

(Semester–III)

Course Code	Course 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		**17**	**8**	**1**	**17**	**4**	**1**	**23**

Course Code	Course 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

University of Mumbai

Scheme of Instructions and Examination

Second Year Engineering (Civil Engineering)

(With effect from 2017 – 2018)

(Semester – IV)

Course Code	Course 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**

Course Code	Course 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**	--	**150**	--	**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 Engg.– 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.)				
		Test1	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	--	--	--	--	--	25	--	25*	50
Total		**--**	**--**	**120**	**480**	**--**	**175**	**--**	**175**	**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	Practs.	Tut.	Theory	Practs.	Tut.	Total
CE-C601	Geotechnical Engg. – II	3	2	--	3	1	--	4
CE-C602	Design and Drawing of Steel Structures	4	2	--	4	1	--	5
CE-C603	Transportation Engg. – II	3	2	--	3	1	--	4
CE-C604	Environmental Engg – 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-C507	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 (In Hrs.)				
		Test1	Test 2	Avg						
CE-C601	Geotechnical Engg. – II	20	20	20	80	3	25	--	25	150
CE-C602	Design and Drawing of Steel Structures	20	20	20	80	4	25	--	25@	150
CE-C603	Transportation Engg. – II	20	20	20	80	3	25	--	--	125
CE-C604	Environmental Engg – 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-C507	Software Applications in Civil Engineering	--	--	--	--	--	25	--	--	25
Total		**120**	**120**	**120**	**480**		**175**	**--**	**125**	**900**

For the course ' Business and Communication Ethics (CE- C507), although 04 (Four) clock hours are mentioned under the head of Practicals, 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 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-DLO 5061:	Advanced Surveying	CE-DLO6061:	Advanced Construction Equipments
CE-DLO 5062:	Advanced Concrete Technology	CE-DLO6062:	Traffic Engineering and Management
CE-DLO 5063:	Building Services and Repairs	CE-DLO6063:	Ground Improvement Techniques
CE-DLO 5064:	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	Practs.	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
CE-ILO705X	Institute Level Optional Course –I	3	--		3	--		3
CE-C706	Project – Part I	--	4	--	--	2	--	2
Total		**17**	**12**	**1**	**17**	**6**	**1**	**23**

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-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
CE-ILO705X	Institute Level Optional Course – I	20	20	20	80	3	--	--	-	100
CE-P706	Project – Part I	--	--	--	--	--	50	--	25@	75
Total		**100**	**100**	**100**	**400**		**150**	**--**	**125**	**775**

@ For Project- PartI (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
CE-ILO804X	Institute Level Optional Course – II	3	--	1	3	--	1	4
CE-C805	Project – Part II	--	8	--	--	4	--	4
Total		**15**	**16**	**1**	**15**	**7**	**1**	**23**

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
CE-ILO804X	Institute Level Optional Course – II	20	20	20	80	3	25	--	--	100
CE-P 806	Project – Part II	--	--	--			50	--	50#	100
Total		--	--	**80**	**320**		**150**		**125**	**675**

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:	Prestressed Concrete	CE-DLO8031:	Advanced Design of Steel Structures
CE-DLO7042:	Solid Waste management	CE-DLO8032:	Industrial Waste Treatment
CE-DLO7043:	Pavement Subgrade and Materials	CE-DLO8033:	Pavement Design and Construction
CE-DLO7044:	Structural Dynamics	CE-DLO8034:	Bridge Engineering and Design
CE-DLO7045:	Application of GIS and Remote Sensing	CE-DLO8035:	Appraisal and Implementation of Infrastructure Projects
CE-DLO7046:	Foundation Analysis and Design	CE-DLO8036:	Soil Dynamics
CE-DLO7047:	Applied Hydrology and Flood Control	CE-DLO8037:	Design of Hydraulic Structures

Institute Level Optional Course – I (Semester –VII)		Institute Level Optional Course – II (Semester – VIII)	
CE-ILO7051:	Product Life Cycle Management	CE-ILO8041:	Project Management
CE-ILO7052:	Reliability Engineering	CE-ILO8042:	Finance Management
CE-ILO7053:	Management Information Systems	CE-ILO8043:	Entrepreneurship Development and Management
CE-ILO7054:	Design of Experiments	CE-ILO8044:	Human Resources Management
CE-ILO7055:	Operations Research	CE-ILO8045:	Professional Ethics and Corporate Social Responsibility (CSR)
CE-ILO7056:	Cyber Security and Laws	CE-ILO8046:	Research Methodology
CE-ILO7057:	Disaster Management and Mitigation Measures	CE-ILO8047:	Intellectual Property Rights and Patenting
CE-ILO7058:	Energy Audit and Management	CE-ILO8048:	Environment Management
		CE-ILO8049:	Digital Business Management

Semester III		
Subject Code	**Subject Name**	**Credits**
CE-C 301	Applied Mathematics – III*	05

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

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	-	125

Rationale

The course is aimed to develop the basic Mathematical skills of engineering students that are imperative for effective understanding of engineering subjects. The topics introduced will serve as basic tools for specialized studies in many fields of engineering and technology.

Objectives

- To provide sound foundation in the mathematical fundamentals necessary to formulate, solve and analyse engineering problems.
- To study the basic principles of Laplace Transform, Fourier series, Complex variables

Detailed Syllabus			
Module	**Sub-Modules/ Contents**		**Periods**
I.	**1. Laplace Transform**		**12**
	1.1	Function of bounded variation, Laplace Transform of standard functions such as 1, t^n, e^{at}, $\sin at$, $\cos at$, $\sinh at$, $\cosh at$.	
	1.2	Linearity property of Laplace Transform, First Shifting property, Second Shifting property, Change of Scale property of L.T. (without proof)	

		$L\{t^n f(t)\}, L\left\{\frac{f(t)}{t}\right\}, L\left\{\int_0^t f(u)du\right\}, L\left\{\frac{d^n f(t)}{dt^n}\right\}$ Heaviside Unit step function, Direct Delta function, Periodic functions and their Laplace Transform.	
	1.3	**Inverse Laplace Transform:** Linearity property, use of theorems to find inverse Laplace Transform, Partial fractions method and convolution theorem.	
	1.4	Applications to solve initial and boundary value problems involving ordinary Differential equations with one dependent variable.	
II.	**2. Complex variables**		**08**
	2.1	Functions of complex variable, Analytic function, necessary and sufficient conditions for f (z) to be analytic (without proof), Cauchy-Riemann equations in polar coordinates.	
	2.2	Milne-Thomson method to determine analytic function f (z) when it's real or imaginary or its combination is given. Harmonic function, orthogonal trajectories.	
	2.3	Mapping: Conformal mapping, standard transformations such as translation, rotation and magnification, inversion and reflection, linear transformation, bilinear transformation, cross ratio, fixed points.	
III.	**3. Complex Integration**		**9**
	3.1	Line integral of a function of a complex variable, Cauchy's theorem for analytic function, Cauchy's Goursat theorem (without proof), properties of line integral, Cauchy's integral formula and deductions.	
	3.2	Singularities, Classification of singularities	
	3.3	Taylor's and Laurent's series development (without proof)	
	3.4	Residue at isolated singularity and its evaluation.	
	3.5	Residue theorem, application to evaluate real integral of type $\int_0^{2\pi} f(\cos\theta, \sin\theta)\, d\theta, \quad \& \quad \int_{-\infty}^{\infty} f(x)\, dx$	
IV.	**4. Fourier Series**		**09**
	4.1	Orthogonal and orthonormal functions, Construction of orthonormal set.	
	4.2	Dirichlet conditions. Fourier series of periodic function with period 2 &2l .Fourier series of even and odd functions, Half range sine and cosine series	
	4.3	Parseval's identities (without proof)	
	4.4	Complex form of Fourier series.	

V.	**5. Partial Differential Equations**		**08**
	5.1	Classification of partial differential equations of second order, Heat equation, Wave equation, Laplace equation,	
	5.2	Method of Separation of variables, Solution of one dimensional heat conduction equation, steady state configuration for heat flow, solution of one dimensional wave equation, transverse vibrations of an elastic string, Laplace equation in rectangular region, Use of Fourier series and applications of Laplace transform in solving these equations.	
	5.3	Numerical Solution of Partial differential equations using Bender-Schmidt Explicit Method and simplified Crank- Nicolson implicit method.	
VI.	**6.1 Correlation and Regression.**		**06**
	6.1.1	Correlation, Co-variance, Karl Pearson Coefficient of Correlation and Spearman's Rank Correlation Coefficient (non-repeated and repeated ranks)	
	6.1.2	Regression Coefficients and lines of regression	
	6.2 Curve fitting		
	6.2.1	Curve fitting by the method of least squares- fitting of the curves of the form, $y = ax + b$, $y = ax^2 + bx + c$ and $y = ae^{bx}$.	
		Total	**52**

Contribution to Outcomes

Learner will be able to…

- Solve the Ordinary and Partial Differential Equations using Laplace Transformation.
- Solve Ordinary and Partial Differential Equations using Fourier series.
- Solve initial and boundary value problems involving ordinary differential equations
- Fit the curve using concept of correlation and regression.
- Apply bilinear transformations and conformal mappings
- Identify the applicability of theorems and evaluate the contour integrals.

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 – 5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may before 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. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work Examination:

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. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments (02) on entire syllabus	:	05 marks
Class Tutorials on entire syllabus (08)	:	15 marks
Attendance (Theory and Tutorial)	:	05 marks
Total	**:**	**25 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

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University rules for practical.
2. Students must be encouraged to write assignments in tutorial class only. Each student has to complete at least 8 class tutorials on entire syllabus.

Recommended Books:

1. Higher Engineering Mathematics, *Dr B. S. Grewal*, Khanna Publication.
2. Advanced Engineering Mathematics, *E Kreyszing*, Wiley Eastern Limited.
3. Higher Engineering Mathematics, *B.V. Ramana*, McGraw Hill Education, New Delhi.
4. Complex Variables: *Churchill*, Mc-Graw Hill.
5. Integral Transforms and their Engineering Applications, *Dr B. B. Singh*, Synergy Knowledgeware, Mumbai.
6. Numerical Methods, *Kandasamy*, S. Chand & CO.

Semester III		
Subject Code	**Subject Name**	**Credits**
CE-C 302	Surveying – I	5

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

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

Rationale

Surveying is a core subject for civil engineers. It is the first step towards all civil engineering projects. A good surveyor is an asset to the company, organization or establishment. All the civil engineering projects such as buildings, transportation systems including roads, bridges, railways, airports along with dams and water/ sewage treatment plants start with surveying as the basic operations. Hence, the knowledge of surveying is very essential to all the civil engineering professionals. In this subject, the students get acquainted with the basic methods and instruments that are used in surveying and it helps them to produce plans and sections. It is also useful in setting out civil engineering structures on construction sites.

Objectives

- To understand appropriate methods of surveying based on accuracy and precision required availability of resources, economics and duration of project.
- To study techniques for measurement of distance, setting offsets, calculate area and volume using surveying instruments
- To study the functions of various instruments, their least counts, possible errors, advantages and limitations.
- To study various techniques for solving Surveying related problems.
- To study the superiority and leverage of using modern methods in surveying over conventional ones.

Detailed Syllabus			
Module	**Sub-Modules/ Contents**		**Periods**
I.	**1. Introduction**		**08**
	1.1	Definition, principles, objectives, classification, technical terms, uses and necessity of surveying. Units of measurement, surveying measurement and errors, type of errors and their corrections (including numericals), corrections for wrong scales, accuracy and precision, stages of survey operations	
	1.2	Chaining, Ranging and offsetting: Definitions, Principles, Types, Instruments required, methods, obstacles (including numericals), sources of errors, conventional signs and symbols.	
	1.3	Electronic Distance Measurement: Working Principles, types, applications in surveying	
II.	**2. Measurement of Directions and Angles**		**10**
	2.1	Basic definitions, meridians, bearings, magnetic and true bearings, compasses, prismatic and surveyor's, temporary adjustments, declination, dip, local attraction	
	2.2	Types of traverse, procedures, control establishments, Conversion of WCB into RB and vice-versa, Traverse Survey and Computations of interior angles of a closed Traverse. Adjustment of closing error, correction for local attraction.	
III.	**3. Levelling and its application**		**12**
	3.1	Introduction to levelling, basic terms and definitions, types of instruments, construction and use of dumpy level, auto level, digital level and laser level in construction industry, principle axes of dumpy level, temporary and permanent adjustments	
	3.2	Booking and reduction of levels, plane of collimation (HI) and rise-fall methods, computation of missing data, distance to the visible horizon, corrections due to curvature and refraction, reciprocal levelling, Numerical problems	
	3.3	Differential levelling, profile levelling, fly levelling, check levelling, precise levelling, sources of errors, difficulties in levelling work, corrections and precautions in levelling work.	

IV.	**4. Plane Tabling, Contouring, Area and Volume**		**08**
	4.1	**Plane Table Surveying:** Definition, principles, accessories required for plane table surveying, merits and demerits, temporary adjustments, Different methods of plane table surveying, Errors in plane table surveying, Use of telescopic alidade.	
	4.2	**Contouring**: definitions, contour interval, equivalent, uses and characteristics of contour lines, direct and indirect methods of contouring. Grade contour: definition and use.	
	4.3	**Area**: Area of an irregular figure by trapezoidal rule, average ordinate rule, Simpson's 1/3 rule, various coordinate methods. Planimeter: types including digital planimeter, area of zero circle, uses of planimeter.	
	4.4	**Volume**: Computation of volume by trapezoidal and prismoidal formula, volume from spot levels, volume from contour plans.	
V.	**5. Theodolite Traversing**		**10**
	5.1	Various parts and axis of transit, technical terms, temporary and permanent adjustments of a transit, horizontal and vertical angles, methods of repetition and reiteration.	
	5.2	Different methods of running a theodolite traverse, Latitudes and departures, rectangular coordinates, traverse adjustments by Bowditch's, transit and modified transit rules, Gales Traverse Table, Numerical Problems.	
	5.3	Use of theodolite for various works such as prolongation of a straight line, setting out an angle, bearing measurements. Omitted measurements, Problems in using theodolite traversing, errors in theodolite traversing; Trigonometrical Levelling: Problems on one plane and two plane methods,	
VI.	**6. Tacheometric surveying**		**06**
	6.1	Principle, purpose, uses, advantages and suitability of tacheometry, different methods of tacheometry, stadia formula, Stadia diagram and tables. Sub-tense bar method.	
	6.2	Application in plane table and curve setting.	
	6.3	Radial Contouring.	
		Total	**52**

Contribution to Outcomes

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

- Apply principles of surveying and leveling for civil engineering works
- Measure vertical and horizontal plane, linear and angular dimensions to arrive at solutions to basic surveying problems.
- Perform various practical and hence projects using different surveying instruments.
- Apply geometric principles for computing data and drawing plans and sections
- Analyze the obtained spatial data and compute areas and volumes and represent 3D data on plane surfaces (2D) as contours

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 4–5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be. 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. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

The oral examination will be conducted in conjunction with the practical/s and will be based on the entire syllabus and the term work. The weightage of the practical examination will be of 10 marks and that of oral, 15 marks.

List of Practical:

1. Computing area of polygon by chaining, ranging and offsetting and verify distances by EDM
2. Measuring bearing of closed traverse using Prismatic/Surveyor's compass and computing included angle.
3. Simple and differential levelling using dumpy level
4. Transferring R.L from benchmark to new point by auto level/digital level with at least three change points and performing check levelling
5. Measurement of horizontal angle by Repetition and Reiteration Method using Vernier Transit theodolite.
6. To find the constants of a tachometer and to verify filed distances.

7. To find R.L and distances by tachometric surveying.
8. To find height of inaccessible tower using one plane and two plane methods using Vernier Transit theodolite.
9. Plane table surveying by various methods with at least four stations.
10. Determination of areas of irregular figures by conventional/digital planimeter

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term work:

It shall consist of the following:

- Field book based on afore-mentioned practicals conducted on and off the field.
- The account of practical performed with aim, apparatus, observations, calculations, results and inferences.
- 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 and field work by the student, appropriate completion of the assignments. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments on entire syllabus	:	10 marks
Practical	:	10 marks
Attendance (Theory and Practical)	:	05 marks
Total	**:**	**25 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. Surveying and Leveling: Vol-I and II: *Kanetkar and Kulkarni*, Pune VidyarthiGriha, Pune.
2. Surveying and Levelling: *N.N.Basak*, Tata McGraw Hill, New Delhi.
3. Surveying: *R. Agor*, Khanna Publishers.
4. Surveying: Vol-I: *Dr K.R. Arora*, Standard Book House.
5. Surveying and Levelling (2nd Edition): *R. Subramanian*; Oxford Higher Education.
6. Surveying and levelling (Vol.-I): *Dr. B.C. Punmia*, Laxmi Publications.
7. Surveying and Levelling (Vol.-I): *S.K. Duggal*, Tata Mc-Graw Hill
8. Textbook of Surveying, By *C Venkatramaiah*, University Press, Hyderabad, Latest Edition

Web Materials:

1. http://nptel.ac.in/courses/105107122/

Semester III		
Subject Code	**Subject Name**	**Credits**
CE-C 303	Strength of Materials	5

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

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

Rationale

There are different types of structures made up of different materials such as concrete, steel, metals and timber. They are subjected to various types of loading/ forces such as axial, shear, bending and torsion. This subject equips the students to analyse the internal behavior of material of the structural members under different types of loading. The knowledge gained in this subject is helpful to study other subjects like Structural Analysis and Structural Design.

Objectives

- To study the engineering properties of the materials and solids and analyze the same to evaluate the stress –strain behaviour.
- To analyze the internal forces for the statistically determinate and compound beams having internal hinges with different types of loading.
- To understand the concept and behaviour of flexural members (beams) in flexure and shear, solid circular shaft for torsion, thin shells for internal stresses.
- To introduce the concept of strain energy for axial, flexure, shear and torsion.
- To study the behaviour of axially loaded columns and struts using different theories available for the analysis with various end conditions.

Detailed Syllabus			
Module	**Sub-Modules/ Contents**		**Periods**
I.	**1. Simple Stresses and Strains**		**08**
	1.1	Stresses, Strains, Modulus of elasticity (E), Modulus of rigidity (G), Bulk Modulus (K), Yield Stresses, Ultimate Stress, Factor of safety, shear stress, Poisson's ratio.	
	1.2	Relationship between E, G and K, bars of varying sections, deformation due to self- weight, composite sections, temperature stress.	
II.	**2. Shear Force and Bending Moment in Beams**		**06**
	2.1	Axial force, shear force and bending moment diagrams for statically determinate beams including beams with internal hinges for different types of loading.	
	2.2	Relationship between rate of loading, shear force and bending moment.	
III.	**3.1 Theory of Simple Bending**		**07**
	3.1.1	Moment of inertia, transfer theorem, polar moment of inertia	
	3.1.2	Flexure formula for straight beam, simple problems involving application of flexure formula, section modulus, moment of resistance, flitched beams.	
	3.2 Strain Energy		**03**
	Strain energy due to axial force, stresses in axial member and simple beams under impact loading.		
IV.	**4.1 Shear Stresses in Beams**		**06**
	Distribution of shear stress across plane sections commonly used for structural purposes.		
	4.2 Theory of Simple Torsion		**06**
	4.2.1	Torsion in circular shafts-solid and hallow, stresses in shaft when transmitting power	
	4.2.2	Concept of equivalent torsional and bending moment	
V.	**5.1 Direct and Bending Stresses**		**05**
	Application to member's subjected to eccentric loads, core of section, problems on chimneys, retaining walls, dams, etc. involving lateral loads.		
	5.2 Columns and Struts		**04**
	Members subjected to axial loading, concept of buckling, Effective length, Euler's formula for columns and struts with different support conditions, Limitation of Euler's formula, Rankine's formula, Problems based on Euler's and Rankine's formulae.		

VI.	**6.1 Principal Planes and Stresses**	**04**
	General equation for transformation of stress, principal planes and principal stresses, maximum shear stress, stress determination using Mohr's circle.	
	6.2 Thin Cylindrical and Spherical Shells	**03**
	Thin Cylindrical and spherical shells under internal pressure.	
	Total	**52**

Contribution to Outcomes

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

- Understand and determine the engineering properties for metals and non-metals.
- Understand the concepts of shear force, bending moment, axial force for statically determinate beams and compound beams having internal hinges; and subsequently, its application to draw the shear force, bending moment and axial force diagrams.
- Analyze the flexural members for its structural behavior under the effect of flexure (bending), shear and torsion either independently or in combination thereof.
- Study the behavior of the structural member under the action of axial load, bending and twisting moment.
- Study the deformation behavior of axially loaded columns having different end conditions and further, evaluate the strength of such columns.
- The successful completion of the course will equip the students for undertaking the courses dealing with the analysis and design of determinate and 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 and may be. 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. 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.

Oral Examination:

The oral examination shall be based on the entire syllabus and the report of the experiments/ practicals conducted by the students including assignments.

List of Practicals:

1. Tension test on mild steel bars (stress-strain behavior, Young's modulus determination)
2. Tests on Tor Steel (Tension, bend and re-bend)
3. Transverse Test on cast iron.
4. Shear Test on mild steel, cast iron, and brass.
5. Torsion Test on mild steel and cast iron bar.
6. Brinell Hardness test (any three metal specimen)
7. Rockwell Hardness test on mild steel.
8. Izod / Charpy impact test (any three metal specimen)

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

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-modules contents thereof further.

Distribution of Term-work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on 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. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Report of the Experiments	:	10 Marks
Assignments	:	10 Marks
Attendance	:	05 Marks
Total	**:**	**25 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. Strength of Materials: *S. Ramamrutham*, Dhanpatrai Publishers.
2. Strength of Materials: *R.K. Rajput*, S. Chand Publications.
3. Mechanics of Materials: Vol-I: *S.B. Junnarkar and H.J. Shah*, Charotar Publications.
4. Strength of Materials: *Subramanian*, Oxford University Press
5. Strength of Materials: *S.S. Rattan*, Tata Mc-Graw Hill, New Delhi
6. Strength of Materials (Mechanics of Materials): *R.S. Lehri and A.S. Lehri*, S.K. Kataria Publishers, New Delhi
7. Strength of Materials: *Dr. V.L. Shah*, Structures Publications, Pune

Reference Books:

8. Mechanics of Materials: *James, M. and Barry J.*; Cengage Learning.
9. Mechanics of Materials: *Andrew Pytel and Jaan Kiusalaas*, Cengage Learning.
10. Mechanics of Materials: *Timoshenko and Gere*, Tata McGraw Hill, New Delhi.
11. Mechanics of Materials: *James M. Gere*, Books/Cole.
12. Strength of Materials: *G.H. Ryder*, Mc-Millan.
13. Mechanics of Materials: *E.P. Popov*, Prentice Hall India (PHI) Pvt. Ltd.
14. Mechanics of Materials: *Pytel and Singer*, Mc-Graw Hill, New Delhi.
15. Strength of Materials: *William A. Nash and NillanjanMallick*, Mc-Graw Hill Book Co. (Schaum's Outline Series)

Semester III		
Subject Code	**Subject Name**	**Credits**
CE-C 304	Engineering Geology	4

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

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

Rationale

Geology is the study of earth, the minerals and rocks of which it is made. The study of the structures presents in the rocks and the effects of the natural forces acting upon them is essential to understand by civil engineers because all work performed by them involves earth and its features. The study helps to understand the causes and prevention of many geological activities like earthquakes, landslides and volcano. For a civil engineering project like dams, bridges, buildings etc. to be successful the engineers must understand the foundation rock and their structures, it also helps them to examine rocks for important metals, oil, natural gas and ground water.

Objective

- To acquire basic knowledge of Geology and to understand its significance in various civil engineering projects.
- To study of 'Theory of Plate Tectonics' which helps to explain much of the global-scale geology including the formation of mountains, oceans, different landforms and the occurrence and distribution of earthquakes, volcanoes, landslides etc.
- To study minerals and rocks in detail in order to understand their origin, texture, structure and classification which is helpful to comment on suitability of rock type for any civil engineering project
- To study structural geology in order to understand deformational structures like fold, fault, joint, etc. and the forces responsible for their formation.
- To study methods of surface and subsurface investigation, advantages and disadvantages caused due to geological conditions during the construction of dam and tunnel.
- To study ground water zones, factors controlling water bearing capacity of rocks, geological work of ground water and techniques of recharge of groundwater.

Detailed Syllabus			
Module	**Sub-Modules/Contents**		**Periods**
I.	**Introduction**		**6**
	1.1	Branches of geology useful to civil engineering, Importance of geological studies in various civil engineering Projects.	
	1.2	Internal structure of the Earth and use of seismic waves in understanding the interior of the earth, Theory of Plate Tectonics.	
	1.3	Agents modifying the earth's surface, study of weathering and its significance in engineering properties of rocks like strength, water tightness and durability etc.	
	1.4	Brief study of geological action of river, wind, glacier, ground water and the related land forms created by them.	
	1.5	Building stones- Requirements of good building stones and its geological factors, controlling properties, consideration of common rocks as building stones, study of different building stones from various formations of Indian Peninsula.	
II.	**Mineralogy and Petrology**		**7**
	2.1	Identification of minerals with the help of physical properties, rock forming minerals, megascopic identification of primary and secondary minerals, study of common ore minerals.	
	2.2	Igneous Petrology - Mode of formation, Texture and structure, Classifications, study of commonly occurring igneous rocks and their engineering application.	
	2.3	Sedimentary Petrology - Mode of formation, Textures, characteristics of shallow water deposits like lamination, bedding, current bedding etc., residual deposits, chemically and organically formed deposits, classification, study of commonly occurring sedimentary rocks and their engineering application.	
	2.4	Metamorphic Petrology - Mode of formation, agents and types of metamorphism, metamorphic minerals, rock cleavage, structures and textures of metamorphic rocks, classification and study of commonly occurring metamorphic rocks and their engineering application.	
III.	**Structural Geology, Stratigraphy and Indian Geology**		**7**
	3.1	Structural elements of rocks, dip, strike, outcrop patterns, outliers and inliers, study of joints, unconformities and their engineering consideration. Faults and folds, their classification and importance in engineering operations.	

	3.2	Determination of thickness of the strata with the help of given data.	
	3.3	General principles of Stratigraphy, geological time scale, Physiographic divisions of India and their characteristics. Stratigraphy of Deccan Volcanic Province	
IV.	**Geological Investigation, study of dam and reservoir site:**		**7**
	4.1	Preliminary Geological Investigation and their importance to achieve safety and economy of the projects like dams and tunnels, methods of surface and subsurface investigations, Excavations-Trial pit, trenches etc.	
	4.2	Core Drilling - Geological logging, Inclined Drill holes. Electrical Resistivity method, Seismic method and their applications	
	4.3	Strengths, stability, water tightness of the foundation rocks and its physical characters against geological structures at dam sites, favourable and unfavourable geological conditions for locating dam sites.	
	4.4	Precautions over the unfavourable geological structures like faults,dykes, joints, unfavourable dips on dam sites and giving treatments, structural and erosional valleys.	
V.	**Tunnel Investigation and Ground Water Control**		**7**
	5.1	Importance of geological considerations while choosing tunnel sites and alignments of the tunnel, safe and unsafe geological and structural conditions, Difficulties during tunneling and methods to overcome the difficulties. Methods of tunneling in soft soil	
	5.2	Sources, zones, water table, unconfined and Perched water tables. Factors controlling water bearing capacity of rocks, Pervious and Impervious rocks, Cone of depression and its use in Civil engineering. Artesian well (flowing and non-flowing)	
	5.3	Springs seepage sites and geological structures. Different types of rocks as source of ground water	
	5.4	Methods of artificial recharge of ground water, geology of percolation tank.	
VI.	**Geological Disasters and Control Measures**		**5**
	6.1	**Landslides –** Types, causes and preventive measures for landslides, Landslides in Deccan region	
	6.2	**Volcano-** Central type and fissure type, products of volcano and volcanic land forms.	
	6.3	**Earthquake-** Earthquake waves, construction and working of seismograph, Earthquake zones of India, elastic rebound theory Preventive measures for structures constructed in Earthquake prone areas.	
		Total	**39**

Contribution to Outcomes

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

- Understand the significance of geological studies for safe, stable and economic design of any civil engineering structure.
- Demonstrate the knowledge of geology to explain major geological processes such as formation of mountain, ocean and the occurrence and distribution of earthquakes and volcanoes.
- Explain various geological structures like folds, faults, joints, unconformity, their origin and distribution which are very essential in the design and construction of dams, tunnels and any other major civil engineering project.
- Understand methods of surface and subsurface investigation, advantages and disadvantages caused due to geological conditions during the construction of dam and tunnel.
- Understand the causes and prevention of natural hazard like earthquake, landslide, volcano etc. will help student to meet the specific needs with suitable considerations for public health and safety.
- Prepare effective reports mentioning advantages and disadvantages caused due to geological condition and can evaluate any site for civil engineering project.

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 4–5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be. 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. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

Oral examination will be based on the entire syllabus and a neatly written report for the practical along with a report of the site visit.

List of Practicals:

1. Study of physical properties of the minerals.
2. Identification of minerals- Quartz and its varieties, Orthoclase, Plagioclase, Muscovite, Biotite, Hornblende, Asbestos, Augite, Olivine, Tourmaline, Garnet, Actinolite, Calcite, Dolomite, Gypsum, Beryl, Bauxite, Graphite, Galena, Pyrite. Hematite, Magnetite, Chromite, Corundum, Talc, Fluorite, Kyanite.

3. Identification of rocks: ***Igneous rocks***-Granite and its varieties, Syenite, Diorite, Gabbro, Pegmatite. Porphyry, Dolerite, Rhyolite, Pumice, Trachyte, Basalt and its varieties, Volcanic Breccia, Volcanic tuffs. ***Sedimentary Rocks***- Conglomerate, Breccia, Sandstone and its varieties, Shales, Limestones, Laterites. ***Metamorphic Rocks***- Mica Schists, Hornblende Schists, Slate, Phyllite, Granite Gneiss, Augen gneiss, Marbles and Quartzite.
4. Study of Geological maps (At least 5).
5. Study of core samples, RQD, Core logging.
6. At least two engineering problems based on field data collected during site investigation.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work:

The term work shall consist of the:

1. Report of the practical conducted in terms of the study of the physical properties of the minerals, identification of minerals and rocks.
2. Report of the Geological maps.
3. Report of the two problems based on field data.
4. At least *six* assignments covering entire syllabus

Site Visit:

Preferably, there shall be a visit to get the geological information according to the various contents mentioned in the syllabus. The students shall prepare a detail report along with the summarized findings. The report will form a part of the term work.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work ensures the satisfactory performance of laboratory work. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein. In case, if the site visit is not conducted, the marks kept under the head of Site Visit may be considered under the head of Assignments.

Report of the Practicals	:	10 marks
Assignments	:	07 marks
Site Visit Report	:	03 marks
Attendance	:	05 marks
Total	**:**	**25 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. Text book of Engineering Geology: *Dr. R. B. Gupte*, Pune Vidyarthi Griha Prakashan, Pune.
2. Text book of Engineering Geology: *P. K. Mukerjee*, Asia.
3. Text book of Engineering and General Geology: *Parbin Singh*, Carson Publication.
4. Text book of Engineering Geology: *N. Chenna, Kesavulu*, Mc-Millan.
5. Principles of Engineering Geology: *K. M. Banger*.

Reference Books:

1. Principles of Physical Geology: Arthur Homes, Thomas Nelson Publications, London.
2. Earth Revealed, Physical Geology: David McGeeary and Charles C. Plummer
1. Principles of Geomorphology: *William D. Thornbury*, John Wiley Publications, New York.
2. Geology for Civil Engineering: A. *C. McLean, C.D. Gribble, George Allen &Unwin*London.
3. Engineering Geology: A Parthsarathy, V. Panchapakesan, R Nagarajan, Wiley India 2013.

Semester III		
Subject Code	**Subject Name**	**Credits**
CE-C 305	Fluid Mechanics – I	4

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

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

Rationale

The concept of fluid mechanics in civil engineering is essential to understand the processes and science of fluids. The course deals with the basic concepts and principles in hydrostatics, hydro kinematics and hydrodynamics with their applications in fluid flow problems.

Course Objectives

Students are introduced to:

- Properties of fluids and basic concepts applicable to fluid mechanics and its relevance in civil engineering.
- Fundamentals of hydrostatics viz. Pascal's law, hydrostatic law and determination of hydrostatic pressure and centre of pressure of surfaces.
- Principle of buoyancy and its application
- The concept of fluid kinematics and ideal fluid flow.
- Concepts of control volume, control surface and dynamics of fluid flow.
- Various flow measuring devices and their applications

Detailed Syllabus			
Module	**Sub-Module / Contents**		**Periods**
I.	**1. Properties of Fluids**		**05**
	Mass density, weight density, specific gravity, specific volume, viscosity, compressibility and elasticity, surface tension, capillarity, vapour pressure, types of fluids, basic concepts applicable to fluid mechanics		
II.	**2. Fluid Statics**		**08**
	2.1	**Pressure measurement:** Pascal's law, hydrostatic law, pressure variation in fluids at rest. Absolute, atmospheric, gauge pressure, measurement of pressure using manometers	
	2.2	**Hydrostatic force on surfaces:** Total pressure and centre of pressure, total pressure on horizontal plane surface, vertical plane surface, Inclined plane surface, centre of pressure for vertical plane surface and for inclined plane surface, practical applications of total pressure and centre of pressure on dams, gates, and tanks.	
	2.3	**Buoyancy and flotation:** Archimedes principle, Meta-centre, metacentric height, Stability of floating and submerged bodies, determination of metacentric height, metacentric height for floating bodies containing liquid, Time period of Transverse oscillations of floating bodies.	
III.	**3. Liquids in Relative equilibrium and Fluid Kinematics**		**08**
	3.1	**Liquids in Relative equilibrium** Fluid mass subjected to uniform linear acceleration, liquid containers subjected to constant horizontal acceleration and vertical acceleration, fluid containers subjected to constant rotation with axis vertical and horizontal.	
	3.2	**Fluid Kinematics:** Types of fluid flow, description of flow pattern, Lagrangian methods, Eulerian method, continuity equation, velocity and acceleration of fluid particles, velocity potential and stream function, streamline, streak line, path line, equipotential lines and flow net, uses of flow net, rotational and irrotational motions, circulation and vorticity	
IV.	**4. Introduction to Ideal flow.**		**04**
	Introduction to ideal fluid flow, uniform flow, source and Sink, free vortex flow, superimposed flow, doublet, Flow past a half body, flow past a Rankine oval body and flow past a cylinder		

V	**5. Fluid dynamics**		**06**
	Control volume and control surface, Forces acting on fluid in motion, NavierStokes Equation, Euler's Equation of motion, Integration of Euler's equations of motion, Bernoulli's Theorem and its derivation, Bernoulli's equation for compressible fluid and real fluid, practical applications of Bernoulli's Equation - Venturimeter, Orifice meter, nozzle meter, pitot tube, rotameter.		
VI	**6. Flow measurement**		**08**
	6.1	**Orifices and Mouthpieces:** Classification of orifices, flow through orifices, determination of hydraulic coefficients, flow through large rectangular orifice, flow through fully submerged and partially submerged orifice, time of emptying a tank through an orifice at its bottom. Classification of Mouthpieces, Flow through external cylindrical mouthpiece, convergent-divergent mouthpiece, Borda's mouthpieces.	
	6.2	**Notches and Weirs:** Classification of notches and weirs, discharge over a rectangular, triangular, trapezoidal notch/weir, velocity of approach, stepped notch, Cipolleti weir, broad crested weir, ogee weir, discharge over a submerged weir, ventilation of weirs.	
		Total	**39**

Contribution to Outcomes

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

- Define various properties of fluids, state and explain different types of laws and principles of fluid mechanics.
- Interpret different forms of pressure measurement and Calculate Hydrostatic Force and its Location for a given geometry and orientation of plane surface.
- Compute force of buoyancy on a partially or fully submerged body and analyse the stability of a floating body.
- Distinguish velocity potential function and stream function and solve for velocity and acceleration of a fluid at a given location in a fluid flow.
- Derive Euler's Equation of motion and Deduce Bernoulli's equation.
- Measure velocity and rate of flow using various devices.

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 4–5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be. 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. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

List of Experiments (Any six):

1. Determination of metacentric height.
2. Verification of Bernoulli's theorem.
3. Determination of coefficient of discharge through Venturimeter.
4. Determination of coefficient of discharge through Orifice meter.
5. Determination of coefficient of discharge through Nozzle meter.
7. Determination of coefficient of discharge through Notches (Rectangular and Triangular notch).
8. Determination of coefficient of discharge over weirs (Broad Crested weir and Ogee weir).
9. Determination of hydraulic coefficients of orifice.
10. Determination of coefficient of discharge through mouthpiece.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

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. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Report of the Experiments	:	10 Marks
Assignments	:	10 Marks
Attendance	:	05 Marks
Total	**:**	**25 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.M. Modi and Dr. S.M. Seth*, Standard Book House, Delhi
3. Theory and Application of Fluid Mechanics: *K. Subramanian*, Tata McGraw hill publishing company, New Delhi.
4. Fluid Mechanics: *Dr. A.K Jain*, Khanna Publishers.
5. Fluid Mechanics and Hydraulics: *Dr. S.K. Ukarande*, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538
6. Fluid Mechanics and fluid pressure engineering: *Dr. D.S. Kumar*, F.K. Kataria and sons
7. Fluid Mechanics: *R.K. Bansal*, Laxmi Publications (P) Ltd.

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, Jr, Ira M. Katz, James P. Schaffer*. Oxford Higher Education.

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 401	Applied Mathematics – IV*	05

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

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	--	--	125

Rationale

The course is aimed to develop the basic Mathematical skills of engineering students that are imperative for effective understanding of engineering subjects. The topics introduced will serve as basic tools for specialized studies in many fields of engineering and technology.

Objectives

- To inculcate an ability to relate engineering problems to mathematical context.
- To provide a solid foundation in mathematical fundamentals required to solve engineering problem.
- To study the basic principles of Vector analyses, complex integration, probability, test of hypothesis and correlation between data.

Detailed Syllabus			
Module	**Sub-Modules/ Contents**		**Periods**
I.	**1. Matrices**		**11**
	1.1	Brief revision of vectors over a real field, inner product, norm, Linear dependence and Independence and orthogonality of vectors.	

	1.2	Characteristic polynomial, characteristic equation, characteristic roots and characteristic vectors of a square matrix, properties of characteristic roots and Eigen vectors of different types of matrices such as symmetric matrix, orthogonal matrix, Hermitian matrix, Skew-Hermitian matrix.	
	1.3	Cayley Hamilton theorem (without proof) and its application	
	1.4	Similarity of matrices, Functions of a square matrix, Minimal polynomial and Derogatory matrix.	
	1.5	Quadratic forms: linear transformation of a quadratic form, congruence of a square matrix, reduction to canonical form under congruent transformations, orthogonal transformation, determining the nature of a quadratic form, Application of Eigen values and Eigen Vectors.	
II.	**2. Vector calculus**		**9**
	2.1	Brief revision of Scalar and vector point functions, Gradient, divergence and curl, Irrotational vectors, scalar potential, solenoidal vectors, Directional derivatives.	
	2.2	Line integrals, Circulation, Green's theorem (without proof) for plane regions and properties of line integrals.	
	2.3	Surface integrals, Stokes theorem(without proof)	
	2.4	Volume integrals, Gauss divergence theorem (without proof) related identities and deductions. (No verification problems on Stoke's Theorem and Gauss Divergence Theorem)	
III.	**3. Linear Programming**		**08**
	3.1	Types of solutions to linear programming problems, standard form of L.P.P. Simplex method to solve L.P.P.	
	3.2	Big M method (Penalty method) to solve L.P.P, Duality, Dual simplex method and Revised simplex method to solve L.P.P.	
IV	**4. Non Linear Programming**		**06**
	4.1	Unconstrained optimization, problems with equality constraints, Lagrange's Multiplier method	
	4.2	Problem with inequality constraints Kuhn-Tucker conditions.	
V.	**5. Probability Distributions**		**10**
	5.1	Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expected value, Variance.	
	5.2	Probability distributions: Binomial, Poisson, Normal and exponential Distributions.	

VI.	**6. Sampling Theory**		**08**
	6.1	Sampling distribution, Test of Hypothesis, Level of significance, critical region, One tailed and two tailed tests Interval Estimation of population parameters.	
	6.2	Test of significance for Large samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two samples.	
	6.3	Test of significance of small samples:-Student's t-distribution and its properties. Test for significance of the difference between sample mean and population mean, Test for significance of the difference between the means of two Samples, paired t-test.	
	6.4	Chi square test, Test of goodness of fit and independence of attributes, Contingency table and Yate's correction.	
	6.5	Analysis of Variance(F-Test): One way classification, Two-way classification (short-cut method)	
		Total	**52**

Contribution to Outcomes

Learner will be able to…

- Solve the system of linear equations using matrix algebra with its specific rules.
- Illustrate basics of vector calculus.
- Apply the concept of probability distribution and sampling theory to engineering problems.
- Apply principles of vector calculus to the analysis of engineering problems.
- Identify, formulate and solve engineering problems.
- Illustrate basic theory of correlations and regression.

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 – 5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may before 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. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work Examination:

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. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments (02) on entire syllabus	:	05 marks
Class Tutorials on entire syllabus (08)	:	15 marks
Attendance (Theory and Tutorial)	:	05 marks
Total	**:**	**25 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

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University rules for practical.
2. Students must be encouraged to write assignments in tutorial class only. Each student has to write at least 8 class tutorials on entire syllabus.

Recommended Books:

1. Advanced Engineering Mathematics, *E Kreyszing*, Wiley Eastern Limited.
2. Higher Engineering Mathematics, *B. S. Grewal*, Khanna Publication.
3. Advanced Engineering Mathematics, *H. K. Dass*, S. Chand & co.
4. Vector Analysis by Murray *R. Spiegel*, Shaum Series.
5. Operations Research, *S.D. Sharma*, S. Chand & CO.
6. Fundamentals of Mathematical Statistics, *S C Gupta & V K Kapoor*, S. Chand & Co

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 402	Surveying – II	4.5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	03	-	03	1.5	-	4.5

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	50	-	25	175

Rationale

This is an advanced course which intended to teach students modern surveying instruments with their principles and uses in surveying along with curves and setting out of different civil engineering works. Students are 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, a 4-day survey camp is arranged to execute the Road project, Block contouring project, Tachometric project and Total Station Traversing at ideal locations.

Objectives

- To understand operation of Total Station, EDM, Electronic Theodolite for desired accuracy in surveying.
- To learn how to establish survey control of determined accuracy using GPS, GIS and Remote sensing.
- To Study various types of curves by linear and angular methods.
- To prepare different layout from surveying data.
- To learn how to generate and manipulate field survey data and incorporate design data using specialized software's.

Detailed Syllabus			
Module	**Sub-Modules/ Contents**		**Periods**
I.	**1. Curves-Horizontal**		**10**
	1.1	Definitions of different terms, necessity of curves and types of curves	
	1.2	Simple circular curves and compound curves, office and field work, linear methods of setting out curves, Angular methods of setting out curves, two theodolites and Rankine deflection angle method.	
	1.3	Reverse and transition curves, their properties and advantages, design of transition curves, shift, spiral angle. Composite curves office and field level. Setting out of curves by angular method, composite curves problems.	
	1.4	Difficulties in setting out curves and solution for the same.	
II.	**2. Curves-Vertical**		**3**
	2.1	Sight distance on a vertical curve	
	2.2	Tangent correction and chord gradient methods.	
	2.3	Sight distance on a vertical curve	
III.	**3. Setting out works**		**4**
	3.1	General horizontal and vertical control, setting out of foundation plan for load bearing and framed structure, batter board, slope and grade stakes, setting out with theodolite	
	3.2	Setting out a foundation plans for building, sewer line, culvert, and use of laser for works; Setting out centre line for tunnel, transfer of levels for underground works.	
	3.3	Project/route survey for bridge, dam and canal;Checking verticality of high rise structures.	
IV.	**4. Special Survey Instruments**		**6**
	4.1	**Electronic Theodolite, Total Station**: Principles, Types, Applications, Topographical Survey and Stake-out, Transferring data to and from other software's for further processing, advantages and limitations	
	4.2	Introduction to Site square, Penta Graph, Auto-setLevel, Transit level, Special Compasses, BruntonUniversal Pocket Transit, Mountain Compass Transit	

V.	**5. Modern Methods of Surveying**		**12**
	5.1	**Global Positioning System (GPS)**:Basic principles, GPS segments, receivers, computations of coordinates, Applications in surveying	
	5.2	**Remote Sensing**: Definition, basic concepts, electromagnetic radiation and spectrum, energy source and its characteristics, image acquisition and image interpretation. Application of remote sensing.	
	5.3	**Global Information System (GIS)**: Geographical concepts and terminology, advantages, basic components ofGIS, data types, GIS analysis, Applications of GIS.	
	5.4	**Field Astronomy**: Introduction, purposes, astronomical terms, determination of azimuth, latitude, longitude and time corrections to the observations.	
	5.5	**Aerial photogrammetry**: Introduction, Principle, Uses, Aerial camera, Aerial photographs, Definitions, Scale of vertical and tilted photograph, Ground Co-ordinates, Displacements and errors, Ground control, Procedure of aerial survey, Photomaps and mosaics, Stereoscopes, Parallax bar	
	5.6	**Hydrographic Survey:** Introduction, Organizations, National and International Maritime Hydrography, Hydrographic survey Methods, Lead lines, sounding poles, and single-beam, echo sounders.	
VI.	**6. Cadastral Surveying**		**4**
	6.1	Interpreting and advising on boundary locations, on the status of land ownership and on the rights, restrictions and interests in property. Legal requirements relating to property boundary surveys in India	
	6.2	Role of revenue department in maintaining survey records, introduction to local survey terminologies like tehsildar, 7/12, utara, namuna8, etc. Introduction to Survey of India Department; Department of Registration and Stamps, Maharashtra	
		Total	**39**

Contribution to Outcomes

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

- Operate Total Station & GPS for desired accuracy in surveying and establish survey control of determined accuracy using Total Station, GPS, GIS and remote sensing.
- Set out various types of curves by linear and angular methods
- Compute setting out data from survey and design information.
- Generate and manipulate field survey data and incorporate design data using specialised software's.
- Appreciate the role of various governmental authorities in maintaining cadastral survey records.

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 4-5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be. 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. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
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 on the entire syllabus, the projects performed and practicals conducted. It will include a practical exam (10 marks) before proceeding for viva (15 marks)

List of Practicals:

1. To set out circular curve by linear methods.
2. To set out circular curve by angular methods.
3. Determination of horizontal and vertical distances, bearings and area using Total Station.
4. Determination of co-ordinates of a traverse, length of traverse lines using GPS
5. Post-processing of data obtained in Total Station & GPS practical using softwares like *TERRAMODEL, AutoCAD* etc. and print out the sheets
6. Analysis of survey projects conducted using computer by applying various softwares like MS excel, SurveyOS, surfit, QuikGrid, etc.
7. Setting out a simple foundation plan in the field.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term work

It shall consist of the following:

1. **Project I:** Road project using Auto level for a minimum length of 500 m including fixing of alignment, Profile levelling, cross-sectioning, at least one simple and one reverse curve, plotting of L section and Cross Section. (Two full imperial sheet including plan, L – section and any three typical Cross-sections, sample data computation for curves, cutting and filling required
2. **Project II**: Block Contouring project using Auto level for minimum 100 × 80 m area and generating contours by MS Excel, etc. (minimum contour interval 0.2 meter)
3. **Project III:** Tachometric contouring project on hilly area with at least two instrument stations about 60 m to 100 m apart and generating contours using software such as Autodesk land desktop, Auto civil, Foresight etc. (minimum contour interval 1 meter)
4. **Project IV:** Traversing using a total station (minimum 10 acres' area)
5. The account of practicals performed with aim, apparatus, observations, calculations, results and inferences
6. Field book submission on afore-mentioned practicals conducted on and off the field.
7. The assignments shall comprise of the minimum 5 problems covering the entire syllabus, theory questions on each chapter

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.Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments on entire syllabus	:	10 marks
Practical performance	:	15 marks
Project (04)	:	20 marks
Attendance (Theory and Tutorial)	:	05 marks
Total	**:**	**50 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. Surveying: *R. Agor*, Khanna Publishers, New Delhi
2. Surveying and Levelling: *N N. Basak*, Tata McGraw Hill, New Delhi.
3. Surveying and Levelling, Vol-I and II: *Kanetkar and Kulkarni*, Pune VidyarthiGriha, Pune.
4. Surveying, Vol-I, II & III: *Dr K.R. Arora*, Standard Book House.
5. Surveying and Levelling, (2Edition): *R. Subramanian*; Oxford Higher Education.
6. Surveying and levelling, Vol.-I, II & III: *Dr. B.C. Punmia*, Laxmi Publications.
7. Surveying and Levelling, Vol.-I& II:*S. K.Duggal*, Tata Mc-Graw Hill
8. Advanced Surveying, *R. Agor*, Khanna Publishers, New Delhi
9. Fundamentals of Surveying, *S.K. Roy*, Prentice Hall India, New Delhi
10. Remote Sensing and GIS, *B Bhatta*, Oxford University Press, New Delhi.
11. Remote sensing and Image interpretation, *T.M Lillesand, R.W Kiefer andJ.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. *Anji Reddy*, B.S.Publications, Hyderabad, 2001.

Web Materials:

1. http://nptel.ac.in/courses/105104100/1
2. http://www.surveyofindia.gov.in/
3. http://igrmaharashtra.gov.in/#

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 403	Structural Analysis – I	5

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

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

Rationale

There are various types of the components of any civil engineering structures which are subjected to different types of loading or combination thereof. Most of the structures which are analyzed for finding its structural response which would form the basis for its structural design are indeterminate structure. Notwithstanding, the structural analysis of any civil engineering structural systems idealizing the same as the statically determinate one shall be the foundation of the analysis of the indeterminate structures. The knowledge gained in the subjects such as engineering mechanics and strength of materials in the preceding semesters where students have been exposed to the principles of engineering mechanics and subsequently, its application on the materials and solids to study its behavior under the action of loads and further to evaluate its strength properties, is extended in this subject for the analysis of various structural systems such as beams, frames, arches and suspension bridges.

Objectives

- To analyze the statically determinate simple portal frame (both- rigid jointed and having an internal hinges).
- To study the methods and evaluating rotation and displacement parameters in respect of beams and frames using various methods.
- To analyze the three hinged arches; and cables, suspension bridges and three hinged stiffening girder.
- To study the buckling behavior of the axially and transversely loaded beam-columns and its analyses.
- To understand the concept and behavior of the beam and trusses under rolling loads and subsequently, to obtain the absolute maximum bending moment.
- To understand the concept of unsymmetrical bending and shear center and its application in solving the problems of structural mechanics.

Detailed Syllabus		
Module	**Sub- Modules/ Contents**	**Periods**
I.	**1. Axial force, shear force and bending moment**	**6**
	Concept of statically determinate structures; Axial force, shear force and bending moment diagrams for statically determinate frames with and without internal hinges.	
	2. General theorems and its application to simple structures	**3**
	General theorems and principles related to elastic structures, types of strain energy in elastic structures, complementary energy, principle of virtual work, Betti's and Maxwell's reciprocal theorems, Castigliano's first theorem, principle of superposition. Application of Energy Approach to evaluate deflection in simple structures such as simple beams, portal frame, bent and arch type structures, etc.	
II.	**3. Deflection of Statically Determinate Structures Using Geometrical Methods**	**7**
	Deflection of cantilever, simply supported and overhanging beams for different types of loadings Using-Integration Approach including Double Integration method and Macaulay's Method, Geometrical Methods including Moment area method and Conjugate beam method.	
III.	**4. Deflection of Statically Determinate Structures Using Methods Based on Energy Principle**	**9**
	4.1 Application of Unit Load Method (Virtual Work Method/ Dummy Load Method) for finding out slope and deflection in beams. Application of Strain Energy Concept and Castigliano's Theorem for finding out deflection in such structures.	
	4.2 Application of Unit Load Method (Virtual Work Method) for finding out deflection of rigid jointed frames. Application of Strain Energy Concept and Castigliano's Theorem for finding out deflection in such frames.	
	4.3 Application of Unit Load Method (Virtual Work Method/ Dummy Load Method) for finding out deflection in pin jointed frames (trusses). Application of Strain Energy Concept and Castigliano's Theorem for finding out deflection intrusses.	
IV.	**5. Rolling Load and Influence Lines for Statically Determinate Structures**	**8**
	Influence lines for cantilever, simply supported, overhanging beams and pin jointed truss including warren truss, criteria for maximum shear force and bending moment, absolute maximum shear force and bending moment under moving loads (UDL and Series of point loads) for simply supported girder.	

	6. Three Hinged Elastic Arches	**5**
	Determination of normal thrust, radial shear and bending moment for parabolic and circular (semi and segmental) three hinged arches, Influence lines for normal thrust, radial shear and bending moment for three hinged parabolic arch.	
V.	**7. Cables, Suspension bridges and Three Hinged Stiffening Girder**	**4**
	Simple suspension cable, different geometries of cables, minimum and maximum tension in the cable supported at same/different levels, anchor cable, suspension cable with three hinged stiffening girder.	
VI.	**8. Columns and Struts**	**4**
	Columns and struts subjected to eccentric loads, Secant formula, Perry's formula, struts with initial curvature.	
	9. Unsymmetrical bending	**3**
	Product of inertia, principal moment of inertia, flexural stresses due to bending in two planes for symmetrical sections, bending of unsymmetrical sections.	
	10. Shear Centre	**3**
	Shear centre for thin walled sections such as channel, tee, angle section and I-section.	
	Total	**52**

Contribution to Outcomes

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

- Understand the behavior of various statically determinate structures including compound structures having an internal hinge for various loadings.
- Analyze these structures to find out the internal forces such as axial force, shear force, bending moment, twisting moments, etc.
- Evaluate the displacements / deflections in beams and frames under the action of loads. They will be able to obtain the response of the beams under the action of moving loads.
- Analyze the structures such as arches and suspension bridges and study the behavior of eccentrically loaded columns.
- Analyze the section with respect to unsymmetrical bending and shear center.
- Demonstrate the ability to extend the knowledge gained in this subject in the subjects *Structural Analysis-II* and elective subjects such as *Advanced Structural Analysis* and *Advanced Structural Mechanics* in the higher years of their UG programme where they will be dealing with the indeterminate structures. The knowledge gained in this subject shall also be useful for application in the structural design in later years.

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 4-5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be . 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. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

Oral Examination:

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

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

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-modules contents thereof further.

Distribution of Term-work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on 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. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments	:	20 Marks
Attendance	:	05 Marks
Total	**:**	**25 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. Mechanics of Structures: Vol-I: *S. B. Junnarkar and H.J. Shah*, Charotar Publishers, Anand.
3. Analysis of Structures: Vol. I and II, *Vazirani and Ratwani*
4. Strength of Materials*: S. Ramamrutham*, Dhanpatrai and Publishers, Delhi
5. Theory of Structures: *S. Ramamrutham*, Dhanpatrai and Sons, Delhi
6. Structural Analysis I: *Hemant Patil, Yogesh Patil, Jignesh Patel*, Synergy Knowledgeware, Mumbai.
7. Strength of Materials*: Rajput*, S. Chand Publications, Delhi
8. Structural Analysis: *Bhavikatti*, Vikas publisher house Pvt, ltd.
9. Structural Analysis: *DevdasMenon*, Narosa Publishing House.
10. Basic Structural Analysis: K.*U. Muthu, Azmi Ibrahim, M. Vijyanand, MagantiJanadharnand. I.K.* International Publishing House Pvt. Ltd.
11. Comprehensive Structural Analysis: Vol-I and II by *Vaidyanathan R. and Perumal R.*Laxmi Publications.
12. Elementary Structural Analysis: *Jindal*
13. Structural Analysis: *L.S. Negi and R.S. Jangid*, Tata Mc-Graw Hill India
14. Fundamentals of Structural Analysis: *Sujit Kumar Roy and SubrotaChakrabarty*, S. Chand Publications.
15. Structural Analysis: *T.S. Thandavamoorthy*, Oxford University Press.
16. Structural Analysis: *Manmohan Das, Bharghab Mohan*Pentice Hall International.

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. Structural Analysis: *Kassimali*, TWS Publications.
5. Element of Structural Analysis: *Norries and Wilbur*, McGraw Hill.
6. Structural Analysis: *Laursen H.I*, McGraw Hill Publishing Co.
7. Structural theorem and their application: *B.G. Neal*, Pergaman Press.
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: *Hseih*, Prentice Hall.

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 404	Building Design and Drawing	3.5

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
02	03	-	02	1.5	-	3.5

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

Rationale

Drawing is the language civil engineers communicate in. Drawing is one of the most essential documents as far as civil engineering is concerned. It provides guidance and instructions to architects, engineers and workmen at field on how to construct structures according to the figures and dimensions shown in the drawing. Approved drawings are also essential for the estimation of cost and materials; as well as a very important contract document.

Objectives

- To remember and recall the intricate details of building design and drawing.
- To gain an understanding of the basic concepts of building design and drawing.
- To learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices.
- To identify, analyse, research literate and solve complex building design and drawing problems.
- To design new solutions for complex building design and drawing problems.
- To effectively communicate ideas related to building design and drawing, both orally as well as in written format like reports & drawings.

Detailed Syllabus			
Module	**Sub- Modules/ Contents**		**Periods**
I.	**1. Principles and Codes of Practices for Planning and Designing of Buildings (Residential and Public buildings)**		**9**
	1.1	Study of IS 962: 1989 – Code of Practice for Architectural and Building Drawings	
	1.2	Principles of planning for residential buildings	
	1.3	Classification of buildings: **Residential** –Bungalows, Apartments/Flats etc. **Public** – Education, Health, Offices/Commercial, Hotels, Hostels.	
	1.4	Study of building Bye – laws and documents / permissions required from commencement to completion of the building according to National Building Code (N.B.C.) of India and local Development Control (D.C.) rules	
	1.5	Study of sun path diagram, wind rose diagram and sun shading devices	
	1.6	Calculation of setback distances, carpet area, built-up area and floor space index (FSI)	
	1.7	Principles of planning for public buildings: i) Building for education: schools, colleges, institutions, libraries etc. ii) Buildings for health: hospitals, primary health centres etc. iii) Office buildings: banks, post offices, commercial complexes etc. iv) Building for public residence: hostels, boarding houses etc.	
II.	**2. Components and Services of a Building**		**5**
	2.1	Staircase (dog legged & open newel in details),	
	2.2	Foundations: stepped footing, isolated sloped footing and combined footing	
	2.3	Openings: doors and windows	
	2.4	Types of pitched roof and their suitability (plan and section)	
	2.5	Building services: Water supply, sanitary and electrical layouts	
III.	**3. Perspective Drawing**		**4**
	3.1	One-point perspective	
	3.2	Two-point perspective	
IV.	**4. Town Planning, Architectural Planning & Built Environment**		**4**
	4.1	Objectives and principles (road systems, zoning, green belt etc.)	

	4.2	Master plan and slum rehabilitation	
	4.3	Architectural Planning: introduction and principles	
	4.4	Built Environment: introduction and principles	
V.	**5. Green Buildings**		**2**
	5.1	Introduction and overview	
	5.2	Certification methods (LEED and TERI)	
VI.	**6. Computer Aided Drawing (CAD)**		**2**
	6.1	Advantages of CAD	
	6.2	Overview of any one of the CAD software's prevailing in the market (AutoCAD, Revit, 3D Max etc.)	
		Total	**26**

Contribution to Outcomes

- Students will be able to list down the types of structures and its various components (for eg. doors, windows, staircase, foundations etc.)
- Students will be able to explain various concepts pertaining to building design and drawing (for eg, principles of planning, architectural planning, green buildings etc.)
- Students will be able to apply principles of planning, architectural planning and building bye laws while designing and preparing building drawings.
- Students will be able to calculate and analyze various technical details of a building (for eg. carpet area, FSI etc.) from its drawings.
- Students will be able to design various components of buildings (for eg. staircases etc.) as well as buildings as a whole, given the requirements of the building owner and local D.C. laws.
- Students will be able to prepare drawings (for eg. plans, elevation, perspective views etc.) of the designed components of buildings as well as buildings as a whole.

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 and based on the drawing work of any one building, may be residential or public building..
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.

Practical Examination (Oral and Sketching)

Practical examination will consist of sketching and oral examination based on the entire syllabus.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment') to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

Term Work

Reports:

1. Summary of Development Control (D.C.) rules of student's own or nearest city
2. Summary of documents required from commencement to completion of the building by the concerned local body i.e. Municipal Corporation or nearest Municipality.
3. One-day site visit could be arranged for students to visit any one public building near the college like commercial complex, library, Bank etc. They need to study in detail of that building take the measurements of that building should submit as a site report with detailed drawing according to some suitable scale. This will become a part of Term Work.

Drawings:

1. Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, site plan, schedule of opening and construction notes of a **residential building (bungalow or apartment)** to be constructed as a (G+1) R.C.C. framed structure
2. Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, site plan, schedule of opening and construction notes of a **public building (school or hostel or hospital or bank)** be constructed as a (G+1) R.C.C. framed structure
3. Roof plan, foundation plan (with section of a typical foundation), plan and section of staircase, one typical door and one typical window of either one of the two above drawings
4. One point and two-point perspective
5. CAD sheet of either one of the first two drawings

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. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Drawing Sheets	:	10 Marks
Report of the Drawing	:	05 Marks
Report on the Site Visit	:	05 Marks
Attendance	:	05 Marks
Total	**:**	**25 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. Building Drawing with an Integrated Approach to Built Environment by *M. G. Shah, C. M. Kale, S. Y. Patki* (Tata McGraw-Hill Education)
2. Civil Engineering Drawing (including Architectural aspect) by *M. Chakraborti* (Monojit Chakraborti Publications, Kolkata)
3. Planning and Designing Buildings by *Y. S. Sane* (Modern Publication House, Pune)
4. Building Drawing and Detailing by *B.T.S. Prabhu, K.V. Paul and C. V. Vijayan* (SPADES Publication, Calicut)
5. Building Planning by *Gurucharan Singh* (Standard Publishers & Distributors, New Delhi)

References:

1. IS 962: 1989 – Code of Practice for Architectural and Building Drawings.
2. National Building Code of India – 2005 (NBC 2005)
3. Development Control Regulations for Mumbai Metropolitan Region for 2016 – 2036 (https://mmrda.maharashtra.gov.in/documents/10180/7761832/5.pdf/e09991a2-b29e-4e04-a33e-a40aca6e2689?version=1.1)
4. Development Control Regulations for Navi Mumbai Municipal Corporation – 1994 (https://www.nmmc.gov.in/development-control-regulations)
5. Development Plan and Control Regulation for 27 villages of Kalyan and Ambernath tehsils of Thane district, Maharashtra (https://mmrda.maharashtra.gov.in)

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 405	Building Materials and Construction Technology	5

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

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

Rationale

Materials are essential elements, constituent parts (or) substances which are used to raise a building, but materials could not be turned into structures without a method of construction. This subject provides necessary knowledge about properties, uses of different types of building materials and the selection of materials, its mix proportioning, mixing, placing, compacting, curing and finishing. This subject is intended for gaining useful knowledge with respect to facts, concepts, principles and procedures related to building construction system so that student can effectively plan and execute building construction work.

Objectives

- To study the manufacturing process, properties, and use of different types of building materials like cement, lime, mortar, concrete, stone, brick, timber, including materials such as paints and varnishes used for treatment of the surfaces so as to achieve good knowledge about the building materials.
- To enable the students to identify various components of building masonry, roof and floor, staircase etc., their functions and methods of construction so as to achieve good knowledge about building construction.
- To study the properties such as workability, durability and porosity of fresh and hardened concrete.
- To understand the concept and optimization of mix design for different environmental conditions.

Detailed Syllabus			
Module	**Sub-Modules/ Contents**		**Periods**
I.	**Introduction** Classification of materials, building materials symbols and requirements of building materials and products: functional, aesthetical and economical		**4**
II.	**Manufacturing Process and Properties of Basic Construction Materials.**		**11**
	2.1	Rocks (Stone) quarrying, milling and surface finishing, preservative treatments. **Aggregate**-Properties of coarse and fine aggregates and their influence on properties of concrete, properties of crushed aggregates.	
	2.2	**Structural clay products** -bricks, roofing tiles, ceramic tiles, raw materials and manufacturing process.	
	2.3	Concrete blocks, flooring tiles, paver blocks -raw materials and manufacturing process.	
	2.4	**Binder material**: lime, cement: Manufacturing process and physical properties, plaster of Paris -properties and uses.	
	2.5	**Mortar** -ingredients, preparation and uses.	
	2.6	Damp -proofing and water proofing materials	
III.	3.1	**Concrete**	**09**
		Grades of concrete, Manufacturing process, Properties of fresh and hardened concrete. Durability – Factors affecting durability, Relation between durability and permeability, laboratory tests on durability such as Permeability test, Rapid chloride penetration test.	
	3.2	**Admixtures**: Plasticizers, Super-plasticizers, Retarders, Accelerators, Mineral admixtures and other admixtures, test on admixtures, chemistry and compatibility with concrete.	
IV.	4.1	**Glass**: Types and uses. Introduction to glass fibre reinforced plastic.	**04**
	4.2	**Timber**: Varieties, defects in timber, preservative treatments and wood composites.	
V.	5.1	**Concrete mix design** Types of mix, Mix design for compressive strength by I.S. method, Mix design for flexural strength, Method of determining compressive strength of accelerated - cured concrete test specimens as per IS:9013-2004 (revised code)	**10**

	5.2	**Ready mix concrete**: Advantages of RMC, components of RMC plant, distribution and transport, handling and placing, mix design of RMC,Mass Concerting, Vaccum Concerting and Concreting Equipments	
VI.	6.1	**Masonry Construction and Masonry Finishes**: Classification and bonding of stone, brick and concrete blocks Masonry finishes -pointing, plastering and painting	**14**
	6.2	**Formwork** Materials used, design considerations, shuttering, centering and staging, scaffolding. Types of form work: Slip form work, Cantilever and other modern form work	
	6.3	**Floor and roof** Different types and its suitability. Type of roofs, wooden and steel trusses and roof covering Different types of cladding.	
		Total	**52**

Contribution to Outcomes

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

- Identify and list the various building materials, their properties and symbols.
- Identify the properties of ingredients of concrete, interpret and design concrete mix for various grades.
- Explain and interpret manufacturing process of basic construction materials and understand various masonry construction and finishes.
- Perform tests on various materials.

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 4-5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be . 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. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
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 on the entire syllabus and term work comprising of the report of the experiments/ practicals conducted by the students and a detail report of the industrial/ site visit.

Internal Assessment:

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

List of Practicals *(Any Eight to be performed)*:

1. Physical properties of cement: Fineness, consistency, setting time, Soundness, Compressive strength.
2. Water absorption and compressive strength test of bricks.
3. Water absorption and transverse load test on tiles.
4. Compression test on timber (Parallel/ perpendicular to the grains).
5. Effect of w/c ratio on workability, (slump cone, compaction factor, V-B test, flow table) and strength of concrete
6. Effect of w/c ratio on strength of concrete,
7. Study of admixtures and their effect on workability and strength of concrete
8. Secant modulus of elasticity of concrete and indirect tensile test on concrete
9. Nondestructive testing of concrete- some applications (hammer, ultrasonic)
10. Mix design in laboratory.

Site Visit/ Industrial Visit:

The students shall visit the brick, paver blocks, concrete block, cement, glass and RMC industrial plants. They shall study various aspects of the plant along with various operations. A visit may also be arranged to the site involving repairs and rehabilitation of concrete structures. The visit to any site where construction is going on may be arranged and the students may be made aware of the various construction activities. They shall prepare a report of the visit which shall include all above points. The same shall be evaluated by the concerned teacher.

Term Work:

The term work shall consist of:

- Report of minimum **08** experiments.
- Assignments, including at least **20** sketches on A2 size drawing sheets covering entire syllabus.
- Industrial visit report to at least **any one** of the above mentioned industrial plants.
- Although minimum numbers of experiments and industrial visits are prescribed, the students shall be encouraged to perform more number of experiments and site/ industrial visits.

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 including industrial/ site visit report. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Report of the Experiments	:	10 Marks
Assignments	:	05 Marks
Sketches	:	05 Marks
Attendance	:	05 Marks
Total	**:**	**25 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. Building Construction: *S. P. Bindra and S. P. Arora*, Dhanpat Rai and Sons, Delhi.
2. Engineering Materials: S.*R. Rangwala,* Charotar Publications.
3. Building Construction: *Rangwala*, Charotar Publications, Anand (Gujrat).
4. Concrete Technology Theory and Practice: Shetty M.S., S. Chand.
5. Concrete Technology: Gambhir M.L., Tata McGraw Hill, New Delhi.
6. Concrete Technology: Neville A.M. & Brooks. J. J., ELBS-Longman.
7. Concrete mix proportioning-guidelines (IS 10262:2009).
8. Concrete Technology: *A. R. Shanthakumar*, Oxford University Press.
9. Engineering Materials: S.*R. Rangwala,* Charotar Publications.
10. Materials of Construction: *D. N. Ghose*, Tata McGraw Hill, Delhi.
11. Architectural Materials science*: D. Anapetor*, Mir Publishers.
12. Introduction to Engineering Materials: *B. K. Agrawal*, Tata McGraw Hill NewDelhi.
13. Engineering Materials: *P. Surendra Singh*, Vani Education Books New Delhi.
14. Building Materials (Products, Properties and Systems): *M.L. Gambhir and NehaJamwal*, Mc-Graw Hill Publications.
15. Specifications for different materials, BIS Publications, New Delhi
16. Properties of concrete: Neville, Isaac Pitman, London.
17. Relevant I.S. codes: Bureau of Indian standard.

Semester IV		
Subject Code	**Subject Name**	**Credits**
CE-C 406	Fluid Mechanics–II	4

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

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

Rationale

The course introduces the fluid flow science, problems and their applications in varied conditions. The study dealt with the characteristics of fluid flow in pipes namely compressible, laminar and turbulent with their applications in detail.

Objectives

- To understand the Pipe flow problems, losses incurred during transmission of power through pipe and nozzle.
- To study hardy cross method and water hammer phenomenon
- To study and analyze the pipe network which will help to design water supply schemes.
- To study laminar, turbulent flows and its significance.
- To study compressible flow and understand boundary layer theory.

Detailed Syllabus			
Module	**Sub-module /Content**		**Periods**
I	**1. Flow through pipes**		**10**
	1.1	**Flow through pipes** Loss of head through pipes, Darcy-Weisbach equation, minor and major losses. Hydraulic gradient line and energy gradient line, pipes in series, equivalent pipes, pipes in parallel, flow through laterals, flow through branched pipes, three reservoir problem, siphon.	
	1.2	**Pipe network and water hammer** Hardy cross method, water hammer in Pipes-Gradual closure and instantaneous closure of valve control measures.	
II	**2. Flow through nozzles:**		**04**
	Power transmitted through nozzle, condition for maximum power transmitted, diameter of nozzle for maximum transmission of power.		
III	**3. Compressible flow**		**05**
	Basic equation of flow (elementary study), velocity of sound or pressure wave in a fluid, Mach number, propagation of pressure waves, area-velocity relationship, Stagnation properties		
IV	**4. Boundary layer theory**		**07**
	Development of boundary layer over flat surfaces. Boundary layer thickness, energy thickness and momentum thickness, Boundary layer separation and control. Introduction to flow around submerges body, drag and lift, terminal velocity of body.		
V	**5. Laminar Flow:**		**05**
	Reynolds experiment, critical velocity, laminar flow through circular pipes, flow between two parallel plates: stationary and moving. kinetic energy correction factor, and momentum correction factor. Dash pot mechanism.		
VI	**6. Turbulent Flow:**		**08**
	Causes of turbulence, shear stress in turbulent flow, Prandtl's mixing length Theory, Hydro dynamically smooth and rough pipes, velocity distribution in smooth and rough pipes, Karman-Prandtl velocity distribution equation, Resistance to flow in smooth and rough pipes, resistance equation and Moody's diagram.		
		Total	**39**

Contribution to Outcomes

- On completion of this course the student will be able to:
- Interpret different pipe fittings and evaluate the fluid velocity considering major and minor losses.
- Solve pipe network problems by Hardy cross method.
- Distinguish the types of compressible flow and understand concept of boundary layer theory.
- Evaluate pressure drop in pipe flow using Hagen-Poiseuille's equation for laminar flow in a pipe.
- Establish Prandtl's mixing theory and solve turbulent flow problems.

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 4-5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be . 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. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
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 on the entire syllabus and the report of the experiments conducted by the students including assignments.

List of Practicals (Any ix experiments to be performed):

1. Reynold's Experiment
2. Determination of viscosity of fluid
3. Friction loss through pipes
4. Minor losses through pipes
5. Laminar flow through pipes
6. Velocity distribution in circular pipes
7. Turbulent flow through pipe
8. Water Hammer phenomenon

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. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Report on Experiments	:	10 marks
Assignments	:	10 Marks
Attendance	:	05 Marks
Total	**:**	**25 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.M. Modi and Dr. S.M. Seth*, Standard book House, Delhi.
2. Theory and Application of Fluid Mechanics: *K. Subramanya*, Tata McGraw hill publishing company.
3. Fluid Mechanics: *Dr. A.K Jain*, Khanna Publishers.
4. Fluid Mechanics and fluid pressure engineering: *Dr. D.S. Kumar, F.K. Kataria.*
5. Fluid Mechanics and Hydraulics: *Dr. S. K. Ukarande*, Ane Books Pvt. Ltd. (Revised Edition, 2012), ISBN 97893 8116 2538.
6. Fluid Mechanics: *R.K. Bansal*Laxmi Publications (P) Ltd.
7. Fluid Mechanics and Machinery: *C.S.P.Ojha, R. Berndtsson and P.N. Chandramouli*. Oxford Higher Education.

Reference Books:

1. Fluid Mechanics: *Frank M. White*, Tata Mc-Graw-Hill International edition.
2. Fluid Mechanics: *Streeter White Bed ford*, Tata McGraw International edition.
3. Fluid Mechanics with engineering applications: *R.L. Daugherty, J. B. Franzini, E.J., Finnemore*, Tata McGraw Hill New Delhi.
4. Hydraulics: *James F. Cruise, Vijay P. Singh and Mohsen M. Sherif*, CENGAGE Learning India Pvt. Ltd., Delhi.

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								
		Internal Assessment			End Sem Exam	Exam. Duration (In Hrs.)	Term Work	Pract	Oral	Total
		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			
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	Total
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.

University of Mumbai

CIRCULAR:- No. UG/ 44 of 2019-20

Attention of the Principals of the Affiliated Colleges, Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/249 of 2010 dated 12th August, 2010 relating to the revised syllabus of Fourth Year (Sem.VII & VIII) of the B. E. Degree Course in branch of Civil Engineering.

They are hereby informed that the recommendations made by the Board of Studies in Civil Engineering at its meeting held on 11th April, 2019 have been accepted by the Academic Council at its meeting held on 15th April, 2019 **vide** item No. 4.51 and that in accordance therewith, the revised syllabus as per the (CBCGS) for the B.E. Civil Engineering (Sem. VII & VIII) has been brought into force with effect from the academic year 2019-20, accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
9th July, 2019

(Dr. Ajay Deshmukh)
REGISTRAR

To

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

A.C/4.51/15/04/2019

****

No. UG/ 44 -A of 2018-19 MUMBAI-400 032 9th July, 2019

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. Ajay Deshmukh)
REGISTRAR

AC 15/4/2019
ITEM NO. 4.51

UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17

Under

FACULTY OF TECHNOLOGY

Civil Engineering

Second Year with Effect from A.Y. 2017-18

Third Year with Effect from A.Y. 2018-19

Final Year with Effect from A.Y. 2019-20

As per Choice Based Credit and Grading System

with effect from the A.Y. 2016–17

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	--	2	5
CE-DLO704X	Department Level Optional Course-III	3	--	2	3	--	2	5
ILO701X	Institute Level Optional Course-I	3	--		3	--		3
CE-C705	Project – Part I	--	6	--	--	3	--	3
Total		**17**	**10**	**4**	**17**	**5**	**4**	**26**

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	--	--	3	--	--	3
CE-P804	Project – Part II	--	12	--	--	6	--	6
Total		**15**	**18**	**-**	**15**	**9**	**-**	**24**

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-P804	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-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: Applied Hydrology and Flood Control

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-VII

Semester VII		
Subject Code	**Subject Name**	**Credits**
CE-C 701	**Quantity Survey, Estimation & Valuation**	**5**

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

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

Rationale

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

Objectives

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

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
I.	**Introduction**		**03**
	1.1	Importance of Course	
	1.2	Measurement systems for various items of civil engineering structures.	
	1.3	Units of measurement of various items of works	
	1.4	I.S1200	

II.	**Specifications & Rate Analysis**		**08**
	2.1	Types & importance of specifications, rules to be followed for drafting the specifications of various items of work etc	
	2.2	Rate analysis, its importance & necessity, Factors affecting rate analysis, Task work, sources of materials, Study of IS 7272 regarding labour output ,District Schedule of Rates(DSR) Rate analysis of important items of construction works.	
III.	**Estimates**		**14**
	3.1	**Approximate Estimate** Definition & Purposes of approximate estimates, Methods for preparing approximate estimates & numerical based on methods, Various terms such as administrative approval, Technical sanction, Contingencies, Work charged establishments etc.	
	3.2	**Detailed Estimate** Definition & purposes of detailed estimate, Data required for preparation of detailed estimate. Methods of taking out quantities such as long wall & short wall method, Centre line method etc Bar Bending Schedule & its necessity, preparation of bar bending schedule of various structural elements as per code IS2502.Preparation of detailed estimate of R.C.C framed structures	
IV.	**Estimation of Earthwork for Roads & Canals**		**06**
	4.1	Methods of computation of volume of earthwork such as mean area method, mid-sectional area method, Prismoidal formula, Trapezoidal formula, Spot level method etc. &numericals based on methods. Mass haul diagram & its necessity, Terms like lead & lift etc.	
V.	**Tenders & Contracts**		**08**
	5.1	**Tenders** Definition & types of tenders, Tender notice & its inclusions, Pre-qualification of contractors, Pre-bid meeting, Procedure for submission & Opening of tender, acceptance & rejection of tender, Tender validity period, E-Tendering	
	5.2	**Contracts** Definition, basic forms such as Valid, void & voidable contract. General types of contract with their suitability, conditions of contract	
	5.3	**Dispute resolution methods** Causes of disputes & disputes resolution methods such as litigation, mediation & arbitration	
VI.	**Valuation**		**09**
	6.1	Difference between cost, price & value. Types of value, Valuation & its purposes. Various terms such as depreciation, sinking fund, capitalized value, years purchase etc. Methods for calculating depreciation of building	
	6.2	Methods of valuation such as Rental method, land & building method, Belting method etc.	
	6.3	Freehold Properties, Leasehold Properties, Easement rights	
	6.4	Numericals based on valuation	

Contribution to Outcomes

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

1) **apply** the measurement systems to various civil engineering items of work.
2) **draft** the specifications for various items of work & determine unit rates of items of works
3) **estimate** approximate cost of the structures by using various methods&**prepare** detailed estimates
   of various civil engineering structures by referring drawings.
4) **assess** the quantities of earthwork &**construct** mass haul diagrams.
5) **draft** tender notice &**demonstrate** the significance of the tender as well as contract process.
6) **determine** the present fair value of any constructed building at stated time.

Theory examination:

Question paper will comprise of **six** questions; each carrying 20 marks.
The **first** question will be **compulsory** based on computation of quantities of various items of work by referring drawings.
The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module or contents thereof.
There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
The students will have to attempt any **three** questions out of remaining five questions.
Total **four** questions need to be attempted.

Oral Examination:

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

Term Work:

The term work shall consist of the following:

1) At least **eight** assignments based on entire syllabus

2) Detailed estimate of any **Three** of the following with the required material survey for the same.

   - Single Storied building (RCC)
   - Road work
   - Load bearing structure
   - Cross drainage work

3) Valuation report in a standard format of the Government/ Private company/Firm.

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

Distribution of Term Work Marks:

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

Assignments : 20 Marks **Attendance : 05 Marks**

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

Recommended Books:

1) Estimating, Costing, Specifications and Valuation: *Chakraborty, M.,* Kolkata.

2) Building and Engineering Contracts: *Patil, B. S.,* University Press, Hyderabad.

3) Estimating and costing: *Datta, B. N.,* UBS Publications

4) Relevant Indian Standard Specifications, BIS Publications

5) World Bank approved contract documents

Semester VII		
Subject Code	**Subject Name**	**Credits**
CE-C 702	**Theory of Reinforced Concrete Structures**	**05**

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

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

Rationale

Working stress Method (WSM) makes use of the concept of modular ratio based on the higher factor of safety in evaluating the stresses in two different materials of the RCC i.e. steel and the concrete. The limit state method (LSM) is based on the statistical probability which provides the rational solution to the design problem. The philosophy lies behind LSM uses multiple safety factors format which attempts to provide adequate safety at the ultimate load as well as adequate serviceability at service load by considering all possible limit states.The subject involves the application of working stress and limit state method in the analysis and design of various elements of the civil engineering structures.

Objectives

1. To develop the clear understanding of design philosophy amongst the students for the design of reinforced concrete structure using (WSM) working stress method and (LSM) limit state method.
2. To study the various clauses of IS: 456-2000 and its significance in the RCC design.
3. To apply the concepts of LSM in the analysis and design of beams, slabs and columns.
4. To study the concept of Serviceability and durability for deflection and crack width calculation in RCC structures.
5. To study the concept of reinforced concrete footing design subjected to axial load and moment.
6. To develop the concept of design using ready charts and curves for column subjected to axial load and moments.

Detailed Syllabus

Module	Contents	Periods
I.	**Working Stress Method** Concept of reinforced concrete, Working Stress Method (WSM) of design for reinforced concrete, permissible stresses as per IS-456-2000; stress- strain curve of concrete and steel, characteristics of concrete steel reinforcement. Concept of balanced, under reinforced and over reinforced sections.Analysis design of singly reinforced and doubly reinforced rectangular beams for	12

	flexure, shear by WSM, Analysis and design of Cracked and un-cracked RCC column sections by WSM	
II.	**Limit State Method** Introduction to limit state method of design as per IS-456-2000; concepts of probability and reliability, characteristic loads, characteristic strength, partial safety factors for loads and materials, introduction to various limit states.	03
III.	**Limit State of Collapse – Flexure, Shear, Bond and Torsion** Limit state of collapse in flexure, shear and Limit state of serviceability in deflection and cracking, design of singly and doubly reinforced rectangular and T sections for flexure, design of members in shear and bond, design of beam subjected to bending and torsion. Requirements governing reinforcement detailing. Deflection and crack width calculation for RCC members.	15
IV.	**Design of Slabs using LSM:** Design of one way, one way continuous slab and two way slabs with all end conditions as per IS-456-2000.	06
V.	**Limit State of Collapse – Compression:** Limit state of collapse compression for short and slender column. Members subjected to combined axial and uni-axial as well as biaxial bending. Development of interactive curves and their use in column design.	08
VI.	**Design of Foundations:** Isolated square and rectangular footings subjected to axial load and moments. Design of combined rectangular pad footings, slab beam type footing. Design of Raft foundations (No numerical to be asked on raft foundations in the exam)	08
	Total	52

Contribution to Outcomes

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

1. Understand the pros and cons of the WSM and LSM.
2. Understand the various clauses specified in IS: 456-2000 for designing structural members with the safety and economy.
3. **Carry out analysis and design of various elements of the reinforced concrete structures such as beam, slab, column, footings using the concept of Limit state method.**
4. **Understand and the use of readymade design curves from Special publications of Bureau of Indian standards.**

Theory Examination:-

1. **Use of IS:456-2000 shall be allowed in the examination.**
2. Question paper will comprise of **six** questions; each carrying 20 marks.
3. The **first** question will be **compulsory** will have the short questions having weightage of 4-5 marks covering the entire syllabus.
4. The remaining **five** questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately further; and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module contents thereof.
5. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
6. The students will have to attempt any **three** questions out of remaining five questions.
7. 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 two problems on each modules/ sub-modules contents thereof.At least one numerical on raft foundation shall be included in assignments.

Distribution of Term-work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on assignments. The final certification acceptance of the term-work warrants the satisfactory and 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. Design of Reinforced Concrete Structures*: Dayaratnam, P;* Oxford and IBH.
2. Limit State Design – Reinforced Concrete: *Jain A. K*, Nemchand and Bros., Roorkee
3. Limit State Design – Reinforced Concrete: *Shah and Karve*, Structure Publications, Pune.
4. Ultimate Strength Design for Structural Concrete: *Arthur, P. D. and Ramakrishnan, V.*, Wheeler and Co. Pvt. Ltd.
5. Reinforced Concrete: *H.J. Shah*, Charotar Publishers, Anand.
6. Fundamentals of Reinforced Concrete: *Sinha& Roy*, S. Chand and Co. Ltd.
7. Illustrated Reinforced Concrete Design: *Dr. V. L. Shah and Dr. S. R. Karve*, Structure Publications, Pune.
8. Reinforced Concrete Design: *Wang, C. K., Salmon, C. G., and Pincheira, J. A*, John Wiley (2007), 7th Edition.
9. Reinforced Concrete Fundamentals: *Ferguson, P. M., Breen, J. E., and Jirsa, J. O.*, John Wiley & Sons (1988) 5th Edition.
10. RCC Design (WSM and LSM): *Punmia, B. C., Jain, A. K., and Jain,Arun, K.*, Laxmi Publications.
11. Limit State Design of Reinforced Concrete (as per IS: 456-2000): *Punmia, B. C., Jain, A. K., and Jain,Arun, K.*, Laxmi Publications.
12. Design of RCC structural Elements (RCC Vol-I): *Bhavikatti, S. S.*, New Age International Publications.
13. Reinforced Concrete: *Syal and Goel*; Wheeler Publishers.
14. Relevant IS Codes: BIS Publications, New Delhi.
15. Reinforced Concrete Design: *Pillai,S.U.*and*Menon,Devdas*, Tata Mc-Graw Hill Publishing House, New Delhi.
16. Reinforced Concrete Designby S.N. Sinha, Tata Mc-Graw Hill Publishing House, New Delhi.
17. Theory of Reinforced concrete structures by N. Subramanian , Oxford University Press.

Semester VII		
Subject Code	**Subject Name**	**Credits**
CE-C 703	**Water Resources Engineering II**	**05**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
03	**-**	**02**	**03**	**-**	**02**	**05**

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

Rationale

This subject provides necessary knowledge about design of gravity dams, earthen dams, energy dissipaters, canal headwork's, and canal structures. This subject is also useful with respect to facts, concepts, principles and procedures related to canal design, canal lining, cross drainage works and water logging. Further students will be able to plan and execute the construction of these structures.

Objectives

1. To understand different types of dams and its suitability to a particular region.
2. To study design consideration of earthen dams
3. To study various types of Spillways
4. To understand the importance of silt theories for design of irrigation channels
5. To study the classification of canals and design of canal system.

Detailed Syllabus

Module	Topics	Periods
I	**Gravity dams** Definition, typical cross section, forces acting on gravity dam, modes of failure and structural stability analysis, profile of dam- elementary and practical profile, low and high gravity dam, design consideration and fixing of section of dam, methods of design, construction of galleries in dams, types of joints, temperature control in concrete dams, foundation treatment, Arch dams, types of arch dams	**08**
II	**Earth and rock fill dams:** Types of earth dams, method of construction, causes and failures of earth dams, design criteria, selecting suitable preliminary section, seepage line for different conditions and its location, seepage control through embankment and through foundations, Swedish circle method with pore pressure, details of construction and maintenance, types of rock fill dams, stability analysis, advantages	**06**
III	**Spillways and flood control works:** Introduction, location of spillway, design consideration of main spillway,	**06**

	controlled and uncontrolled spillway, types of spillways, design principles of ogee spillway. Chute spillway. Siphon spillway and shaft spillway, energy dissipation below overflow and other types of spillways, design of bucket type energy dissipater and stilling basin, flood mitigation reservoirs. Crest gates, types, advantagSes, design of radial gate, outlet works through dams, intake structures.	
IV	**Irrigation Channels (Silt Theories)**	**07**
	Kennedy's theory, Kennedy's methods of channel designs silt supporting capacity according to Kennedy's theory. Drawbacks in Kenned' % theory Lacey's regime theory, Lacey's theory applied to channel design. Comparison of Kennedys and Lace 'S theory defects in Lacey's theory. Introduction to Sediment transport in channels.	
V	**Canal Head works and Distribution System**	**06**
	Canals: Classification, canal alignment, canal losses, estimation of discharge, cross sections of irrigation canals, maintenance of irrigation canal, canal lining, economics of canal lining, water logging, effect of water logging, remedial measures.	
VI	**Canal structures**	**06**
	Canal falls, types of canal falls, canal escapes, types, canal head regulators, cross regulators, canal outlets and its types cross drainage works and types of cross drainage works.	

Course Outcomes

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

1. Design the section of gravity dams, earth and rockfill dams, arch dams and buttress dams.
2. Design spillways and energy dissipaters.
3. Apply silt theories to design irrigation canals.
4. Explain various types of canals and its maintenance.
5. Explain different cross drainage works of a canal system.

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

Distribution of 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.

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

Semester-VII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 7041	**Pre-stressed Concrete**	**5**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorials**	**Theory**	**Practical**	**TW/Tutorials**	**Total**
3	**-**	**2**	**3**	**-**	**2**	**5**

Evaluation Scheme

Theory					Termwork/Practical/Oral/Tutorials			Total
Internal Assessments			ESE	Duration of ESE	TW/TU	PR	OR	
IAE-I	IAE-II	Average						
20	**20**	**20**	**80**	**3Hr**	**25**	**-**	**25**	**150**

Rationale

The course is aimed to make the student to be aware of highly mechanized technology in civil engineering construction and to develop the basic understanding of prestressed concrete which is used in a wide range of building and civil structures. A Prestressed Concrete section improves performance/efficiency, reduces structural thicknesses, and material savings compared with simple reinforced concrete sections. Typical applications of prestressed concrete include high rise buildings, residential slabs and bridge structures etc.

Objectives

1. To bring the students to such a level so as to enable them to take the appropriate decision in respect of choice of prestressed section over R. C. C. as a civil engineer.
2. To make the candidate to understand the analysis of Prestressed Concrete sections and losses in prestress.
3. To make the candidate able to understand and implement the guidelines of Indian Standard code for analysis and design sections using limit state philosophy.

Detailed Syllabus

Module	Sub module/Contents	Periods
1	**Introduction to prestressed concrete and analysis of prestressed concrete section :** Basic concept and general principles, materials used and their properties, methods, techniques and systems of prestressing	04
2	**Analysis of Prestressed Concrete Section:** Loading stages, stress method, load balancing method and internal resisting couple method of analysis, cable profiles, pressure line, kern points, choice and efficiency of sections	10
3	**Losses in prestress:** Loss of stresses due to elastic deformation of concrete, creep in concrete, creep in steel, shrinkage in concrete, relaxation in steel, anchorage slip and friction	06
4	**Analysis of Prestressed Concrete Members in Limit State of Serviceability deflection:** Short time and long time deflection of uncracked members, permissible limits	03
5	**Analysis and Design of Prestressed Concrete Members for Limit State of Collapse Shear** Calculation of principle tension, permissible principle tension, Analysis and	05

	Design of members in shear (sections uncracked in flexure)	
6	**Analysis and Design of Prestressed Concrete Members for Limit State of Collapse Flexure** General philosophy of design, Analysis and design of members in flexure	03
7	**Analysis and Design of Prestressed Concrete Members for Limit State of Serviceability Cracking** permissible stresses in concrete and steel at different stages, suitability of section, safe cable zone	05

Contribution to outcome

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

1. To understand the concept of pre-stressing its casting techniques and applications, behaviour of the pre-stressed structures vis-à-vis that of the RCC structure.
2. To take the decision with respect to the choice of pre-stressed section over RCC.
3. To analyze the various pre-stressed components of the structure and design the same using relevant IS Code.

Theory Examination:-

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

Oral Examination:

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

Site Visit/ Field Visit:

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

Term Work:

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

Distribution of Term Work Marks:

The marks of term-work shall be judiciously awarded depending upon its quality. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments, properly compiled report of the site visit /field 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: 15 Marks

Report of the Site Visit/Field Visit: 05 Marks
Attendance: 05 Marks

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

Recommended Books:

1. Prestressed Concrete*: N. Krishna Raju*, McGraw Hill, New York.
2. Prestressed Concrete: *N. Rajgopalan*, Narosa Publishing House.
3. Fundamentals of Prestressed Concrete: *Sinha, N.C.*and*S.K. Roy*, S.C. Chand and Company.
4. Prestressed Concrete Structures: *Dayaratnam, P.*, Oxford andIBH
5. Design of Prestressed Concrete Structures: *T.Y.Lin*and*N.H. Burns*, John Willey, New York.
6. Design of Prestressed Concrete: *Nilson Arthur*, McGraw Hill Book Company.
7. Prestressed Concrete Vol—I*: IY.Guyon*, Contractors Record, London.
8. Prestressed Concrete*: S. Ramamurtham*, DhanpatRaiandSon's
9. Relevant latest IS codes (IS:1343-2012)

Semester-VII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 7042	**Solid Waste Management**	**5**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorials**	**Theory**	**Practical**	**TW/Tutorials**	**Total**
3	**-**	**2**	**3**	**-**	**2**	**5**

Evaluation Scheme

Theory					Teamwork/Practical/Oral/Tutorials			Total
Internal Assessments			ESE	Duration of ESE	TW/TU	PR	OR	
IAE-I	IAE-II	Average						
20	20	20	80	3Hr	25	-	25	150

Rationale

This course will be of interest to those wishing to understand the principles and techniques of solid waste management, including the legislative, environmental, economic and social drivers. Students will be introduced to the selection and design of appropriate methods of storage, collection, transfer, treatment and disposal in both industrialized and developing countries. The course also provides the opportunity to visit recycling facilities and disposal sites to better understand links between theory and practice.

Objectives

- To make the students conversant with different aspects of the types, sources, generation, storage, collection, transport, processing and disposal of municipal solid waste.
- To provide knowledge of different types of sources, sampling and characteristics of solid waste.
- To impart knowledge and skills in the collection, storage, transport and recycling options for solid wastes including the related engineering principles, design criteria, methods and equipments.
- To fully appreciate the current practices available and implement the systems available in solid waste management.
- To be aware of the significance of recycling, reduce, reuse of solid wastes and also to impart students with the skill of design and operation of disposal system based on latest technology.
- To provide students prerequisite knowledge necessary for higher studies and research in the field of Solid waste management.

Module	Sub Modules/Contents	Periods
1.	**Introducing Municipal Solid Waste Management** Overview: problems and issues of solid waste management - Need for solid waste management-Functional elements such as waste generation, storage, collection, transfer and transport, processing, recovery and disposal in the management of solid waste.	03
2.	**Generation and characteristics of waste** Sources, Types, composition, quantity, sampling and characteristics of waste, factors affecting generation of solid wastes	03

3.	**Waste collection, storage and transport** Collection and storage of municipal solid waste; Methods of collection - House to House collection -collection routes; on site storage methods-materials used for containers -Recycling and Reuse of waste -Need for transfer and transport; transfer station-selection of location, operation and maintenance; transportation Methods-manual, Mechanical methods with or without compaction, economy in transportation of waste optimization of transportation routes.	10
4.	**Waste processing techniques** Processing techniques-biological and chemical conversion technologies – composting and its methods, Vermi-composting, mechanical composting, In vessel composting, incineration, pyrolysis, gasification.	04
5.	**Disposal of Solid Waste** Segregation, Volume reduction at source, recovery and recycle; dumping of solid waste-sanitary waste- sanitary landfills-site selection-design and operation of sanitary landfill - leachate and landfill gas management-landfill closure and environmental monitoring-landfill remediation; Municipal solid waste in Indian conditions, legal aspects of solid waste disposal, Plastic waste disposal.	10
6.	**Types of Solid Waste** **Industrial** Waste products during manufacturing and packing, operation of pollution control facilities, generation, and minimization at source, recycling, disposal. **Hazardous waste** Definition, sources, hazardous characteristics, management, treatment and disposal **Electronic waste** Waste characteristics, generation, collection, transport and disposal **Biomedical waste** Definition, sources, classification, collection, segregation- Color coding, treatment and disposal.	09

Contribution to outcomes

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

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

- Explain generation, storage, collection, transfer and transport, processing, recovery and disposal in the management of solid waste.
- Understand the characteristics of different types of solid waste and the factors affecting variation.
- Identify the methods of collection, storage and transportation of solid waste.
- Suggest suitable technical solutions for processing of wastes.
- Ability to plan waste minimization and disposal of municipal solid waste.
- Ensure the safe handling and treatment of Hazardous, Electronic and Biomedical waste.

Theory Examination:-

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

2. The first question will be compulsory which will have the short questions having weightage of 4-5 marks covering the entire syllabus.

3. The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module 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.

Site Visit: The students will visit landfilling /composting site in the nearby vicinity and prepare detailed report thereof. This report will form a part of the term work.

Oral Examination:-

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

Assignments, Tutorials including the site visit report.

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the assignments. Each student shall prepare a report on any industrial/hazardous/municipal solid waste comprising source, characterization, transportation, recycles, treatment and disposal.

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

1. Report (on any industrial/hazardous/municipal solid waste/site visit): 05 Marks
2. Seminar : 05Marks
3. Attendance : 05 Marks
4. Assignments and Tutorials :10 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. Integrated Solid Waste Management: Techobanglous, Thisen and Vigil, McGraw Hill International.
2. Hazardous Waste Management: Lagrega, Buckingham and Evans, McGraw Hill International.
3. Solid Waste Management in Developing Countries: A.D. Bhide, Nagpur publications.
4. Environmental Pollution Control Engineering: C.S. Rao, Wiley Eastern, Manual of solid waste of management, CPHEEO.
5. E-Waste: Implications, Regulations, and Management in India and Current Global Best Practices, Rakesh Johri, The Energy and Resources Institute.
6. Biomedical Waste Management in India: Jugal Kishore and G. K. Ingle, Century Publications.

Semester-VII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 7043	**Pavement Subgrade and Materials**	**5**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorials**	**Theory**	**Practical**	**TW/Tutorials**	**Total**
3	**-**	**2**	**3**	**-**	**2**	**5**

Evaluation Scheme

Theory					Termwork/Practical/Oral/Tutorials			Total
Internal Assessments			ESE	Duration of ESE	TW/TU	PR	OR	
IAE-I	IAE-II	Average						
20	20	20	80	3Hr	25	-	25	150

Rationale

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

Objectives

- To give the students hands on experience on various material properties and testing procedures of pavement materials as per IRC standards.
- To study the significance of the soil subgrade along with its functions.
- To study the soil classification for highway engineering purpose as per different classification system.
- To understand the concept of stresses in soil.
- To enable the student to identify the basic deficiencies of various soil deposits and to arrive upon the various ways and means of improving the soil and implementing the techniques of improvement.
- Learn bituminous mix and cement concrete mix designs
- Learn basic principles of superpave technology of bituminous mixes

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	**Soil: Soil-Classification methods, Tests:**CBR test, effect of lateral confinement on CBR and E value of Subgrade soil, Consistency, Engineering Properties and Modulus of sub-grade reaction ofsoil, estimation of modulus of subgrade reaction, Static and cyclic plate load test, correction for plate size, correction for worst moisture content. Soil classification as per HRB.	**08**

II.	**Stresses in Soil:** Theories of elastic and plastic behavior of soils, Cyclic triaxial test on subgrade soils, resilient deformation, resilient strain, resilient modulus Stabilized Soils: Method of sampling and Preparation of Stabilized Soils for testing , Relation for Moisture content and Dry Density of Stabilized mixes, UCS of Stabilized soil, test for: soil bituminous, soil lime and soil fly ash mixes.	**06**
III.	**Aggregate:** Classification, requirements, Blending of aggregates, Importance of aggregate shape factor in mix design. Grading requirements for aggregate, selection of bases and sub-base material (including stabilized materials),	**04**
IV.	**Bitumen, Tar and Bituminous Mix Design**; requirements, criteria for selection of different binders, Temperature susceptibility, Bituminous emulsion and Cutbacks, fillers, extenders Polymers, Crum rubber, and rubber modified bitumen and anti-Stripping agents on pavement performance.	**08**
V.	**Bituminous Mix Design:** selection of different grade of bitumen, skid qualities, types of bituminous surfaces, bituminous mix design, Marshall Stability test, design aspect of paving concrete.Experimental characteristics of road aggregate.	**06**
VI.	**Introduction to Super pave Technology:** Methods of selection of suitable ingredient for super pave method, Gyratory compaction, rolling thin film oven, pressure aging vessel, rotational viscometer, dynamic shear rheometer, bending beam rheometer, direct tension test. Use of super pave perform and grade binder specifications. Comparison between Marshal Mix method and Super pave method.	**07**

Contribution to Outcomes

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

- Understand the soil classification in accordance with various soil classify the system and evaluate the ability of the soil as a subgrade material.
- Understand the requirements and desirable properties of the various materials to be used in the construction of pavements.
- Understand the characterization of different paving materials along with the tests to be conducted on these materials.
- Know the various ground improvement methods.
- Understand subgrade soil strength in terms of standard engineering parameters
- Application of basic principles of mix design of cement concrete and bituminous mixes

Theory Examination:

Question paper will comprise of **six** questions; each carrying 20 marks.
The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
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.
There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
The students will have to attempt any three questions out of remaining five questions.
Total four questions need to be attempted.

Oral Examination:

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

Term Work:

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

Distribution of Term Work Marks:

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

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

Assignments : 20 Marks

Attendance : 05 Marks

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

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

Recommended Books:-

1. Principles of Pavement Design, Second Edition, 1975: *Yoder, E.J.* , John Wiley and Sons, Inc., New York.

2. Concrete Roads: *HMSO*, Road Research Laboratory, London.

3. Highway Engineering: *Khanna, S.K., Justo, C,E.G. and Veeraragavan, A.*,Nem Chand and Brothers, Roorkee (10^{th} Revised Edition, 2014)
4. Principles and Practices of Highway Engineering; *Dr. L. R. Kadiyali and Dr. N. B.Lal*, Khana Publishers, New Delhi.

5. Highway Engineering, *Sharma, S.K.*, S. Chand Technical Publishers, New Delhi (3^{rd} Revised Edition, 2013).

6. Principles of Transportation and Highway Engineering: *Rao, G.V.* , Tata Mc-Graw Hill Publications, New Delhi

Semester-VII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 7044	**Structural Dynamics**	**5**

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorials**	**Theory**	**Practical**	**TW/Tutorials**	**Total**
3	**-**	**2**	**3**	**-**	**2**	**4**

Evaluation Scheme

Theory					Termwork/Practical/Oral/Tutorials			Total
Internal Assessments			ESE	Duration of ESE	TW/TU	PR	OR	
IAE-I	IAE-II	Avg.						
20	**20**	**20**	**80**	**3Hr**	**25**	**-**	**25**	**150**

Course Objective

- To expose the students to understand the basic theory of structural dynamics, structural behaviour under vibratory load and the effect of damping.
- To study the difference between static load and different types of dynamic loads.
- To study the free vibration analysis of SDOF systems, concept of damping and dynamic analysis of SDOF system subjected to different dynamic loads.
- To study the dynamic degrees of freedom and calculation of the frequencies and mode shapes for lumped mass for discrete Two DOF systems,
- To study the modal analysis of Two DOF systems and analysis of systems with distributed mass for continuous system.

Details Syllabus

Module	Contents	Hrs
I.	**Introduction to structural Dynamics- Definition of Basic Problem in Dynamics.** Static vs. Dynamic loads. Different types of dynamics loads	**4**
II	**Introduction to single Degree of freedom (SDOF) Systems.** Undamped vibration of SDOF system natural frequency and period of vibration Damping in structures, viscous damping and Coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, Logarithmic decrement. Forced vibration, response to periodic loading, response to pulsating forces, dynamic load factor. Response of structure subjected to General dynamic load, Duhamel's Integral Numerical Evaluation of Dynamics Response of SDOF system. Equivalent stiffness of spring in series and parallel	**10**
III	Introduction to vibration isolation. Distributed mass system idealized as SDOF system, use of Rayleigh's method. Response of SDOF system subjected to ground motion	4
IV	**Lumped mass multi-degree of freedom (Two DOF) system, coupled and uncoupled system** Direct determination of frequencies of vibration and mod shape. Orthogonality principle. Vibration of Two DOF systems with initial conditions	**12**

	Approximate method of determination of natural frequencies of vibration and mode shapes – Energy methods	
V	**Earthquake analysis – Introduction.** Seismicity of a region, causes of earthquake Intensity of earthquake, Richter Scale, Measurement of Earthquake ground motion, Seismogram, construction of seismograph Application of modal analysis concept to seismic disturbance, Introduction to Response spectrum method.	**12**
VI	**I.S code provisions for seismic analysis of buildings.** Approximate method of earthquake analysis– Seismic co-efficient method and its limitation Introduction to time history analysis.(6)	**6**

Contributions to Outcomes

The students are expected to understand the difference between static and dynamic loads and analysis. They are expected to evaluate the response of SDOF and Two DOF systems to different types of dynamic loads including ground motions. They are also expected to understand the basics of random vibrations and the application of this concept to analyze Linear SDOF systems.

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

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

2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.

3. The students will have to attempt any **four** questions out of **total six** questions.

4. The questions can be of **mixed nature** irrespective of modules.

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

Recommended Books:-
1. Craig R.R.: 'Structural Dynamics-An Introduction to Computer Methods',*John Wiley and Sons.*

2. Anil K. Chopra: ‘Dynamics of Structures’, *Prentice Hall India Pvt. Ltd.*

3. CloguhandPenzein: ‘Dynamics of Structures’*TataMc-Graw Hill Pvt. Ltd.*

4. John M. Biggs: ‘Structural Dynamics’,*TataMc-Graw Hill.*

5. Mario Paz: ‘Structural Dynamics Theory and Computation’, *CBS Publisher.*

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 7045	**Applications of Geographic Information Systems & Remote Sensing**	**05**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
03	**--**	**02**	**04**	**--**	**02**	**05**

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

Rationale

Geographic Information Systems & Remote Sensing Applications provides power of mapping to civil engineers. GIS lets us visualize, question, analyze and interpret date to understand relationships, patterns and trends. In this subject, the students get acquainted with the detailed study of GIS & Remote sensing. Data models of spatial and non-spatial information are also explained. An overview on digitizing, editing and structuring of map data is also provided for error detection, correction and appropriate topology creation. Digital Elevation Models (DEM) and their needs are also incorporated along with the applications of Remote Sensing and GIS. Solution can be provided for Various Civil Engineering problems using Integration GIS-GPS & Remote Sensing Techniques.

Objectives

- To Study principles of physics of Electromagnetic radiation as applied to remote sensing.
- To Learn the GIS data & its processing using Softwares
- To get acquainted with GPS Satellite & their segments
- To Understand the GIS & RS Applications in various fields of Civil Engineering

Module	Content	Periods
I	**Remote sensing (RS):** Introduction, physics of remote sensing- electromagnetic radiations and their characteristics, thermal emissions, multi-concept in remote sensing, remote sensing satellites and their data products, sensors and orbital characteristics, spectral reflectance curves for earth surface features, methods of remotely sensed data interpretation- visual interpretation, concept of fcc, digital image processing- digital image and its characteristics, satellite data formats, image rectification and restoration, image enhancement- contrast manipulation, spatial feature manipulation, multi-image manipulation.	**8**
II	**Geographical Information System (GIS):** History, Introduction , spatial and non- spatial information,	**8**

	geographical concept and terminology, advantages of GIS, Basic component of GIS Commercially available GIS hardware and Software Field data, statistical data, maps, aerial Photographs, satellite data, points , lines, and areas features, vector and raster data, data entry through keyboard, digitizer and scanners, pre-processing of data rectification and registration , interpolation techniques, introduction to GIS softwares (Arc GIS, QGIS, Gram++. etc)	
III	**Global Positioning System (G.P.S) :** G.P.S. Segments: Spaces Segment, Control Segment, User Segment Features of G.P.S. Satellites, Principle of Operation Surveying with G.P.S.: Methods of observations, Absolute Positioning, Relative Positioning, differential G.P.S., Kinematics of G.P.S. G.P.S. Receivers: Navigational Receivers, Surveying Receivers, Geodetic Receivers, Computation of Co- ordinates:- Transformation from Global to Local Datum , Geodetic Coordinates to map co- ordinates , G.P.S. Heights and mean sea level Heights Applications of G.P.S	**5**
IV	**Application of G.I.S.& R.S. in Water Resources & Environmental Studies:** Site selection of Hydraulic Structures, Surface water delineation, surface keys for subsurface water, Steps in water investigations of the area, Water management	**6**
V	**Application of G.I.S.& R.S. in Infrastructure Management;** Role of GIS in Town Planning , Urban Transport Planning, Underground Infrastructure Management	**6**
VI	**Application of G.I.S.& R.S in Disaster Management :** RS and GIS applications for disaster vulnerable zones, fire hazards, flood and storm water inundations, earthquake impact assessment, post Tsunami/ cyclone damage assessment.	**6**

Contribution to Outcomes

After completion of course, student will be able to:

CO1. Explain the principles of physics of Electromagnetic radiation as applied to remote sensing.

CO2. Describe Spatial and non-spatial database of geographic information system

CO3 Demonstrate the GPS Satellites & their Segments.

CO4. Apply the GIS & RS techniques in Water Resources & Environmental Management.

CO5. Integrate the GIS-GPS & RS techniques for Infrastructure Management

CO 6 Illustrate applications of GIS& RS in Disaster Management

Theory examination:

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

The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.

The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module or contents thereof.

There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.

The students will have to attempt any **three** questions out of remaining five questions.

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

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

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

Distribution of Term Work Marks:
The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on assignments. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments; and the minimum passing marks to be obtained by the students. The following weight age 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. Introduction to GeographicInformationSystems:Kang-TsungChang,TataMcGrawHill.
2. Text book on Remote Sensing –C.S.Agrawal and P.K.Garg,Wheeler Publishing, New-Delhi.
3 G.I.S- Anji Reddy, publishers- MGH.
4. GIS, SpatialAnalysis, andModeling:Maguire,D.,M.Batty,andM.Goodchild.2005.ESRIPress.
5 Remote sensing in Civil Engineering – T. J. M. Kennie and M. C. Mathews, Surry University press, London
6. Principles of Remote Sensing- P.N.Patel and Surendra Singh, Scientific Publishers, Jodhapur.
7. RemoteSensingandImageInterpretation: LillesandandKiefere:, JohnWiley,1987.
8. GlobalPositioningSystem: Signals, Measurements, andPerformance, PratapMisraandPe r Enge(2nd Ed.), 2006.
9. Introduction to geomatics –QGIS user guide – Mr.C.V. Nishinkanth, Mrs.AnnuNishinkanth, Dr S S Vasudevan, Dr P Ramkumar, Publishers-

Semester VII		
Subject Code	**Subject Name**	**Credits**
CEC-DLO7046	**Foundation Analysis and Design**	**5**

Teaching Scheme						
Contact Hours			**Credits Assigned**			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorials**	**Total**
03	**-**	**02**	**03**	**-**	**02**	**05**

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

Objectives

- To study the bearing capacity and settlement of shallow foundations and To understand the design concepts for shallow foundations including strip and raft foundations
- To study the estimation of vertical stresses in soil
- To study different types of well foundations
- To study the load carrying capacity of pile and design of under reamed piles
- To study Cantilever sheet piles including anchored sheet piles in cohesion-less and cohesive soils and to analyse braced cuts
- To learn different types of machine foundations and understand the design philosophy; and carry out the design thereof.

Detailed Syllabus		
Module	**Sub Modules/Contents**	**Periods**
I	**Estimation of stresses in soils:**Boussinesque and Westergaard's theories, Newmark Chart, Practical applications.	**06**
II	**Shallow Foundation**: Basic requirements of foundation, types and selection of foundation, design of shallow foundations by Terzaghi's and IS code method; total settlement analysis including elastic settlements; Structural design of strip and raft foundation.	**07**
III	**Pile Foundation**: Introduction, Necessity of piles, Types of pile foundation, load carrying capacity of single pile and pile in group, , group efficiency, group settlements, design of single pile and pile cap, design of under-reamed pile foundation	**06**
IV	**Floating Foundation and Well Foundation:** Floating Foundation- Introduction, Floatation, bottom elastic heave, Design of floating foundation on piles, Well Foundation- Introduction, forces acting on well foundation.	**06**
V	**Sheet piles and Braced cuts:** Cantilever sheet piles including anchored sheet piles in cohesion-less and cohesive soils: lateral earth pressure diagram, computation of embedment depth. Difference in open cut and retaining wall theories, apparent earth pressure diagram, Average apparent earth pressure diagram for cohesion-less and cohesive soils. Estimation of strut loads in	**08**

	braced cuts placed in cohesion-less and cohesive soils.	
VI	**Machine Foundations:** Introduction, Dynamic soil properties, types of machine vibrations, basic principal of machine foundation.	**06**

Contribution to outcomes

1. On successful completion of the course, the learner shall have an: 1. Ability to identify, formulate and solve geotechnical engineering problems
2. Ability to design a suitable foundation system from economic and safe aspects
3. Ability to design machine foundations
4. Ability to relate easily to allied subjects such soil dynamics; advanced engineering geology, rock mechanics etc.
5. Ability to understand design of sheet piles
6. Ability to analyze vertical stresses developed in soil and used in practical problems

Theory Examination:-

1. Question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, 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.

Oral Examination:-

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

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the assignments. Each student shall prepare a report on any industrial/hazardous/municipal solid waste comprising source, characterization, transportation, recycles, treatment and disposal.

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

5. Attendance : 05 Marks

6. Assignments and Tutorials :20 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. Bowels J.E.: 'Analytical and Computer Methods in Foundation', *McGraw Hill Book Co. New York, 1974*
2. Das, B. M.: 'Geotechnical Engineering Handbook', *J. Ross Publishing, 2010*
3. Verghese, P. C.: 'Foundation Engineering', *PHI Learning Private Limited, Delhi, 2012*
4. Verghese, P. C.: 'Design of Reinforced Concrete Foundations', *PHI Learning Private Limited, Delhi, 2011*
5. N. Subramanian: 'Reinforced Concrete Structures', *Oxford University Press, 2013*

6. Alam Singh: ‘Soil Mechanics and Foundation Engineering’, Vol. I- II. *Standard Book House, Delhi*
7. Swami Saran: ‘Analysis and Design of Substructures’*, Oxford and IBH publishing company, Delhi 1998*

Semester-VIII

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C 801	**Design and Drawing of Reinforced Concrete Structures**	**5**

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

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

Rationale

Reinforced concrete construction are widely used for residential, commercial and industrial structures. IS code has specified the use of Limit State Method (LSM) design philosophy for design of structures. Pre-stressed Concrete structures are another class of structures used for bridge girders, long span slabs etc.Civil engineers must have knowledge of designing and detailing of RCC and PSC structures to make structures safe and serviceable during its life span.Also the knowledge about response of structures during an earthquake is prerequisite of design engineers. During previous semester students have studied design of basic elements by LSM. This course coves complete design of G+ 3 structures in addition to advanced topics of design of water tank and retaining wall. The course also contains PSC beam topics and introduces Earthquake Resistant Design of structures, drawing and detailing of structures.

Objectives

- To explain the LSM design procedure of G+ 3 structures by proper application of IS code clauses including loading calculation, analysis and design of individual elements.
- To acquaint the concepts in the design of staircase, water tank and retaining wall.
- To explain concept of Pre-stressed Concrete members.
- To introduce Earthquake Resistant Design method.
- To explain drawing and detailing of structures.
- To develop the concept of design using ready charts and curves for different elements of structure.

Detailed Syllabus		
Module	**Contents**	**Periods**
I	**COMPREHENSIVE DESIGN OF BUILDING:** Complete design of residential/commercial/industrial G+ 3 structures. Load transfer mechanism, arrangement of beams, slabs ,columns. Design of footing, beams, columns, staircase, lintels, chajja.	12
II	**DESIGN OF STAIRCASE:** Design of dog legged and open well staircase	3
III	**DESIGN OF RETAINING WALL:**	7

	Design of Cantilever and Counterfort retaining wall	
IV	**DESIGN OF WATER TANK** Classification of Water Tank, Permissible Stresses, design ofcircular and rectangular water tanks resting on ground and underground. Codal provisions. Use of IS coefficient method and approximate method. Design of elevated water tank.frame and shaft type of staging.	11
V	**EARTHQUAKE RESISTANT DESIGN OF STRUCTURES:** Earthquake and ground motion, response of structure, design forces calculation by seismic coefficient method.Ductile design and detailing as per IS:13920.	12
VI	**PRESTRESSED CONCRETE:** Prestressed Concrete: Basic principles of prestressed concrete, materials used, systems of prestressing, losses in prestress, analysis of beam sections at transfer and service loads.	7
Total		**52**

Contribution to Outcomes

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

- Design independently RCC structure by applying IS code provisions.
- Design staircase, water tank and retaining wall.
- Explain principles of PSC and calculate losses.
- Draw and explain the structural detailing.
- Explain response of structure during an earthquake and calculate design forces.

Theory Examination:-

8. 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.
9. The **first** question will be based on design project from following. (any one out of given two is to be answered)

a) Design of slab and continuous beam (max three span) or design of column from terrace to footing.
b) Design of counterfort retaining wall
c) Design of overhead water tank including design of staging

10. The next four questions will be based on remaining modules of syllabusand 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 sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
11. All relevant IS codes will be allowed during examination.

Oral Examination:@

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

Term Work:

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

1. Design report of (G+3) building using relevant IS codes.
2. Design report of counter fort retaining wall OR overhead water tank and staging.
3. Report of one site visit to under construction building/PSC site.
4. Assignments consisting of max five questions each on module III to VI.

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

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

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

1. Design report and drawing sheets : 15marks
2. Assignments and site visit report: 05 marks
3. Attendance : 05 marks

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

Attendance	Marks awarded
75%- 80%	03 Marks
81%- 90%	04 Marks
91% onwards	05 Marks

Recommended Books:-

18. Design of Reinforced Concrete Structures*: Dayaratnam, P;* Oxford and IBH.
19. Limit State Design – Reinforced Concrete: *Shah and Karve*, Structure Publications, Pune.
20. Reinforced Concrete - Limit State Design: Ashok K. Jain, Nemchand& bro.
21. Reinforced Concrete: *H.J. Shah*, Charotar Publishers, Anand.
22. Illustrated Reinforced Concrete Design: *Dr. V. L. Shah and Dr. S. R. Karve*, Structure Publications, Pune.
23. Reinforced Concrete Design: Wang, C. K., Salmon, C. G., and Pincheira, J. A,John Wiley.
24. Reinforced Concrete Fundamentals: Ferguson, P. M., Breen, J. E., and Jirsa, J. O., John Wiley & Sons.
25. Design of Prestressed Concrete Structures: Lin T.Y. and Ned Burns; John Wiley.
26. Prestressed concrete : Krishna Raju, Tata Mc-Graw Hill Publishing House,NewDelhi
27. Prestressed concrete, problems and solutions , Krishna Raju, CBS Publishers and distributors, New Delhi.
28. Prestressed concrete : N. Rajgopalan, Narosa Publishers.
29. Earthquake resistant design of structures: S. K. Duggal, Oxford University Press.
30. Earthquake resistant design of structures: Pankaj Agarwal, Manish Shrikhande, PHI, New Delhi.
31. Relevant IS Codes: BIS Publications, New Delhi

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C 802	**Construction Management**	**5**

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

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

Rationale

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

Objectives

- To understand the basic functions and construction management.
- To learn scheduling techniques such as CPM &PERT.
- To gain knowledge of time-cost optimization & effective utilization of resourceson construction sites.
- To understand allocating the resources and project monitoring
- To know about safety and quality aspect of construction works..

Detailed Syllabus		
Module	**Sub Modules/Contents**	**Periods**
I	**Introduction to Construction Management:** 1.1 Concept of Management, Principles of management, contribution byeminent personalities towards growth of management thoughts. 1.2 Significance of construction, management, objectives& functions of construction management 1.3 Resources required for construction.	04
II	**Construction Projects:** 2.1 Role of Construction industry in economic development of country 2.2 Unique features of construction industry. 2.3 Construction projects- Classification, Characteristics, Project life cycle etc. 2.4Roles and responsibilities of various agencies associated with a Construction project**.** 2.5 Pre-requisites of commencing construction work such as sanctions, Approvals to be sought, and feasibility studies. 2.6 Site layout, organizing & mobilizing the site	05

III	**Construction project planning & Scheduling:** 3.1 Stages of planning in the view of owner/Department as well as contractor. 3.2 W.B.S, Bar Charts. 3.3 Network-Terminology, Network Rules, Fulkerson's rule, skip numbering, Precedence network etc. 3.4 C.P.M- Activity & event with their types, activity times, event times, Critical path, forward pass, backward pass, float & its types. 3.5 P.E.R.T- Assumption underlying PERT analysis time estimates, slack& its types, probability of completing the project etc.	12
IV	**Resources Management & Allocation :** 4.1 Material Management- Importance, objectives, functions of material management, Inventory control, A-B-C analysis, E.O.Q etc. 4.2 Human Resource Management- Manpower planning, recruitment, Selection training, performance evaluation of worker etc. 4.3 Resources Allocation Methods- Resource levelling resource smoothening.	10
V	**Project Monitoring& Cost Control :** 5.1 Supervision, record keeping, Periodic progress reports etc. 5.2 Updating- Purpose of frequency of updating method of updating anetwork etc. 5.3 Time cost optimization in construction projects compression & decompression of network etc. 5.4 Common causes of time over run & cost overrun & Corrective measures.	08
VI	**Safety & Health on Construction Sites** 6.1 Common causes of accidents on construction sites, costs of accident, precautionary measures to avoid accidents, 6.2 Occupational health hazards in construction industry. 6.3 Safety & Health Campaign. 6.4 O.S.H.A	03
VII	**Quality Control :** 7.1 Concept of Quality, quality control check list in quality control etc. 7.2 Role of inspection in quality control, 7.3 Quality manual, Quality assurance statistical quality control 7.4 ISO14000	03
VIII	**Construction Labors& Legislation :** 8.1 Need for legislation & Importance of labour laws. 8.2 Acts applicable to Indian construction labours such as Payment of wages act, Minimum wages act, Workmen's compensation act, Factories act etc.	03

Contribution to Outcomes

On completion of the course, the learners will be able to:-

1) understand & apply the knowledge of management functions like planning, scheduling, executing & controlling the construction projects.
2) Prepare feasible project schedule by using various scheduling techniques.
3) gain knowledge of managing various resources &recommend best method of allocating the resources to the project.
4) develop optimum relationship between time & cost for construction projects
5) Implement quality & safety measures on construction sites during execution of civil engineering projects.
6) Understand the importance of labour legislation

Term Work: At least 10 assignments covering the entire syllabus.

Theory Examination:

1) The question paper will comprise of six questions, each carrying 20 marks.
2) The first question will be compulsory & out of remaining questions students have to attempt Any three questions.
3) Total four questions need to be attempted.

Oral Examination: The oral examination shall be based on the entire syllabus & the Term-work Prepared by the students including assignments..

Recommended books:

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

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C DLO8031	**Advanced Design of Steel Structures**	**5**

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

Evaluation Scheme								
Theory					**Term Work/ Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test 1	**Test 2**	**Average**						
20	**20**	**20**	**80**	**04 Hrs.**	**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 industrial structures for which the higher strength is a prime concern, are made up of steel .These special structure are design by working stress method and limit state method. The design approaches of different components given in the syllabus are based on limit state method and working state method.

Objectives

To understand the analysis and design concept of round tubular structures
To understand the design concept of different type of steel water tank
To understand the design concept of lattice tower and steel chimney
To understand the design concept of gantry girder
To develop Civil Engineering graduates having clear understanding of concepts and practical knowledge of modern Civil Engineering techniques for design of steel structures.
Use of various relevant IS codes for designing such special steel structures

Detailed Syllabus		
Module	**Sub – Modules / Contents**	**Periods**
I	**1. Introduction to Steel Structure**	**03**
	Introduction to types of steel, mechanical properties of Structural steel, advantages of steel as structural material, design philosophies of Working Stress Method (WSM), Limit state method and design of simple bolted connection.	
	2. Moment Resistant Beam End Connections :	**05**
	Design of moment resistant bolted and welded beam end connections by limit state method	
II	**3. Round Tubular Structural Members :**	**06**

	Properties of steel tubes, design of tension member and compression member, design of welded connections, design of flexural members, analysis and design of tubular trusses including purlins and supports.	
III	**4. Elevated Steel Tanks and Stacks :**	**14**
	Loads acting on tanks including wind and earthquake, design of circular tanks with hemispherical and conical bottom, supporting ring beam, staging for circular tanks including design of columns and foundation, design of rectangular steel tanks including design of staging, columns and foundation. .(consider the effect of wind and earthquake)	
IV	**5. Gantry Girder :**	**O7**
	Loads acting on gantry girder, Analysis of gantry girder, design of gantry girder by limit state method.	
V	**6. Lattice Tower :**	**09**
	Different configuration of lattice towers, loads acting on lattice towers, Analysis of lattice tower, design of lattice tower including welded or bolted connections for members by limit state method.(consider the effect of wind and earthquake)	
VI	**7. Steel Chimney :**	**08**
	Forces acting on chimney, design of self supporting welded and bolted chimney and components including design of foundation. .(consider the effect of wind and earthquake)	

Contribution to Outcomes

On completion of this course, the students will be able

1. To perform the analysis and design of special steel structures
2. The will be able to analysis and design the gantry girder by limit state method.
3. They will be able to analysis and design steel chimney, lattice tower, tubular truss and watertank
4. Students should able to independently design steel structures using relevant IS codes.

Theory Examination:-

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

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

Term Work:
The Term work shall consists of a design report and detailed drawings on three projects as indicated below:

1) Roofing system including details of supports using tubular section

2) Design of elevated circular tank with conical bottom or rectangular steel tank.
3) Design of lattice tower or steel chimney.

The drawing should be drawn in pencil only on minimum of A-1 (imperial) size drawing sheets. Each student has to appear for at least two written test during term .The term work shall comprise of the neatly written report based on assignments. The assignments shall be given covering the entire syllabus.

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 and projects.

Recommended Books:

1 Design of Steel Structures : N Subramanian,Oxford- University Press
2 Design of Steel Structures: Punamia, A. K. Jain &Arun Kumar Jain .Laxmi Publication
3 Design of Steel Structures: Dayaratnam, Wheeler Publication, New Delhi.
4 Design of steel structures: Krishnamachar B.S, &AjithaSinha D.

Reference Books:

1. Design of Steel Structures: Mac. Ginely T.
2. Design of Steel Structures: Kazimi S. M. & Jindal R. S., Prentice Hall of India.
3. Design of Steel Structures: Breslar, Lin and Scalzi, John Willey, New York.
4. Design of Steel Structures: Arya and Ajmani, New chand& Bros.
5. Relevant IS codes, BIS Publication, New Delhi
6. Steel structures, Controlling behavior through design: R. Englekirk, Wiley
7. LRFD Steel Design : William T. Segui, PWS Publishing
8. Design of Steel Structures: Edwin H. Gaylord, Charles N. Gaylord and James. Stallmeyer, McGraw-Hill

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C DLO8032	**Industrial Waste Treatment**	**5**

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

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

Rationale

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

Objectives

- To provide knowledge of different types and characteristics of industrial wastes. Also to make the students conversant with effluent and stream standards.
- To study the problems faced by many industrial plants with new effluent limits to be met with their existing treatment plant.
- To understand in-depth yet practical review of wastewater treatment technologies and how to optimize their operation.
- To develop rational approaches towards sustainable waste water management via sludge recovery and treatments.
- To provide an understanding of the mechanisms and processes used to treat waters that have been contaminated in some way by various industrial activities prior to its release into the environment or its re-use.
- To study the sources of contaminants, legislative framework for their remediation as well as the technical aspects of the unit operations involved. To Utilize EIA documents for policy development, project planning or for legal or political action planning.

Detailed Syllabus		
Module	**Sub Modules/Contents**	**Periods**
1	General:Liquid wastes from industries – their volumes and characteristics, Effect of disposal into natural water courses, Municipal sewers and on land, stream standards and effluent standards.	**04**
2	Sampling and analysis of industrial wastes, Treatability study, good housekeeping, bioassay test, population equivalence.	**04**
3	Stream sanitation: Effects of industrial wastes on self-purification of streams and fish life, Statement and significance of the parameters of Streeter and Phelp's equation and BOD equations, Deoxygenating and reaeration , Oxygen sag and numerical based on this.	**06**
4	General treatment of industrial wastes:Neutralization, Equalization, segregation. Modification of conventional aerobic and anaerobic biological treatment methods. Dewatering and disposal of sludges,unit operation– floatation, Vacuum filtration, Centrifugation, Filter press and membrane filters, Advanced treatment.	**12**
5	Detailed consideration of wastes produced from following industries: Manufacturing processes normally followed , Volume and effects of raw and treated effluent on streams, Sewers, Characteristics of effluents and land Treatment methods, reuse-recovery 1) Sugar-sugarcane 2) Distilleries 3) Pulp & paper: Sulphate process 4) Textiles: Cotton 5) Dairy 6) Tanneries 7)Electroplating	**16**
6	Provision of various acts pertaining to industrial wastes / effluents, introduction to environmental impact assessment and environmental audit. Common Effluent Treatment Plants (CETPs): Location, Need, Design, Operation & Maintenance Problems and Economical aspects.	**10**

Contribution to outcomes

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

Students should able to

1. Understand the characteristics of industrial wastewater.

2. Identify sampling method and analyze industrial waste.

3. Design facilities for the processing and reclamation of industrial waste water.

4. Explain on-site treatment methods and solve Analyze and design wastewater treatment systems. (floatation, vacuum filtration, centrifugation, filter press and membrane filters)

5. Detailed on-site manufacturing processes and treatments of industrial waste water.

6.Analyze proposed development project plans for possible environmental effects and to improve treated effluent quality to confirm standard prescribed by regulatory agencies.

Theory Examination:-

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

2. The first question will be compulsory which will have the short questions having weightage of 4-5 marks covering the entire syllabus.

3. The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module 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 and Tutorial including the site visit report.

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the assignments. Each student shall prepare a report comprising design criteria and flow sheet of the proposed treatment scheme including laboratory analysis for any one industrial waste. Demonstration of available software for design of effluent treatment plant is to be considered.
The following weightage of marks shall be given for different components of the term work.

7. Report (on any industry/site visit): 05 Marks
8. Seminar : 05Marks
9. Attendance : 05 Marks
10. Assignments and Tutorials :10 Marks

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

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

Recommended Books:-

1. Waste Water Treatment: Rao & Datta, Oxford & IBH Publishing Co.
2. Environmental Pollution and control in chemical process industries: S.C.Bhatia, Khanna Publication.
3. Industrial Water Pollution Control: W W Eckenfelder Jr, Mc Graw Hill.
4. Industrial Water Pollution Management: E F Gurnham, John Wiley.
5. Biological Waste Treatment: Eckenfelder & Connor Pergamon Press.
6. Theories and Practices of Industrial Waste Treatment: Addisoon Wesley.
7. Pollution Control in Process Industries: S P Mahajan , Tata mcgraw Hill.

8. Industrial Waste: W Rudolfs ,(Ed), L E C Publishers Inc.
9. The Treatment of Industrial Wastes: E D BesselievreMcgraw Hill.
10. Industrial Waste Disposal: R D Ross , (Ed), Reinhld Bok Croporation.
11. Wastewater Engineering, Treatment and Reuse : Metcalf and Eddy,Tata mcgraw Hill
12. Industrial Wastewater Management Handbook, Hardam S. Azad.
13. Industrial Waste Treatment, Frank Woodwoard.
14. Environmental Impact Assessment :Larry W. Canter, Mcgraw Hill Book Company.
15. Environmental Impact Analysis Handbook :G.J. Rao and C.D. Weeten ,Mcgraw Hill
16. Environmental Management, Vijay Kulkarni and T. V. Ramchandra, Capital Publishing
17. Environmental Audit, MhaskarA.K.,Enviro Media Publications.

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C DLO8033	**Pavement Design and Construction**	**5**

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

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

Rationale

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

Objectives

- To study the different types of pavements(highway and airfield) depending upon the mode of transportation, use and structural behaviour.
- To understand the concept of consideration of wheel loads, axle loads, wheel-axle configuration and allied aspects as a pre-requisite in the analysis and design of the pavement.
- To study the various types of structural responses (stresses and deformations) inducing the pavements due to wheel load and other climatic variations.
- To study the various methods of analysis and design of the pavements and its subsequent applications to the various types of pavements.
- To study the different types of distresses in pavement, evaluation of the existing pavements using different methods and rehabilitation of the distressed pavements.
- To study the construction of the concrete roads and low volume roads.
- To study the quality control and quality assurance in the road construction and introduce pavement management system.

Detailed Syllabus		
Module	**Sub-Modules/ Contents**	**Periods**
I.	Pavement structure and functional attributes, factors affecting pavement design, types of wheel loads for highways and airports, development of design method for highway and airport pavements.	12
	Stresses in flexible pavements, 1-layer, 2-layer, 3-layers theories, EWLF,ESWL Stresses in Rigid pavement: load and temperature stresses, combined stresses.	
II.	Flexible Pavement Design Airport pavement: Corps of Engineer's method, FAA method CDOT method, Asphalt institute method. Highway Pavement: Empirical methods using no soil strength criteria, empirical method based no soil strength criteria: CBR method as specified by IRC-37 1970,1984,2001,2012,2018 Road note 29 methods, AASHTO method, Asphalt institute method. Fatigue and rutting as a failure criterion.	16
	Rigid Pavement Design: Airport pavements: PCA methods, corps of Engineer's method, FAA method. Joints and reinforcement requirement. Highway pavement: Current British procedure, IRC-58-2012,2015. method.	
III.	Evaluation and strengthening: flexible and rigid pavement distresses, condition and evaluation surveys, present serviceability index, roughness measurement, Benkelman beam deflections, design of overlays(IRC-81-1997), skid resistance and measurement.	12
	Concrete road construction: Mix design, concrete strength, size of aggregates, gradation, and workability, preparation of base form work, placing of reinforcement, compaction, and finishing, curing, joints.	
IV.	Low Cost Roads (Rural Areas) (IRC-SP-20-2002) Classification of low cost roads, construction of low cost roads, stabilization of subgrade, base and its advantages, construction of granular base courses, macadam surface, macadam bases, low cost materials and methods used for highway construction, suitability of different types of roads under different situation. Soils.	05
V	Quality control (QC) and Quality assurance (QA) during construction of various pavements, importance, process control and end product control, statistical methods in quality control, control charts, frequency of testing etc. (IRC-SP-11-1997) (MORTH SECTION 900).	05
VI	Introduction to pavement management systems.	02

Course Outcome

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

- Understand the structural actions involved in the pavement due to different types of load acting thereon and the various methods of analysis of pavements.
- Understand the applications of the analysis in the design of pavements using different methods of pavement design.

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

Theory Examination:-

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

Oral Examination:-

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

Term work:

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

Distribution of Term Work Marks:

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

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

- Assignments : 20 Marks
- Attendance : 05 Marks

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

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

Recommended Books:-

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

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-C DLO8034	**Bridge Engineering and Design**	**5**

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

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

Rationale

In the age of increase in traffic load and rapid transportation, bridges are a very important part of a nation's transportation infrastructure associated with the economic growth. They allow for roads and railways to cross over otherwise impassable obstacles such as rivers, valleys or other roads etc. Bridges are being built mainly with reinforced concrete, prestressed concrete or steel depending on various factors such as environment& site conditions, nature of loads and span etc. The civil engineering profession is much concerned with proper planning, design and construction, as well as maintenance, repairs and rehabilitation of bridges which are of utmostimportance. In this subject, students will be well acquainted with the types of bridges and their selection based on the specific needs. They will learn analysis and design of superstructure of Reinforced Concrete Culvert and Prestressed Concrete bridges for IRC loads along withbasics of substructure (foundation, Pier, abutments) using relevant IRC. They will also understand the analysis and design of a lattice girder bridge in steel for railway loading using relevant bridge rules and IRS.

Objectives

1. To bring the students to such a levelthat they being civil engineers will be able to take the appropriate decision in respect of choice of site, type of bridge, components of bridge, superstructure, sub structure, foundation, type of bearing and launching method of girder and construction methods.
2.To make the candidate to understand the analysis and design of reinforced concrete culvert/Prestressed Concrete bridges using relevant IRCs.
3. To make the candidate to understand the analysis and design of lattice girder steel bridge for railway loading using relevant IRS code.

Detailed Syllabus		
Module	**Sub module/Contents**	**Periods**
1	**Introduction:** Types of Bridges, Selection of suitable site and type of bridge, Components of a bridge, aesthetics, economic span	06
2	**Design Loads and their Distribution:** **IRC loads:**IRC-Class AA tracked and wheeled, 70R tracked and wheeled, Class-A, Class-B, distribution of loads on RC culverts, Prestressed Concrete deck slab and girdered bridge, **IRS loads**: Railway loading and distribution on lattice girder bridge	10

3	**Design of Superstructure:** Design of prestressed concrete deck slab bridge, I-girder bridge and box girder bridge for roadway, Design of RC Culvert, Design of balanced cantilever RC bridge for roadway, Design of steel lattice girder bridge for railway	20
4	**Substructure:** Different types of foundations, their choice and methods of construction, well foundation, pile foundation,piers and abutments, wing walls	06
5	**Bearing:** Various types of bearings and their suitability	03
6	**Construction Methods:** Various methods of erection of bridge girders, cantilever method of construction of bridge	03

Contribution to outcome

On successful completion of the course, the student shall be able to:
1. Select the suitable type of bridge according to the site condition.
2. Understand IRC loads, distribution of these loads on deck slab and among longitudinal beams/girders of a bridge.
3. Design of culvert, balanced cantilever reinforced concrete bridge, prestressed concrete deck slab bridge, I-girdered and box girdered bridge, lattice girder railway bridge.
4. Understand different types of foundations, piers and abutments, their methods of construction.
5. Understand various types of bearings and their suitability, erection of bridge superstructure.

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

Site Visit/ Field Visit:
The students shall visit the site where the construction of bridge structure using pre-stressed concrete is going on. The students shall prepare the detailed report thereof and submit as a part of the term work.

Oral Examination:
The oral Examination shall be based upon the entire syllabus, term work and site/field visit.

Term work:
The termwork shall comprise of the neatly written assignments. The assignments shall be given covering the entire syllabus. There shall be minimum four problems for design of roadway bridges and one railway bridge.
Presentation on any emerging trend in bridges, its design, methods of erection and construction, types of foundations and bearings etc relevant to syllabus.

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

The following weightage of marks shall be given for different components of the term work.
Assignments: **10 Marks**
Presentation: **05 Marks**
A Bridge site visit report **or** A project on Design of superstructure of a bridge using software: **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

A-Recommended Books:

1. Design of Bridges: *Raju N. K.*, Oxford and IBH fifth Edition.
2. Bridge Engineering: *Ponnuswamy S.*, Tata Mc Graw Hill.
3. Concrete Bridge Practice: *Raina V. K.*, Tata Mc Graw Hill.
4. Essentials of Bridge Engineering: *Victor D.J*, Oxford and IBH.
5. Design of Bridge Superstructures: *T.R. Jagdeesh*and*M.A. Jayaram*, Prentice Hall India Private Ltd., New Delhi.
6. Bridge Engineering Handbook: *Chen W. F. and Duan L.*, CRC Press, 2000.
7. Bridge Bearings and Expansion Joints: *David Lee*, E & FN Spon.

B-IRC Codes:
IRC: SP13- 2004, IRC: 5- 2015, IRC: 6- 2016, IRC: 18-2000, IRC: 21-2000, IRC: 24-2001, IRC: 27-2009, IRC: 45, IRC: 78-2014, IRC: 83 (i)-1999, IRC: 83 (ii)-1987, IRC: 83 (iii)-2002, IRC:112- 2011

C-IRS Codes:
IRS- 2003, Bridge rules (Railway board): Rules specifying the loads for design of super-structure and sub-structure of bridges and for assessment of the strength of existing bridges-2008.
Indian railway standard code of practice for the design of steel or wrought iron bridges carrying rail, road or pedestrian traffic (steel bridge code) adopted- 2003

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 8035	**Appraisal & Implementation of Infrastructure Projects**	**05**

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

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

Rationale

This course is intended to make students aware of the appraisal criteria for any Civil engineering project. This course will make studentsunderstand the importance of feasibility studies and acquaint them with the process of preparing a project report, both of which play a significant role in deciding the viability of a project. The professional construction engineering practice will be rendered meaningless if student do not grasp the knowledge of financial analysis. This course shall be helpful to students in studying all the economic aspects of Infrastructure projects.

Objectives

- To know the procedure of feasibility studies for any infrastructure project.
- To learn the procedure of appraisals required for deciding the worthiness of any project.
- To learn the procedure of forecasting demand and know its importance.
- To know the components and importance of technical appraisal.
- To make students acquainted with important decision making tools like Break even analysis, SWOT analysis and other ways to carry out economic analysis of a project.
- To get acquainted with different methods of implementing a project.

Detailed Syllabus			
Module	**Sub-Modules/ Contents**		**Periods**
I.	**Construction Projects and Report Preparation**		**04**
	1.1	Classification of construction projects.Project Formulation and phases involved in it.	
	1.2	Feasibility studies, SWOT analysis.Preparation of Project report.	
II.	**Project Appraisal**		**08**
	2.1	Importance and phases in a project development cycle for major infrastructure projects.	
	2.2	Importance of Appraisal, its need and steps involved in it.	
III.	**Market Appraisal**		**10**
	3.1	Importance and methods of carrying out demand analysis. Sources to gather project related information and ways to carry out market survey.	

	3.2	Methods to forecast demands.Uncertainities involved in demand forecasting.	
IV.	**Technical and Managerial Appraisal**		**08**
	4.1	Method to study the technical appraisal/viability of a project in terms of its location, type of land and intended use of building, technology requirements of the project, Size and complexity of tools and plants, raw materials to be used and their impact on the vicinity, energy requirements, water supply and disposal of effluents if any.	
	4.2	Study of managerial requirements of a project, Desirable organisational structure and hierarchy to manage as well as implement the project, Method of assessment of entrepreneurs.	
V.	**Financial analysis and Economic Appraisal**		**10**
	5.1	Various costs related to a project, Methods to determine the profitability of a project, Break even analysis.	
	5.2	Economic appraisal: Urgency, Payback period, Avg. Rate of return, Net Present Value, Internal rate of return, Benefit cost ratio, Cost of Capital etc.	
VI.	**Project Financing and Implementation**		**08**
	6.1	Types and Sources of finance in local, National and International context. Issues related to project financing.	
	6.2	Agencies involved in the implementation of a project. Methods of implementation like Built, operate and Transfer and its other variants like B.O.O, B.O.O.T, B.L.T, etc.	
		Total	**48**

Contribution to Outcomes

On successful completion of the course, the learners will be able to:

- **classify** the projects and **describe** the phases involved in project formulation.
- **prepare**a detailed project report on the basis of various feasibility studies and SWOT analysis.
- **devise** a project's development cycle and get acquainted with the different appraisals in the process of deciding the worthiness of a project.
- **exhibit** and **apply** the managerial skills and knowledge of financial aspects required during the implementation of projects.
- **identify** various sources for project finance.
- **know** the various agencies involved in project implementation as well as **select** the method of project implementation which is best suited for a particular project.

Theory Examination:

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

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

Oral Examination:

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

Term Work:

The term work shall consist of the following:

4) Minimum **Six assignments** covering the entire syllabus**.**
5) **Report** on studying the SWOT Analysis of any one major infrastructure project.
6) **Case study – Powerpoint presentation** covering the various appraisals of any one major infrastructure project.

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report and powerpoint presentation. 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, guideline to be resorted to is: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

Recommended Books:

1) Project Preparation, Appraisal, Budgeting, and Implementation: Prasanna Chandra (Tata McGraw Hill).
2) Infrastructure Development & Financing in India - N. Mani (New Century Publications).
3) Infrastructure & economic development - Anu Kapil (Deep&Deep Publications).
4) Construction Management: Planning and finance - Cormican D.(Construction press, London).
5) Engineering Economics – Kumar (Wiley, India).
6) Real Estate, Finance and investment - Bruggeman.Fishr (McGraw Hill).
7) The cost management toolbox; A Managers guide to controlling costs and boosting profits. - Oliver, Lianabel (Tata McGraw Hill).

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 8036	**Soil Dynamics**	**05**

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

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

Rationale

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

Objectives

- To study fundamental concepts of vibrations, degrees of freedom and damping systems.
- To study phenomena like liquefaction and theireffects.
- To study principals of machine foundation design and dynamic earth pressure theories on retainingwall.
- To learn test methods of evaluating dynamic properties ofsoil.

Detailed Syllabus		
Module	**Sub- Modules/Contents**	**Periods**
I.	Scope and objective; Nature and types of dynamic loading; Importance of soil dynamics. Vibration of elementary system, degree of freedom, analysis of system with one degree of freedom, spring-mass system, harmonic vibration, uniform circular motion natural frequency, free and forced vibrations with and without damping, type of damping	**10**
II.	Wave propagation in elastic rods, in an elastic infinite medium and in semi elastic half space, wave generated by surface footing.	**05**

III.	Liquefaction of soils, criterion and factors affecting liquefaction of soil, laboratory and field studies on liquefaction, liquefaction studies in oscillatory simple shear, evaluation of liquefactionpotentials, liquefaction of clay.	**10**
IV.	Principles of machine foundation design, criteria for satisfactory machine foundation, degree of freedom of a block foundation analysis of vertical and sliding vibration of a machine foundation, mass ofsoil participating in vibration. Practical design considerations and codal provisions.	**06**
V.	Vibration isolation and screening methods, improvement of distressed machine foundation.	**07**
VI.	Field and laboratory tests for evaluation of dynamic properties of soil under vertical vibration coefficient of elastic uniform shear, spring constant damping modulus of elasticity typical values of soils.	**07**
VII.	Basics of dynamic earth pressure on retaining walls: conventional gravity type, reinforced soils, distribution of pressure,point of application of the resultant, simple examples.	**07**

Course Outcome

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

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

Theory Examination:-

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

The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entiresyllabus.

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 contentsthereof.

There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/sub-topics.

The students will have to attempt any **three** questions out of remaining fivequestions.

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

Laboratory Test

It is recommended to conduct block foundation tests.

Oral Examination:-

The oral examination will be based on the entire syllabus.

Term Work:

Each student shall prepare a project report covering the selection of design parameters, design analysis including drawing on any aspect of soil dynamics included in the syllabus. The project report referred above along with the assignments will form a part of the term work.The assignments shall be given covering the entire syllabus in such a way thatthestudents would attempt at least four problems and/or questions on each modules/ sub- modules and contents

thereof, further. The report on the block vibration tests, if conducted, shall also form a part of the term work.

Distribution of Term Work Marks:

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

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

- Assignments : 20Marks
- Attendance : 05Marks

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

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

Recommended books:

1. Soil Dynamics: *Shamsher Prakash,* McGraw-Hill bookcompany
2. Principles of Soil Dynamics: *Braja, M. Das,* PWS-Kent PublishingCompany
3. Dynamics of Bases and Foundations: *Barkan, D. D.*, McGraw- Hill Bookcompany
4. Steven L. Kramer, "Geotechnical Earthquake Engineering", Prentice Hall lnc.
5. E. E. Richart et al. "Vibrations of Soils and Foundations", Prentice Hall Inc.
6. Relevant IScodes

Semester VIII		
Subject Code	**Subject Name**	**Credits**
CE-DLO 8037	**Applied Hydrology & Flood Control**	**05**

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

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

Rationale

This subject deals with the various processes involved in hydrological cycle and provides in depth understanding of the theories and concepts of surface, subsurface and ground water hydrology. It focuses on types and forms of precipitations. It also explains the application of hydrographs, unit hydrographs and further describes various techniques of estimating stream flows. It further describes the various techniques of estimating streamline flows. It also describes the importance of floods, flood routing and ground water hydrology.

Objectives

- To understand the various processes involved in the hydrological cycle.
- To measure rainfall, computation of average rainfall, various water losses etc.
- To study the hydrograph and unit hydrographs, applications of unit hydrograph concept.
- To study various flood control methods, estimate design flood, and flood routing
- To study the concepts of ground water movement, steady and unsteady flow towards fully penetrating wells and well yields.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I	**Introduction:** Hydrological cycle, scope of hydrology, water budget equation, sources of data. **Precipitation:** Measurement of precipitation, network of rain gauges and their adequacy in a catchment, methods of computing average rainfall, hyetograph and mass curve of rainfall, adjustment of missing data, station year method and double mass curve analysis, Depth-Area -Duration relationship, Intensity-Duration -Frequency relationship, Probable Maximum Precipitation.	7
II	**Abstractions from Precipitation:** Evaporation and transpiration, evapo-transpiration, interception, epression storage, infiltration and infiltration indices, determination of water losses. **Stream Flow Measurement:** Measurement stream-flow by direct and indirect methods, measurement of stage and velocity, area-velocity method, stage-discharge relationships, current meter method, pitot tube method, slope-area method, rating curve method, dilution technique, electro-magnetic method, ultrasonic method.	7
III.	**Runoff:** Catchment, watershed and drainage basins, Factors affecting runoff, rainfall-runoff relationship, runoff estimation, droughts.	6
IV.	**Hydrograph Analysis:** Characteristics, base *flow* separation, unit hydrograph, S-hydrograph, complex hydrograph, synthetic hydrograph, dimensionless unit hydrograph, Instantaneous unit hydrograph.	7
V.	**Floods:** Estimation, envelope curves, flood frequency studies, probability and stochastic methods, estimation of design flood, flood control methods, Limitations, risk-reliability and safety factor.	6
VI.	**Ground Water Hydrology:** Yield , transmissibility, Darcy's law, DuPont's theory of unconfined flow, steady flow towards fully penetrating wells(confined and unconfined).Unsteady flow towards wells: Jacob's curve and other methods, use of well Function, pumping tests for aquifer characteristics, methods of recharge.	6

Contribution to Outcomes

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

- Explain hydrologic cycle and various methods of Measurement of rainfall.
- Calculate optimum number of rain gauge station, average rainfall and missing rainfall over catchment
- Describe various methods of measurement of stream flow and to calculate obstraction losses over the catchment
- Develop rainfall runoff relationship and calculating runoff over catchment
- Perform hydrologic and hydraulic routing

- Derive the equation for the discharge of well for confined and unconfined aquifer

Theory examination:

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- 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.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Oral Examination:

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

Term Work:

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

Distribution of Term Work Marks:

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

Assignments : 20 Marks
Attendance : 05 Marks

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

Recommended Books:

- Engineering Hydrology: *K. Subramanya,* Tata McGraw Hill Publishing Co. Ltd. New Delhi.
- Irrigation Engineering and Hydraulic Structures:*S. K. Ukarande*, Ane‘s Books Pvt. Ltd. (Abridged Edition 2015), ISBN 9789383656899
- Hydrology: *H. M. Raghunath,* New Age International Publishers, New Delhi
- Irrigation and Water Power Engineering: Dr. *B.C. Punmia* and Dr. *Pande, B.B.Lal*, Laxmi Publications Pvt. Ltd. New Delhi.
- Irrigation Engineering and Hydraulics Structures: *S. K. Garg*, Khanna Publishers. Delhi
- Irrigation Water Resources and Water Power Engineering: Dr. *P.N. Modi*, Standard BookHouse. Delhi.
- Elementary Hydrology: *V. P. Singh*, Prentice Hall
- Engineering Hydrology: Principles and practice*: V. M. Ponce*, Prentice Hall