AC 7/6/2014, Item No. 4.25

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Civil Engineering

Third Year (Sem. V & VI)

Revised Syllabus (REV- 2012) w.e.f. A. Y. 2014 -15

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit Grading System)

Preface

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

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

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

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

Preamble

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

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

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

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

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

University of Mumbai

Scheme of Instructions and Examination

Second Year Engineering (Civil Engineering)

(With effect from 2013-2014)

Semester III

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC301	Applied Mathematics III *	4	--	--	4	--	--	4
CEC302	Surveying – I	3	2	--	3	1	--	4
CEC303	Strength of Materials	4	2	--	4	1	--	5
CEC304	Building Materials Construction	3	2	--	3	1	--	4
CEC305	Engineering Geology	3	2	--	3	1	--	4
CEC306	Fluid Mechanics – I	3	2	--	3	1		4
CEC307	Database Information Retrieval System*	--	4‡	--	--	2	--	2
Total		**20**	**14**	**--**	**20**	**7**	**--**	**27**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CEC301	Applied Mathematics III *	20	20	20	80	3	--	--	--	100
CEC302	Surveying – I	20	20	20	80	3	25	--	25	150
CEC303	Strength of Materials	20	20	20	80	3	25	--	25	150
CEC304	Building Materials Construction	20	20	20	80	3	25	--	25	150
CEC305	Engineering Geology	20	20	20	80	3	25	--	25	150
CEC306	Fluid Mechanics – I	20	20	20	80	3	25	--	--	125
CEC307	Database Information Retrieval System*	--	--	--	--	--	25	25**		50
Total		**120**	**120**	**120**	**480**	**--**	**150**	**25**	**100**	**875**

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

** For the subject 'Database Information and Retrieval System', the there will be an oral examination in conjunction with the practicals.

Semester IV

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC401	Applied Mathematics – IV	4	--	--	4	--	--	4
CEC402	Surveying – II	3	3	--	3	1.5	--	4.5
CEC403	Structural Analysis – I	5	2		5	1	--	6
CEC404	Building Design and Drawing – I	2	3	--	2	1.5	--	3.5
CEC405	Concrete Technology	3	2	--	3	1	--	4
CEC406	Fluid Mechanics – II	3	2	--	3	1	--	4
Total		**20**	**12**	**--**	**20**	**6**	**7**	**26**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CEC401	Applied Mathematics – IV	20	20	20	80	3	--	--	--	100
CEC402	Surveying – II	20	20	20	80	3	25	--	25*	150
CEC403	Structural Analysis – I	20	20	20	80	3	25	--	25	150
CEC404	Building Design and Drawing – I	20	20	20	80	4	25	--	25#	150
CEC405	Concrete Technology	20	20	20	80	3	25	--	25	150
CEC406	Fluid Mechanics – II	20	20	20	80	3	25	--	25	150
Total		**120**	**120**	**120**	**480**	--	**125**	**--**	**125**	**850**

***Oral & Practical** **#Oral & Sketching**

University of Mumbai

Scheme of Instructions and Examination

Third Year Engineering (Civil Engineering)

(With effect from 2014-2015)

Semester V

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC501	Structural Analysis – II	4	2	--	4	1		5
CEC502	Geotechnical Engg.– I	4	2	--	4	1	--	5
CEC503	Building Design and Drawing – II	1	4*	--	1	2	--	3
CEC504	Applied Hydraulics – I	4	2		4	1	--	5
CEC505	Transportation Engg. – I	4	2	--	4	1	--	5
CEC506	Business and Communication Ethics	-	2+2†	-	-	2		2
Total		**17**	**16**	**--**	**17**	**8**		**25**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CEC501	Structural Analysis – II	20	20	20	80	3	25	--	25	150
CEC502	Geotechnical Engg. – I	20	20	20	80	3	25	--	25	150
CEC503	Building Design and Drawing – II	20	20	20	80	4	25	--	25#	150
CEC504	Applied Hydraulics – I	20	20	20	80	3	25	--	--	125
CEC505	Transportation Engg. – I	20	20	20	80	3	25	--	--	125
CEC506	Business and Communication Ethics	--	--	--	--	-	50	--		50
Total		**100**	**100**	**100**	**400**	-	**150**	**-**	**100**	**750**

 # Oral Sketching ****Oral Presentation**

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

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

Semester VI

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC601	Geotechnical Engg. – II	4	2	--	4	1	--	5
CEC602	Design and Drawing of Steel Structures	4	2	--	4	1	--	5
CEC603	Applied Hydraulics – II	3	2	--	3	1	--	4
CEC604	Transportation Engg. – II	4	2	--	4	1	--	5
CEC605	Environmental Engg – I	3	2	--	3	1	--	4
CEC606	Theory of Reinforced Prestressed Concrete	4	2	--	4	1	--	5
Total		**22**	**12**	**--**	**22**	**6**	**--**	**28**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CEC601	Geotechnical Engg. – II	20	20	20	80	3	25	--	25	150
CEC602	Design and Drawing of Steel Structures	20	20	20	80	4	25	--	25[@]	150
CEC603	Applied Hydraulics – II	20	20	20	80	3	25	--	25	150
CEC604	Transportation Engg. – II	20	20	20	80	3	25	--	25	150
CEC605	Environmental Engg. – I	20	20	20	80	3	25	--	--	150
CEC606	Theory of Reinforced and Prestressed Concrete	20	20	20	80	3	25	--	25	150
Total		**120**	**120**	**120**	**480**		**150**		**125**	**875**

[@]Oral & Sketching

Semester V

Subject Code	Subject Name	Credits
CEC501	Structural Analysis –II	5

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
04	02	-	4	1	-	5

Evaluation Scheme

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

Rationale

There are various types of the components of any civil engineering structures which are subjected to different types of loading or combination thereof. The knowledge gained in the subjects such as Engineering Mechanics, Strength of Materials and Structural Analysis-I is extended in this subject. The scope of the subject is to evaluate the response in the form of Shear Forces, Bending Moments, Axial Forces, and Twisting Moment in various statically indeterminate structures such as beams, rigid and pin jointed frames; and two hinged arches. The subject involves the concept of the displacement and flexibility approach for analyzing the indeterminate structures. The subject also involves the analysis of the indeterminate structures using the concept of plastic analysis.

Objectives

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

Detail Syllabus

Module	Sub Modules/Contents	Periods
1.	**General** Types of structures occurring in practice, their classification. Stable and unstable structures, statically and kinematical determinacy indeterminacy of structure. Symmetric structures, symmetrical & anti-symmetrical loads, distinction between linear and non-linear behaviors of material and geometric non-linearity.	**06**
2.	**Deflection of statically determinate structures**	**06**
	Review of general theorems based on virtual work energy methods, introduction to the concept of complimentary energy, absolute & relative deflection caused by loads, temperature changes settlement of supports, application to beams, pin jointed frames, rigid jointed frames.	
3.	**Analysis of indeterminate structures by flexibility method**	**14**
	Flexibility coefficients their use in formulation of compatibility equations. Fixed Beams, Application of the Clapeyron's Theorem of Three Moments. Castigliaonos theorem of least work, application of above methods to	

	propped cantilevers, fixed beams, continuous beam, simple pin jointed frames including effect of lack of fit for members, simple rigid jointed frames, two hinged parabolic arches.	
4.	**Analysis of indeterminate structures by stiffness method**	**14**
	Stiffness coefficients for prismatic members, their use for formulation of equilibrium equations, direct stiffness method, Slope deflection method, Moment distribution method. Application of the above methods to indeterminate beams & simple rigid jointed frames, rigid jointed frames with inclined member but having only one translation degree of freedom including the effect of settlement of supports.	
5.	**Introduction to plastic analysis of Steel structures**	**08**
	Concept of plastic hinge, plastic moment carrying capacity, shape factor, determination of collapse load for single and multiple span beams.	

Contribution to Outcomes

On completion of this course, the students will be able to understand the behaviour of various statically indeterminate structures including two hinged arches. They will be able to analyze these structures to find out the internal forces. Further, the students shall be able to extend the knowledge gained in this subject further in the subjects related to structural engineering mechanics in the higher years of their UG programme. The knowledge gained in this subject shall be useful for application in the structural design in later years.

Theory Examination:

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

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

Oral Examination:

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

Term Work:

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

Distribution of Term-work Marks

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

- Assignments : 20 Marks
- Attendance : 05 Marks

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

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

Recommended books:

1. Basic Structural Analysis: *C.S. Reddy*, Tata McGraw Hill Publishing House, New Delhi.
2. Mechanics of Structures (Vol-I and II) : *S. B. Junnarkar H.J. Shah*, Charotar Publishers.
3. Structural Analysis: *L.S. Negi and R.S. Jangid*, Tata Mc-Graw Hills Publishing House, New Delhi
4. Analysis of Structures: Vol. I II, *Vazirani and Ratwani*, Khanna Publishers
5. Structural Analysis: *Bhavikatti*, Vikas Publishing House Pvt, ltd.
6. Structural Analysis: *Devdas Menon*, Narosa Publishing House.
7. Basic Structural Analysis: K.*U. Muthu, Azmi Ibrahim, M. Vijyan, Maganti Janadharn. I.K.* International Publishing House Pvt. Ltd.

8. Comprehensive Structural Analysis (Vol-I and II): *Vaidyanathan R. and Perumal R.* ; Laxmi Publications.
9. Fundamentals of Structural Analysis: *Sujit Kumar Roy and Subrota Chakrabarty*, S. Chand and Co., New Delhi
10. Structural Analysis: *T.S. Thavamoorthy*, Oxford University Press.
11. Structural Analysis: *Manmohan Das and Bharghab Mohan*, Pentice Hall International.

Reference Books:

12. Structural Analysis: *Hibbler*, Pentice Hall International.
13. Structural Analysis: *Chajes*, ElBS London.
14. Theory of Structures: *Timoshenko and Young*, Tata McGraw Hill New Delhi.
15. Structural Analysis: *Kassimali*, TWS Publications.
16. Element of Structural Analysis: *Norries & Wilbur*, McGraw Hill.
17. Structural Analysis: *Laursen H.I*, McGraw Hill Publishing Co.
18. Structural Theorem and Their application: *B.G. Neal*, Pergaman Press.
19. Fundamentals of Structural Analysis: *K.M. Leet*, C.M. Uang and A.M. Gilbert, Tata McGraw Hill New Delhi.
20. Elementary theory of Structures: *Hseih*, Prentice Hall.
21. Fundamentals of Structural Analysis: Harry, H.W. and Louis, F.G., Wiley India

Semester V

Course Code	Subject Name	Credits
CE-C502	Geotechnical Engineering -I	5

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
04	02	-	4	1	-	5

Evaluation Scheme

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

Rationale

All the civil engineering structures, e.g., buildings, dams, bridges, highways, etc., are supported on the ground, i.e., supported by soil rock. The geotechnical analysis depends on the basic of physical properties which are useful for determining the strength, compressibility, drainage etc. The soil mechanics is the basic tool for all branches of geotechnical engineering. Soil is used as construction materials; thus, it is necessary to study this curriculum.

Objectives

- To study the composition, types relationships involving weight, volume weight-volume of soil.
- To study the index properties of soil that is indicative of the engineering properties.
- To characterize the soil based on size, shape, index properties plasticity.
- To classify the soil based on different classification systems.
- To study the properties of soil related to flow of water
- To understand the concept of total stress, effective stress pore water pressure in soil.

- To understand the load-deformation process in soils through compaction consolidation.
- To study the shear strength of soil.
- To understand the techniques of site exploration, assessing the subsoil conditions the engineering properties of the various strata method of reporting.
- To perform different laboratory tests.

Detail Syllabus

Module	Sub Modules/Contents	Periods
1.	**Introduction**	**01**
	i. Definitions: Rock, Soil - origin & formation, Soil mechanics, Rock mechanics, Soil engineering, Geotechnical engineering. ii. Scope of soil engineering- Importance of field exploration & characterization, design construction phases of foundations, post construction phase monitoring. iii. Limitations of soil engineering. iv. Cohesionless cohesive soil; Terminology of different types of soil.	
2.	**Basic definitions and relationships**	**05**
	i. Soil as three phase and two phase system in terms of weight, volume, void ratio, porosity. ii. Weight, volume weight–volume relationships: water content, void ratio, porosity, degree of saturation, air voids, air content, unit weights, specific gravity of solids, mass absolute specific gravity. iii. Relationships between: different unit weights with void ratio-degree of saturation-specific gravity; different unit weights with porosity; void ratio-water content; different unit weights with water content; unit weight – air voids. iv. Mention different methods to find water content, specific gravity, unit weight of soil (Detailed description to be covered during practical).	
3.	**Particle size analysis and Plasticity characteristics of soil**	**06**
	i. Mechanical analysis: dry sieve analysis combined sieve sedimentation analysis; Stokes'law theory of sedimentation; introduction to hydrometer method of analysis, relation between	

	percentage finer hydrometer reading, Limitation of sedimentation analysis, Particle size distribution curve its uses. ii. Relative density iii. Plasticity of soil, consistency limits- determination of liquid limit, plastic limit, shrinkage limit, definitions of: shrinkage parameters, plasticity, liquidity consistency indices, measurement of consistency, flow toughness indices, uses of consistency limits. iv. Clay mineralogy:- gravitational surface forces, primary valence bond, hydrogen bond, secondary valance bonds, basic structural units of clay minerals, difference in kaolinite, montmorillonite illite minerals, adsorbed water, soil structure. v. Sensitivity, thixotropy activity of soils.	
4.	**Classification of soils**	**03**
	i. Necessity of soil classification, Indian Stard particle size classification, Indian stard soil classification system, boundary classifications ii. General characteristics of soils of different groups.	
5.	**Permeability of soils**	**06**
	i. Introduction: ground water flow- water table, types of aquifers; capillary water – types of soil water, surface tension, capillary rise in small diameter tubes, capillary tension, capillary rise in soils. ii. Hydraulic head hydraulic gradient, Darcy's law, validity of Darcy's law. iii. General laminar flow, Laminar flow through soil, Factors affecting permeability of soil. iv. Determination of coefficient of permeability of soil:- Laboratory methods: constant head variable head; Field methods: pumping out pumping in tests; Indirect methods: Consolidation test data. v. Permeability of stratified soil.	
6.	**Seepage analysis**	**05**
	i. Two dimensional flow- Laplace equation, analytical solution: stream potential functions, graphical representation: flow net, characteristics of flow net, uses of flow nets.	

	ii. Other solution methods for Laplace equation- numerical methods. iii. Soil migration filtration: Seepage velocity; Effect of seepage pressure soil migration in structures such as earth dams, retaining walls, pavements, basements; soil migration prevention through graded soil filters, geotextile & geo-composite filters. iv. Geosynthetics: Definition, basic functions, types of geosynthetics—geotextiles, geogrids, geo cells, geomembranes, geo composites; geotextile types– woven nonwoven, Apparent Opening Size (AOS), basic hydraulic properties- permittivity transmissivity of geotextiles v. Filter design criteria for graded soil geotextile filters.	
7.	**Effective stress principle**	**03**
	i. Sources of stress in the ground- geostatic stresses induced stresses; vertical, horizontal shear stresses, effective stress principle, and nature of effective stress. ii. Effect of water table fluctuations, surcharge, capillary action, seepage pressure on effective stress; quick s condition	
8.	**Compaction of soils**	**02**
	i. Introduction, theory of compaction, laboratory methods of determination of optimum moisture content maximum dry density, ii. Factors affecting compaction, effect of compaction on properties of soil; Relative compaction.	
9.	**Consolidation of soils**	**06**
	i. Compressibility & settlement, comparison between compaction & consolidation, concept of excess pore water pressure, initial, primary secondary consolidation, spring analogy for primary consolidation, consolidation test results, coefficient of compressibility, coefficient of volume change , compression, expansion recompression indices, normally over consolidated soils. ii. Terzhaghi's theory of consolidation- assumptions, coefficient of vertical consolidation, distribution of hydrostatic excess pore water pressure with depth & time, time factor, relationship between time factor degree of consolidation, determination of coefficient of vertical consolidation, pre-consolidation pressure.	

	iii. Final settlements of a soil deposit in the field, time settlement curve, field consolidation curve.	
10.	**Shear strength**	**06**
	i. Introduction, three dimensional state of stress in soil mass, principal stresses in soil, shear failure in soils- frictional cohesive strength, general shear stress-strain curves in soil definition of failure, graphical method of determination of stresses on a plane inclined to the principal planes through Mohr's circle, important characteristics of Mohr's circle. ii. Mohr-Coulomb theory- shear strength parameters; Mohr-Coulomb failure criterion- relation between major minor principle stresses, total & effective stress analysis. iii. Different types of shear tests drainage conditions; Direct shear test, Triaxial compression test (UU, CU CD), Unconfined compression test, Vane shear test; comparison between direct & triaxial tests, interpretation of test results of direct shear & triaxial shear tests-stress-strain curves Mohr failure envelopes iv. Determination of shear strength of soil with geosynthetics- pull out test: ASTM procedure for finding shear strength of soil-geosynthtic system.	
11.	**Soil exploration**	**05**
	Introduction, methods of investigation, methods of boring, soil samplers & sampling, number & disposition of trial pits & borings, penetrometers tests-SPT,CPT; borehole logs	

Contribution to outcomes

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

- To classify soils with a view towards assessing the suitability of a given soil for use in a designed, constructed facility e.g. foundation, embankment, or highway.
- To evaluate compaction characteristics interpret field compaction result with respect to compaction specification.

- To evaluate consolidation properties of soils apply those properties to settlement problems frequently encountered in civil engineering.
- To apply engineering science principles, using shear strength compressibility parameters, to analyze the response of soil under external loading.
- To obtain soil properties required for many design applications
- To design conduct laboratory experiments to collect, analyze, interpret, present data.
- To understand the soil boring data for foundation design.

Theory Examination:-

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **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. 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 the term work consisting of the report of experiments performed in the laboratory assignments.

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

1. Determination of natural moisture content using oven drying method.
   Following other methods to find moisture content shall be explained briefly.
   a) Pycnometer method,
   b) S bath method,
   c) Alcohol method,
   d) Torsional balance method,
   e) Radio activity method,
   f) Moisture meter.

2. Specific gravity of soil grains by density bottle method or pycnometer method.
3. Field density using core cutter method.
4. Field density using s replacement method.
5. Field identification of fine grained soils.
6. Grain size distribution by sieve analysis
7. Grain size distribution by hydrometer analysis
8. Consistency limits: Liquid limit, plastic limit
9. Consistency limit: Shrinkage limit
10. Permeability test using constant head method
11. Permeability test using falling head method
12. Compaction test: stard proctor / IS light compaction
13. Compaction test: modified proctor / IS heavy compaction
14. Relative density
15. Differential free swell index test/ un-restrained swell test

Term Work:

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

Distribution of Term-work Marks

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

- Report of the Experiments: 10 Marks
- Assignments : 10 Marks
- Attendance : 05 Marks

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

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

Recommended Books:

1. Soil Engineering in Theory Practice: *Alam Singh*, CBS Publishers Distributors, New Delhi.
2. Soil Mechanics & Foundation Engineering: *V. N. S. Murthy*, Saitech Publications
3. Soil Mechanics & Foundation Engineering: *K. R. Arora*, Stard Publishers Distributors, New Delhi.
4. Soil Mechanics & Foundation Engineering: *B.C. Punimia*, Laxmi Publications
5. Geotechnical Engineering: *C. Venkatramaiah*, New Age International.
6. Fundamentals of Soil Engineering: *D. W.Taylor*, John Wiley & sons.
7. An Introduction to Geotechnical Engineering: *R. D. Holtz*, Printice Hall, New Jersey.
8. Soil Mechanics: *R. F. Craig*, Chapman & Hall.
9. Soil Mechanics: *T. W. Lambe R. V. Whitman*, John Wiley & Sons.
10. Theoretical Soil Mechanics: *K. Terzaghi*, John Wiley & Sons.
11. Designing with geosynthetics: *R. M. Koerner*, Prentice Hall, New Jersey.
12. An introduction to soil reinforcement geosynthetics: *G. L. SivakumarBabu*, Universities Press.
13. Geosynthetics- an introduction: *G. Venkatappa Rao*, SAGES.
14. Relevant Indian Standard Specifications Codes, BIS Publications, New Delhi
15. ASTM D6706: Standard Test Method for measuring Geo-synthetic Pull-out Resistance in soil.
16. ASTM D5321: Standard Test Method for determining Shear Strength of Soil Geo-synthetic or Geo-synthetic Geo-synthetic Friction by Direct Shear Method

Semester V

Course Code	Subject Name	Credits
CE503	Building Design & Drawing – II	3

Teaching Scheme

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

Evaluation Scheme

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem. Exam	Duration of End Sem. Exam	Term Work	Practical	Oral	
Test-I	Test-II	Average						
20	20	20	80	04 Hrs.	25	--	25#	150

Rationale

The complete knowledge of Planning, Designing & drawing of Public Buildings, which includes Offices like Bank, Post-Office, Commercial Complexes, Hostels, Hotel, Rest Houses; buildings for education like Schools, Colleges including Library; buildings for health like Primary Health Center to Hospitals etc. is essential for Civil Engineering students. The structures include Load Bearing Framed type with respect to Plan, Elevation, Section, Foundation Plan, Roof Plan, Site plan for the same. The subject also involves drawings of One-Point & Two-Point Perspectives for public buildings which will represent the real impression of building when we see them from a long distance, may be seeing by sitting on ground level from top like bird's eye-view. This subject imparts the theoretical knowledge to students like concept of Green buildings, Town Planning concepts with reference to development of a Town or large urban area, slum clearance redevelopment of old dilapidated buildings in a broader way. This subject also outlines the drawings of different Plans, Elevations sections at various levels using latest software techniques like Auto CAD, with reference

to drafting of various types of public buildings. Over all, by the end of semester, the civil engineering students will have the complete knowledge with reference to Planning, Designing, drawing concepts of all types of public buildings.

Objectives

1. To understand the Planning concepts, rules, regulations, various bye-laws of local administration/authorities with reference to all types of public buildings.
2. To understand the application of bye-laws in Planning, Designing Drawing of all types of public buildings.
3. To understand all the concepts involved in drawing the different Perspective drawings for public buildings, workshops.
4. To prepare various types of drawings for the public building structures planned designed, satisfying the functional market requirements.
5. To study & apply the provisions made in the relevant Indian Specifications pertaining to the practice for public buildings, the society needs for over all development.

Detail Syllabus

Module	Sub-Module/Contents	Periods
1.	Planning & Design of Public Buildings such as: i) Buildings for education: Schools, Colleges, Institutions, Libraries ii) Buildings for health: Hospitals, Primary Health Centers iii) Industrial Buildings, Workshops, Warehouses iv) Buildings for entertainment: Theaters, Cinema Halls, Club houses, sports club v) Offices: Banks, Post Offices, Commercial Complex vi) Hostels, Hotels, Boarding houses, Rest houses vii) Bus Depots	**10**
2.	Perspective Drawing : One Point Perspective & Two Point Perspective	**04**
3.	Town Planning: Objectives Principles, Master Plan, Road Systems, Zoning, Green Belt, Slums	**02**
4.	Redevelopment of Buildings, Introduction to Residential Township	**02**

5.	Architectural Planning, massing composition, concept of built environment its application in planning	**02**
6.	Principles of modular planning, planning as recommended by National Building Organization	**01**
7.	Use of Computers in Building Planning & Designing	**03**
8.	Introduction to Green Buildings, understanding certification methods (TERI,LEEDS)	**02**

Contribution to Outcomes

On successful completion of the course work, the students shall be able to understand the principles of planning, designing of public buildings. They will demonstrate the ability to plan the public buildings according to the requirements, design the various components involved therein by keeping all the principles of planning following the extant bye-laws of the local authorities. The students will also understand the different control rules of the local authorities, besides provisions made in the relevant Indian specifications meant for practice for architectural drawings. They will further demonstrate the ability of preparing different types of drawings showing complete details therein with respect to public buildings as a whole.

Theory Examination:

1. The question paper will comprise of **six** questions, each carrying 20 marks.
2. Question No.1 will be **compulsory,** based on the planning of any one public building mentioned in the syllabus.
3. The remaining **five** questions will be based on all the modules sub-modules, consisting of Plan, Elevation, Section, Foundation Plan theoretical concepts mentioned in the entire syllabus.
4. These five questions shall be based on Plan, Elevation, Section, Elevation, Foundation Plan; Roof/Terrance Plan on the public buildings (may be on framed or load bearing structure). Some questions could be asked on the theoretical portion mentioned in the module/sub-modules also.
5. The students will have to attempt **any three** questions from the **remaining five** questions.
6. **Total four** questions need to be attempted.

Oral Examination:

There shall be an Oral Examination in conjunction with the Sketching examination. The Oral examination shall be based on the entire syllabus term work.

Contents of the Practicals /Site Visit:

1. Planning drawings of different public buildings.
2. Writing of the Report related to the buildings that are planned & drawn by the students.
3. One-day site visit could be arranged for students to visit any one public building near the college like commercial complex, library, Bank etc. They need to study in detail of that building take the measurements of that building should submit as a site report with detailed drawing according to some suitable scale. This will become a part of Term Work.

Term Work:

The Term Work shall consist of all the following:

1. A-1 size drawing sheets drawn for one public building as Framed Structure as (G+1) with Ground Floor Plan, First Floor Plan, Front Elevation, Sectional Elevation, Foundation Plan, Roof/Terrace Plan, Site Plan, Schedule of Openings, Construction Notes Area Statement for the building.
2. A-1 size drawing sheets drawn for one public building as Load Bearing Structure for Single storied structure with Ground Floor Plan, Front Elevation, Sectional Elevation, Foundation Plan, Schedule of Openings and Construction Notes.
3. Perspective drawings for One-Point & Two-Point.
4. One public building one workshop can be considered for the perspective drawings.
5. Report on the problem taken for the drawing sheets with respect to public buildings.
6. Site visit report with drawings.

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 acceptance of term work warrants the satisfactory performance of drawing work by the student, appropriate completion of the report on the

said drawing sheets, minimum passing marks to be obtained by the student. The following weightage of marks shall be given for different components of the term work.

- Drawing Sheets : 10 Marks
- Report of the Drawing : 05 Marks
- Report on the Site Visit : 05 Marks
- Attendance : 05 Marks

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

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

Recommended Books:

1. Building Drawing : *M.G.Shah, C.M.Kale and Patki*; Tata McGraw Hill Publishers, Delhi
2. Civil Engineering Drawing: *Chakraborty M*; Monojit Chakraborty Publication,Kolkata
3. Building Drawing Detailing : *B.T.S. Prabhu, K.V. Paul and C. Vijayan*; SPADES Publications, Calicut,Kerala
4. Planning Designing Buildings : *Y.S. Sane*; Modern Publication House, Pune
5. Civil Engineering Drawing: *Sushilkumar,* Stardard Publishers
6. IS: 962-Code of Practice for Architectural Drawings: BIS, New Delhi
7. Town Planning : *Rangwala*, Charotar Publishers

Reference Books:

1. Time Saver Standards for Building Types: Joseph De Chiara John Callender

Semester V

Course Code	Subject Name	Credits
CEC504	Applied Hydraulics – I	5

Teaching Scheme

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

Evaluation Scheme

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

Rationale

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

Course Objectives

- To study hydraulic machines like centrifugal pumps, reciprocating pumps and turbines.
- To study devices based on the principals of fluid statics fluid kinematics.
- To study the mathematical technique used in research work for design for conducting model tests.

- To impart the dynamic behavior of the fluid flow analyzed by the Newton's second law of motion.

Detail Syllabus

Module	Sub Modules/Contents	Periods
1	**Dynamics of Fluid Flow:** Momentum principle (applications: pipe bends) moment of momentum equation (applications: sprinkler).	06
2	**Dimensional Analysis:** Dimensional homogeneity, Buckingham's π theorem, Reyleigh's method, dimensionless numbers their significance, Model (or similarity) laws, Types of models, application of model laws: Reynold's model law Froude's model law, scale effect in models.	07
3	**Impact of Jets:** Introduction, Force exerted bon stationary flat plate: held normal to jet, held inclined to jet, curved plate: symmetrical unsymmetrical (jet striking at centre tangentially), jet propulsion of ships.	09
4	**Hydraulic Turbines:** General layout of hydro-electric plant, heads efficiencies of turbine, classification, Pelton Wheel Turbine, Reaction Turbine, Francis Turbine, Kaplane Turbine, draft tube theory, specific speed, unit quantities, Characteristic curves, Governing of turbines, Cavitations.	13
5	**Centrifugal pumps:** Work done, heads, efficiencies, Minimum speed: series parallel operation, Multistage pumps, specific speed, model testing, priming, characteristic curves, cavitations, Brief introduction to reciprocating pump.	09
6	**Miscellaneous Hydraulic Machines:** Introduction: Hydraulic ram, Hydraulic press, Hydraulic accumulator, Hydraulic intensifier, Hydraulic crane, Hydraulic lift.	04

Contribution to Outcomes

On completion of this course the student will be able to understand the design of turbines pumps. They will be able, further, to understand the forces acting on pipe bends sprinklers. They will be able to study the dimensional analysis model laws, apply the principle of momentum to fluid flow problems.

Theory Examination:-

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** will have to 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 examinations shall be based on the entire syllabus the report of the experiments conducted by the students including assignments.

List of Experiments: *(At least six to be performed)*

1. Impact of jet on flat plate
2. Impact of jet on flat inclined plate
3. Impact of jet on curved plate
4. Performance of Pelton wheel- full gate opening
5. Performance of Pelton wheel- half gate opening
6. Performance of Centrifugal pumps
7. Performance of Kaplan turbine
8. Performance of Francis turbine
9. Hydraulic ram
10. Pumps in series
11. Pumps in parallel

Term Work:

The term-work shall comprise of the neatly written report based on the afore-mentioned experiments and the assignments. The assignments shall comprise of minimum 15 problems covering the entire syllabus divided properly module wise.

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 acceptance of term work warrants the satisfactory performance of drawing work by the student, appropriate completion of the report on the said drawing sheets minimum passing marks to be obtained by the student. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 10 Marks
- Assignments : 10 Marks
- Attendance : 05 Marks

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

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

Recommended Books:

1. Fluid Mechanics Hydraulics: *Dr. S. K. Ukarande*, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 81162538.
2. Hydraulic Fluid Mechanics: *Dr. P. M. Modi & Dr. S. M. Seth*, Stard Book House, Delhi.
3. Theory Application of Fluid Mechanics: *K. Subramanya*, Tata Mc-Graw Hill publishing Company, New Delhi.
4. Fluid Mechanics Fluid Pressure Engineering: *Dr. D. S. Kumar*, S. K. Kataria Sons.
5. Fluid Mechanics: *Dr. A. K. Jain*, Khanna Publishers.
6. Fluid Mechanics: *Dr. R. K. Bansal*, Laxmi Publications Ltd., New Delhi

Reference Books:

7. Fluid Mechanics Fundamentals Applications, *Yunus A. Cengel & John M. Cimbala*, Tata Mc-Graw Hill Education Private Limited, New Delhi.
8. Fluid Dynamics: *Daiy Harleman*; Addition Wesley, New York, 1973.
9. Fluid Mechanics: *R.A. Granger*; Dover Publications, New York, 1995.

Semester V

Course Code	Subject Name	Credits
CE-C505	Transportation Engineering – I	5

Teaching Scheme

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

Evaluation Scheme

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test I	Test II	Average						
20	20	20	80	03 Hrs	25	-	-	125

Rationale

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

Objectives

- To enable the students to study the various elements pertaining to air transportation, water transportation, railway transportation.
- To study the various components of railway track, materials used functions of component parts.

- To study the various imaginary surfaces of an airport, geometric standards, runway taxiway lighting.
- To study the various parking system, holding apron, hangars drainage system.
- To study the various modes of water transportation, types of breakwater, harbours and port facilities equipment.
- To study the various aspects of jetties, wharves, piers, dolphins, fenders buoyancy etc.

Detail Syllabus

Module	Sub Modules/Contents	Periods
01	**Introduction:** Role of transportation in Society, objectives of transportation system, different types of modes, planning coordination of different modes for Indian conditions.	**03**
02	**Railway Engineering** i Role of Indian Railways in national development-Railways for urban transportation-Engineering surveys for track alignment-Obligatory points-Conventional mordern methods(Remote sensing, GIS) ii Permanent way-track components their functions, sleeper – functions types, sleeper density, ballast functions different ballast materials. iii Rails: coning of wheels tilting of rails, rail cross sections, wear creep of rails, rail fastenings. iv Geometrics: gradients, transition curves, widening of gauge on curves, cant deficiency. v Points crossing: design of turnouts, description of track junctions, different types of track junctions. vi Yards: details of different types of railway yards their functions. vii Signalling interlocking: classification of signals, interlocking of signals points, control of train movement. viii Construction maintenance of railway track, methods of construction, material requirements, maintenance of tracks traffic operations. ix Modernization of track railway station for high speed trains special	**19**

	measures for high speed track.	
03	**Airport Engineering** i Aircraft component parts its function, aircraft characteristics their influence on airport planning. ii Airport planning: topographical geographical features, existing airport in vicinity, air traffic characteristics, development of new airports, factors affecting airport site selection. iii Airport obstruction: zoning laws, classification of obstructions, imaginary surfaces, approach zones, turning zones. iv Airport layout: runway orientation, wind rose diagrams, basic runway length, corrections for runway length, airport classification, geometric design, airport capacity, runway configuration, taxiway design, geometric standards, exit taxiways, holding aprons, location of terminal buildings, aircraft hangers parking. v Airport marking lighting marking lighting of runways, taxiway, approach other areas. vi Terminal area & airport layout: terminal area, planning of terminal buildings, apron: size of gate position, number of gate position, aircraft parking system, hanger, general planning considerations blast considerations. vii Air traffic control: Air traffic control aids, en-route aids, ling aids. viii Airport drainage: requirement of airport drainage, design data, surface drainage design. ix Airport airside capacity delay: runway capacity delays, practical hourly capacity, practical annual capacity, computation of runway system, runway gate capacity, taxiway capacity. x Air traffic forecasting in aviation: forecasting methods, forecasting requirement applications.	**21**
04.	**Water Transportation** Introduction of water transportation system, harbors docks, port facilities.	**05**

Contribution to Outcomes

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

1. Understand the knowledge of various systems of railway, airport water transportation.
2. Understand the design concept of railway track, runway, taxiways, etc.
3. Apply the concept of geometric design of railway track, runway, taxiway, etc.
4. Apply the knowledge of various signaling system for railway engineering, air traffic control navigational aids.

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

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

Text Books:

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

Reference Books:

1. Indian Railway Track: *Agarwal, M. M.,* Suchdeva Press New Delhi.
2. Planning Design of Airport: *Horonjeff Mckelrey*, Tata Mc-Graw Hill India Publishing House, New Delhi.
3. Design and Construction of Ports and Marine Structures: Quinn, A. D., Tata Mc-Graw Hill India Publishing House

Semester V

Course Code	Subject Name	Credits
CEC506	Business and Communication Ethics	2

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorials	Theory	Practical	Tutorials	Total
-	2+2		-	2		2

Evaluation Scheme

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

Rationale

With the advancement in technology and diverse need of the corporate world, proficiency in English and communication is considered essential for the student's personal and professional growth. Also it is necessary to equip with desired qualities required in an employee and provide tips for achieving success in interviews. The exposure to various interpersonal skills helps to make a conscious attempt of how to communicate and improve one's personality.

Course Pre-requisite:

- FEC206 Communication Skills

Objectives

- To inculcate in students professional ethical attitude, effective communication skills, teamwork, skills, multidisciplinary approach an ability to understand engineer's social responsibilities.

- To provide students with an academic environment where they will be aware of the excellence, leadership lifelong learning needed for a successful professional career.
- To inculcate professional ethics codes of professional practice
- To prepare students for successful careers that meets the global Industrial Corporate requirement' provide an environment for students to work on Multidisciplinary projects as part of different teams to enhance their team building capabilities like leadership, motivation, teamwork etc.

Detail Syllabus

Module	Sub Modules/Contents		Periods
1.	**Report Writing**		**08**
	1.1	Objectives of report writing	
	1.2	Language Style in a report	
	1.3	Types of reports	
	1.4	Formats of reports: Memo, letter, project survey based	
2.	**Technical Proposals**		**02**
	2.1	Objective of technical proposals	
	2.2	Parts of proposal	
3.	**Introduction to Interpersonal Skills**		**08**
	3.1	Emotional Intelligence	
	3.2	Leadership	
	3.3	Team Building	
	3.4	Assertiveness	
	3.5	Conflict Resolution	
	3.6	Negotiation Skills	
	3.7	Motivation	
	3.8	Time Management	

4.	**Meetings Documentation**		**02**
	4.1	Strategies for conducting effective meetings	
	4.2	Notice	
	4.3	Agenda	
	4.4	Minutes of the meeting	
5.	**Introduction to Corporate Ethics etiquettes**		**02**
	5.1	Business Meeting etiquettes, Interview etiquettes, Professional work etiquettes, Social skills	
	5.2	Greetings Art of Conversation	
	5.3	Dressing Grooming	
	5.4	Dinning etiquette	
	5.5	Ethical codes of conduct in business corporate activities (Personal ethics, conflicting values, choosing a moral response, the process of making ethical decisions)	
6.	**Employment Skills**		**06**
	6.1	Cover letter	
	6.2	Resume	
	6.3	Group Discussion	
	6.4	Presentation Skills	
	6.5	Interview Skills	

Contribution to Outcomes

On successful completion of the students, the students will be able to

1. Communicate effectively in both verbal written form demonstrate knowledge of professional ethical responsibilities
2. Participate succeed in Campus placements competitive examinations like GATE, CET.
3. Possess entrepreneurial approach ability for life-long learning.

4. Able to have education necessary for understanding the impact of engineering solutions on Society demonstrate awareness of contemporary issues

Reference Books:

1. Organizational Behaviour: *Fred, Luthans*; Mc-Graw Hill
2. Report Writing for Business: *Lesiker, Petit*; Mc-Graw Hill
3. Technical Writing Professional Communication: *Huckin, Olsen*; Mc-Graw Hill
4. Personal Development for Life Work: *Wallace Masters*, Thomson Learning, 12th Ed.
5. Effective Business Communication: *Heta, Murphy* , Mc-Graw Hill
6. Business Correspondence Report Writing: *Sharma, R. C. and Krishna Mohan*
7. Managing Soft Skills for Personality Development: *Ghosh, B. N*. Tata Mc-Graw Hill
8. BCOM: *Sinha,* Cengage Learning (2nd Ed.)
9. Management Communication: *Bell, Smith*; Wiley India Edition (3rd Ed.)
10. Soft Skills: *Dr. Alex, K.*; S. Chand Co. Ltd.

Oral Examination:

The oral examination shall be based upon the entire syllabus and the report of the assignments prepared by the students.

Term Work:

The term work shall be comprised of the neatly written report comprising below-mentioned assignments.

List of Assignments for Term Work:

Assignment 1- Report Writing (Synopsis or the first draft of the Report)

Assignment 2- Technical Proposal (Group activity, document of the proposal)

Assignment 3- Interpersonal Skills (Group activity Role play)

Assignment 4- Interpersonal Skills (Documentation in the form of soft copy or hard copy)

Assignment 5- Meetings Documentation (Notice, Agenda, Minutes of Mock Meetings)

Assignment 6- Corporate ethics etiquettes (Case study, Role play)

Assignment 7- Cover Letter Resume

Assignment 8- Printout of the PowerPoint presentation

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

Distribution of Marks on Oral Examination:

The marks meant for oral examination will be distributed as below:

- Presentation of the Project Report: 15 Marks
- Group discussion: 10 Marks

Semester V

Course Code	Subject Name	Credits
CE-C601	Geotechnical Engineering – II	5

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
04	02	-	4	2	-	6

Evaluation Scheme

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

Rationale

The basic knowledge of the analysis and design foundation in the context of geotechnical engineering is very important for the civil engineering students. The subject provides the power of analyzing the laboratory and field experiments, their results and further its suitability in the analysis and design of geotechnical projects. The stability and suitability of foundation plays the important role in the field of civil engineering.

Objectives

- To understand the concepts of the stability of slopes and study various methods of evaluating the stability of slopes.
- To understand the importance and basics of foundation engineering in the civil engineering projects.

- To study the classical theories of earth pressure, load bearing capacity and settlement of foundations.
- To study the geotechnical aspects of foundations in view of safety and economy.
- To study the braced cuts and underground conduits.
- To understand the concept of reinforced soil.
- To understand the use of various BIS codes in the geotechnical design of foundation

Detail Syllabus

Module	Sub Modules/Contents	Periods
1.	**Stability of Slopes** i. Introduction, Types of slope failures, Different factors of safety, Analysis of infinite and finite slopes: ii. Analysis of infinite slopes in cohesionless, cohesive and cohesive-frictional soil under dry, submerged and steady seepage along slope conditions. iii. Analysis of finite slopes- planar failure plane (wedge failure) and circular failure plane by Swedish circle method, friction circle method, stability numbers and charts.	**05**
2.	**Lateral earth pressure theories** i. Introduction, Concept of lateral earth pressure based on vertical and horizontal stresses, At rest, active and passive state of soil. ii. Earth retaining structures: Rigid and flexible types, mechanically stabilized retaining wall. iii. Rigid retaining wall: Failure planes in back fill for active and passive condition.Classical earth pressure theories by Rankine and Coulomb. iv. Rankine'slateral earth pressure theory: active and passiveearth pressure for horizontal and inclined backfill for cohesionless and cohesive soils. v. Coulombs wedge theory: active and passive lateral earth pressure conditions (no proof). vi. Graphical methods: Rebhann's construction for active pressure, Culmann's method for active pressure, Friction circle method for	**10**

	passive pressure in cohesion less and cohesive soils.	
3.	**Earth Retaining Structures:** i. Stability analysis of rigid retaining walls. ii. Cantilever sheet piles (no anchors) in cohesion-less and cohesive soils: lateral earth pressure diagram, computation of embedment depth.	**05**
4.	**Bearing Capacity of Shallow Foundation** i. Definitions: Ultimate bearing capacity, safe bearing capacity and allowable bearing pressure, types of shallow foundations.Bearing capacity estimation by theoretical and field methods : ii. Theoretical methods: Terzaghi's Theory: Assumptions,zones of failure, concept behind derivation of general bearing capacity equation, modes of failure,ultimate bearing capacity in case of local shear failure, factors influencing bearing capacity, limitations of Terzhaghi's theory. Bearing capacity for different geometries: square, rectangle and circular footings, effect of water table on bearing capacity. iii. Vesic's Theory: Bearing capacity equation. iv. IS Code Method: Bearing capacity equation. v. Field Methods: vi. Standard Penetration Test: Estimation of bearing capacity from corrected SPT "N". vii. Field plate load test based on IS: 1888: Estimation of bearing capacity, footing size and settlement.	**12**

5.	**Axially Loaded Pile Foundations:** i. A) Introduction to deep foundations, Necessity of pile foundation, Construction methods of bored and driven piles, types of pile foundations. ii. Pile capacity estimation in Cohesion-less and Cohesive soil: Single pile: a) Static methods, b) Dynamicmethods, c) In-situ Penetration Test (SCPT) and d) Pile load test as per IS: 2911. iii. Pile Groups : a) Ultimate Capacity b) Settlement of pile group in cohesion-less and cohesive soils as per IS 2911.	**07**
6.	**Underground Conduits:** Types of underground conduits, load on ditch conduit, positive and negative projecting conduits,settlement ratio, plane of equal settlement,ditch and projection condition, imperfect ditch conduit (no proofs).	**02**
7.	**Open Cuts:** i. Difference in open cut and retaining wall theories, apparent earth pressure diagram, ii. Average apparent earth pressure diagram for cohesion-less and cohesive soils. iii. Estimation of strut loads in braced cuts placed in cohesion-less and cohesive soils.	**02**
8.	**Reinforced Soils:** i) Reinforcing materials: metal strips, geotextiles, geogrids, geocells,mechanism of soil- reinforcement interaction. ii) Physical, mechanical, hydraulic, degradation and endurance properties of geotextiles. iii)Applications areas of reinforced soil: a) Mechanically stabilized retaining wall: Stability analysis of mechanically	**05**

	stabilized (metallic strip and geotextile) retaining wall. b) Geotextile as roadway reinforcement: concept of load distribution in pavement with and without geotextile. c) Geotextile reinforced embankment: Embankment on soft foundation and potential embankmentfailure modes.	

Contribution to Outcomes

On successful completion of the course, the students shall have the:

- Ability to apply the principle of shear strength and settlement analysis for foundation system.
- Ability to design shallow and deep foundations
- Ability to analyze and design earth retaining structures.
- Ability to analyze load carrying capacity of conduits and open cuts.
- Ability to understand the concepts of reinforced soil and its application in the field.

Theory Examination:

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

Oral Examination:

The oral examination shall be based upon the entire syllabus and the term work comprising the report of the experiments performed in the laboratory including assignments.

List of Practicals: *(At least five to be conducted)*

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

Term work:

The term work shall comprise of the neatly written report based on the afore-mentioned experiments and the assignments. The assignments shall comprise of the minimum 15 problems based on the above syllabus, distributed as far as evenly so as to cover all the modules/ sub-modules.

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 acceptance of term work warrants the satisfactory performance of drawing work by the student, appropriate completion of the report on the said drawing sheets minimum passing marks to be obtained by the student. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 10 Marks
- Assignments : 10 Marks
- Attendance : 05 Marks

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

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

Recommended books:

1. Soil Engineering in Theory and Practice: *Alam Singh*; CBS Publishers Distributors, New Delhi.
2. Soil Mechanics and Foundation Engineering: *V. N. S. Murthy*; Saitech Publications
3. Soil Mechanics and Foundation Engineering: *K. R. Arora*; Standard Publishers and Distributors, New Delhi.

4. Geotechnical Engineering: *C. Venkatramaiah*; New Age International.
5. Fundamentals of Soil Engineering: *D. W. Taylor;* John Wiley and sons.
6. An Introduction to Geotechnical Engineering: *R. D. Holtz*; Prentice Hall, New Jersey.
7. Soil Mechanics: *R. F. Craig*; Chapman and Hall.
8. Soil Mechanics: *T. W. Lambe and R. V. Whitman*; John Wiley and Sons.
9. Theoretical Soil Mechanics: *K. Terzaghi*; John Wiley and Sons.
10. Designing with geosynthetics: *R. M. Koerner*; Prentice Hall, New Jersey.
11. An introduction to soil reinforcement geosynthetics: *G. L. SivakumarBabu*; Universities Press.
12. Geosynthetics- An introduction: *G. Venkatappa Rao*; SAGES.
13. Relevant Indian Standard Specifications Code: BIS Publications, New Delhi

Semester VI

Course Code	Subject Name	Credits
CEC602	Design and Drawing of Steel Structure	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	Test	Average						
20	20	20	80	04	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 structure are made of steel .These structure are designed either by working stress method or limit state method. The design methods of different components given in the syllabus are base on limit state method. Here in this course, Limit State methods are studied in detail

Objectives

- To understand the design concept of design of tension and compression member
- To understand the design concept of laterally supported and unsupported beams
- To understand the concept of plastic analysis of simple beam
- To understand the design concept of welded plate girder

Detail Syllabus

Module	Sub – Modules / Contents	Periods
I	**Introduction to Steel Structure**	02
	Introduction to type of steel, mechanical properties of Structural steel, advantages of steel as structural material, design philosophies of Working Stress Method (WSM)	
II	**Introduction to Limit State Method**	03
	Limit state Method, limit state of strength serviceability (deflection, vibration, durability, fatigue, fire) characteristics, partial safety factor design loads, partial safety factor for material. Structural steel section .Classification of cross section-plastic, compact, semi-compact slender, limiting width to thickness ratio.	
III	**Simple Connection Bolted & Welded**	05
	Introduction to bolted welded connection by working stress method and limit state method, Type of bolts, advantage of bolts & welds, simple connection for bolted and welded connection.	
IV	**Tension Members**	04
	Design of tension members with welded and bolted end connection using single angle section & double angle section by Limit State Method, design strength due to yielding of gross section, rupture of critical sections and block shear.	
V	**Compression Members as Struts**	04
	Design of compression members as struts with welded /bolted end connection using single angle sections & double angle section by Limit State Method. Effective length of compression members, buckling class of various cross sections, limiting values of effective slenderness ratio.	
VI	**Compression Members as Column**	06
	Design of column with single built-up section, design of lacing batten plates with bolted & welded connection using Limit State Method, column buckling	

	curves, effective length of compression members, buckling class of various cross sections, limiting values of effective slenderness ratio,	
VII	**Column Bases**	**03**
	Design of slab bases & gusseted base using bolted /welded connection by Limit State Method,	
VIII	**Design of Member subjected to Bending**	**06**
	Design of member subjected to bending by Limit State Method ,design strength in bending, effective length, design strength of laterally supported beams in bending, design strength of laterally unsupported beams, single built-up rolled steel section using bolted/ welded connection, shear strength of steel beam, web buckling, web crippling ,shear lag effect	
XI	**Bracket Connection Beam to Column Connection**	**05**
	Bolted welded connection by Limit State Method, beam to beam, beam to column connection (simple frame connection, unstiffened and stiffened seat connections.	
XII	**Design of Trusses**	**04**
	Determinate truss, imposed load on sloping roof, wind load on sloping roof, vertical cladding including effect of permeability wind drag, analysis of pin jointed trusses under various loading cases, design detailing of member end connection support, design of purlin's , wind bracing for roof system.	
XIII	**Design of Welded Plate Girder**	**06**
	Introduction of plate girder , design of plate girder using IS 800 provision, load bearing stiffeners, vertical stiffeners, horizontal stiffener	

Contribution to Outcomes

On completion of this course, the students will be able to understand the design of tension member, compression member, laterally supported beam, laterally un-supported beam by limit state method. They will be able to design truss. Students will be able to independently design steel structures using relevant IS codes.

Theory Examination:-

1. Question paper will comprise of **five** questions.
2. The first question will be **compulsory** which will carry **32** marks. This will be based on the projects.
3. The remaining **four** questions will be based on rest of the modules in the syllabus and will carry 16 **marks** each. 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. There can be an **internal** choice in various questions/ sub-questions in order to accommodate the questions on all the topics/ sub-topics.
5. The students will have to attempt **any three** questions out of **remaining** four questions.
6. Total **four** questions need to be attempted.

Oral Examination:

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

Term Work:

The Term work shall consists of a neatly written Design Report including detail drawings on any of the two projects as indicated below:

1. Roofing system including details of supports
2. Flooring system including column.
3. Welded plate girder

The drawing should be drawn in pencil only on minimum of A-1 (imperial) size drawing sheets. In addition, the term work shall consist of the neatly written assignments covering the remaining syllabus.

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 acceptance of term work warrants the satisfactory performance of drawing work by the student, appropriate completion of the report on the said

drawing sheets minimum passing marks to be obtained by the student. The following weightage of marks shall be given for different components of the term work.

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

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

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

Recommended Books:

1. Design of Steel Structures: *N Subramanian*, Oxford- University Press.
2. Limit State Design of Steel Structures: *V. L. Shah and Veena Gore*, Stuctures Publication, Pune.
3. Limit State Design of Steel Structures: S.K. *Duggal*, Tata Mc-Graw Hill India Publishing House
4. Design of Steel Structures: K.S. Sairam, Pearson

Reference Books:

1. LRFD Steel Design: *William T. Segui*, PWS Publishing
2. Design of Steel Structures: *Edwin H. Gaylord, Charles N. Gaylord James*, Stallmeyer, Mc-Graw-Hill
3. Design of Steel Structures: *Mac. Ginely T.*
4. Design of Steel Structures: *Dayaratnam*, Wheeler Publications, New Delhi.
5. Design of Steel Structures: *Punamia, A. K. Jain and Arun Kumar Jain*, Laxmi Publication
6. Design of Steel Structures: *Kazimi S. M. and Jindal R. S.*, Prentice Hall India.
7. Design of Steel Structures: *Breslar, Lin Scalzi*, John Willey, New York.
8. Design of Steel Structures: *Arya and Ajmani*, Nem Chand and Bros., Roorkee
9. Structural Design in Steel: *Sarwar Alam Raz;* New Age International Publsihers
10. Relevant Indian Specifications, Bureau of Indian Specifications, New Delhi.

Semester VI

Course Code	Subject Name	Credits
CEC603	Applied Hydraulics – II	4

Teaching Scheme

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

Evaluating scheme

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

Rationale

The knowledge of this subject is essential to understand facts, concepts of and design aspects of airplanes, submarines, ships, bridges as well as channels in alluvial and non alluvial soils. This subject provides necessary knowledge about concept of boundary layer theory, study of drag and lift in case of flow around submerged bodies, design of open channel and understanding of surface profiles.

Objectives

- To compute slope of a channel
- To calculate rate of flow in a channel
- To compute wetted perimeter and hydraulic radius of open channel flow
- To identify normal depth in an open channel
- To compute critical depth of a an open channel

- To study the design of open channel and understanding the concept of surface profile with hydraulic jump.
- To study the Kennedys and Lacey's silt theory to design irrigation channels.

Detail Syllabus

Module	Sub – Modules / Contents	Periods
1.	**Boundary layer theory:** Development of boundary layer over flat curved surfaces, laminar and turbulent boundary layer. boundary layer thickness, displacement thickness, momentum thickness, energy thickness, drag force on a flat plate due to a boundary layer, turbulent boundary layer on a flat plate, analysis of turbulent boundary layer, total drag on a flat plate due to laminar turbulent boundary layer, boundary layer separation and control.	**5**
2.	**Flow around submerged bodies:** Force exerted by a flowing fluid on a stationary body, expression for drag lift, drag on a sphere, terminal velocity of a body, drag on a cylinder. Development of a lift on a circular cylinder, development of a lift on an aerofoil.	**5**
3.	**Flow through open channel:** Definition, types of channels, Types of flows in channels, Prismatic non-prismatic channels, Uniform flow: steady flow and unsteady flow, laminar and turbulent flow, subcritical flow, supercritical flow, Chezy's formula, Manning's formula, hydraulically efficient channel cross-section (most economical section), Velocity distribution in open channels, and pressure distribution in open channels. Applications of Bernoulli's equation to open channel flow. Non uniform flow: Specific energy and specific energy curve, discharge curve, Dimensionless specific energy discharge curve, applications of specific energy. Momentum principle, application to open channel flow, specific force. Hydraulic jump and standing wave, small waves surges in open channels. Gradually varied flow, equation for gradually varied flow, back water curve and afflux, surface profiles. Control section, location of hydraulic jump.	**17**

4.	**Fluvial Hydraulics:** Kennedy's theory, Kennedy's methods of channel designs, silt supporting capacity according to Kennedy's theory. Drawbacks in Kennedy's theory Lacey's regime theory, Lacey's theory applied to channel design. Comparison of Kennedys and Lacey's theory, defects in Lacey's theory. Introduction to sediment transport in channels.	**9**

Contribution to Outcomes

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

1. Develop the understanding of the flow phenomena (e.g. hydraulic jump, backwater waves, critical depth, etc) using experiments.
2. Understand the impact of engineering solutions for boundary layer theory in the context of submerged bodies.
3. Develop the understanding of the design and measurement of flow velocity in open channel.
4. Understand the different slope profiles and its effect on the flow characteristics
5. Study the specific energy it's applications

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

List of Experiments: *(Any Six)*

1. Determine Chezy,s roughness factor
2. Determination of gradually varied flow
3. Study of hydraulic jump and its characteristics.
4. Calibration of venturiflume
5. Calibration of standing wave flume
6. Determination of mean velocity of flow in open channel.
7. Study of wind tunnel
8. Calibration of broad crested weir
9. Calibration of submerged weir

Term Work:

The term-work shall comprise of the neatly written report based on the afore-mentioned experiments and the assignments. The assignments shall comprise of minimum 15 problems covering the entire syllabus divided properly module wise.

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 acceptance of term work warrants the satisfactory performance of drawing work by the student, appropriate completion of the report on the said drawing sheets minimum passing marks to be obtained by the student. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 10 Marks
- Assignments : 10 Marks
- Attendance : 05 Marks

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

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

Recommended Books:

1. Fluid Mechanics Hydraulics: *Dr. S. K. Ukarande*; Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 81162538.
2. Hydraulics and Fluid Mechanics: *P. M. Modi S. M. Seth*;Stard Book House, Delhi.

3. Theory and Application of Fluid Mechanics: *K. Subramanya*; Tata McGraw Hill India Publishing Company, New Delhi.
4. Fluid Mechanics and Fluid Pressure Engineering: *D. S. Kumar*; S. K. Kataria and Sons.
5. Fluid Mechanics: *A. K. Jain*; Khanna Publishers.
6. Fluid Mechanics: *R. K. Bansal*; Laxmi Publications Pvt. Ltd.
7. Fluid Mechanics: Fundamentals and Applications, *Yunus A. Cengel John M. Cimbala*, Tata Mc-Graw Hill Education Private Limited, New Delhi.
8. Fluid Dynamics: *Daiy Harleman*, Addition Wesley, New York, 1973.
9. Fluid Mechanics: *R.A. Granger;* Dover Publications, New York, 1995.
10. Flow in Open Channels: *Subramanya K.* ; Tata Mc-Graw Hill Publishing House Pvt. Ltd.
11. Irrigation and Water Power Engineering: *B. C. Purnnia*.; Standard Publishers, New Delhi

Semester VI

Course Code	Subject Name	Credits
CE-C604	Transportation Engineering. – II	5

Teaching Scheme

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

Evaluation Scheme

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test I	Test II	Average						
20	20	20	80	03Hrs	25	-	-	125

Rationale

Transportation contributes to the economical, industrial, social cultural development of any country. The adequacy of transportation system of a country indicates its economic social development. Three basic modes of transportation include land, water and air. The land mode further includes highways railways. The highways owing to its flexibility in catering door-to- door service are one of the important modes. This course deals with the investigation, planning, design, construction and maintenance of highways including urban roads. This course also deals with the traffic planning, operation and control. The bridges are the essential structures of highway and railway engineering. In view of this, the subject imparts the fundamental aspects of bridge engineering to the students.

Objectives

- To give insight of the development in the field of highway engineering right from inception up to construction and maintenance.
- To understand the principles of highway geometrics.

- To understand the concept of traffic planning, design, operation and control.
- To study the various materials required for pavement construction including their characterization
- To analyze the different types of pavements and subsequently, their design.
- To study the various methods of construction of different types of pavements.
- To study the functional and structural evaluation of existing pavements and methods to strengthen the distressed pavements.
- To study the fundamental concepts of bridge engineering including selection of site for bridge, different types of bridges, bridge hydrology and various components of bridge structures.

Detail Syllabus

Module	Sub Modules/Contents	Periods
01	**Highway Planning** i Classification of roads, brief history of road developments in India, present status of roads in India ii Highway alignment, basic requirement of ideal alignment, factors governing highway alignment iii Highway location survey, map study, reconnaissance, topographic surveys, highway alignment in hilly area, drawing report preparation	**03**
02	**Geometric design of highway** i Terrain classification, vehicular characteristics, highway cross section elements, salient dimensions, clearances, width of carriage way, shoulders, medians, width of road way, right of way, camber its profile.(IRC Standards) ii Design speed, sight distance, perception time, break reaction time, analysis of safe sight distance, analysis of overtaking sight distance, intersection sight distance iii Horizontal curves: design of super elevation, its provisions, minimum radius of horizontal curves, widening of pavement, transition curves. iv Gradients: different types, maximum, minimum, ruling exceptional, grade	**09**

	compensation in curves, vertical curves: design factors, comfort sight distance. Summit curve, valley curve. v Introduction of geometric design software.	
03	**Pavement materials:** i Subgrade materials: desirable properties, modulus of elasticity, modulus of subgrade reaction, classification of subgrade soils, importance of CBR. ii Subbase material: desirable properties, different tests on aggregate, requirement of aggregate for different types of pavements. iii Bituminous materials: types of bituminous material, test on bituminous material, desirable properties, grade of bitumen	**04**
04	**Pavement Design:** i Types of pavements, different method of pavement design, comparison of flexible rigid pavements, design wheel load, equivalent single wheel load, equivalent wheel load factor, ii Flexible pavement design: GI method, IRC approach (IRC:37--1970; IRC:37- 1984; IRC: 37- 2001), Burmister's layers theory, introduction to AASHTO method. iii Stress in Rigid Pavements, critical load position, stress due to load, stress due to temperature variation, combine loading temperature stress.; Design of rigid pavements (IRC: 58- 1988; IRC: SP- 62-2004) iv Introduction to pavement design software, relationship between numbers of cumulative axle, strain value elastic modulus of materials.	**09**
05	**Highway Construction** i. Modern equipment for road construction, construction of different types of roads: water bound macadam (WBM) road, different types of bituminous pavements, cement concrete pavement.(As per IRC MORTH specifications) ii. Constructions of stabilized roads: different method of soil stabilization, use of geo-textile geogrid in highway subgrade.	**04**
06	**Highway Maintenance Rehabilitation** i. Pavement failure: flexible pavement failure, rigid pavement failure, maintenance of different types of pavements. ii. Evaluation of pavements: structural evaluation of pavements, functional	**05**

	evaluation of pavement, iii. Strengthening of existing pavement: objective of strengthening, types of overlay, different types of overlay, overlay design methodologies-effective thickness approach, deflection approach and mechanistic-empirical approach, design of overlays using effective thickness approach and deflection approach resorting to Benkeleman Beam method (IRC: 81-1981; IRC: 81-1997)	
07	**Traffic Engineering and Control** i. Traffic study and surveys: speed studies, presentation of data, journey time delay studies, use of various methods, merits demerits ii. Vehicular volume count: types, various available methods, planning of traffic count. iii. O- D survey, need uses, various available methods iv. Parking survey, need types, traffic sign marking, signals, miscellaneous traffic control aids, traffic regulations, traffic signals. v. Intersection types: at grade separation, factors influencing design. vi. Introduction to traffic design related software's.	**07**
08	**Highway drainage** Necessity, surface drainage, subsurface drainage.(IRC recommendations)	**02**
09.	**Bridge Engineering** Bridge engineering: importance, investigations, site selection, collection of data, determination of flood discharge, waterway, afflux, economic span, scour depth, Bearing Design criteria for Bridge Foundations. IRC Code of practice for bridges	**05**

Outcomes

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

- Basic concept about highway engineering.
- Types of pavements different elements in each type.
- Materials used for highway construction
- Method of design of flexible rigid pavement.
- Construction maintenance of different type of pavement

- Different types of traffic control system
- Basic idea about the bridge engineering.

Theory Examination:-

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which 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 examinations shall be based on the entire syllabus the report of the experiments conducted by the students including assignments and the Traffic Survey Report.

List of practical :- (At least seven to be performed)

1. Impact test on aggregates
2. Abrasion test on aggregates
3. Crushing test on aggregates
4. Shape test on aggregates
5. Penetration test on bitumen
6. Ductility test on bitumen
7. Softening point test on bitumen
8. Viscosity test on bitumen
9. Marshall stability test
10. Subgrade CBR

Tests on Aggregate:

Aggregate grading; Sp. Gravity; Crushing; Abrasion; Impact; Soundness; Flakiness; Shape. silica

Tests on Bitumen:

Viscosity, Penetration, softening point, flash & Fire point, Marshall Stability.

Tests on Subgrade:

Sub-grade CBR.

Term Work:

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

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The final certification acceptance of term work warrants the satisfactory performance of drawing work by the student, appropriate completion of the report on the said drawing sheets minimum passing marks to be obtained by the student. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 8 Marks
- Assignments : 8 Marks
- Traffic Study Report : 4 Marks
- Attendance : 05 Marks

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

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

Recommended Books:

1. Highway Engineering: *Khanna, S.K. and Justo, C. E. G.*; Nem Chand and Bros., Roorkee,
2. Principles and Practice of Highway Engineering: *Kadiyali, L. R.*; Khanna Publsihers, Delhi
3. Principles of Transportation and Highway Engineering, *Rao, G.V.;* Tata McGraw Hill Publishing House Pvt. Ltd., New Delhi.

4. Principles, Practice and Design of Highway Engineering (Including Airport Engineering)" Sharma, S.K.; S. Chand and Company Pvt. Ltd., New Delhi
5. Bridge Engineering: Victor, D. J., Tata Mc-Graw Hill Publishing House Pvt. Ltd., New Delhi
6. Bridge Engineering: *Bindra, S. P*., Dhanpatrai and Sons, New Delhi

Reference Books:

1. Transportation Engineering and Planning: C.S. Papacostas and P.D. Prevedouros; Prentice Hall India Learning Pvt. Ltd., New Delhi
2. Principles of Transportation Engineering: Chakrabory, Partha and Das, Animesh; Prentice Hall India Learning Pvt. Ltd., New Delhi
3. Transportation Engineering: *Khisty, C.J. and Lall, Kent, B.;* Prentice Hall India Learning Pvt. Ltd., New Delhi
4. Traffic Engineering and Transport Planning: Kadiyali, L.R., Khanna Publishers, Delhi
5. Relevant specifications of Bureau of Indian Standards
6. Relevant specifications of Indian Roads Congress

Semester VI

Course Code	Subject Name	Credits
CEC605	Environmental Engineering – I	4

Teaching Scheme

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

Evaluating 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

Environmental engineering is important for all human endeavors not simply about construction within the environment. This subject lays emphasis on the practical application of knowledge, while at the same time recognizing the importance of theoretical knowledge in developing the intellectual capacity of the engineer. Knowledge of this subject is useful for planning, designing, execution monitoring water supply sanitary schemes for the towns/cities.

Objectives

- To prepare students who can accomplish planning, design & construction of water systems & related infrastructural facilities.
- To give a practical orientation to so that they can give practical solutions to environmental problems in our society.

- To inculcate the students with sound theoretical knowledge in engineering sciences as well as in research consultancy skills.
- To impart positive responsive vocational attitudes, initiative creative thinking in their mission as engineers.

Detail Syllabus

Module	Sub Modules/Contents	Periods
1	**Water**	
1.1	Man's environment; Importance of environmental sanitation Water supply systems: need for planned water supply schemes, Sources of water, components of water supply system determination of their design capacities, Quantity of water, Water demand, Population forecasting methods with numerical. Types of Intake structures.	**05**
1.2	Distribution systems: Requirements of good distribution systems. Lay out of distribution networks, advantage, disadvantages, Methods of distribution. Design of distribution networks (Hardy cross method)	**06**
1.3	Quality of water: wholesomeness palatability, physical, chemical, Biological standards. Treatment of water; impurities in water- processes for their removal- typical flow sheets. **Sedimentation :** Theory of sedimentation, Types, factors affecting efficiency, design of sedimentation tank, tube settlers Coagulation flocculation ; mechanisms, common coagulations, rapid mixing flocculating devices, G GT values, Jar test, coagulant aids – Polyelectrolyte etc. **Filtration:** classification, slow and rapid sand filters, dual media filters, gravel under drainage system, mode of action, cleaning, limitations, operational difficulties, performance, basic design consideration, pressure filters: construction & operation. Water softening: lime soda base exchange methods, Principle reactions, design considerations, sludge disposal.	**30**

	Miscellaneous Treatments : removal of Iron, Manganese, taste, odour, colour, principles methods, de-fluoridation, reverse osmosis **Disinfection :** chlorination, chemistry of chlorination, kinetics of disinfection, chlorine demand, free combined chlorine, break point chlorination, super chlorination, dechlorination, chlorine residual, uses of iodine, ozone, ultra violet rays, chlorine dioxide as disinfectants, well water disinfection	
2	**Municipal solid waste management** **Solid waste :** Sources, Types , composition, Physical biological properties of solid wastes, sources types of hazardous infectious wastes in municipal solid wastes Solid waste generation collection, storage, handling , transportation, processing Treatment disposal methods Material separation recycle, physic- chemical biological stabilization solidification thermal methods, of disposal, site remediation, leachate & its control. **Hazardous wastes:** Effects of hazardous waste on environment & its disposal	**04**
3	**Building water supply:** Introduction, per capita supply, service connections from main, storage of water supply systems in a building, sizing of pipes, water meters Fixtures and fittings: Introduction, classification of fixtures, special accessories, fittings. Pipe material, Joints, Valves. Design of pipes, primary & secondary branches, Laying of pipes, testing and maintenance of pipes.	**03**

Outcomes

On completion of this course, the students will have an ability to understand the water quality criteria and standards and further, to design the water treatment plant and water distribution system. The students will understand the various methods of disposal of solid waste. They will have an understanding of the nature and characteristic 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.

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 examinations shall be based on the entire syllabus, the report of the experiments conducted by the students including assignments and the report of the visit to the Sewage Treatment Plant.

List of Practicals: *(Any eight experiments are to be performed)*

1. Determination of Alkalinity in water
2. Determination of Hardness in water
3. Determination of pH in water
4. Determination of Turbidity in water
5. Determination of Optimum dose of coagulant by using Jar Test Apparatus
6. Determination of Residual chlorine in water
7. Solid Waste : Determination of pH
8. Solid Waste :Determination of moisture content

9. Most probable Number
10. Determination of chlorides in water

Term work:-

The termwork shall include the reports on experiments performed in the laboratory and the brief report on the visit to sewage treatment plant.

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 acceptance of term work warrants the satisfactory performance of the experiments by the student, properly compiled report thereof and the report on the site visit and the minimum passing marks to be obtained by the student. The following weightage of marks shall be given for different components of the term work.

- Report of the Experiments: 12 Marks
- Report on the visit to Sewage Treatment Plant : 08 Marks
- Attendance: 05 Marks

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

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

Recommended Books:-

1. Water Supply and Sanitary Engineering: *S. K. Hussain*, Oxford & IBH Publication, New Delhi.
2. Manual on Water Supply Treatment (Latest Ed.): Ministry of & Housing. New Delhi
3. Plumbing Engineering Theory and Practice: *S.M. Patil*, Seema Publications, Mumbai
4. Water Supply and Sewage: *E.W. Steel*, Mc-Graw Hill Publications, New York.
5. Water Supply and Sewage: *T.J. McGhee*, McGraw Hill Publications, New York
6. CPHEEO Manual on Water Supply and Treatment
7. Water Supply Engineering- *P. N. Modi*
8. Water Supply Engineering: *S.K. Garg*, Khanna Publishers, Delhi
9. Introduction to Environmental engineering: *Vesilind*, PWS Publishing Company.

10. Water supply and pollution control: *J.W. Clark, W. Veisman and M.J. Hammer*, International Textbook Company.
11. Relevant Indian standard specifications.
12. Integrated Solid Waste Management: *Tchobanoglous Theissen Vigil*, Mc-Graw Hill Publications, New York.
13. Solid Waste Management in Developing Countries: *A.B. Bhide and B.B. Sundaresan*.
14. Manual on Municipal Solid Waste Management: Ministry of Urban Development, New Delhi.
15. Environmental Pollution: *Gilbert Masters*
16. Basic Environmental Engineering: *Nathanson J.A.*; Prentice Hall of India Publications

Semester VI

Course Code	Subject Name	Credits
CEC606	Theory of Reinforced and Prestressed Concrete	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	--	--	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 new concept of pre-stressed concrete has also assumed significance in the field of concrete technology. The pre-stressed is the high strength concrete in which permanent internal stresses are deliberately introduced to counteract to the desired degree, the stresses caused in the member in service usually by high tensile steel wire or tension steel, embedded pre-tensioned prior application of the external load. The subject involves the application of either method in the analysis and design of the various elements of the civil engineering structures such as beams, slabs, columns and footing. The application of the concept of pre-stressed concrete also forms part of the subjects.

Objectives

- To study the elastic theory philosophy in respect of R.C. structures and its applications to various elements such as beam, column, slab and footings
- To study the concept of prestressing of R.C structures and its applications in the analysis of R.C. structures.

Detail Syllabus

Module	Sub Modules/Contents	Periods
1.	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 steel, characteristics of concrete steel reinforcement.	**04**
2.	Analysis design of singly reinforced doubly reinforced rectangular, Tee, L-beams for flexure by WSM, balanced, under reinforced over reinforced sections.	**06**
3.	Design for shear bond by WSM.	**04**
4.	Analysis & Design of rectangular circular columns subjected to axial bending by WSM.	**06**
5.	Design of one way two way slab by WSM	**06**
6.	Design of axially loaded isolated sloped pad footings	**05**
7.	Prestressed Concrete: Basic principles of prestressed concrete, materials used their properties, methods systems of prestressing, losses in prestress, analysis of various types of sections subjected to prestress external loads.	**09**
8.	General design principles: Concepts of centre of compression, kern of a section, efficiency of the section, pressure line safe cable zone, principal tension in prestressed concrete members.	**04**
9.	Simple design of prestressed concrete I beams (excluding end block design)	**04**

Outcomes

The students shall use the lectures to study the analysis & design of various elements of the reinforced concrete structures such as beam, slab, column, footings using the concept of working stress method. The student shall apply the knowledge gained in the subjects such as engineering mechanics, strength of materials structural analysis in analyzing the structural components further implement it for the designing these elements. Further the student shall use the tutorials to solve more practice 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.

Term Work:

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

Distribution of Term-work Marks

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

marks to be obtained by the students. 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: *By Dayaratnam P*.; Oxford & IBH.
2. Design of Reinforced Concre Structures: *S. Ramamrutham*
3. Design of Concrete Structures (Vol.I): *Ramchandra*
4. R.C.C. Designs: *B.C. Punimia, Ashok Kumar Jain and Arun Kumar Jain*; Laxmi Publications
5. Fundamentals of Reinforced Concrete: *Sinha and Roy*; S. Chand and Co., New Delhi.
6. Reinforced Concrete: *Warnerr. R. F*. Rangan B.C. & Hall A. S., Pitman.
7. Reinforced Concrete (Vol. I): *H.J.Shah*; Charotar Publishers.
8. Reinforced Concrete: *Syal and Goel*; Wheeler Publishers
9. Design of Prestressed Concrete Structures: *Lin T.Y. and Ned Burns*; John Wiley.
10. Prestressed Concrete: *Krishna Raju*, Tata Mc-Graw Hill Publishing House, New Delhi
11. Prestressed Concrete: *Evans R. H. and Bennett E.W.*, Chapman and Hall.
12. Prestressed Concrete: *N. Rajgopalan*, Narosa Publishers
13. Relevant IS Codes: BIS Publications, New Delhi
14. Reinforced Concrete Design: *Pillai, S.U.* and *Menon, Devdas*, Tata Mc-Graw Hill Publishing House, New Delhi