University of Mumbai

Scheme of Instruction andExamination

Fourth Year Engineering (Civil Engineering)

(With effect from 2015-2016)

Semester VII

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CE-C701	Limit State Method for Reinforced Concrete Structures	4	2	--	4	1	--	5
CE-C702	Quantity Survey Estimation and Valuation	4	2	--	4	1	--	5
CE-C703	Irrigation Engineering	4	2	--	4	1	--	5
CE-C704	Environmental Engineering – II	4	2	--	4	1	--	5
CE-E705	Elective – I	4	2	--	4	1	--	5
CE-P706	Project – Part I	--	4	--	--	2	--	2
Total		**20**	**14**	**--**	**20**	**7**	**--**	**27**

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)				
		Test 1	Test 2	Avg						
CE-C701	Limit State Method for Reinforced Concrete Structures	20	20	20	80	3	25	--	--	125
CE-C702	Quantity Survey Estimation and Valuation	20	20	20	80	4	25	--	25	150
CE-C703	Irrigation Engineering	20	20	20	80	3	25	--	25	150
CE-C704	Environmental Engineering – II	20	20	20	80	3	25	--	25	150
CE-E705	Elective – I	20	20	20	80	3	25	--	25	150
CE-P706	Project – Part I	--	--	--	--	--	50	--	25[@]	75
Total		**100**	**100**	**100**	**400**	--	**175**	**--**	**125**	**800**

[@] **Seminar on Project (Internal)**

University of Mumbai

Fourth Year Civil Engineering

List of Electives

Semester VII (Theory: 4, Practical: 2)

1. Advanced Surveying
2. Rock Mechanics
3. Applied Hydrology Flood Control
4. Solid Waste Management
5. Systems Approach in Civil Engineering
6. Risk Value Management
7. Advanced Structural Analysis
8. Structural Dynamics
9. Advanced Structural Mechanics
10. Advanced Foundation Engineering
11. Ground Water Hydrology
12. Pavement Subgrade Materials
13. Air Pollution
14. Prestressed Concrete
15. Traffic Engineering Control
16. Reinforced Concrete Repairs Maintenance
17. Advanced Computational Techniques

Semester VIII (Theory: 4, Practical: 2)

1. Advanced Construction Engineering
2. Advanced Engineering Geology
3. Geographical Information Systems
4. Water Resources Engineering Management
5. Bridge Design Engineering
6. Environmental Impact Assessment Audit
7. Appraisal Implementation of Infrastructure Projects
8. Disaster Management
9. Pavement Design and Construction
10. Advanced Design of Steel Structures
11. Earthquake Engineering
12. Soil Dynamics
13. Building Services
14. Design of Hydraulic Structures
15. Industrial Waste Treatment
16. Transportation Planning Economics
17. Advanced Repairs and Rehabilitation of Structures
18. Geosynthetics and Reinforced Structures

Semester VII

Subject Code	Subject Name	Credits
CE–C701	Limit State Method for Reinforced Concrete Structure	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	25	--	--	125

Rationale

The limit state method (LSM) is based on the statistical probability which provides the rational solution to the design problem. The philosophy lies behind LSM uses multiple safety factors format which attempts to provide adequate safety at the ultimate load as well as adequate serviceability at service load by considering all possible limit states.The ultimate load method (ULM) proportions the structural element in such a way that the elements withstand the ultimate load, which is obtained by enhancing the service load by some factor referred to as the load factor, for giving a desired margin of safety. The ULM,thus, ensures safety but disregards the serviceability aspects, whereas the LSM ensures the safety at the ultimate load and serviceability at the working load rendering the structure fit for its intended use. The subject involves the application of limit state method in the analysis and design of various elements of the civil engineering structures such as beams, column, slab and footing. The application of the concept of Ultimate Load Method in the limited extent, i.e., for the flexural members like beams also forms a part of the course.

Objectives

1. To develop the clear understanding amongst the students of the concepts of the design of reinforced concrete structure using ULM and LSM.
2. To study the various clauses of IS: 456-2000 and its significance in the RCC design.
3. To apply the concepts of ULM in the analysis and design of beams.
4. To apply the concepts of LSM in the analysis and design of beams, slabs, columns and footings.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	**Ultimate Load Method:** Brief introduction to fundamentals of ultimate strength theory: curved stress distribution, compressive stress block, simplified rectangular stress block as per Whitney's approach, ultimate moment of resistance of singly reinforced section and doubly reinforced sections.	05
II.	**Limit State Method :** Introduction to limit state method of design as per IS 456 (latest edition): concepts of probability and reliability, characteristic loads, characteristic strength, partial safety factors for loads and materials, introduction to various limit states.	04
III.	**Limit State of Collapse – Flexure:** Limit state of collapse in flexure, shear and Limit state of serviceability in deflection and cracking, design of singly and doubly reinforced rectangular and T sections for flexure, design of members in shear and bond, design of beam subjected to bending and torsion. Requirements governing reinforcement detailing.	17
IV.	**Design of Slabs:** Design of one way and two way slabs	07
V.	**Limit State of Collapse – Compression:** Limit state of collapse compression for short and slender column. Members subjected to combined axial and uni-axial as well as biaxial	08

	bending. Development of interactive curves and their use in column design.	
VI.	**Design of Foundations:** Isolated square and rectangular footings subjected to axial load and moments. Design of combined rectangular pad footings, slab beam type footing and strap footing.	11

Contribution to Outcomes

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

1. Understand the pros and cons of the ULM and LSM vis-à-vis Working Stress method (WSM), covered in Semester VI.
2. Understand the various clauses specified in IS: 456-2000 for designing structural members with the safety and economy.
3. Understand the application and effectiveness of the LSM to the considerable extent along with the application of ULM in the limited extent.

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 the entire syllabus. For this, the modules shall be divided proportionately further; and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module 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.

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 three problems and/ or questions on each modules/ sub-modules or contents thereof, further.

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 : 20 Marks
- Attendance : 05 Marks

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

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

Recommended Books:-

1. Design of Reinforced Concrete Structures*: Dayaratnam, P;* Oxford and IBH.
2. Limit State Design – Reinforced Concrete: *Jain A. K,* Nemchand and Bros., Rorrkee
3. Limit State Design – Reinforced Concrete: *Shah and Karve,* Structure Publications, Pune.
4. Ultimate Strength Design for Structural Concrete: *Arthur, P. D.and Ramakrishnan, V.*, Wheeler and Co. Pvt. Ltd.
5. Limit State Theory of Reinforced Concrete Design:*Huges, B. P.,* Pitman.
6. Reinforced Concrete:*Warner, R. F., Rangan, B. C.and Hall, A. S.*, Pitman.
7. Reinforced Concrete:*H.J. Shah,* Charotar Publishers, Anand.
8. Fundamentals of Reinforced Concrete: *Sinha and Roy,* S. Chand and Co. Ltd.
9. Illustrated Reinforced Concrete Design: *Dr. V. L. Shah and Dr. S. R. Karve,* Structure Publications, Pune.
10. Reinforced Concrete Design: *Wang, C. K., Salmon, C. G., and Pincheira, J. A,*

John Wiley(2007), 7th Edition.

11. Reinforced Concrete Fundamentals: *Ferguson, P. M., Breen, J. E., and Jirsa, J. O.*, John Wiley andSons (1988) 5th Edition.
12. RCC Design (WSM and LSM): *Punmia, B. C.,Jain, A. K., and Jain, Arun, K.*, Laxmi Publications.
13. Limit State Design of Reinforced Concrete (as per IS: 456-2000): *Punmia, B. C., Jain, A. K., and Jain, Arun, K.*,Laxmi Publications.
14. Design and RCC structural Elements (RCC Vol-I): *Bhavikatti, S. S.*,New Age International Publications.

Semester VII

Subject Code	Subject Name	Credits
CE-C702	Quantity Survey Estimation and Valuation	05

Teaching Scheme

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

Evaluation Scheme

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

Rationale

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

Objectives

- To read, understand and interpret plans, sections, detailed drawings and specifications for a construction project.

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

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	**Estimates:** Various types, their relative importance, factors to be considered, 14 complete set of Estimate. Approximate estimates: importance, purpose, different methods. Use of CBRI Equations for the same. Methods of preparation of estimates for projects such as: i) Building R.C.C., Load bearing ii) Road iii) Cross drainage work iv) Factory shed including steel truss	18
II.	**Measurements for various items:** Use of relevant Indian Standard Specifications for the same, taking out quantities from the given requirements of the work, comparison of different alternatives, Bar bending schedules, Mass haul Diagrams	06
III.	**Material survey:** Approximate estimates of requirement of various materials for	05

	building works, percentage breakup of the cost, cost sensitive index, market survey of basic materials	
IV.	**Specifications:** Types, requirements and importance, detailing of specifications for various items	03
V.	**Rate analysis:** Purpose, importance and necessity of the same, factors affecting, task work.	06
VI.	**Tender:** Preparation of tender documents, importance of inviting tenders, contract types, relative merits, prequalification. general and special conditions, termination of contracts, extra work and items, penalty and liquidated charges, Settlement of disputes, R.A. Bill and Final Bill, Payment of advance , insurance, claims, price variation, etc.	06
VII.	**Valuation:** Different terms used the role of a valuer, purpose and necessity of the same. Capitalized Value, Years purchase,sinking fund, depreciation, types of values, Purpose of valuation. Different methods of valuation for 1. open plots. 2. open plots with existing residential and commercial structures 3. lease hold properties Use of valuation tables and formulae	08

Contribution to Outcomes

At the end of this course, the students will be able to:

- Read, understand and interpret plans, sections, detailed drawings and specifications for a construction project.
- Prepare approximate and detailed estimates based on the quantity survey of the available general and detailed drawings.
- Draft specifications, make bar bending schedules and draw mass haul diagrams.

- Haveknowledge about the current market rates for labour and material required for construction, perform rate analysis and compare with DSR.
- Draft tenders, prepare valid contract documents.
- Understand the process of arbitration.
- Understand the role of a valuer and assess the value of a property**.**

Theory examination:

1. Question paper will comprise of **six** questions; each carrying 20 marks.
2. The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module or 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 will be based on the entire syllabus and the term work.

Term Work:

The term work shall consist of the following:

1. An approximate estimate of a multistoried building by approximate method.
2. Detailed estimate of any **four** of the following with the required material survey for the same.
    a) a single storeyed building (RCC)
    b) a bridge with minimum 2 spans
    c) a factory building
    d) a road work
    e) a cross drainage work
    f) a load bearing structure

3. Valuation report in a standard format of the Government/ Private company/Firm.
4. Assignments on rate analysis, market survey, specifications and simple estimates.
5. Detailed estimate of a minor structure.
6. Bar bending schedule.

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

Distribution of Term Work Marks:

The marks of the term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on assignments. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments; and the minimum passing marks to be obtained by the students. The following 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. Estimating, Costing Specifications and Valuation: *Chakraborty, M.,* Kolkata.
2. Building and Engineering Contracts: *Patil, B. S.,* University Press, Hyderabad.
3. Estimating and costing: *Datta, B. N.,* UBS Publications
4. Relevant Indian Standard Specifications, BIS Publications
5. World Bank approved contract documents

Semester VII

Subject Code	Subject Name	Credits
CE-C703	Irrigation Engineering	5

Teaching Scheme

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

Evaluation Scheme

Theory					Termwork/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 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 survey for investigation, hydrology for calculation of yield from rainfall, designing the storage capacity, planning design and constructions of important irrigation structures like dams, weirs, cross drainage woks and canal structures. This subject is also useful to the students with respect to facts, concepts, principles and procedures related to irrigation structures so that they can effectively plan and execute these structures.

Objectives

1. To collect the data for irrigation system.
2. To calculate the yield from catchments.

3. To calculate the capacity of Canals.
4. To calculate the storage capacity of reservoirs.
5. To find out and fix the control levels of reservoirs.
6. To decide the section of Dams, Weirs and Barrages.
7. To classify the Canals and design the Canals.
8. To classify different irrigation systems.

Detailed Syllabus

Module	**Sub- Module/Content**	**Periods**
I	**Introduction:** Definition of irrigation, water resources in India, development of irrigation in India, need of irrigation in India, Benefits of irrigation, ill effects of irrigation, irrigation systems: major, medium and minor irrigation projects, command area development,impact of irrigation on environment, national water policy.	4
II	**Water requirement of crops:** Crops and crop seasons in India, cropping pattern, duty and delta. Quality of irrigation water. Soil water relationship: soil characteristics significant from irrigation considerations, root zone soil water, infiltration, consumptive use, irrigation requirement, frequency of irrigation. Methods of applying water to the fields: surface, sub-surface, micro irrigation: sprinkler irrigation, drip irrigation.	8
III	**Hydrology:** 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.	9

IV	**Ground water and well hydraulics:** Ground water resources, occurrence of ground water, methods of ground water exploration, well irrigation. Well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifer, aquifer tests, design of water wells.	7
V	**Investigation and reservoir planning** 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.	4
VI	**Dams:** Introduction, classification. Gravity dams: forces acting on gravity dam, modes of failure, stability analysis. Design, galleries, joints. Keys, water seals. Earth and rock-fill dams: types, causes of failure, seepage analysis, stability analysis, design, rock-fill dams. Arch and buttress dams: types. Spillways and types of spillways, other energy dissipating devices: types.	12
VII	**Distribution systems:** Canal systems, alignment of canals, canal losses, estimation of design discharge. Bandhara Irrigation. Canal outlets: non-modular, semi-modular and modular outlets. Waterlogging: causes, effects and remedial measures. Lining of canals: economics of lining. Drainage of irrigated land: necessity, methods, Canal regulation works. Cross drainage works and its types.	8

Contribution to Outcomes

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

1. Calculate the demand of water required for agricultural land
2. Understand basic requirements of irrigation and how can they be managed
3. Apply their knowledge on ground water, well hydraulics to estimate the safe yield and ground water potential
4. Perform analysis and design of various Irrigation systems including hydraulic structures
5. Carry out design of water resources projects independently.

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

Distribution of the Term Work Marks:

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

- Assignments : 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 Water Resources and Water Power Engineering: *P.N. Modi*, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
2. Irrigation Engineering and Hydraulic Structures:*S. K. Ukarande*, Ane's Books Pvt. Ltd. (Abridged Edition 2015), ISBN 9789383656899
3. Irrigation and Water Power Engineering: *B.C. Punmia, Pande, B.B. Lal, A.K Jain*. Laxmi Publications Pvt, Ltd. New Delhi.
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 and Bros., Roorkee
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 Bros. Roorkee
10. Concrete *Dams: R. S. Varshney*, Oxford and IBH Publishing Co.

Semester VII

Subject Code	Subject Name	Credits
CE-C704	Environmental Engineering - II	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	25	--	25	150

Rationale

Every civil engineer must be acquainted with the principles of public health engineering, design of waste water collection and treatment systems; and develop rational approaches towards sustainable waste management via appropriate treatmentand reuse. The course deals with the overall features and study of treatment of sewage processes. 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 in the urban water cycle and its relation to public health and environment.
- To develop rational approaches towards sustainable wastewater management via pollution prevention.

- To understand the relevant physical, chemical and biological processes and their mutual relationships within various sanitation components.
- Tocontribute to the development of innovative approaches to the provision of adequate and sustainable sanitation services in the country.
- To study the appropriate treatment, Reclamation and resource recovery and re-use at both centralized and decentralized levels.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	**Sewage Generation, Collection and Conveyance**	12
	Introduction : Need for sewerage system, Domestic sewage, Industrial waste and Storm Water- Quantification and design. Definitions: sewage, sullage, sewerage, 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, dry weather flow	
	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: Types, selection of pumps, Pumping station	
II.	**Primary Treatment of sewage:** Need for Analysis, Characteristics of sewage: Composition, Biochemical characteristics, aerobic decomposition, anaerobic decomposition, Sampling of sewage, Analysis of sewage. Treatment processes: Objective, methods of treatment, flow sheets showing Preliminary, Primary, Secondary and Tertiary treatment.	10

	Screens, Grit chamber, Primary and secondary clarifier. Design of primary treatment units.	
III.	**Secondary treatment methods:** Principles, Trickling filter, Activated sludge process, recirculation, hydraulic design of trickling filter and activated sludge process, Sludge volume index, Operational problems in trickling filter and activated sludge process, Aerated lagoons, Rotating Biological contractors, Stabilization Ponds, UASB . Design of secondary treatment units **Sludge treatment and disposal:** Sludge Digestion: Principles of anaerobic digestion, quantity and characterization of sludge, design of sludge digestion tanks, disposal of digested sludge, drying beds. **Sewage disposal :** Discharge of Raw and treated sewage on land and water, standards for disposal. **Self-purification of natural water bodies:** Oxygen economy, Numericals on BOD, Sewage farming. Disposal of treated effluent	16
IV.	**Reclamation and Reuse of Waste water :** Tertiary treatment for removal of residual organics, removal of nutrients, recycling and reuse of wastewater.	04
V.	**House drainage and Environmental sanitation** **Plumbing :** basic principles, Plumbing regulations, preliminary data for design, Preparation and submission of plans, Plumbing fixtures , materials used for plumbing system, systems of plumbing, antisiphonic and vent pipes. **Low cost sanitation:** Septic tanks, Imhoff tanks- Principles, Operation and suitability, Design.	06
VI.	**Environmental Pollution**: Air-Composition and properties of air, Quantification of air pollutants,Monitoring of air pollutants, Air pollution- Occupational hazards, Urban air pollution automobile pollution, Chemistry of combustion, Automobile engines, quality of	04

	fuel,operating conditions and interrelationship. Air quality standards, Control measures for Air pollution, construction and limitations, **Noise**-Basic concept, measurement and various control methods. Thermal pollution.	

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. Further, the students shall be able to design the treatment facilities and assess the guidelines for disposing of waste. Lastly, they shall be able to formulate approaches to treat waste water in most effective manner.

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 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.

List of Practical (*At least eight to be performed)*

1. Measurement of Noise level
2. Determination of chlorides
3. Determination of pH of sewage
4. Determination of Total Solids, suspended solids, dissolved solids, volatile solids
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. Measurement of air quality standard by High volume sampler
10. Plumbing demonstration of accessories, fittings and fixtures.

Site Visit:

The students will visit the 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.

Oral Examination:-

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

Term Work:

The term-work shall comprise of the neatly written report based on the experiments performed in the laboratory and the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems and/or questions on each modules/ sub-modules and contents thereof, further. Adetailed report on the visit to sewage treatment plant will also be submitted as a part of the term work.

Distribution of the Term Work Marks:

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

1. Report of the Experiments: 08 Marks
2. Assignments: 08
3. Report on the visit to Sewage Treatment Plant : 04 Marks
4. 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

Demonstration of available software for design of sewage treatment plant and sewer network is to be done.

Recommended Books:

1. Environmental Engineering (Vol. II):*Garg, S. K.*, Khanna Publishers, New Delhi.
2. Water supply and Sanitary Engineering:*Hussain, S. K.*, Oxford and IBH Publication, New Delhi.
3. Plumbing Engineering,Theory and Practice: *Patil, S. M.*, Seema Publications, Mumbai.
4. Environmental Engineering: *Punmia, B. C.*, Laxmi Publications, New Delhi
5. Air pollution:*Rao, M. N.*, Tata Mc-Graw Hill Publishers, New Delhi
6. Environmental Engineering:*Peavy, H. S., Rowe D. R. and Tchobanoglous G.*; Tata-Mcgraw Hill, 1991.
7. Wastewater Engineering Treatment, Disposal, Refuse: *Metcalf and Eddy*, Tata McGraw Hill Publishers, New Delhi, 1995.
8. Water Supply and Sewerage:*Steel, E.W.*
9. Introduction to Environmental Engineering:*P. Aarne Vesilind*, PWS Publishing Company, 2000
10. Introduction to Environmental Engineering :*P. Aarne Vesilind, Susan M. Morgan*, Thompson /Brooks/Cole; Second Edition 2008
11. Manual on Wastewater Treatment: CPH and Env. Engg. Organization (3rd Ed.), Ministry of Urban Development, Govt. of India, New Delhi, 1991.
12. CPHEEO Manual on Sewage and Treatment
13. Relevant Indian Standard Specifications

Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: Advanced Surveying	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	25	--	25	150

Rationale

This is an advanced course dealing in modern surveying instruments such as Total Station, Electronic Theodolite and Electronic Distance Measuring (EDM) Instruments. This subject also includes the study of GPS (Global Positioning System) for navigation and positioning including the applications of GIS (Geographic Information System). Detailed study of Photogrammetry and its geometrical considerations are taken into account. Advanced surveying also includes Remote Sensing and image interpretation techniques along with field astronomy and hydrographic surveying.

Objectives

- To study traversing using Total Station.
- To establish Waypoints/ Networks using GPS receivers.
- To demonstrate GIS software
- To Measure the Relief Displacement using Mirror Stereoscope.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	**ModernSurveyingEquipment:** Dataandequipmentneededforengineering projects. Review of traditional surveying equipment. Changingsceneinsurveyingandmapping,mapsubstitutes,useand advantage of modern surveying equipment in project. Modernsurveying electronicequipment,theirprinciples,constructionsworkinganduse-ElectronicTheodolite,E.D.M.Instruments-Distomat,Totalstation.Applicationoflasersin distanceandangularmeasurements.Introductionof electronicnavigationandpositionfixing.Differentsystemsandtheir characteristics.	09
II.	**GlobalPositioningSystem:** Introductiontonavigationandpositioning, Geodesy;geospatialreferencesystems,overviewofGPS;GPSsegments, 2Dand 3Dpositioning, GPS error sourcesandhandling, GPSapplications.	06
III.	**GeographicInformationSystem:** GeographicInformationSystem(GIS)-DefinitionofGIS,Geographicalconcepts and terminology,Componentsof GIS,Dataacquisition,Rasterandvectorformats,scannersand digitizers. AdvantagesofGPSandGISinthestoragethematicinformationextracted fromremotelysensedimages.	08
IV.	**Photogrammetry:** Definitionofphotogrammetricterms,geometryofaerial andterrestrialphotographs,aerialcameraandphoto theodolite,scalesof photographs,tiltandheightdisplacementsstereoscopicversionand stereoscopes,heightdeterminationfromparallaxmeasurements,flight planning.mansand mansubstitutesandtheiruses.	08

V.	**RemoteSensing:** Introductionand definitionofremotesensingterms,remote sensingsystem,principlesofremotesensing,InteractionofEMR, Fundamentalsofaerialphotography,platformsandorbits,sensors,data products,principlesofvisualinterpretation,principlesanduses;thermal remotesensitize, microwave remotesensing.	08
VI.	**ImageInterpretation:** Principlesofinterpretationofaerialandsatellite images,equipmentsandaidsrequiredforinterpretation,groundtruth-collectionand verification,advantagesofmultidateandmultibandimages, digitalimageprocessing;introduction,imageenhancementtechniques, digital image classification.	07
VII.	**FieldAstronomy:** Terms,coordinatesystems,hourangle,right declination,altitude,and azimuth:studyofastronomicalcharts,deter latitudeandbearingbyobservationonthesunandpolestar,time, standardtime,localtime,universaltime,equationoftime.	03
VIII.	**HydrographicSurveying:** Uses, Methodofhydrographicsurveys, mean sea-level,tidegauges,soundingequipments,locationofsoundings, the capacity of reservoir, stream gauging	03

Contribution to Outcomes

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

1. Use modern surveying instruments.
2. Use GPS receivers.
3. Demonstrate GIS software.
4. Use Mirror Stereoscope.

Theory Examination:-

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

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

Oral Examination:

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

Term Work:

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

Distribution of Term-work Marks:

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

- Report of the Practical/ Field Studies : 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. Highersurveying:*A.M.Chandra*, NewAgeInternationalpublishers.
2. Highersurveying:*B.C.Punimia,AshokJoin,ArunK.Jain*, LaxmiPublications(P), Ltd.
3. Geographic Information System and Science: *Longley, Paul A., Michael F. Goodchild, David J. Maguuire, David W. Rhind*, John Wiley and Sons, New York (2nd Ed.), 2005
4. ModelingOurWorld:TheESRIGuidetoGeodatabaseDesign:*Zeiler,M*.ESRI Press,Redlands,California, 1999.
5. GIS,SpatialAnalysis,andModeling:Maguire,*D.,M.Batty,andM.Goodchild*.2005. ESRIPress(070.212.05842005)
6. GlobalPositioningSystem:Signals,Measurements,andPerformance,*PratapMisraandPe r Enge*(2nd Ed.), 2006.
7. RemoteSensingPrinciplesand Interpretation*: Floyd,F.Sabins,Jr:,Freeman*andCo.,San Franscisco,1978.
8. RemoteSensingandImageInterpretation:*LillesandandKiefere*:,JohnWiley,1987.
9. A Remote Sensing Perspective: Introductory Digital Image Processing:*John,R. Jensen*, PrenticeHall.
10. ImagingRadarforResource Survey:Remote SensingApplications:*W.Travelt*,Chapman andHall.

Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: Rock Mechanics	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	25	--	25	150

Rationale

There are several structures such as foundations, dams, rock slopes, tunnel, hydroelectric and energy generating plants, mines, etc. which are built directly on or in rock masses. The design of structures depends on the rock mass properties and the interaction between the rock and the structure. This demands the study of mechanics applied to rocks and engineering activity involving rocks. The course is an interdisciplinary course with applications in geology and geophysics, mining, petroleum and geotechnical engineering.

Objectives

1. To study the structural geology and classification of rock masses
2. To study the stress distribution and stress - strain behaviour of rocks
3. To study bearing capacity of rocks
4. To study the stability of rock slopes and openings in rocks

5. To study the rock bolting and grouting.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	**Structural Geology of Rocks**: Introduction	04
II.	Subsurface Investigations in Rocks and Engineering Characteristics of Rock Masses	04
III.	**Engineering Classification of Rocks and Rock Masses:** Classification of intact rocks, rock mass classifications {rock quality designation, rock structural rating, geomechanics classification (RMR)}, strength and modulus from classifications, classification based on strength and modulus, geo-engineering classification, Deere and Miller's Engineering Classification.	06
IV.	**Stress Distribution in Rocks:** Field and Laboratory Tests on Rocks	07
V.	**Strength, Modulus and Stress-Strain Responses of Rocks:** Factors influencing rock responses, strength criteria for isotropic intact rocks, modulus of isotropic intact rocks with confining pressure, uni-axial compressive strength of intact anisotropic rocks, strength due to induced anisotropy in rocks, compressive strength and modulus from SPT, stress- strain models (constitutive models, elastic stress-strain model, elasto-plastic stress-strain model, equivalent material concept), influence of intermediate principal stress.	07
VI.	**Bearing Capacity of Rocks:** Estimation of bearing capacity (foundation on intact rock, heavily fractured rock, UBC with Hoek-Brown criterion, foundation on slope), stress distribution in rocks, factor of safety, strengthening measures (concrete shear keys, bored concrete piles, tensioned cable anchors, concrete block at toe), settlement in rocks (from joint factor, for horizontal joints, from field tests).	07
VII	**Stability of Rock Slopes:**	06

	Modes of failure, rotational failure, plane failure, wedge method of analysis, buckling failure, toppling failure, improvement of slope stability and protection.	
VIII	**Opening in Rocks:** Introduction to theory of elasticity, lines and unlined tunnels, pressure tunnels and tunnels for other purposes.	06
IX	**Rock Bolting and Grouting:** Grouting in rocks, objectives, contact grouting, consolidation grouting, process of grouting, grout requirement, types of grout, stage grouting, grout curtain. Rock bolts, rock bolt types and applications, theory of rock bolting, rock anchors, modes of failure, uplift capacity.	05

Contribution to Outcomes

On successful completion of the course, the students shall develop an ability to identify, formulate and solve rock associated problems. They are further expected to acquire the knowledge about the latest trends and methodologies for understanding rock mechanics and engineering.

Theory Examination:-

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

Oral Examination:

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

Term Work:

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

Distribution of Term Work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments;andthe 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. Fundamentals of Rock Mechanics: *J. C. Jaegar and N. G. W. Cook*, Oxford Press.
2. Rock Mechanics and Design of Structures on Rock: *Obert, Leon and W. I. Duvall*.
3. Rock Mechanics in Engineering Practice: *K. G. Stagg and O. C. Zienkiewicz*, John Willey and Sons, New York.
4. Rock Mechanics – Vol. I and II: *Jumukis*, Trans Tech Publication, USA.

Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: Applied Hydrology and Flood Control	05

Teaching Scheme

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

Evaluation Scheme

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

Rationale

This subject deals with the various processes involved in hydrological cycle and provides in depth understanding of the theories and concepts of surface, subsurface and ground water hydrology. It also explains the application of hydrographs, unit hydrographs and further describes various techniques of estimating stream flows.

Objectives

1. To study the various processes involved in the hydrological cycle.
2. To study the Measurement of rainfall, computation of average rainfall, various water losses etc.
3. To study the hydrograph and unit hydrographs, applications of unit hydrograph concept.
4. To study various flood control methods, estimate design flood, and flood routing.

5. To study the concepts of ground water movement, steady and unsteady flow towards fully penetrating wells and well yields.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	**Introduction:** Hydrological cycle, scope of hydrology, water budget equation, sources of data.	2
II.	**Precipitation:** Measurement of precipitation, network of rain gauges and their adequacy in a catchment, methods of computing average rainfall, hyetograph and mass curve of rainfall, adjustment of missing data, station year method and double mass curve analysis, Depth-Area - Duration relationship, Intensity-Duration -Frequency relationship, Probable Maximum Precipitation.	5
III.	**Abstractions from Precipitation:** Evaporation and transpiration, evapotranspiration, interception, depression storage, infiltration and infiltration indices, determination of water losses.	3
IV.	**Stream Flow Measurement:** Measurement stream-flow by direct and indirect methods, measurement of stage and velocity, area-velocity method, stage-discharge relationships, current meter method, pitot tube method, slope-area method, rating curve method, dilution technique, electro-magnetic method, ultrasonic method.	6
V.	**Runoff:** Catchment, watershed and drainage basins, Factors affecting runoff, rainfall-runoff relationship, runoff estimation, droughts.	4
VI.	**Hydrograph Analysis:** Characteristics, base *flow* separation, unit hydrograph, S-hydrograph, complex hydrograph, synthetic hydrograph, dimensionless unit hydrograph, Instantaneous unit hydrograph.	14

VII.	**Floods:** Estimation, envelope curves, flood frequency studies, probability and stochastic methods, estimation of design flood, flood control methods, Limitations, risk-reliability and safety factor.	5
VIII.	**Flood Routing:** Reservoir routing, channel routing.	5
IX.	**Ground Water Hydrology:** Yield , transmissibility, Darcy's law, Dupuit's theory of unconfined flow, steady flow towards fully penetrating wells (confined and unconfined).Unsteady flow towards wells: Jacob's curve and other methods, use of well Function, pumping tests for aquifer characteristics, methods of recharge.	8

Contribution to Outcomes

On completion of this course, student shall have a good understanding of the:

- principles of hydrologic cycle and water budgeting
- measurement and analysis of precipitation and water losses
- rainfall-Runoff relationships, runoff estimation and stream gauging techniques
- hydrographs and unit hydrographs, application of unit hydrographs
- steady and unsteady flow towards well, aquifer characteristics and yields from wells.

Theory examination:

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

Term Work:

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

Distribution of Term Work Marks:

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

- Assignments : 20 Marks
- Attendance : 05 Marks

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

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

Recommended Books:

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

Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: Solid Waste Management	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	25	--	25	150

Rationale

This course will be of interest to those who wishes to understand the principles and techniques of solid waste management, including the legislative, environmental, economic and social drivers. The course also provides the opportunity to visit recycling facilities and disposal sites to better understand links between theory and practice.This subject deals with control of generation, storage and collection, transfer, processing and disposal of solid waste in a manner in which it benefits-public health economics, conservation aesthetics and other environmental considerations.

Objectives

- To understand the implications of the production, resource management and environmental impact of solid waste management.

- To understand the components of solid waste management infrastructure systems to minimize the above effects.
- To be aware of the significance of recycling, reuse and reclamation of solid wastes.
- To be familiar with relationships between inappropriate waste management practices and impacts on water, soil and sediment quality.
- To fully appreciate the current practices available and implement the systems available in solid waste management.
- To be capable of carrying out an assessment of the relationships between environmental guidelines, human activities and environmental quality of impacted soils and water.
- To study the different storage and collection method of the solid waste management.

Detailed Syllabus

Module	Sub-Modules/Contents	Periods
1.	**Introducing Municipal Solid Waste Management** Overview: problems and issues of solid waste management - Need for solid waste management-Functional elements such as waste generation, storage, collection, transfer and transport, processing, recovery and disposal in the management of solid waste.	05
2.	**Generation and Characteristics of Waste** Sources, Types, composition, quantity, sampling and characteristics of waste, factors affecting generation of solid wastes.	04
3.	**Waste Collection, Storage and Transport** Collection and storage of municipal solid waste; Methods of collection - House to House collection - Type of vehicles-Manpower requirement-collection routes; on site storage methods-materials used for containers-Reduction of solid waste at source-on site segregation of solid waste-Recycling and Reuse Need for transfer and transport; transfer station-selection of location, operation and maintenance; transportation Methods-manual, Mechanical methods with or without compaction, economy in transportation of waste optimization of transportation routes.	10

4.	**Waste Processing Techniques** Processing techniques-biological and chemical conversion technologies – composting and its methods, vermicomposting, mechanical composting, In vessel composting, incineration, pyrolysis, gasification.	07
5.	**Disposal of Solid Waste** Segregation, reduction at source, recovery and recycle; dumping of solid waste-sanitary waste- sanitary landfills-site selection-design and operation of sanitary landfill-secure landfills-landfill bioreactors-leachate and landfill gas management-landfill closure and environmental monitoring-landfill remediation; Municipal solid waste in Indian conditions, legal aspects of solid waste disposal.	12
6.	**Industrial Solid Waste** Waste products during manufacturing and packing, operation of pollution control facilities, generation, minimization at source, recycling, disposal.	04
7.	**Hazardous Waste** Definition, sources, hazardous characteristics, management, Treatment and disposal, mutagenesis, carcinogenesis, Toxicity testing.	04
8.	**Biomedical Waste** Definition, sources, classification, collection, segregation, treatment and disposal.	04
9.	**Electronic Waste** Waste characteristics, generation, collection, transport and disposal.	02

Contribution to outcomes

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

Theory examination:

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

Site Visit:

Each student shall visit any site involving industrial/hazardous/municipal solid waste comprising source, characterization, transportation, recycles, treatment and disposal. The detailed report prepared on such visit will also form a part of the term work.

Term Work:

The term-work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems and/ or questions on each modules/ sub-modules and contents thereof further. A detailed report prepared on the site visit as mentioned in the afore-mentioned section will also be submitted along with the assignments.

Distribution of Term Work Marks:

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

1. Tutorial and Assignments: 16Marks
2. Report on the site visit : 04 Marks
3. 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

Demonstration of available software for design of sewage treatment plant and sewer network is to be done.

Recommended Books:-

1. Integrated Solid Waste Management: *Techobanglous, Thisen, and Vigil*, McGraw Hill International.
2. Hazardous Waste Management: *Lagrega, Buckingham, and Evans*, McGraw Hill International.
3. Solid Waste Management in Developing Countries: *Bhide, A. D.*, Nagpur publications.
4. Environmental Pollution Control Engineering: *Rao, C. S.*, Wiley Eastern, Manual of solid waste of management, CPHEEO.
5. E-Waste: Implications, Regulations, and Management in India and Current Global Best Practices, *Rakesh Johri*, The Energy and Resources Institute.
6. Biomedical Waste Management in India: *Jugal Kishore and Ingle, G. K.*, Century Publications.

Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: System Approach in Civil Engineering	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	25	--	25	150

Rationale

Use of advanced analytical techniques to improve decision making is the need of the hour in Civil Engineering, considering the present scenario. Systems approach is also known as operations research, management science or industrial engineering. People with skills in systems approach hold jobs in decision support, business analytics, marketing analysis and logistics planning in civil engineering projects.This course is indeed required by the civil engineering professionals, as it makes sense to make the best use of available resources. Today's global markets and instant communications mean that customers expect high-quality products and services when they need them, where they need them. The organizations, whether public or private, need to provide these products and services as effectively and efficiently as possible. This requires careful planning and analysis – the hallmarks of good systems approach. This is usually based on process modelling, analysis of options or business analytics.This course helps a civil engineer to arrive at proper scheduling, facility planning, forecasting, managing and marketing their projects

Objectives

1. To develop the skill for problem formulation amongst the students so as to enable them understand various components for formulating a problem
2. To develop decision making, especially, under uncertain scenario, risks, etc.
3. To enable thestudents formulate LPP, NLP, distribution queuing models, assignment and transportation models, games theory, replacement models and other such optimization techniques and should be able to analyze them.

Detailed Syllabus

Module	Sub- Modules/Contents	Periods
I	**Concept of Systems Approach:** 1.1 System, boundaries of system, goals and objectives, optimality, 1.2 Mathematical models, objective function and constraints, 1.3 Problem solving mechanism, types of problems, modeling/problem formulation, 1.4 Sub-optimization, solution techniques, 1.5 Sensitivity Analysis	07
II	**Decision Theory:** 2.1 Classification of decision situations, decision tables and decision tree, 2.2 criteria for decision making under certain, uncertain and risk conditions, 2.3 Utility theory	07
III	**Time Series Analysis::** 3.1 Variations in time series, 3.2 Trend analysis: method of moving averages 3.3 Method of least squares	06

IV	**Linear Programming:** 5.1 Formulation of Linear optimization models, Civil engineering applications. 5.2 Simplex method, special cases in simplex method, 5.3 Method of Big M, Two phase method, duality, sensitivity analysis General nature of problem, formulation of problems 5.4 Graphical nature and formulation of problem, method of solution, 5.5 Sensitivity analysis	08
V	**Non-Linear Programming:** 4.1: Single variable unconstrained optimization –Local and Global optima, Uni-modal Function 4.2 Sequential Search Techniques: Dichotomous, Fibonacci, Golden Section methods.	05
VI	**Distribution Models:** 6.1 Transportation problems and its variants 6.2 Assignment problems and its variants 6.3 Games Theory	07
VII	**Queuing, Sequencing and Replacement Models:** 7.1 Queuing Theory, queue discipline, Simulation 7.2 Sequencing model – n jobs through 2, 3 and M machines 7.3 Replacement Models	06
VIII	**Dynamic Programming:** 8.1 Multi stage decision processes, Principle of optimality, Recursive equation, Application of D.P. 8.2 Decision theory	06

Contribution to Outcomes

On successful completion of the course, the students shall be able to solve various civil engineering problems by formulating them into linear and non-linear programmes. Further, they are expected to be able to analyze and take appropriate decisions by applying transportation, assignment, sequencing making, replacement models to the specific problems. They are also expected to apply dynamic programming, games theoryand other such optimization approaches to civil engineering 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, 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 the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least three problems and/ or questions on each modules/ sub-modules and contents thereof further.

Distribution of Term Work Marks:

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

- Assignments : 20 Marks
- Attendance : 05 Marks

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

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

Reference Books:

1. Operations Research : *Hamdy A.Taha*
2. Engineering Optimization—Theory and Practice:*Rao.S. S.,* Wiley.
3. Engineering Optimization—Methods and Applications: *Ravindran Philip*s,Wiley
4. Operations Research:*Sharma, J. K.*
5. Quantitative Techniques in Management:*Vohra, N. D.*
6. Principles of Construction Management:*Pilcher, R.*
7. Operations Management: *Buffa, E. S.*
8. Principles of Operations Management: *Wangner, H. M.*
9. Principles of Operation Research: *Wagner,* Prentice Hall.
10. Operation Research:*Hira* and *Gupta*, S.Chand
11. Operations Research: Principles and Practice: *RavindravPhilip* and *Solberg*,Wiley,India

Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: Risk and Value Management	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	25	--	25	150

Rationale

Many risks and uncertainties are associated with civil engineering projects. As these projects are directly applicable and beneficial to the society, oneneeds to carry out all such projects with great care by applying risk management in practices. At the same time, one needs to maintain the value right from the conception stage of the project. This course is indeed required by the civil engineering professionals as it makes sense to identify the risks involved and manage risks through the management system. This course helpsthecivil engineer to get acquainted with value engineering approach, function analysis, etc.

Objectives

1. To understand the types of risks involved in civil engineering/ construction projects.
2. To enable the students develop the skills of managing the risks.
3. To prepare value engineering job plan.

4. To make the students understand the basic concept of function analysisfor achieving the value.
5. To impart to the students the knowledge of the life cycle costing of the civil engineering/ construction projects.

Detailed Syllabus

Module	Sub- Modules/Contents	Periods
I.	**Risks** Definition, Types of risks; Uncertainties in projects.	03
II.	**Risks associated with construction** Risks related to resources- Time, Money, Technology, Manpower etc.; Risks related to agencies- Client, Contractor etc.; Decision making in construction.	05
III.	**Risk Management Systems:** Risk identification, sources of risks.; Classification of risks, Impact and consequences of risks; Risk qualification and risk analysis; Risk response, retention, reduction, transfer and avoidance	07
IV.	**Value Engineering:** Definition: Value, Value Engineering, Value Analysis; Value Management; Habits, attitudes and roadblocks and their relation to value Engineering.	07
V.	**Value Engineering Job Plan:** Definition: Value Engineering Job Plan, Various versions of plan; Phases involved in Job Plan.	04
VI.	**Function Analysis:** Function and its role in achieving value; Function in terms of its cost and worth; Graphical functional analysis; Function analysis system technique.	06
VII.	**Creative Thinking:** Definition: Creative Thinking; Creative People and their characteristics; Creative Processes, Creative sessions etc.	06

VIII.	**Life Cycle Costing :** Definition, Purpose and implications; Economic Principles for L.C.C.; Types of life cycle costs.	05
IX.	**Energy :** Energy resources and consumption; Energy embodiment of construction materials; Factors affecting energy consumption; Impact of maintenance on energy saving.	07
X.	Integrated approach to value and risk management**.**	02

Contribution to Outcomes

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

1. Identify the risks associated with the projects and apply risk management systems.
2. Understand the value approach clearly and apply the measures for achieving the value.
3. Prepare value engineering job plan.
4. Know about the creative thinking, creative people which will be very much helpful for them in future.
5. Understand the effective consumption of valuable energy.

Theory Examination:-

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

Oral Examination:

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

Term Work:

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

Distribution of TermWork Marks:

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

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

- Assignments : 20 Marks
- Attendance : 05 Marks

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

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

Recommended Books:-

1. Value Engineering: L.W. Zimmerman, *Hart, G.D.* (CBS publishers and distributors.)
2. Value andRisk Management: *Dallas, M.F.* (Blackwell publishing.)
3. Risk Management andConstruction: *Flagnan, R.*and*Norman, G.*(Blackwell Scientific)
4. Value Engineering in the Construction Industry – *Dell'lsola, A.J.*(Construction publication company)

Semester VII

Subject Code	Subject Name	Credits
CE – C 705	Advanced Structural Analysis	6

Teaching Scheme

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

Evaluation Scheme

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

Rationale

There are various types of the civil engineering structures which are subjected to various types of loading and their combination. Most of the structures are indeterminate. There are various advanced method to analyze these structure. The methods of analysis which are given in the syllabus are amenable to computer software.

Objectives

- To analyze the statically indeterminate portal frame.
- To study the various methods for evaluating rotation and displacement parameters in complete frame.
- To analyze the symmetrical frame with symmetrical and anti-symmetrical loading.
- To understand the concept of analysis of non-prismatic frame and beam.
- To understand the concept of influence lines with respect to statically indeterminate beams.

- To understand the concept of plastic analysis with respect to the simple portal frame.
- To understand thoroughly the stiffness matrix method of analysis which is the basis of all computerbasedsoftware methods used in practice.

Detailed Syllabus

Module	Sub – Modules / Contents		Periods
I.	**1. Introduction to stiffness Method in Matrix Form** :		15
	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.	
II.	**2. Conventional Form of stiffness Method, Modified Moment Distribution Method, Kani's Method :**		10
	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	
	2.2	Fundamental equation of Kani's method, frames with side sway and without sway.	
III.	**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	
IV.	**4. Conventional Form of Flexibility Method :**		10
	4.1	Elastic Center Method and its application to rectangular box, rigid jointed portal frames and fixed arches.	
	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	
V.	**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.		
VI.	**6. Approximate Method for Analysis of Building Frames :**		05
	6.1	Approximate method for gravity loads: Substitute frame method and equivalent frames.	
	6.2	Approximate method for lateral loads: Portal and cantilever method.	
VII.	**7. Plastic Analysis of Steel Structures :**		03
	Application to single bay single storey rectangular frames		

Contribution to Outcomes

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

- Understand the stiffness matrix method and to analyze various types of structures using this method.
- Understand the conventional and approximate 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

Theory Examination:-

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

Oral Examination:

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

Term Work:

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

Distribution of Term Work Marks:

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

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

- Assignments : 20 Marks
- Attendance : 05 Marks

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

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

Recommended Books:

1. Basic Structural Analysis: *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. Structural Analysis: *L. S. Negi and R. S. Jangid*, Tata McGraw hill.
6. Structural Analysis Vol. I and Vol. II: *Pandit and Gupta*, Tata McGraw Hill.
7. Fundamentals of Structural Mechanics and Analysis: *Gambhir, M.L*., Prentice Hall India (PHI) Learning Pvt. Ltd.
8. Structural Analysis Vol.II: *Vaidyanathan, R. and Perumal*, P., Laxmi Publications
9. Fundamentals of Structural Analysis: Roy, Sujit Kumar and Chakrabarty, Subrata, S. Chand and Co. Ltd., New Delhi
10. Structural Analysis: *T.S. Thandavamoorthy*, Oxford Higher Education

Reference Books:

1. Matrix Method in Structural Analysis: *Livesley R. K. Pergamon Press*, London.
2. Elementary Structural Analysis: *Wilber*, McGraw 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. Structures: *Schodek, D.L. and Bechthold, Martin*, Prestice Hall India Learning Pvt. Ltd.
7. Matrix Analysis of Structures: *P. K. Singh*, Cengage Learning.

Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: Advanced Structural Mechanics	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	25	--	25	150

Rationale

There are different types of structures subjected to various types of loading/ forces such as axial, shear, bending and torsion. This course equips the students to analyze the behavior of structural members under different types of loading. This course also aimed at imparting certain theoretical foundation and physical understanding to solve structural mechanics problems mostly involving beams and thin-walled structures under different loading conditions.

Objectives

1. To understand the concept of the shear centre and evaluation of the shear centre for symmetrical and non-symmetrical thin walled sections.
2. To understand the concept and behavior of beams resting on elastic foundation.
3. To study the behavior of beams curved in plan.

4. To understand the concept of different theories of failure with respect to materials.
5. To study the behavior of deep beams using different theories available for the analysis of different sections.
6. To introduce the concept of torsion theories for solid section.

Detailed Syllabus

Modules	Sub-Modules/ Contents	Periods
I.	Shear Centre for symmetrical and non-symmetrical (about both axes) thin walled open sections.	07
II.	Bending of beams with large initial curvature loaded in their plane of curvature. Application to analysis of hooks, circular closed rings, chain links with straight length and semi-circular ends.	08
III.	Beams on elastic foundation: Analysis of beams of infinite length subjected to concentrated force/moment and semi-infinite length subjected to concentrated load/moment at one end. Semi-infinite beam hinged at one end (origin) and subjected to UDL throughout.	08
IV.	Beams curved in plan: Analysis of beams loaded perpendicular to their own plane, simply supported, fixed and continuous beams.	07
V.	Theories of Failure: Maximum principal stress theory, Maximum principal strain theory, Maximum shear stress theory, maximum total strain energy theory.	08
VI.	Analysis of deep beams: Determination of deflection. Determination of shear correction factor for various sections rectangular solid and hollow section and circular solid and hollow section and I-section	06
VII.	Torsion in non-circular solid section rectangle, triangular and hexagon section.	08

Contribution to Outcomes

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

1. Understand the concept of shear centre for thin walled open sections.

2. Study the behavior of beam resting on elastic foundation with various loading conditions.
3. Analyze the beam curvedin plan for different support conditions.
4. Understand the concept of different theories of failure in different sections.
5. Determine deflection, shear correction factor for different sections like solid and hollow sections.
6. Understand the concept of torsion in non-circular solid section.

Theory Examination:-

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

Oral Examination:

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

Term Work:

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

Distribution of Term Work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. The final certification and acceptance of the term-work warrants the satisfactory and

the appropriate completion of the assignments and the minimum passing marks to be obtained by the students.

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

- Assignments : 20 Marks
- Attendance : 05 Marks

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

Recommended Books:-

1. Mechanics of Materials: *Popov, E.P.* Prentice Hall of India Pvt. Ltd.
2. Mechanics of Materials: *James Gere, M.,*Thomson Brooks.
3. Mechanics of Materials: *Beer, F.P., E. Russell Jhonston and John T. DeWolf,* TMH, New Delhi.
4. Advanced Mechanics of Materials: *Arthur P. Boresi and Omar M. Sidebottom*, Wiley and Sons.
5. Advanced Mechanics of Materials: *Arthur P. Boresi and Richard Schmidt*, John Wiley and sons.
6. Strength of Material Part I and Part II: *Timoshenko*, McGraw Hill, New York.
7. Mechanics of Solids: *Shames, I* and *Pitarresi,J. M.,* Preentice Hall, New Delhi.
8. Beams on Elastic Foundation: *Heteny M*.
9. Strength of Materials: *Subramanian*, Oxford University Press.

Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: Structural Dynamics	05

Teaching Scheme

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

Evaluation Scheme

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

Rationale

The civil engineering structures are mostly designed for only static gravitational loads. However, in actual practice the structures may be subjected to dynamic loads due to wind, vibrations, impacts, explosion, shocks and earthquake forces apart from the static loads. This subject involves the basic understanding of the analysis of structures subjected to such type of loading.

Objectives

- To expose the students to understand the basic theory of structural dynamics, structural behavior under vibratory load and the effect of damping.
- To study the difference between static load and different types of dynamic loads.
- To study the free vibration analysis of SDOF systems, concept of damping and dynamic analysis of SDOF system subjected to different dynamic loads.

- To study the dynamic degrees of freedom andcalculation of the frequencies and mode shapes for lumped mass for discrete MDOF systems,
- To study the modal analysis of MDOF systems and analysis of systems with distributed mass for continuous system.
- To study the random vibrations, probabilistic theory, random process and related parameters.
- To study the stochastic response analysis of linear SDOF systems.

Detailed Syllabus

Module	Sub-Modules/Contents	Period
I	**Introduction:** Introduction to structural dynamics, definition of basic problem in dynamics, static v/s dynamic loads, different types of dynamic load	02
II	**Single Degree of Freedom (SDOF) Systems:** Undamped vibration of SDOF system, natural frequency and period of vibration, damping in structures, viscous damping and coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, Logarithmic decrement. Forced vibration, response to harmonic forces, periodic loading, dynamic load factors, response of structure subjected to general dynamic load, Duhamel's integral, numerical evaluation of dynamics response of SDOF systems subjected to different types of dynamic loads. Introduction to frequency domain analysis, response of structure in frequency domain subjected to general periodic and non-periodic / impulsive forces of short duration, use of complex frequency response function. Use of Fourier Series for periodic forces, introduction to vibration isolation. Distributed mass system idealized as SDOF system, use of Rayleigh's method, response of SDOF system subjected to ground motion.	16

III	**Generalized Single-Degree of Freedom System:** Generalized properties, assemblages of rigid bodies, systems with distributed mass and elasticity, expressions for generalized system properties.	04
IV	**Lumped Mass Multi Degree of Freedom (MDOF) system:** Coupled and uncoupled systems, direct determination of frequencies of vibration and mode shapes, orthogonality principle, vibration of MDOF systems with initial conditions, approximate methods of determination of natural frequencies of vibration and mode shapes-vector iteration methods, energy methods and use of Lagrange's method in writing equations of motions. Decoupling of equations of motion, modal equation of motion, concept of modal mass and modal stiffness, forced vibration of MDOF system, modal analysis, and application to multi storey rigid frames subjected to lateral dynamic loads.	10
V	**Structure with Distributed Mass System:** Use of partial differential equation, free vibration analysis of single span beams with various boundary conditions, determination of frequencies of vibration and mode shapes, forced vibration of single span beams subjected to the action of specified dynamic loads.	05
VI	**Random Vibrations:** Probability theory: Single random variable, important averages of single random variable, two random variables, important averages of two variables, principal axis of joint probability density function, Rayleigh's probability density function. Random processes, stationary and ergodic processes, autocorrelation function, power spectral density function, relationship between power spectral and autocorrelation functions, power spectral density and autocorrelation functions for derivatives of processes, superposition of stationary processes, stationary Gaussian processes, stationary white noise, probability distribution for maxima and extreme values	09

VII	**Stochastic Response of Linear SDOF Systems:** Transfer functions, relationship between input and output autocorrelation functions, relationship between input and output power spectral density functions, response characteristics for narrowband systems	06

Contribution to Outcomes

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

Theory Examination:-

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

Oral Examination:

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

List of experiments: *(At least five to be performed)*

1. To find the time period of compound pendulum
2. To study instrumentations in structural dynamics

3. To find natural frequency of SDOF system
4. To find natural frequency of two DOF system
5. To find natural frequency of three DOF system
6. To observe liquefaction of soil
7. To observe phenomenon of vibration absorption

Term Work:

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

Distribution of Term Work Marks:

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

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

- Report of the Practical: 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:-

- Structural Dynamics-An Introduction to Computer Methods: *Craig R.R.*, John Wiley and Sons.
- Dynamics of Structures: *Anil K. Chopra*, Prentice Hall India Pvt. Ltd.
- Dynamics of Structures: *Cloguh*and*Penzein*, Tata Mc-Graw Hill Pvt. Ltd.
- Structural Dynamics:*John M. Biggs*, Tata Mc-Graw Hill.

Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: Advanced Foundation Engineering	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	25	--	25	150

Rationale

In order to find the solution to field problems and design issues in wide range of geotechnical structures such as slopes, retaining walls, foundations etc., a detailed study on the theories and analysis methods is required. This course develops the capability and requisite skills of a student to problem solving in geotechnical application areas and with eemphasis on indepth study exposes the student to dwell on further new developments.

Objectives

- To study site investigation techniques and characterization of the soil
- To understand the one and three dimensional consolidation process and their practical applications
- To study stress paths and failure criteria
- To learn the different vertical stress theories

- To study the bearing capacity and settlement of shallow foundations
- To study the load carrying capacity of pile foundations
- To study different ground improvement methods

Detailed Syllabus

Module	Sub-modules/ Contents	Periods
I.	**Site exploration and characterization** Purpose and scope, influence of soil conditions and type of foundations on exploratory programme, project assessment, phasing of site exploration. Open excavation and boring methods of exploration, types of samplers and their design features. Subsurface soundings- static, dynamic and geophysical methods. Planning of subsurface investigations, type and sequence of operations, lateral extent and depth of exploration, interpretation of field and laboratory data.	06
II.	**Consolidation** Terzaghi's one dimensional consolidation- derivation of equation (solution in detail need not be covered) Estimation of C_c and c_v from laboratory tests, estimation of preconsolidation pressure by various methods, field consolidation curves, prediction of field settlement, practical applications. Quasi-preconsolidation and secondary consolidation. Concept of three dimensional consolidation in cylindrical coordinates, theory of sand drain and prefabricated vertical drains.	10
III.	**Stress and strain behaviour of soil** Triaxial test – drained and undrained behaviour of sands and clays. Stress path, ideal, plastic and real soil behaviour, shear strength of sands and clays, failure criteria in soils- Mohr-Coulomb's criteria, modified cam clay model.	06
IV.	**Estimation of stresses** i. Boussinesq's theory, vertical stress due to concentrated load,	05

	horizontal and shear stress due to concentrated load, isobar diagram, vertical stress distribution on horizontal plane, influence diagram, vertical stress distribution on vertical plane. ii. Vertical stress due to line load, vertical stress under strip load, maximum shear stress at points of under strip loads, vertical stress under a circular area, vertical stress under a corner of a rectangular area, Newmark's influence charts. iii. Westergard's theory.	
V.	**Bearing capacity and settlement of shallow foundation** Modes of failure, failure criteria- Terzahi concept, Vesic concept, IS code recommendations. Assumptions in estimation of ultimate loads, effect of shape, embedment of footing, eccentricity in loading, choice factor of safety. Compressibility (including critical rigidity index), settlement of foundations on sand- Schmertmann method. Evaluation of bearing capacity using plate load test and standard penetration test, Housel method.	12
VI.	**Pile foundations** Estimation of single pile capacity by static and dynamic methods, group capacity in sand and clay deposits, separation of skin friction and end bearing capacity. Settlement of single and group of piles.	07
VII	**Ground improvement** Improvement of deep cohesionless soils. Improvement in cohesive soils. Improvement of soil using additives such as fibres, chemicals, sustainable waste materials Concept of using geosynthetics, soil nailing to stabilize slopes and embankments Instrumentation- pore pressure gauges and settlement gauges and their applications.	06

Contribution to Outcomes

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

1. Ability to identify, formulate and solve geotechnical engineering problems
2. Ability to design a suitable foundation system from economic and safe aspects
3. Awareness of the latest trends and instrumentation in ground improvement methods
4. Ability to relate easily to allied subjects such soil dynamics; advanced engineering geology, rock mechanics etc.

Theory Examination:-

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

Oral Examination:

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

List of Experiments:

It is recommended to perform the following laboratory tests.

1. Unconsolidated Undrained, Consolidated Undrained and Consolidated Drained triaxial tests.
2. Direct box shear test on c-ϕ soils.

Site / Field Visits:

The students shall be taken to visit the sites where pile driving/SPT/CPT/plate load tests are carried being out. They will prepare a detailed report thereof which will be submitted along with the term work.

Term work:

The term-work shall comprise of the neatly written report based on the experiments performed in the laboratory and the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least three problems and/ or questions on each modules/ sub-modules or contents thereof further. A project report covering the selection of soil parameters and design of shallow / pile foundations and ground improvements using stone columns and sand drains shall also form a part of the term work.

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon its quality. The final certification and acceptance of term work warrants the satisfactory performance of the experiments by the student, properly compiled report thereof along with the assignments 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	:	05 Marks
Assignments	:	10 Marks
Report of Site Visit/ Field Visit	:	05 Marks

Attendance: 05 marks

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

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

Recommended books:

1. Soil Mechanics and Foundation Engineering: *V. N. S. Murthy*, Saitech Publications
2. Soil Mechanics and Foundation Engineering: *K. R. Arora*, Standard Publishers and

Distributors, New Delhi.

3. Geotechnical Engineering: *C. Venkatramaiah*, New Age International.
4. Soil mechanics in Engineering Practice: *K. Terzaghi* and *R. B. Peck*, Wiley international edition.
5. Foundation Engineering Hand Book: *Winterkorn* and *Fang*, Galgotia publications.
6. Foundation Design Manual: *N. V. Nayak*, DhanpatRai publications (P) Ltd.
7. Principles of Foundation Engineering: *Braja M. Das*, PWS publishing.
8. Relevant Indian Standard Specifications and Codes, BIS Publications, New Delhi.

Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: Ground Water Hydrology	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	25	--	25	150

Rationale

This subject deals with the basic principles of ground water flow and application of ground water engineering. It discusses theground water availability, ground water flow, storage and yield of well. It also provides basic knowledge on ground water pollution, ground water management and ground water modeling.

Objectives

- To understand the sources of ground water, aquifers, water occurrence and movement in different types of rocks.
- To understand the ground water potential theory, movement of ground water, evaluation of aquifer parameter.
- To study yield of well, the various types of wells, construction, maintenance, etc.

- To study the quality of ground water analysis and ground water pollution, recharge of ground water, etc.
- To study the ground water management and ground water modelling.

Detailed Syllabus

Module	Sub-Modules / Contents	Periods
I.	**Introduction:** Ground water utilization and historical background, ground water in hydrologic cycle, ground water budget, ground water level fluctuations and environmental influence, literature/ data/ internet resources.	2
II.	**Occurrence and Movement of Ground Water:** • Origin and age of ground water, rock properties affecting groundwater, groundwater column, zones of aeration and saturation, aquifers and their characteristics/classification, groundwater basins and springs. • Darcy's Law, permeability and its determination, Dupuit assumptions, heterogeneity and anisotropy. • Ground water flow rates and flow directions, general flow equations through porous media	6
III.	**Advanced Well Hydraulics:** • Steady /unsteady, uniform / radial flow to a well in a confined/ unconfined /leaky aquifer, well flow near aquifer boundaries/ for special conditions. • Partially penetrating/horizontal wells and multiple well systems, well completion/ development/ protection/ rehabilitation/ testing for yield	12

IV.	**Pollution and Quality Analysis of Ground Water:** • Municipal /industrial /agricultural /miscellaneous sources and causes of pollution, attenuation/underground distribution / potential evaluation of pollution. • Physical /chemical /biological analysis of groundwater quality, criteria and measures of ground water quality, ground water salinity and samples, graphical representations of ground water quality.	6
V.	**Surface/ Sub-Surface Investigation of Ground Water:** • Geological /geophysical exploration/ remote sensing / electric resistivity /seismic refraction based methods for surface investigation of groundwater, test drilling and ground water level measurement. • Sub-surface ground water investigation through geophysical / resistivity /spontaneous potential/radiation / temperature / caliper / fluid conductivity.	6
VI.	**Artificial Ground Water Recharge:** • Concept and methods of artificial ground water recharge, recharge mounds and induced recharge, wastewater recharge for reuse, water spreading.	5
VII.	**Saline Water Intrusion in Aquifers:** • Ghyben-Herzberg relation between fresh and saline waters, shape and structure of the fresh and saline water interface. • Upcoming of saline water, fresh-saline water relations on oceanic islands, seawater intrusion in Karst terrains, saline water intrusion control	5

VIII	**Modeling and Management of Ground Water:** • Ground water modeling through porous media/analog / electric analog / digital computer models. • Ground water basin management concept, hydrologic equilibrium equation, conjunctive use of surface and ground water, ground water basin investigations, data collection and field work, dynamic equilibrium in natural aquifers. • Management potential and safe yield of aquifers, stream-aquifer interaction.	10

Contribution to Outcomes

On successful completion of this course, the studentsare expected to have a good understanding of:

- Porous medium properties that control ground water flow
- Ground water flow equations to confined and unconfined aquifers
- Pump test for determining the aquifer properties, yield of well, etc.
- Quality analysis of ground water, fresh-saline water relationsand ground water pollution.
- Various surface and sub-surface investigations, conjunctive use of surface and ground water, ground water management, etc.

Theory examination:

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

5. The students will have to attempt any **three** questions out of remaining five questions.
6. Total **four** questions need to be attempted.

Oral Examination:

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

Term Work:

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

Distribution of Term Work Marks:

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

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

- Assignments : 20 Marks
- Attendance : 05 Marks

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

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

Recommended Books:

1. Numerical Modeling of Coastal Aquifers: *S .K. Ukarande* and*A. K.Rastogi* ISBN-978-3-639-17552-3"
2. Numerical Groundwater Hydrology: *A.K Rastogi*, Penram International Publication, Mumbai-ISBN-798187972272
3. Groundwater Hydrology: *D. K. Todd* , John Wiley and sons
4. Hydrogeology: *Karanth K. R.,* TataMc-Graw Hill Publishing Company.
5. Groundwater*: Freeze, R.A.* and *Cherry*, J.A Prentice Hall, New Jersey

Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: Pavement Subgrade and Materials	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	25	--	25	150

Rationale

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

Objectives

1. To give the students hands on experience on various material properties and testing procedures of pavement materials as per IRC standards.
2. To study the significance of the soil subgrade along with its functions.
3. To study the soil classification for highway engineering purpose as per different classification system.
4. To understand the concept of stresses in soil.
5. To enable the student to identify the basic deficiencies of various soil deposits and to arrive upon the various ways and means of improving the soil and implementing the techniques of improvement.
6. To understand the various system of drainage system.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	**Subgrade:** Functions, Importance of subgrade soil properties on pavement performance, subgrade soil classification for highway engineering purpose soils as per PRA system, revised PRA system, Bur mister system, Compaction system.	10
II.	Grading requirements for aggregate, selection of bases and sub-base material (including stabilized materials), selection of different grade of bitumen, types of bituminous surfaces, skid qualities, bituminous mix design, Marshall Stability test, design aspect of paving concrete. Experimental characteristics of road aggregate.	08
III.	**Soil Survey:** Soil Survey Procedure for Highway and Ground Water Investigation. Identification and Significance of soil Characteristics, effect of water in soil Swelling/shrinkage, cohesion, plasticity in soil. Soil Moisture movement- ground water, gravitational water, held water, soil suction.	08
VI.	**Stress in soil:** Theories of elastic and plastic behavior of soils, Methods of	10

	reducingsettlement, estimation of rate of settlement due to consolidation in foundation of road embankment. Static and cyclic triaxial test on subgrade soils, resilient deformation, resilient strain, resilient modulus. CBR test, effect of lateral confinement on CBR and E value of Subgrade soil. Static and cyclic plate load test, estimation of modulus of subgrade reaction, correction for late size, correction for worst moisture content.	
V.	**Ground Improvement Technique:** Different method of soil stabilization, use of geo-textile, geogrid and fibres in highway subgrade. Vertical sand drain: design criteria, construction and uses	08
VI	**Storm water Drainage:** General principles subsoil Drainage. Frost action soil: Frost susceptible soils, depth of frost penetration, and loss of strength during frost melting. Compaction of soils, field and laboratory method of soil compaction, equipment's used in field compaction. Design of surface and subsurface drainage system, pumping system, water body, holding ponds	08

Contribution to Outcomes

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

- Understand the soil classification in accordance with various soil classify the system and evaluate the ability of the soil as a subgrade material.
- Understand the requirements and desirable properties of the various materials to be used in the construction of pavements.
- Understand the characterization of different paving materials along with the tests to be conducted on these materials.
- Know the various ground improvement methods.
- Know the different methods of drainage in highways and design the drainage systems.

Theory Examination:

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

Oral Examination:

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

Term Work:

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

Distribution of Term Work Marks:

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

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

- Assignments : 20 Marks
- Attendance : 05 Marks

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

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

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Recommended Books:-

1. Principles of Pavement Design, Second Edition, 1975: *Yoder, E.J.* , John Wiley and Sons, Inc., New York.
2. Concrete Roads: *HMSO*, Road Research Laboratory, London.
3. Highway Engineering: *Khanna, S.K., Justo, C,E.G. and Veeraragavan, A.,* Nem Chand and Brothers, Roorkee (10^{th} Revised Edition, 2014)
4. Principles and Practices of Highway Engineering; *Dr. L. R. Kadiyali and Dr. N. B. Lal*, Khana Publishers, New Delhi.
5. Highway Engineering, *Sharma, S.K.,* S. Chand Technical Publishers, New Delhi (3^{rd} Revised Edition, 2013).
6. Principles of Transportation and Highway Engineering: *Rao, G.V.* , Tata Mc-Graw Hill Publications, New Delhi

Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: Air Pollution	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	25	--	25	150

Rationale

Air pollution is the introduction of particulates, biological molecules, or other harmful materials into the Earth's atmosphere, possibly causing disease, death to humans, damage to other living organisms such as food crops, or the natural or built environment. The atmosphere is a complex natural gaseous system that is essential to support life on planet Earth. Stratospheric ozone depletion due to air pollution has been recognized as a threat to human health as well as to the Earth's ecosystems. This course makes the students acquainted with the classification, sources and effects of air pollution, various methods; and equipment available for controlling it.

Objectives

- To have the knowledge of mathematics, science and engineering to identify and to solve the problem of air pollution.

- To lay emphasis on the principles underlying the understanding of ambient air pollution, its sources and its effects.
- To give an exposure to the students of the air pollution problem in India.
- To have an introduction to sources of air pollution, basic meteorological processes and technology for air pollution control; and odor control.
- To understand the health problems, risk assessment and global atmospheric changes due to air pollution.
- To understand the reasons for environment degradation due to air pollution.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	Composition of dry ambient air Properties of air. Function of air, Definition of pollution. Classification of air pollutants. Units for Qualification of air pollution,History of air pollution, Global and national scope of the problem- general, urban, rural, specific.	06
II.	Sources of air pollution natural and man-made Major pollutants from different sources in Greater Bombay area (or any metropolis of Maharashtra), Emission factors.	05
III.	Effects of air and noise pollution on human health, plants ,animals, properties and visibility, indoor air pollution and personal exposure to air pollution , simple numerical problems based on COH, CoHb	05
IV.	Meteorological aspects of air pollution Large scale wind circulation geotropic wind, gradient wind, cyclone, anticyclone, planetary boundary layer. Lapse rate, stability conditions, wind velocity profile, maximum mixing depth, topographic effects.	06
V.	Plum patterns, plum dispersion, Gaussian model for predicting concentration, downwind from a single source, diffusion coefficients, Turner's stability categories and graphs for dispersion estimates. Maximum ground level concentration, inversion effects, distance touching ground modification of Gaussian model to predict particulate dispersion, plume rise, modified Holland equation for small source. ASME equation for large source, Brigg's equation for buoyant plum	09

	rise, Brigg's equation for momentum plum rise.	
VI.	Methods and instruments for sampling and analysis of air for stack and ambient air monitoring.	05
VII.	Government of India: air pollution laws. Indian standards- emission and air quality standards.	04
VIII.	Control Devices Principles, operations and types, simple hoods and ducts. Settling chambers, cyclones, electrostatic precipitators (ESP), Filters,scrubbers, absorption towers and incinerators. Collection efficiencies for laminar and turbulent flows for settling chambers, particle cut size for cyclone, ESP Concept of frictional and overall efficiencies. Design criteria for filters, scrubbers, absorption towers and incinerators.	12

Contribution to Outcomes

On completion of this course, the students are expected to understand the classification, sources, effects, various methods and equipment available for controlling air pollution. They are expected to have a better understanding of the nature and characteristics of air pollution and regulatory requirements regarding air pollution and further, they shall have an ability to plan air pollution control.

Theory Examination:-

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

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

Oral Examination:

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

Term Work:

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

Distribution of Term Work Marks:

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

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

- Assignments : 20 Marks
- Attendance : 05 Marks

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

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

Recommended Books:

1. Air Pollution: *Henry Capeskins*, McGraw Hill publication.
2. Air Pollution: Part A- Analysis and Part B-Prevention and Control: *Ledbetter, J. O*., Make Dekker Inc., New York.
3. Air Pollution: *Wark* and *Warner, Harper* and *Row*, New York.
4. Air Pollution Control Guidebook for Management: Edited by *Rossano, A.T*., Environ Science Service Division. ERA Inc., USA
5. Air Pollution Control Theory: *Martin Crawford*, McGraw Hill publication.

6. Government of India's Publication of laws related to air pollution, Maharashtra Pollution Control Board's (MPCB) Publication of standards. IndianStandards relevant to Air Pollution Monitoring, Definitions, Standards.
7. Air Pollution: *Rao. M. N. and Rao, H. V. N.,* Tata McGraw Hill Publication, New Delhi.
8. Air Pollution Vol.1: *Tripathi, A. K.*, (editor) Ashish Publication House, New Delhi.
9. Air Pollution (Bio-pollutants in air): *Srivastava, A.K.*, Ashish Publication House, New Delhi.
10. Environmental Engineers Handbook Vol. II, Air pollution: *Liptak, B. G.*, (ed) Chilton Book Co .USA.
11. Air Pollution Handbook: *Magill, P. L.*et al., McGraw Hill publication.
12. Industrial Air Pollution Handbook: *Parker, A.*, Tata McGraw Hills Publication.

Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: 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	25	--	25	150

Rationale

Pre-stressed concrete combines high strength steel and high strength concrete in an active manner. Today, pre-stressed concrete is being used in the construction of wide range of structures. It helps an engineer to achieve a much economical section for carrying heavy loads over larger span lengths. Thus, the use pre-stressed concrete has become a standard practice for long span bridges. Building codes have been developed for the design and detailing of pre-stressed concrete. This course involves the study of various types of pre-stressing techniques in detail.

Objectives

1. To bring the students to such a level so as to enable them to take the appropriate decision in respect of choice of prestressed section over R. C. C. as a civil engineer.

2. To make the student to be aware of such a highly mechanized technology in civil engineering construction.
3. To imbibe the culture of entrepreneurship in pre-cast and pre-stressed industry in mass housing, railway sleepers, electric transmission poles, etc.
4. To understand the basic design considerations in pre- stressed concrete structures in relation to its applications.
5. To employ and develop new techniques in rehabilitation of distressed structures like buildings, bridges and infrastructures.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	**Introduction to Prestressed Concrete:** Basic concept and general principles, materials used and their properties, methods, techniques and systems of prestressing.	03
II.	**Analysis of Prestressed concrete sections:** Loading stages and computation of section properties, critical section under working load for pre tensioned and post tensioned members, stress method, load balancing method and internal resisting couple method, kern points, choice and efficiency of sections, cable profiles.	08
III.	**Loss of Prestress:** Loss of stresses doe to elastic deformation of concrete, creep in concrete, creep in steel, shrinkage in concrete, relaxation in steel, anchorage slip and friction.	06
IV.	**Deflections of Prestressed Concrete Members:** Short time and long time deflection, deflection of uncracked sections, Uni-linear and bi-linear methods for cracked sections.	05
V.	**Design of Prestressed Concrete Sections for Flexure in Working Stress and Limit State Method:** General philosophy of design, permissible stresses in concrete and steel,suitability of section, safe cable zone, design of simply supported pretension and post tension slabs and beams using limit state method	10
VI.	**Design for shear:**	06

	Calculation of principle tension under working load, permissible principle tension, shear strength calculation under limit state of collapse for both sections cracked and uncracked in flexure.	
VII.	**End zone stresses in prestressed concrete members:** Pretension transfer bond, transmission length, end block of post-tensioned members.	06
VIII.	Introduction to application of prestressing to continuous beams and slabs, linear transformation and concordancy of cables.	08

Contribution to Outcomes

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

1. To understand the concept of pre-stressing, behavior of the pre-stressed structures vis-à-vis that of the RCC structure.
2. To take the decision with respect to the choice of pre-stressed section over RCC.
3. To understand the application of these techniques in civil engineering construction, especially in mass housing, railway sleepers, transmission of poles, bridges, etc.
4. To analyze the various pre-stressed components of the structures and design the same.

Theory Examination:-

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

Oral Examination:

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

Site Visit/ Field Visit:

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

Term Work:

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

Distribution of Term Work Marks:

The marks of term-work shall be judiciously awarded depending upon its quality. The final certification and acceptance of the term-work warrants the satisfactory and the appropriate completion of the assignments, properly compiled report of the field/ site visit; 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 : 15 Marks
- Report of the Field Visit/ Site Visit: 05 Marks
- Attendance : 05 Marks

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

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

Recommended Books:-

1. Prestressed Concrete*: N. Krishna Raju*, McGraw Hill, New York.
2. Prestressed Concrete: *N. Rajgopalan*, Narosa Publishing House.
3. Fundamentals of Prestressed Concrete: *Sinha, N.C.*and *S.K. Roy*, S.C. Chand and Company.

4. Prestressed Concrete Structures: *Dayaratnam, P.*, Oxford andIBH
5. Design of Prestressed Concrete Structures: *T.Y.Lin* and*N.H. Burns*, John Willey, New York.
6. Design of Prestressed Concrete: *Nilson Arthur*, McGraw Hill Book Company.
7. Prestressed Concrete Vol—I*: IY.Guyon*, Contractors Record, London.
8. Prestressed Concrete*: S. Ramamurtham*, Dhanpat RaiandSon's
9. Relevant latest IS codes.

Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: Traffic Engineering and Control	05

Teaching Scheme

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

Evaluation Scheme

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

Rationale

The complete knowledge of traffic engineering for urban and rural roads is essential for civil engineers, especially who are dealing with thetransportation problems in day-to-day activities. This subject imparts the skills required in controlling the traffic on the busy roads. The complete concepts learning here may include planning, Design and implementation of traffic signals, islands, intersections, markings on the roads, network flow problems related with all the important aspects for complete control of traffic on all the important and busy roads.

Objectives

1. To understand all the traffic characteristics.
2. To understand all the traffic surveys conducted for complete analysis of busy roads, which requires for effective traffic management.

3. To understand, to plan and design all the important elements on the roads like signals, junctions, islands for effective traffic engineering.
4. To understand the various network flow problems, whichincludes the traffic management skills.

Detailed Syllabus

Module	Sub- Modules/Contents	Periods
I	**Traffic Engineering and Control** : Various traffic surveys and traffic studies: Speed, journey time and delay survey and studies, vehicle volume count classification and occupancy	10
II	**Origin-Destination surveys andParking survey:** Origin-Destination Studies: Purpose, various methods of conducting O-D studies with pros and cons of each method, interpretation of the analysis results of O-D studies, utility Parking Survey: Purpose, different types of parking surveys, methods of conducting parking surveys and interpretation of the results.	04
III	**Statistical Methods for Traffic Engineering and their Applications:** Distributions, sampling theory and significance testing, regression and correlation.	05
IV	**Intersection Design:** Principles, various available alternatives, rotary design, mini round about, traffic signals: types of traffic signals, advantages, determination of optimal cycle time and signal setting for an intersection with fixed time signals, coordination of signals, types area traffic control, delay at signalized intersection.	07
V	**Accidents and Road Safety:** Accident cause, recording system, analysis and preventive measures, accident cost, alternative methodologies for calculation.	04
VI	**Traffic Management:** Various measures and their scope, relative merits and demerits.	03

VII	**Highway Capacity:** Passenger's car units, level of service, factor affecting capacity and level of service, influence of mixed traffic, capacity and level of service analysis.	03
VIII	**Highway Lighting:** Need for street lighting, important definitions, law of illumination, discernment by artificial lighting, mounting height, spacing, lantern arrangements, types of lamps, lighting of some important highway structures.	04
IX	**Traffic Signs and Markings:** General principle of traffic signing, types of traffic signs, design of signs, location and maintenance of signs, different types of road marking, marking design, marking maintenance, introduction to intelligent transportation systems.	04
X	**Theory of Traffic Flow:** Scope, definitions and basic relationship, review of flow density speed studies, hydrodynamic analogies, application of hydrodynamic analogy, Lighthill and Whitams theory, car-following theory and its application to traffic engineering, probabilistic description of traffic flow, an introduction to queuing theory as applied to traffic flow problems for study state conditions, fundamentals of traffic stimulation modeling.	05
XI	**Network Flow Problems and Entropy in Transportation:** Wardope principles of equilibrium, graph theoretic approach, network flows, minimum path trees, primal level solutions, introduction to entropy in transportation	03

Contribution to Outcomes

After completion of the course work, the student are expected to understand the complete knowledge of traffic surveys, traffic characteristics and management skills related with various problems on busy roads. The students shall be in a commanding position to plan, design and implement the traffic signals, islands, markings, network flow characteristics

required in the transportation planning. The student is expected to get full knowledge related to all the modern techniques, various important methods for effective management of control of traffic on all the important and busy urban roads.

Theory Examination:-

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

Oral Examination:

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

Term Work:

The term work shall comprise of the neatly written 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 : 12 Marks
- Report of the Traffic Surveys: 08 Marks
- Attendance : 05 Marks

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

Recommended Books:-

1. Traffic Engineering and Transportation Planning: *Kadiyali L. R.*, Khanna Publishers, Delhi.
2. Principles of Traffic Engineering: *Pingnataro, G. J.*, McGraw-Hill
3. Traffic System Analysis for Engineering and Planners: *Wohl* and *Martin*, Mc-Graw Hill
4. Principles of Transportation Engineering: *Partha Chakroborty, Animesh Das*, Prentice Hall (India).
5. Traffic Flow Theory and Control: *Drew, D. R.*, Mc-GrawHill, New York
6. Highway Capacity Manual, Transportation Research Board, National Research Council, Washington D.C.
7. Transportation Engineering and Planning: *Papacostas, C. S., Prevedouros, P. D.*, PHI Learning Pvt. Ltd.
8. Principles, Practice and Design of Highway Engineering: Dr. *Sharma, S. K.*
9. Transportation Engineering: *C. Jotin Khisty* and *B. Kent Lall*, PHI Learning Pvt. Ltd.

Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: Reinforced Concrete Repairs and Maintenance	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	25	--	25	150

Rationale

For an existing building to be in a good condition, so that it can continue to perform the intended functions, maintenance of the building plays a key role. Adequate maintenance improves aesthetic and functional values.Moreover; it facilitates extending the building life and ensures the safety of dwellers. Usually, the structures do perform well for about 50 years after the construction and thereafter, the deterioration begins. Insufficient maintenance and lack of repairs may lead to the limited life span of the structure. However, the regular maintenance and timely identification of deteriorated building elements for proper remedial measures may result in to the extension of life span of the structure up to 100 years also. Most of the modern structures built in India are becoming old as they have reached about 50 years of their age and are in the dire need of the repair and maintenance. Hence, there is a huge employment potential in conformity with the field of repair and maintenance. This course, therefore, finds its place in the curriculum such that the pupils can acquire the

competency in this area. The course deals with the building maintenance, special materials, concrete repair chemicals, strengthening of RCC members by underpinning, plate bonding, shoring, RC jacketing, etc. Technical knowhow and skills developed through this course may be helpful to preserve the historical buildings. Therefore, it is vital and imperative to get acquainted with the course for civil engineers.

Objectives

- To get familiar with the causes of distress of concrete structures, seepage and leakage in concrete structures and the effect on steel corrosion.
- To study the condition survey, evaluation and assessment of damage through the visual inspection and various Non-Destructive Testing methods.
- To acquire the knowledge in connection with the special repair materials and crack repair methodologies to be applied in the field.
- To study the concrete protective materials, thermal protection coatings, etc.
- To implement the steel corrosion protection methods in the field.
- To know the various ways to maintain the reinforcedconcrete structures.

Detailed Syllabus

Module	Sub-Modules/Contents		Periods
I	**Introduction**		08
	1.1	Causes of deterioration of concrete structures, effects of climate, moisture, temperature, chemical, wear, erosion and loading on serviceability and durability	
	1.2	Design and construction errors	
	1.3	Causes of seepage and leakage in concrete structures	
	1.4	Formation of cracks including those due to corrosion	
II	**Condition Survey, Evaluation and Damage Assessment**		12
	2.1	Diagnostic methods and analysis.	
	2.2	Destructive, semi-destructive and non-destructive methods: core test, carbonation test, chloride test, petrography, corrosion analysis, cover meter test, rebound hammer test, ultrasonic pulse velocity	

		test, and crack measurement techniques.	
	2.3	Concrete endoscopy and thermal imaging	
	2.4	Pull-off test and pull-out test	
III	**Materials and Repair Methodologies**		10
	3.1	Repair analysis and design	
	3.2	Repair materials and their desired properties	
	3.3	Methodologies for crack and patch repair: polymer modified mortar, polymer modified concrete, polymer concrete	
	3.4	Injection grouting, shortcreting, joints and sealants, rebar corrosion crack repair	
IV	**Protection of Concrete Structures**		08
	4.1	Protective materials and their properties for moisture barrier systems.	
	4.2	Above grade and below grade water-proofing of concrete structures.	
	4.3	Systems like integral, crystalline, coatings, membranes, etc.	
	4.4	Thermal protection coatings.	
V	**Rebar Corrosion Protection**		08
	5.1	Methods of corrosion protection, corrosion inhibitors	
	5.2	Corrosion resistant steels, cathodic protection	
	5.3	Pre-packed zinc sacrificial anode, Snap-on zinc mesh anode CP system	
VI	**Maintenance of Concrete Structures**		06
	6.1	Facets of maintenance	
	6.2	Planned preventive maintenance	
	6.3	Maintenance cycles	
	6.4	Statutory legislation and obligation	

Contribution to Outcomes

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

- Assess the structural health of the buildings and infrastructural works.
- Inspect and evaluate the damaged structures.

- Implement the techniques for repairing the concrete structures.
- Employ the methods of steel protection in the field.
- Maintain the concrete structures in the working and safe condition.
- Be able to take the decision of dismantling the structure, if it is deteriorated beyond the repairing.

Theory examination:

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

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

1. Rapid chloride penetration test
2. Carbonation test by spraying phenolphthalein
3. Non -destructive testing of concrete structures by Rebound hammer, UPV meter etc.
4. Corrosion analyzer by half-cell potential meter
5. Tests on polymer modified mortar/concrete and coating for adhesion by Pull-off test method
6. Outdoor exposure test to measure weathering of coating
7. Test for flexibility of coating by applying on a tin sheet
8. Test for effectiveness by measuring temperature difference of a thermal protection coating and concrete substrate on terrace
9. Test for effectiveness by measuring water absorption of coating applied on a card board

Condition Survey:

The students will carry out the condition survey of any damaged structures by visual observations, crack management and will prepare a detailed report thereof. This report will form a part of the term work.

Term Work:

The term-work shall comprise of the neatly written report based on the experiments/ practicalperformed and the assignments along with the detailed report on the condition survey.

Distribution of Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components depending upon its quality. The final certification and acceptance of the term work warrants the satisfactory performance of the experiments/ practical by the student, properly compiled report thereof along with the assignments and the report on condition survey; and the minimum passing marks to be obtained by the student. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems/ questions on each sub-modules and contents thereof further.

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

1. Report of the Experiments: 08 Marks
2. Assignments: 08 Marks
3. Report on the Condition Survey : 04 Marks
4. 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. Concrete Repair and Maintenance: *Peter H.Emmons* and *Gajanan M. Sabnis*, Galgotia Publication.

2. Repairs and Rehabilitation-Compilation from Indian Concrete Journal-ACC Publication.
3. Guide to Concrete Repair and Protection, HB84-2006, A joint publication of Australia Concrete Repair Association, CSIRO and Standards Australia.
4. CPWD hand book on Repairs and Rehabilitation of RCC buildings published by DG(Works), CPWD, Government of India (Nirman Bhawan), http://www.cpwd.gov.in/handbook.pdf
5. Guide to Concrete Repair, *Glenn Smoak*, US Department of the Interior Bureau of Reclamation, Technical Service Center, http://books.google.co.in
6. Management of Deteriorating Concrete Structures: *George Somerville*, Taylor and Francis Publication
7. Concrete Building Pathology: *Susan Macdonald*, Blackwell Publishing.
8. Testing of Concrete in Structures: *John H. Bungey, Stephen G. MillardandMichael G. Grantham*, Taylor and Francis Publication.
9. Durability of concrete and Cement Composites: *Page, C.L.*and*Page, M.M.*, Woodhead Publishers

Semester VII

Subject Code	Subject Name	Credits
CE-E705	Elective-I: Advanced Computational Techniques	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	25	--	25	150

Rationale

With the dramatic increase in data generation and due to rapid technological developments, in fields including civil engineering the field of statistics has undergone a major change, as new and novel techniques of statistical modeling and advanced computational techniques are continually required. This subject includes the basic understanding of concepts like hypothesis testing, regression and correlation, linear programming and introduction of genetic algorithm

Objectives

- To introduce different methods of statistics.
- To enhance the knowledge of probability theory and application in construction industry.
- To discuss about different methods of data collections and its analysis.
- To discuss the importance of Hypothesis testing and its application in civil engineering.

• To discuss application of ANOVA.

• To explain the application of linear programming problem and transportation problem in construction industry.

Detailed Syllabus

Module	Sub-Modules/ Contents	Periods
I.	**Review of Basic Statistics and Probability:** Probability Distributions, Theoretical: binomial, poisson, normal, exponential, hypergeometric, uniform	07
II.	**Sampling and Sampling Distributions** Probability and non-probability samples, sampling and non-sampling errors Sample size, sampling distributions: t, F and ȷ ²distributions.	05
III.	**Hypothesis Testing** Type I and II error, testing of mean, proportion, tests for equality of mean and variances of two populations, confidence interval, ȷ ² test for goodness of fit, ANOVA (one way classification),Non parametric tests: sign test, U test	08
IV.	**Correlation and Regression** Karl Pearson's and Rank Correlation coefficient, simple linear regression least squares method	06
V.	**Management Decision Making** System approach, decision making under uncertainty and risk: decision tables and decision tree.	08
VI.	**Linear Programming** Graphical solution, simplex method, dual, sensitivity analysis, transportation and assignment problems	10
VII.	**Introduction to Genetic Algorithms**	08

Contribution to Outcomes

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

- Learnt different methods of statistics and its applications, different methods of data collection and presentation.
- Learnt about probability theory, application of Binomial distribution, Poisson distribution in civil engineering projects.
- An understanding of implementing the concept of linear programming problem and the transportation problem in getting the optimum solution for civil engineering problem.
- Understood the concept of hypothesis, significance level, type – I and type – II error in hypothesis.

Theory Examination:-

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

Oral Examination:

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

Term Work:

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

Distribution of the Term Work Marks:

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

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

- Assignments : 20 Marks
- Attendance : 05 Marks

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

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

Recommended Books:-

1. Quantitative Techniques for Managerial Decisions: *Shrivastava, Shenoy and Sharma*, Wiley.
2. Research Methodology: *Kothari, C. R.*, Wiley Eastern
3. Methods in Social Research: *Goode, W. J.and Hatt, P. K.*, McGraw Hill
4. Handbook of Genetic Algorithms (1991): *Davis,L. D. and Melanie Mitchell*, Van Nostrand Reinham.
5. An Introduction to Genetic Algorithms (1998): *Melanie Mitchell*, Van Nostrand Reinham

Semester VII

Subject Code	Subject Name	Credits
CE-P706	Project – Part I	02

Teaching Scheme

Contact Hours	Credits Assigned
01 Hr Per Project Group	02

Evaluation Scheme

Term Work/ Oral		Total
TW	OR	
50	25	75

The Project shall be based on thrust areas in Civil Engineering (Construction Engineering and Management; Structural Engineering, Geotechnical Engineering including Geology, Transportation Engineering, Hydraulics Engineering, Environmental Engineering, Remote Sensing, etc.) or interface problem of any of the diversified fields of the Civil Engineering Branch.

For this purpose, the students shall form a group of minimum two students and maximum four students. Further, each faculty shall be permitted to guide maximum four groups.

Guidelines for Project- Part I:

- Student should carry out the preliminary literature survey and subsequently, identify the problem in broad terms for the project and finalize/ settle it in consultation with Guide/ Supervisor.
- Pursuant to this, the student shall refer multiple literatures pertaining to the theme of the problem and understand the problem and define the problem in the precise terms.
- Student should attempt solution to the problem by analytical/simulation/experimental methods. The solution shall be validated with proper justification. The students shall compile the report in standard format.

- The work to be pursued as a part of the project shall be divided broadly in two parts, namely- Project Stage- I and Project Stage- II.
- The topic of the project should be such that it is a value addition for the existing knowledge in the field and has some worthwhile outcomes.

Guidelines for Assessment of Project Stage- I

- Project Stage- I should be assessed based on following points
  1. Quality of Literature survey and Novelty in the problem
  2. Clarity of Problem definition and Feasibility of problem solution
  3. Relevance to the field
  4. Clarity of objective and scope
  5. Methodology for carrying out the work defined as a Problem Statement (Formulation in respect of the analytical studies/ Experimental Work / Combination thereof depending upon the nature of the work involved)/ Data Collection, etc.
- Project Stage I should be assessed through a presentation by a panel of internal examiners appointed by the Head of the Department.