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

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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)** 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.	**07**
V	**Canal Head works and Distribution System** 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.	**06**
VI	**Canal structures** 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.	**06**

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