Semester VI

Subject Code	Subject Name	Credits
CEC601	Geotechnical Engineering-II	5

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

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 Hrs.	25	-	25	150

Rationale

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

Objectives

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

Detailed Syllabus

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

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

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

Contribution to Outcomes

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

Theory Examination

1. Question paper will consist of total **6** questions; each carrying 20 marks.
2. Only **4** questions (out of 6) need to be attempted.
3. Question no. **1** will be **compulsory.**
4. Any **3** out of the remaining **5** questions need to be attempted.
5. In question paper, weightage of each module maybe approximately proportional to the number of lecture hours assigned to it in the syllabus.

Oral Examination:

The oral examination shall be based upon the entire syllabus

Term Work:

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

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

Assignments:

a) Assignments should contain at least 15 numerical problems covering the entire syllabus.
b) One assignment shall be given on GROUND IMPROVEMENT TECHNIQUES. The teacher is expected to deliver extra lectures on the topic, thereby imparting the knowledge to the students, about the concept of ground improvement. The questions related to ground improvement techniques shall **NOT** be asked in the theory examination. However, it shall be treated as a part of term work submission. It shall preferably cover the following points:

- Reinforced earth: Design of reinforced earth wall
- Geotextiles: definition, types, functions and use in civil engineering
- Introduction to stone columns and prefabricated vertical drains

Distribution of Term Work Marks

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The following weightage of marks shall be given for different components of the term work.

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

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

Recommended Books:

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

Semester VI

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

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

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

Rationale

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

Objectives

- To make students familiar with behavior of steel structure and their components under the action of various loads.
- To train the students for effective use of IS codes, design tables and aids in analyzing and designing the steel structures by limit state method.

Detailed Syllabus

Module	Sub Modules/Contents	Periods
1.	**Introduction**	04
	Types of steel structures, Properties of Structural Steel, Indian Standard Specifications and Sections, Design Requirements & Design Process, Advantages and limitations of WSM, Introduction to Limit State Design, partial safety factors for load and resistance, design load combinations, section classification such as plastic, compact, semi-compact and slender.	

2.	**Design of tension members**		**06**
	Introduction, types of tension members, net area calculation. Design strength due to yielding, rupture and block shear. Design of tension members with welded and bolted end connection using single angle section & double angle section.		
3.	**Design of compression members and column bases**		**15**
	3.1	Introduction, types of compression members, classification of cross sections, types of buckling, effective length of column and slenderness ratio, buckling curves, design of compression members as struts using single angle sections & double angle section.	
	3.2	Design of axially loaded column using rolled steel sections, design of built up column, laced and battened Columns.	
	3.3	Design of slab bases & gusseted base.	
4.	**Design of beams and welded plate girder**		**13**
	4.1	Design strength in bending, effective length, Lateral torsion buckling behavior of unrestrained beams, design of single rolled section with or without flange plates, design strength of laterally supported beams, low and high shear, design strength of laterally unsupported beams, web buckling, web crippling, shear lag effect and deflection. Design of angle section purlin.	
	4.2	Design of welded plate girder: proportioning of web and flanges, flange plate curtailment, stiffeners and connections	
5.	**Design of connections**		**05**
	Design of bolted and welded beam to beam and beam to column connections. Framed, stiffened and unstiffened seat, bracket connections.		
6.	**Design of truss**		**05**
	Design of determinate truss. Calculation of dead load, live load and wind load acting on truss. Load combinations and calculation of internal forces. Design and detailing of members. Support detailing.		
		Total	**48**

Contribution to Outcomes

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

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

Theory examination:

1. The question paper will comprise of **six** questions; each carrying 20 marks.
2. The first question will be **compulsory** and will have short questions having weightage of 5-8 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt any **three** questions out of remaining five questions.
5. Total **four** questions need to be attempted.
6. Sketches must be drawn on drawing sheets with pencil.

Oral Examination:

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

Term Work:

The Term work shall consist of following:

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

c) Welded plate girder.

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

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

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory and appropriate completion of the design report, drawing work and assignments and minimum passing marks obtained by student. The following weightage of marks shall be given for different components of the term work.

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

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

Recommended Books:

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

Semester VI

Subject Code	Subject Name	Credits
CEC603	Transportation Engineering-II	4

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

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

Rationale

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

Objectives

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

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	General Introduction: Role of transportation in Society, objectives of transportation system, different types of modes, planning coordination of different modes for Indian conditions.		**02**
	Railway Engineering		**08**
	1.1	Railways for urban transportation-Engineering surveys for track alignment-Obligatory Points-Conventional and modern methods (eg.Remote sensing, GIS)	
	1.2	Permanent way-track components their functions, sleeper – functions types, sleeper density, ballast functions different ballast materials.	
	1.3	Rails: coning of wheels tilting of rails, rail cross sections, wear creep of rails, rail fastenings.	
	1.4	Yards: details of different types of railway yards their functions.	
	1.5	Construction maintenance of railway track, methods of construction, material requirements, maintenance of tracks traffic operations.	
	1.6	Modernization of track and railway station for high speed trains, Mono rails and Metro rails.	
	1.7	Permanent way-track components their functions, sleeper – functions types, sleeper density, ballast functions different ballast materials.	
2.	**Geometric Design of Railway and Traffic Control**		**08**
	2.1	Geometrics: gradients, transition curves, widening of gauge on curves, cant deficiency.	
	2.2	Points crossing: design of turnouts, description of track junctions, different types of track junctions.	
	2.3	Signaling interlocking: classification of signals, interlocking of signals points, control of train movement.	
3.	**Airport Engineering**		**08**
	3.1	Aircraft component parts,their functions, aircraft characteristics and their influence on airport planning.	
	3.2	Airport planning: topographical geographical features, existing airport in vicinity, air traffic characteristics, development of new airports, factors	

		affecting airport site selection.	
	3.3	Airport obstruction: zoning laws, classification of obstructions, imaginary surfaces, approach zones, turning zones.	
	3.4	Airport layout: runway orientation, wind rose diagrams, basic runway length, corrections for runway length, airport classification, geometric design, airport capacity, runway configuration, taxiway design, geometric standards, exit taxiways, holding aprons, location of terminal buildings, aircraft hangers parking.	
	3.5	Airport marking lighting marking lighting of runways, taxiway, approach other areas.	
	3.6	Terminal area & airport layout: terminal area, planning of terminal buildings, apron: size of gate position, number of gate position, aircraft parking system, hanger, general planning considerations blast considerations.	
4.	**Air Traffic Control**		**06**
	4.1	Air traffic control aids, en-route aids, landing aids.	
	4.2	Airport drainage: requirement of airport drainage, design data, surface drainage design.	
	4.3	Airport airside capacity delay: runway capacity delays, practical hourly capacity, practical annual capacity, computation of runway system, runway gate capacity, taxiway capacity,	
	4.4	Air traffic forecasting in aviation: forecasting methods, forecasting requirement applications.	
5.	**Water Transportation**		**03**
	Introduction of water transportation system, harbors docks, port facilities.		
6.	**Bridge Engineering**		**04**
	Bridge Engineering: Importance, Investigations, Site Selection, Different terms related with Bridges; Waterway, Afflux, Economic span, Scour depth, Different types of bridges: Superstructures and sub-structures, Different loadings for design of bridges, Design requirements for high speed trains		
		Total	**39**

Contribution to Outcomes

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

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

Theory Examination:

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

Term Work:

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

Distribution of Term-work Marks

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

work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments: 20 Marks
- Attendance: 05 Marks

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

Recommended Books:

1. A Course of Railway Engineering: *Saxena, S. C. and Arora, S. P.*; Dhanpat Rai Sons, New Delhi.
2. Airport Planning Design: *Khanna, S.K., Arora, M.G.and Jain, J.J.; Nemchand Bros., Roorkee.*
3. Docks and Harbour Engineering: *Bindra, S. P.*; Dhanpat Rai and Sons, New Delhi.
4. Principles and Practice of Bridge Engineering: *Bindra, S.P.;* Dhanpat Rai and Sons, New Delhi.
5. Harbour, Dock and Tunnel Engineering: *Shrinivas, R.;* 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
4. Bridge Engineering: Victor, D. J., Tata Mc-Graw Hill Publishing House Pvt. Ltd., New Delhi
5. Bridge Engineering: *Bindra, S. P.*, Dhanpatrai and Sons, New Delhi

Semester VI

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

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

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

Rationale

Environment has gained increasing importance in the relation with the principles of public health engineering, design of waste water collection and treatment systems; and develops rational approaches towards sustainable waste management via appropriate treatment and reuse. The course deals with the overall features and study of treatment of sewage processes and solid waste management. The course lays emphasis on complete update of the knowledge of these processes related to design of treatment plant.

Objectives

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

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**Sewage Generation, Collection and Conveyance**		**10**
	1.1	**Introduction**: Need for sewerage system, Domestic sewage, Industrial waste and Storm Water, Conservancy and water carriage system, Systems of sewerage and their layouts: Separate, Combined and partially combined system, Merits and demerits, Patterns of sewerage layout, Quantity of sewage	
	1.2	**House drainage and Environmental sanitation** **Plumbing:** basic principles, Plumbing regulations, preliminary data for design, Preparation and submission of plans, Systems of Plumbing, anti-siphonic and vent pipes.	
	1.3	**Conveyance of sewage** Sewer: Shapes and materials of sewers, open drains, Design of sewers: sewer size, Determination of velocity of flow using empirical formulae, limiting velocities. Laying and testing of sewers, Sewer joints, Sewer appurtenances, Ventilation of sewers. Construction and Maintenance of sewers. Pumping of sewage: Pumping station components	
2.	**Characterization and Primary Treatment of sewage**		**07**
	2.1	Need for Analysis, Characteristics of sewage: Composition, Biochemical characteristics, aerobic decomposition, anaerobic decomposition, Sampling of sewage, Analysis of sewage. Treatment processes: Objective, methods of treatment, flow sheets showing Preliminary, and Primary, Secondary and Tertiary treatment. Primary treatment: Screening, Grit removal, Oil and Grease removal, settling tank.	
3.	**Conventional Biological treatments**		**11**
	3.1	**Secondary Treatment Methods** Trickling filter- Principle, Process description and Operational problems and Design. Activated sludge process (ASP) - Principle, Process description,	

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

Contribution to Outcomes

Having completed this course, the students shall ensure the safe handling and treatment of wastewater and sewage. The students shall be able to conduct quality control tests on samples obtained from sewer water, soil, nearby rivers and groundwater. The students shall be able to design the treatment facilities and assess the guidelines for disposing of waste. They shall be able to formulate approaches to treat waste water in most effective manner.

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

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

Theory examination:

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

List of Practical:(Any eight to be performed)

1. Determination of pH of sewage.
2. Determination of Chlorides.
3. Determination of Total Solids, suspended solids, dissolved solids, volatile solids.

4. Determination of Oil and Grease in waste water.
5. Determination of Dissolved oxygen.
6. Determination of Bio Chemical Oxygen Demand of sewage sample.
7. Determination of Chemical Oxygen Demand of sewage sample.
8. To find Sludge Volume Index (SVI) of sewage sample.
9. Plumbing demonstration of accessories, fittings and fixtures.
10. Solid waste: Determination of pH.
11. Solid waste: Determination of moisture content.

Term work:

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

Site Visit:

The student will visit to sewage treatment Plant in the nearby vicinity or in the city and prepare detailed report thereof. This report will form a part of the term work.

Mini Project :(Any one)

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

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon the quality of the term work. The final certification acceptance of term work warrants the satisfactory performance of the experiments by the student, properly compiled report thereof and the report on the

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

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

- Internal Oral examination based on Experiments and Assignments: 10 Marks
- Mini Project: 10 Marks
- Attendance: 05 Marks

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

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

Oral Examination

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

Recommended Books

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

Semester VI

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

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

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3	25	-	25	150

Rationale

India is an agricultural country where majority of population lives in villages so agricultural industry is the backbone of Indian economy. Being a tropical country with large temporal and spatial variation of rainfall and availability of rainfall only for three to four months, irrigation is strongly needed in India. To satisfy this need, enhancing the irrigation facilities in the country is required. This subject provides necessary knowledge about various irrigation methods based on crop water requirements, hydrologic processes, estimation of storage capacity of reservoir and hydraulics of wells.

Objectives

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

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
1.	**Introduction:**	6
	Definition of irrigation, water resources in India, development of irrigation in India, need of irrigation in India, Benefits of irrigation, ill effects of irrigation, irrigation systems: minor and major, medium and minor irrigation projects,	

	command area development, impact of irrigation on environment, national water policy.	
2.	**Irrigation methods and management**	**6**
	Types of irrigation: surface irrigation, subsurface irrigation; lift irrigation, bandhara irrigation, percolation tanks. Techniques of water distribution: free flooding, border flooding, check flooding, basin flooding, furrow irrigation method, micro irrigation: sprinkler irrigation, drip irrigation. Irrigation scheduling, participatory irrigation management.	
3.	**Water requirement of crops:**	**7**
	Crops and crop seasons in India, cropping pattern, duty and delta, quality of irrigation water, soil water relationship, soil characteristics significance from irrigation considerations, root zone soil water, infiltration, consumptive use, irrigation requirement, frequency of irrigation, water requirement and capacity of canal and reservoir, assessment of irrigation water, water conservation, rain water harvesting	
4.	**Hydrology**	**8**
	Hydrologic cycle, Precipitation: Types of precipitations, measurement of rainfall by rain gauges, stream flow measurement, runoff, factors affecting runoff, computation of runoff, yield of the catchment runoff hydrograph, runoff computations, flood discharge and calculations, unit hydrograph, application of unit hydrograph, methods of deriving unit hydrograph, S-hydrograph, complex hydrograph.	
5.	**Ground water and well hydraulics:**	**6**
	Ground water resources, occurrence of ground water, well irrigation. Well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifer, aquifer tests, design of water wells.	
6.	**Investigation and reservoir planning**	**6**
	Selection of site for reservoir, zones of storage reservoir, capacity elevation and area elevation curve of reservoir site, control levels, fixation of control levels, reservoir sedimentation, methods of control of sedimentation, evaporation loss, estimation and controlling methods of evaporation.	
	Total	**39**

Contribution to Outcomes

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

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

Theory Examination:

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

Oral Examination:

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

Term Work:

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

Distribution of the Term Work Marks:

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

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

- Assignments: 20 Marks

- Attendance: 05 Marks

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

Recommended Books:

1. Irrigation and Water Power Engineering: *B.C. Punmia, Pande B.B. Lal, A.K Jain*. Laxmi Publications Pvt, Ltd. New Delhi.

2. Irrigation Water Resources and Water Power Engineering: *P.N. Modi*, Standard Book House, Delhi, ISBN 978-81-87401-29-0.

3. Irrigation Engineering and Hydraulic Structures: *S.K. Ukarande,*Ane Books Pvt. Ltd.ISBN,9789383656899.

4. Irrigation Engineering and Hydraulics Structures: *S. K. Garg*, Khanna Publishers. Delhi.

5. Design of Irrigation Structures: *S. K. Sharma*, S. Chand and Co.

6. Theory and Design of Irrigation Structures: *R. S. Varshney and R, C. Gupta*, Nem Chand

7. Engineering for Dams, Vol. I to III: *Crager, Justin and Hinds*, John Wiley

8. Design of Small Dams: USBR.

9. Hydro Power Structures: *R. S. Varshney*, Nem Chand and Bross.

10. Concrete *Dams: R. S. Varshney*, Oxford and IBH Publishing Co.

Semester VI

Subject Code	Subject Name	Credits
CE-DLO6061	Departmental Elective-II: Advanced Construction Equipments	04

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

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 Hrs.	25	-	25	150

Rationale

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

Objectives

- To understand the characteristics and complexities involved in large civil engineering projects.
- To study the various advanced equipments used on, below or above ground/water.
- To study the various non-conventional construction techniques which make use of these advanced equipments.
- To gain knowledge regarding selection of appropriate equipment and techniques in construction for large and heavy engineering projects on the basis of suitability, availability, productivity, output, initial and operation cost, savings in time and other resources etc.

Detailed Syllabus

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

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

Contribution to Outcomes

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

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

- Understand the techniques involved and the equipments required thereof for construction of various transporting facilities.
- Gain knowledge about the setting up of different kinds of the power generating structures.

Theory Examination:

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

Oral Examination:

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

Term work:

The term work shall comprise of the neatly written report based on assignments (One for each module) and site visits (minimum 2). The assignments shall be given covering the entire syllabus and preferably different questions can be given to different group of students so that they themselves will create the question bank and answers for the same.

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

Distribution of Term Work Marks:

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

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

- Assignments: 10 Marks
- Report on Site Visits: 10 Marks
- Attendance: 05 Marks

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

Recommended Books/Study material:

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

Semester VI

Subject Code	Subject Name	Credits
CE-DLO6062	Departmental Elective-II:Traffic Engineering and Management	04

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

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 Hrs.	25	-	25	150

Rationale

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

Objectives

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

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

Detailed Syllabus

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

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

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

Contribution to Outcomes

After successful completion of the course:

- The students shall be able to understand different various characteristics of the road users and vehicles from their consideration view point in the traffic engineering and transportation planning.
- The students shall gain the knowledge of conducting different traffic surveys, analysing the data collected as a part of such studies and interpreting it with the help of the different statistical models.
- They will learn the concepts of PCU and LoS, their implication in determination of the capacity using Speed-Flow-Density relationships.
- The students shall, further, learn the aspects associated with highway safety and different TSM measures.
- They will acquire the knowledge of transportation planning and ascertain the financial viability of any transportation network in the inception stage itself.
- Pursuant to this, they will be able to design or plan the various features of highway geometrics and transportation infrastructure constituents to ensure safe, rapid, economical and efficient of the traffic.

Theory Examination:

1. The question paper will comprise ofthe six questions; each carrying 20 marks.
2. All the questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
3. There can be an option within various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics and to give justice to all the contents of the entire syllabus.
4. The students will have to attempt any three questions out of remaining five questions.
5. Total four questions need to be attempted.

Oral Examination:

The oral Examination shall be based upon the entire syllabus and the term work prepared by the student and appropriately certified by the course instructor/ teacher concerned.

Term Work:

The term work shall comprise of the neatly written report based on assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems/questions on each sub-modules and contents thereof further. Apart from this, the students shall conduct at least three traffic surveys and shall prepare a detailed report of the analysis of these surveys. This report shall also form a part of the term work.

Distribution of the Term Work Marks:

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

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

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

Recommended Books:

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

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

Semester VI

Subject Code	Subject Name	Credits
CE-DLO6063	Departmental Elective-II:Ground Improvement Techniques	04

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

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 Hrs.	25	-	25	150

Rationale

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

Objectives

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

Detailed Syllabus

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

Contribution to Outcomes

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

1. Identify problematic soils and their associated issues.
2. Study the various ground improvement techniques and propose suitable remedial techniques and design.
3. The course would develop the understanding for selection of appropriate soil improvement technique based on the soil type and application.
4. The course would cover details related to necessary knowledge for grouting design for various engineering applications in the field.
5. The course will make students acquainted with the pseudo-static method mostly used in designing the geotechnical structures under seismic condition

Theory examination:

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

Oral Examination:

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

Term Work:

The term work shall comprise of neatly written report based on assignments. The term work shall cover the entire syllabus in such a way that the students would attempt conceptual theory part from each module. Also the students in a group (maximum four students) should analysis and design any **three** with different data from the following:

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

Distribution of the Term Work Marks:

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

- Assignments: 10 Marks
- Report on Analysis and Design: 10 Marks
- Attendance: 5 Marks

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

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

Recommended Books:

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

Reference books:

1. Constructional and Geotechnical Methods in Foundation Engineering: R.M. Koerner, McGraw Hill, (1985).
2. Design and Construction of Stone Column: FHWA Report No. Rd 83/026, (1983)
3. Principles of Foundation Engineering: B. M. Das, 7th edition, Cengage Learning, (2013).
4. Designing with Geosynthetics: R.M.Koerner,4th Edition,Prentice Hall, Jersey, (1999).

Semester VI

Subject Code	Subject Name	Credits
CE-DLO6064	Departmental Elective-II: Advanced Structural Analysis	04

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

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

Rationale

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

Objectives

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

Detailed Syllabus

Module	Sub-Modules / Contents		Periods
1.	**Introduction to Stiffness Method in Matrix form**		**10**
	1.1	Basic concepts of stiffness coefficients, member stiffness matrix for beam, member stiffness matrix for plane truss, member stiffness matrix for rigid jointed plane frame, member stiffness matrix for plane grid and of space frame.	
	1.2	Properties of stiffness matrix, co-ordinate transformation matrix, stiffness matrix in local and global co-ordinate axes system, assemblage of structural stiffness matrix and application of boundary conditions.	
	1.3	Joint loads, Equivalent joint loads, method of solution for displacements and computation of internal forces in members	
	1.4	Application of stiffness method to beams, pin jointed trusses, rigid jointed plane frames and simple plane grid structures.	
2.	**Conventional Form of Stiffness Method, Modified Moment DistributionMethod**		**07**
	2.1	Symmetrical structure, Symmetric and anti-symmetric loads, Modification of stiffness and carryover factors for symmetric and anti-symmetric loads both for sway and non-sway cases for frames with different support conditions. Application to frames involving side sways.	
3.	**Flexibility Method in Matrix form**		**04**
	3.1	Review of concepts of flexibility coefficients, Flexibility member matrix for beam, member flexibility matrix for plane truss, member flexibility matrix for rigid jointed plane frame, member flexibility matrix for plane grid and of space frame.	
	3.2	Selection of primary structure, concepts of flexibility matrix, compatibility equation, solution for redundant forces, computational of internal forces, and joint displacement. Application to pin jointed trusses and rigid jointed plane frames for different loading including the effect of settlement of support, temperature changes and elastic supports.	
4.	**Conventional Form of Flexibility Method**		**07**
	4.1	Elastic Center Method and its application to rectangular box, and rigid	

		jointed portal frames.	
	4.2	Column Analogy Method and its application to analysis of non-prismatic beams, simple rectangular frames, determination of stiffness coefficients and carry over factors for non-prismatic beam members.	
5.	**5. Influence Line Diagrams for Indeterminate Structures**		**05**
	Muller Breslau's Principle for drawing influence line diagrams for statically indeterminate structures. Influence Lines Diagrams for propped cantilevers, fixed beams and continuous beams.		
6.	**6. Introduction to Finite Element Method**		
	6.1	Brief History of the Development; Advantages & Disadvantages of Finite Element Method.	**06**
	6.2	Different elements (1-D, 2-D, 3-D, CST Elements); Shape Functions & Interpolation Polynomials for two nodded bar and beam elements; Stiffness Matrix for the basic Bar & Beam Element, Solution Methodology.	
		Total	**39**

Contribution to Outcomes

The students will be able to

- Understand the Stiffness Matrix method and will be able to analyze various types of structures by this method understand the conventional methods of analysis.
- Understand the methodology involved in commercially available computer software for analysis which are based on stiffness matrix method.
- Obtain the response of the indeterminate beams under the action of moving loads.
- Evaluate the displacement/ deflection in frames under the action of loads.
- Demonstrate the ability to extend the knowledge gained in this subject for their higher years UG program courses, in which they will be dealing with the indeterminate structures.
- Understand the concepts of the finite element method toward solving the problem, different elements and shape functions (displacement functions) to extend the application to the short problems.

Theory Examination:

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

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

Oral Examination:

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

Term Work:

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

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

Or

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

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded depending upon the quality of the term work. Final certification, acceptance of term work warrants a satisfactorily appropriate completion of assignments the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Assignments: 20 marks
- Attendance: 5 marks

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

Recommended Books:

1. Basic Structural Analysis: Reddy C. S. Tata McGraw hill.
2. Analysis of Framed Structures: Gere and Weaver, East-West Press

3. Analytical Methods in Structural Analysis: S. A. Raz , New Age Int Publishers
4. Modern Method in structural Analysis: Dr. B. N. Thadani and Dr. J. P. Desai, Weinall Book Corporation.
5. Sructural Analysis: L. S. Negi & R. S. Jangid, Tata McGraw hill.
6. Structural Analysis Vol. I and Vol. II: Pandit and Gupta, Tata McGraw hill.
7. Analysis of Structures: V.N.Vazirani and M.M.Ratwani Khanna Publishers.
8. Finite Element Analysis: S.S. Bhavikatti, New Age International Publication

Reference Books:

1. Matrix Method in structural Analysis: Livesley R. K. Pergamon Press, London.
2. Elementary Structural Analysis: Wilber, M MethodGraw Hill, New York.
3. Plastic Method of Structural Analysis: B. G. Neal, Chapman and Hall, London.
4. Intermediate Structural Analysis: Wang C. K., Tata McGraw hill
5. Matrix Method of Structural Analysis: Dr. A. S. Meghre, S. K. Deshmukh, Charotar Publishing House.
6. Finite Element Analysis: S. Rajasekaran, S. CHAND & COMPANY PVT. LTD
7. Finite Element Method with application in Engineering Y.M.Desai,T. I.Eldho and A.H, Shah PEARSON
8. Finite Element Method: Daryl L. Logan, THOMSON
9. Matrix Structural Analysis: William McGuire, Richard H. Gallagher, Ronaid D. Ziemian, Wiley India Pvt. Ltd.

Semester VI

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

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

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

Rationale

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

Objectives

Students are introduced to:

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

Detailed Syllabus

Module	Sub-Modules/ Contents		Periods
1.	**General**		**02**
	1.1	Importance and need of software for modeling, analysis and design in Civil Engineering field, Advantages and limitations of software, causes for errors, validation of software results. Failures due to errors in modeling, data entry and interpretation of software results.	
2.	**Software application in various disciplines of Civil Engineering:** Learning and practice of any one software from each discipline		**24**
	2.1	**Drafting and drawing**: AutoCADD, Civil 3D, Auto plotter, Design and detailing of same using AutoCAD Beams (simply supported, continuous etc), Slabs (one way, two way), Columns, Portal frame, Truss	
	2.2	**Building Information Modelling**: Revit and ArchiCAD	
	2.3	**Numerical Analysis and Mathematical operations:**MATLAB	
	2.4	**Structural Analysis and Design:** STAAD Pro, ETABS, SAP 2000, SAFE, NISA, MIDAS, Tekla	
	2.5	**Finite Element Analysis**: ANSYS, ABAQUS	
	2.6	**Project Management:** Primavera, MS Project	
	2.7	**Geotechnical Engineering: Geo** studio, PLAXIS	
	2.8	**Quantity Surveying:** QS red, CCS Candy	
	2.9	**Environmental Engineering:** StormCAD, EPANET, Sewer CAD	
	2.10	**Remote Sensing and Geographical Information System:**QGIS, GRAM++, Arc GIS	
	2.11	**Transportation Engineering:** MXRoad, HDM, Road estimator	
	2.12	**Hydraulics and Water Resources Engineering**: Water Gems, Water CAD, FlowMaster, CulvertMaster, Nerosolution, Discipulus, HEC-RAS, ArcSWAT, Hydrology: HEC, HMS	
	2.13	Different Open source softwares used for specific problems	
	2.14	**MS Excel:** Conduct concrete mix design for M40 grade concrete. or any exercise of Civil Engineering domain.	
		Total	**26**

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

Contribution to Outcome

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

- Explain the use of softwares in various disciplines of Civil Engineering
- Demonstrate the ability to use the software in chosen field and provide solutions to field problems
- Validate the software results using judgment about range of answers.
- Identify the software application in particular field of Civil Engineering
- Identify open source softwares used in case of specific problems.
- Apply Independently different software's for specific problems

Term Work

Every student will prepare and give detailed power point presentation on any one software. Presentation should cover salient features, capability of software and should contain some applications from field.

The term work shall comprise of:

- At least hands-on working on any one Software from each domain listed above and preparing report of the same.
- Presentation Report on any one software.
- Open Source Software report
- Two neatly written assignments based on entire syllabus.

Distribution of the Term Work Marks

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

- Analysis and Design Report: 15 marks
- Presentation: 3 marks
- Assignments :2 marks

- Attendance: 5 marks

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

Recommended reading:

1. Software manuals.
2. Refereed Journal papers on Software applications.