UNIVERSITY OF MUMBAI

Bachelor of Engineering

Civil Engineering (Third Year – Sem. VI), Revised

course (REV- 2012) from Academic Year 2014 -15,

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit Grading System)

Semester VI

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CE-C601	Geotechnical Engg. – II	4	2	--	4	1	--	5
CE-C602	Design and Drawing of Steel Structures	4	2	--	4	1	--	5
CE-C603	Applied Hydraulics – II	3	2	--	3	1	--	4
CE-C604	Transportation Engg. – II	4	2	--	4	1	--	5
CE-C605	Environmental Engg – I	3	2	--	3	1	--	4
CE-C606	Theory of Reinforced Prestressed Concrete	4	2	--	4	1	--	5
Total		**22**	**12**	**--**	**22**	**6**	**--**	**28**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CE-C601	Geotechnical Engg. – II	20	20	20	80	3	25	--	25	150
CE-C602	Design and Drawing of Steel Structures	20	20	20	80	4	25	--	25[@]	150
CE-C603	Applied Hydraulics – II	20	20	20	80	3	25	--	25	150
CE-C604	Transportation Engg. – II	20	20	20	80	3	25	--	25	150
CE-C605	Environmental Engg. – I	20	20	20	80	3	25	--	--	150
CE-C606	Theory of Reinforced and Prestressed Concrete	20	20	20	80	3	25	--	25	150
Total		**120**	**120**	**120**	**480**		**150**		**125**	**875**

[@]**Oral & Sketching**

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	Duration of	TW	PR	OR	
Test 1	Test 2	Average	Exam	End Sem Exam				
20	20	20	80	03 Hrs.	25	-	25	150

Rationale

The basic knowledge of the analysis and design of 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 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 understand the use of various BIS codes in the geotechnical design of foundation

Detail Syllabus

Module	Sub Modules/Contents	Periods
1.	Stability of Slopes Introduction, Types of Slope Failures, analysis of finite & infinite slopes (No proof), wedge failure, Swedish circle method, friction circle method, Stability numbers , charts, numericals based on all the above concepts	06
2.	Lateral Earth Pressure Theories i Introduction, types of earth pressure (At rest , active, passive) ii Rankine's earth pressure theory: Active earth pressure; Passive Earth pressure for horizontal & inclined backfill for cohesive & Cohesionless soils. iii Coulomb's Wedge Theory: Active earth pressure; Passive Earth pressure conditions (No Proof) iv Graphical Methods: a) Rebhann's construction for active pressure, b) Culmann's Method for active condition, c) Friction circle method: Cohesive & Cohesion less Soils,. V Numericals on all the above concepts	06
3.	Earth Retaining Structures: I) Types viz., Rigid & flexible ii) Stability Analysis of Retaining Walls iii) Cantilever Retaining walls: Earth Pressure Diagram, Embedment Length iv) Numericals on the above concepts	04
4.	Bearing Capacity of Shallow Foundations i) a) Definitions: Ultimate Bearing Capacity, Safe bearing Capacity, Allowable Bearing Pressure, b) Factors influencing Bearing Capacity ii) Bearing Capacity Estimation Theories: A) Terzaghi's Theory: a) Assumptions, limitations, concept behind derivation, zone of failure, its relevance to bearing capacity equation, modes of Failure. b) Bearing Capacity for different Shear Failures, Different geometries. c) Effect of Water Table on bearing Capacity.	12

	B) Vesic's Theory: Bearing Capacity Equation.
	
	C) IS Code Method: Bearing Capacity Equation.
	
	  iii) Field Methods:
	
	    a) Standard Penetration Test: Estimation of Bearing Capacity from corrected SPT "N".
	
	    b) Field Plate Load Test: Estimation of Footing Size, Graphical method of estimating Allowable Bearing Pressure
	
	  iv) Numericals on the above concepts	

5.	Axially Loaded Pile Foundations:
	
	A) Definition, Types of Pile Foundations, Necessity of Pile Foundations.
	
	B) Pile Carrying Capacity Estimation in Cohesive & Cohesion-less soils
	
	  i) Single Pile:
	
	  a) Static Methods,
	
	  b) Dynamic Methods,
	
	  c) Insitu Penetration Test (SCPT)
	
	  d) Pile Load Test as per IS: 2911.
	
	C)Pile Groups : a) Ultimate Capacity
	
	D) Settlement of Pile Groups in Cohesive & Cohesion-less soils as per IS: 2911.
	
	E) Numericals on the above concepts.
		06

6.	Underground Conduits: i. a) Types of Conduits, b.) Load on Ditch Conduit c) Settlement Ratio, ii.a) Plane of Equal Settlement, b) Ditch Projection Condition. iii No Proofs; numerical	**01**
7.	Open Cuts: i.a)Definition: Open cut, Apparent Earth Pressure Diagram, i.b) Average Apparent Earth Pressure Diagram for Cohesive & Cohesion-less soils. ii) Estimation of Strut Loads: Determination of Strut loads for struts placed in Cohesive & Cohesion-less soils.	**02**

8.	Stress Distribution:	03
	i. Stress due to self weight	
	ii. Boussinesq Theory	
	a) Concentrated Load	
	b) Uniformly distributed Load	
	iii Wetergaard's Theory	
	iv Newmarks influence charts	
	v Numericals on the above concepts.	
9.	Reinforced Soils:	06
	i) Definition of Geosynthetics, Types: Based on Materials, manufacturing Process.	
	ii) Function & application of various Reinforcements.	
	iii) Geotextile in Pavement Construction.	
	iv) Geotextile Reinforced embankment on Soft Foundation, Potential Embankment Failure modes	
	v) Geotextile Reinforced Railroad Track Construction	
	vi) Brief Discussion on Tests to be conducted on Geosynthetics.	

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.

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
CE – C 602	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	Duration of	TW	PR	OR	
Test	Test	Average	Sem Exam	End Sem Exam				
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.

Course Code	Subject Name	Credits
CE-C603	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,	17

	back water curve and afflux, surface profiles. Control section, location of hydraulic jump.		
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

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	Duration of	TW	PR	OR	
Test I	Test II	Average	Sem Exam	End Sem Exam				
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 most 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.

Objectives

- To give an 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.

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 compensation in curves, vertical curves: design factors, comfort sight distance. Summit curve, valley curve. v Introduction of geometric design software.	10
03	**Pavement materials:** i Subgrade materials: desirable properties, modulus of elasticity, modulus	04

	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 materials, test on bituminous materials, desirable properties, grade of bitumen	
04	**Pavement Design:**	**10**
	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.	
05	**Highway Construction**	**05**
	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.	
06	**Highway Maintenance Rehabilitation**	**06**
	i. Pavement failure: flexible pavement failure, rigid pavement failure, maintenance of different types of pavements.	
	ii. Evaluation of pavements: structural evaluation of pavements, functional 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.
		08

08	**Highway drainage**: necessity, surface drainage, subsurface drainage.(IRC recommendations)	02

Outcomes

On successful completion of the course, the students will 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 systems
- 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 Publsihing 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

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

Course Code	Subject Name	Credits
CE-C605	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.

<table>
<tr><th colspan="3" style="text-align:center">Detail Syllabus</th></tr>
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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**

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
- Sewage Treatment Plant Report   : 08 Marks
- Attendance   : 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
CE-C606	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.

- 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