FACULTY OF ENGINEERING No.

Revised Syllabus for the

B.E. (Civil)

(2003 Course)

(From Academic Year : 2006-2007)

University of Pune

Price : Rs. 40/-

University of Pune

B.E. (Civil Engineering) 2003 Course

Semester I

Subject Code	Subject Title	Teaching Scheme Lect.	Tut.	Exam Scheme Hours per week Pr/Drg	Paper	Tw	Pr	Or	Total Marks
401001	Hydrology & Irrigation	4	—	—	100	—	—	—	100
401002	Environmental Engineering-II	4	—	2	100	—	—	50	150
401003	Quantity Surveying Contracts and Tenders	4	—	2	100	25	—	50	175
401004	Structural Design III	4	—	2	100	25	—	50	175
401005	Elective-I	4	—	2	100	50	—	—	150
401006	Project Work*	—	—	2	—	—	—	—	
	Total	**20**	—	**10**	**500**	**100**	—	**150**	**750**

It is mandatory to submit preliminary project report for the grant of the term I

B.E. (Civil Engineering) 2003 Course
Semester II

Subject Code	Subject Title	Teaching Scheme			Exam Scheme Hours per week				Total Marks
		Lect.	Tut.	Pr/Drg	Paper	Tw	Pr	Or	
401007	Elective-II	4	—	2	100	—	—	50	150
401008	Dams and Hydraulic Structure	4	—	2	100	25	—	50	175
401009	Transportation Engineering-II	4	—	2	100	25	—	50	175
401010	Foundation Engineering	4	—	-	100	—	—	—	100
401006	Project Work	—	—	6	—	100	—	50	150
	Total	**16**	—	**12**	**400**	**150**	—	**200**	**750**

Lect.: Lecture, Tut.: Tutorial, Drg: Drawing, Th: Theory, TW: Term Work, Pr: Practical, Or: Oral

Elective I

1. Advanced Geotechnical Engineering
2. Systems Approach in Civil Engineering
3. Finite Element Methods
4. Structural Design of Bridges
5. Architecture and Town Planning
6. Advanced Environmental Management
7. Geo-informatics

Elective II

1. Advanced Concrete Technology
2. Earthquake Engineering
3. Advanced Transportation Engineering
4. Advanced Structural Design
5. Construction Management
6. Integrated Water Resources Planning & Management
7. Advanced Engineering Geology with Rock Mechanics

401001 : HYDROLOGY AND IRRIGATION

Teaching Scheme :
Lectures : 4 Hrs/Week

Examination Scheme :
Theory : 100 Marks
Duration : 3 Hrs

Unit 1 — 16 Marks / 9 Hrs.

Introduction to Hydrology : Hydrologic data and its sources, hydrologic cycle, application of hydrology, isohyets, toposheet, introduction to stochastic hydrology - statistical and probabilistic methods - water resources - surface water, ground water, global and national water review.

Precipitation : Forms : types of precipitation, measurement, analysis of precipitation data, mass rainfall curves, intensity-duration curves, and concept of depth area duration analysis, frequency analysis and artificial rain.

Unit II — 16 Marks / 9 Hrs.

Evaporation and infiltration : Elementary concepts of evaporation and infiltration, effect of infiltration on runoff and recharge of ground water, evapo-transpiration, consumptive use; factors affecting measurement and computations for evaporation, infiltration and evapo-transpiration.

Stream gauging : Selection of site, various methods and instruments of discharge measurements.

Unit III **18 Marks / 8 Hrs.**

Runoff : Factors affecting runoff, rainfall-runoff relationships, runoff hydrograph, Unit hydrograph theory, S-curve hydrograph, synthetic unit hydrograph, use of unit hydrograph.

Floods : Estimation of peak flow, rational formula and other methods, flood frequency analysis, Gumbel's method, design flood, flood routing.

Unit IV **16 Marks / 9 Hrs.**

Introduction to Irrigation : Inundation irrigation, definition, functions, advantages and necessity; methods of irrigation: surface irrigation, subsurface irrigation and micro irrigation.

Water requirements of crops : Soil classification, soil moisture and crop water relationship, factors governing consumptive use of water, principle Indian crops, their season and water requirement, crop planning, agricultural practices, calculations of canal capacities - duty, delta, irrigation efficiency, water quality for irrigation.

Unit V **16 Marks / 8 Hrs.**

Lift Irrigation Schemes : Various components and their design, lifting devices, water logging and drainage: causes, preventive and curative measures.

Water management : Distribution, warabandi, rotational water supply system, volumetric distribution, Global Water Partnership (GWP), Area Water Management, Participatory Irrigation Management (PIM), National Water Policy (NWP).

Unit VI **18 Marks / 8 Hrs.**

Ground Water Hydrology : Occurrences and distribution of ground water, specific yield of aquifers, movement of ground water, Darcy's law, permeability, safe yield of basin. Hydraulics of wells under steady flow condition in confined and unconfined aquifers, specific capacity of well, well irrigation: tube wells, open wells, their design and construction.

Crop Area Assessment : Irrigation acts, various methods, crop area assessment by using RS and GIS, reservoir sedimentation study, Morphometric analysis.

Text Books :

1. Irrigation Engineering and hydraulic structures S. K. Garg, Khanna Publishers.
2. Irrigation, Water Resources and Water Power Engineering, Dr. P. N. Modi; Standard Book house.
3. Irrigation and Water Power Engineering, Dr. Punmia, Dr. Pande; Standard Publisher
5. Engineering Hydrology, K.Subramanyam; Tata McGraw Hill.

Reference Books :

1. Hydrology & Water resources, R.K. Sharma; Dhanpatrai & Sons
2. Theory & Design of Irrigation Structures Vol. I, II, III, Varshney Gupta; Nemchand and Brothers Publication.
3. River Behavior Management and Training, C.B.I.P. vol. I 1989
4. Irrigation Theory and Practices, Michael, Vikas Publication House
5. Water Management, Jaspal Singh, M.S.Acharya, Arun Sharma; Himanshu Publication.

401002 : ENVIRONMENTAL ENGINEERING-II

Teaching Scheme :	**Examination Scheme :**
Lectures : 4 Hrs./Week	**Theory : 100 Marks**
Practical : 2 Hrs./Week	**Duration : 3 Hrs.**
	Oral : 50 Marks

Unit I **9 Hrs.**

Sewage Flow : Sources of sewage, Variations in sewage flow, storm water runoff, ground water infiltration. Design of sanitary sewers, minimum size of sewer, velocities in sewers & gradient of sewers. Sewer materials, choice of materials, testing of sewer pipes, sewer appurtenances i.e. manholes, street inlets, flushing devices, vent pipes etc. Pumping of sewage, types of pumps for sewage pumping.

Characteristics of wastewater : Physical, chemical &biological characteristics waste water sampling & Analysis, interpretation & practical significance of test results.

Unit II **8 Hrs.**

Stream Sanitation : Self purification of natural streams, stream standards & effluent Standards, Oxygen Sag Curve, Streeter - Phelps equation and terminology (no derivation or numerical is expected)

Waste Water Treatment : Necessity of treatment, process design. Theory & design of primary treatment Units. Types of screens, design of screen chamber, disposal of screening. Grit Chamber - Sources of grit, design of grit chamber, disposal of grit, Sources of oil & grease, importance of removal methods of oil & grease removal, design of skimming tanks.

Primary Sedimentation : Necessity, design of PST with inlet & outlet details, Sludge & its disposal.

Unit III **8 Hrs.**

Theory & Design of Aerobic Secondary Treatment Units :

Activated Sludge Process : Biological Principle, Important Microorganisms in wastewater & their importance in waste water treatment systems, Bacterial growth, general growth pattern, growth in terms of bacterial numbers and bacterial mass. Kinetics of Biological growth, cell growth, substrate limited growth, cell growth and substrate utilization, effect of endogenous metabolism. Modification of ASP, oxygen requirement, Design of ASP, sludge volume index, sludge bulking & control.

Trickling filter : Biological Principle, different T.F media & their Characteristics, Design of standard rate and high rate filters using NRC formula, single stage & two stage filters, Recirculation, Ventilation, Operational problems, Control measures, Rotating Biological contractors.

Unit IV **8 Hrs.**

Low cost Treatment Methods :

Oxidation Pond : Bacteria- algae symbiosis, design of oxidation pond as peraltitudes, disposal of pond effluent advantages disadvantages of oxidation ponds.

Aerated Lagoons : Principle, aeration method, advantages & disadvantages of Aerated Lagoons. Oxidation Ditches: Principle, advantages & disadvantages.

Unit V **8 Hrs.**

Theory & Design of Anaerobic Treatment Units : Septic tanks, suitable conditions & situations, biological principle, method of treatment & disposal of septic tank effluent. Anaerobic Digester: Principal of anaerobic digestion, stages of digestion, bio - gas production its characteristics & application, factors governing anaerobic digestion, design, design of anaerobic digesters. Sludge disposal methods, advantages & disadvantages, Upflow Sludge Banker Reactor (UASBR) - Principle, advantages & disadvantages.

Unit VI **8 Hrs.**

Industrial Waste Treatment : Equalization, neutralization, proportioning, sampling Composite sample. Effluent sampling, characteristics, different methods of treatment & disposal of effluent & standards for the following industries: - Paper & Pulp, Sugar, Textile, Dairy, Tannery & distillery.

Hazardous Waste : Definition, Hazardous waste characterization: - Ignitability, corrosivity, reactivity, toxicity.

Introduction to waste Minimization : - Benefits of Hazardous Waste reduction and approaches to waste reduction only introduction to treatment methods. i.e. various treatment alternatives like physical, chemical & biological treatment (No Design is expected)

Term Work : The term work shall consist:

A) Practicals : Performance of at least 8 out of 10 experiments from following:

1. Determination of Total solids, suspended solids, volatile solids, settleable solids & non-settleable solids.
2. Determination of Dissolved oxygen
3. Determination of B.O.D.
4. Determination of C.O.D.
5. Determination of Phosphates by spectrophotometer.
6. Determination of Nitrites by spectrophotometer.
7. Determination of Conductivity
8. Determination of S.V.I.

B) Technical Visit : At domestic / Industrial wastewater treatment plant & its detailed report.

C) Computer aided design : of any one Primary or Secondary treatment Unit using 'C' language or any suitable software.

Oral Examination : Oral shall be based on term work:

Reference and Text Books:

1. Waste Water Treatment & Disposal, Metcalf & Eddy, TMH publication.
2. Environmental Engineering, Peavy, Rowe, McGraw Hill Publication.
3. Waste Water Engineering, B.C. Punmia & Jain - Arihant Publications.
4. Water Supply & Waste Water Engineering, B.S.N. Raju, TMH publication.
5. Sewage disposal & Air Pollution Engineering, S. K. Garg, Khanna Publication.
6. Environmental Engineering, Davis, McGraw Hill Publication
7. Hazardous Waste Management, Chartes A. Wentz McGraw Hill Publication

8. Manual on Sewerage and Sewage Treatment, Public Health Dept., Govt. of India.
9. Waste Water Treatment for Pollution Control, Soli J. Arciwala, Tata McGraw Hill Publication.
10. Sewage Disposal and Treatment, Dr. Modi, Standard Publications, New Delhi.

401003 : QUANTITY SURVEYING, CONTRACTS & TENDERS

Teaching Scheme :
Lectures : 4 Hrs./Week
Practical : 2 Hrs./Week

Examination Scheme :
Theory : 100 Marks
Duration : 4 Hrs
Oral : 50 Marks
Term Work : 25 Marks

Unit I **9 Hrs.**

Estimating : Definition, importance of quantity surveying for civil engineer, purpose, type of estimates, data required for estimates. Items of work, description of an item of work, a Unit of measurement & principles deciding the Units, mode of measurement of building works.

Approximate Estimate : Definition, purpose, methods of approximate estimating of building & other civil engineering projects like roads, irrigation & water supply & sanitary engineering.

Unit II **8 Hrs.**

Taking out quantities : Principles, methods of taking out quantities for different assignments in term work, Schedule of rates (D. S. R.) Abstracting, bill of quantities. Provisional & prime cost items, contingencies, establishment charges, centage charges, sundries, extra items.

Unit III **8 Hrs.**

Specifications : Definition & purpose, type, drafting specifications, legal aspect. Specifications with reference to materials, quality, workmanship, method of execution, mode of measurement and payment for major items like stone/ brick masonry, woodwork, dewatering, plastering and earthwork, R.C.C. work etc.

Analysis of rates : Factors affecting cost of an item of work, materials, labours, tools & plant, overheads & profit. Task work - definition & factors affecting task work. Transportation of material & cost, analysis of rates of all major items.

Unit IV **8 Hrs.**

Valuation of Properties : Purpose, nature of value, price, cost and value, factors affecting value of property. Free hold and lease hold property. Depreciation & methods of working out depreciation, sinking fund, Years purpose, out goings and valuation tables.

Methods of Valuation of Building: Land & building basis, Rental basis, Reproduction & replacement cost basis, Belting basis, Profit basis, fixation of rent.

Unit V **9 Hrs.**

Methods of Executing Works : PWD procedure of execution of work, Administrative approval, budget provision Technical Sanction, Different methods of execution of work in PWD, like piecework, rate list, day work, daily labor.

Tenders : Definition. Methods of inviting tenders, tender notice, Pre- qualifications of contractor, tender documents, preparation of tenders. Submission in 3 bid/ 2 bid or single bid system. Qualitative and quantitative evaluation of tenders, comparative statement, pre- bid conference, acceptance of tenders, various forms of BOT tenders, global tendering.

Unit VI **8 Hrs.**

Contracts : General idea, types of contracts. Conditions of contracts FIDIC document, standard contract published by MOS and PI, Law of contract. Definition, object & essential of valid contract conditions, specific conditions condition regarding EM, SD, time as an essence of contract. Important conditions regarding addition, alteration, extra items, testing & materials, defective work, subletting powers delegated to engineer in-charge regarding the above aspect, defect liability period, retention money, interim payment or running amount bills, advance payment, secured advance, final bill. Settlement of disputes viz. dispute resolving board, arbitration, concept of partnering. Liquidated damages, termination of contract.

Term Work :

1. Estimating quantities using C-L and PWD method for a load bearing Structure or for an industrial shed.
2. Detailed estimate of a single storied R. C. C. framed building using D.S.R. rates.
3. Working out quantities of steel reinforcement for an R. C. C. Structure

4. Estimating quantities for any **two** of the following:
   (a) House drainage & water supply arrangement
   (b) Formwork items in a RCC Structure.
   (c) Pipe culvert or slab culvert.
   (d) Septic tank with soak pit.
5. Drafting detail specification of any two items and working out their rates using market prices.
6. Valuation report of a residential building using O-1 form.
7. Preparation of draft tender notice.
8. Use of computer software for any of the above exercises.

Oral Examination : Oral shall be based on term work:

Reference Books :

1. Estimating and Costing, B.N. Dutta
2. Estimating and Costing, Chakraborty
3. Estimating and Costing, Birdie
4. Estimating and Costing, Rangawala
5 Contracts and Estimates, B.S. Patil
6. Practical Information for Quantity Surveyors, P.T. Jogalekar
7. Valuation of Real Estate, Rangawala.
8. Standard Contracts Clauses For Domestic Bidding Contracts - Ministry of Statistics and Programme Implementation, Government of India

401004 : STRUCTURAL DESIGN III

Teaching Scheme :
Lectures : 4 Hrs./Week
Practical : 2 Hrs./Week

Examination Scheme :
Theory : 100 Marks
Duration : 4 Hrs.
Oral : 50 Marks
TW : 25 Marks

Unit I **08 Hrs.**

Dynamics of Structures : (Analysis) :

Equation of motion for free & forced vibration, concept of degree of freedom, undamped and damped vibration, natural frequency, problems on single degree of freedom only.

Prestressed concrete Structures : **08 Hrs.**

Introduction - Basic concepts, Materials, Various pre-tensioning and post tensioning systems, concept of Losses, stress calculations, concept of cable profile.

UNIT II **12 Hrs.**

Design of Pre-stressed concrete simply supported Beam :

Rectangular and flange sections for flexure and shear, Analysis of continuous beams of two spans.

Unit III **12 Hrs.**

Multistoried frame :

Calculation of Earthquake loads by seismic coefficient method, analysis by substitute frame method, analysis for lateral loads by cantilever and portal method and design of an intermediate continuous beam in that Structure.

Unit IV **14 Hrs.**

Design of special Structures :

(a) Water tanks- circular and rectangular- resting on ground.
(b) Combined footing- with and without strap beam.
(c) Cantilever retaining wall- Tee and Ell shapes.

Term work :

Design shall confirm to latest IS codes: IS 456, IS 875, IS 1343, IS 3370, IS 1893, IS 13920. It will consist of minimum three full imperial sheets based on:

1. Two projects of RCC
2. One project of Pre-stressed concrete.
3. Two sites visit and detail reports one of RCC and another of PSC.
4. Report on analysis and design of small RCC Structure using computer program / software.

Oral Examination : Oral will be based on above term work.

Reference books :

1. Limit state theory and design of reinforced concrete, Dr. V. L. Shah & S. R. Karve
2. Design of RCC Structures, Roy and Sinha
3. Advanced Design of Structures, Krishnaraju
4. Design of Pre-stressed concrete Structures, T. Y. Lin
5. Structural Dynamics, Mario and Paz, CBS Publications.
6. Comprehensive RCC Design, B C Punmia, & Jain, Laxmi Publications.
7. Dynamics of Structures, Anil K. Chopra, Theory and Application to Earthquake Engineering, Prentice Hall Publications

401005 : ELECTIVE-I ADVANCE GEOTECHNICAL ENGINEERING

Teaching Scheme
Lecture : 4 Hrs. /Week
Practical : 2 Hrs. /Week

Examination Scheme :
Theory : 100 Marks
Duration : 3 Hrs.
Term Work : 50 Marks

Unit I **9 Hrs.**

Soil Classification :

Identification and Classification, Criteria for classifying soil - Classification on the basis of Grain size, Plasticity, Symbolic & Graphical presentation. Classified soils and Engineering properties.

Soil Structure & Clay Minerals :

Clay minerals, Clay water relations, Clay particle interaction, Soil Structure & fabric, Granular soil fabric.

Unit II **8 Hrs.**

Earth Pressure Theory :

Earth Pressure theories for calculation of Active and Passive pressure, Rankines and Coulombs Earth pressure theories, Analytical and Graphical Methods.

Design of Earth Retaining Structures :

Design of gravity and cantilever Retaining walls, Design - Cantilever sheet pile walls, Anchored sheet pile walls, Timbering and Bracing for open cuts.

Unit III **8 Hrs.**

Geosynthetics : Types, Functions, Properties and functional requirements. Application of geosynthetics in geo-enviroment.

Reinforced Soil : Mechanism, Reinforcement Soil - Interaction. Applications- Reinforcement soil Structures with vertical faces, Reinforced soil embankments. Reinforcement soil beneath unpaved roads, Reinforcement of soil beneath foundations. Open excavation and Slope stabilization using soil nails.

Unit IV **9 Hrs.**

Soil Behavior under Dynamic loads : Soil behavior under Static and Dynamic loads. Acceptable levels of strain under static and dynamic loading. Soil properties relevant to dynamic loading and its determination.

Machine Foundations : Types of Machine foundations, Design criteria, Methods of analysis - Elastic Half space method, Linear elastic weightless spring method. Evaluation of soil parameters. Design procedure for a block foundation for cyclic loading and Impact loading.

Unit V **8 Hrs.**

Ground Improvement : In-situ ground improvement by Compaction piles, Dynamic loads, Sand drains, Grouting, Deep mixing, Inserting reinforcement elements, Freezisoil,Vibro-flotation.

Unit VI **8 Hrs**

Rheology : Rhelogical elements, Basic & Composite Rhelogical models. Examples of compound models used to explain different soil phenomena; such as Secondary consolidation, Creep etc.

Term Work :

(A) Experiments to be conducted (Any Three)

(1) Plummet balance / Hydrometer Analysis.
(2) Consolidation test.
(3) Swelling Pressure Test.
(4) Triaxial test with measurement of pore pressure.

(B) Assignments (Any Four)

(1) Soil Classification.
(2) Computation of Earth pressure behind Retaining Wall by Analytical method.
(3) Computation of Earth pressure behind Retaining Wall by Graphical method.
(4) Typical slope design with reinforced soil / Geosynthetics.
(5) Design of machine foundation

(C) Computer programme / Software package for solution of any two topic of theory.

(D) Report on one site visit.

Text Books :

1. Geotechnical Engineering by Shashi K. Gulati & Manoj Datta, Tata Mc-Graw Hill
2. Basic and Applied Soil Mechanic, Gopal Ranjan & A.S. Rao, New Age Publication

Reference Books :

1. Physical and Geotechnical properties of soils, Joseph E. Bowels, Tata Mc Graw hill
2. Advance Soil Mechanics, Braja Mohan Das- Tata Mc Graw Hill

Society - Indian Geotechnical Society, 206, Manisha, 75-76, Nehru Place, New Delhi-19

401005 : ELECTIVE-I SYSTEMS APPROACH IN CIVIL ENGINEERING

Teaching Scheme :	**Examination Scheme :**
Lectures : 4 Hrs./Week	**Theory : 100 Marks**
Practical : 2 Hrs./Week	**Duration : 3 Hrs.**
	Term Work : 50 Mark

Unit I **8 Hrs. / 16 marks**

Use of systems approach in Civil Engineering and managerial decision-making process. Introduction to Optimization Techniques and their application in Engineering Planning, design and Construction, Various models, Objective function and constraints, convex and concave functions, regions and sets.

Linear Programming : Formulation of Linear optimization models for Civil engineering applications. The simplex method, special cases in simplex method, Two phase method, method of Big M,

Unit II **9 Hrs. / 18 marks**

Linear Programming : duality, sensitivity analysis. The Transportation Model and its variants, Assignment Model,

Unit III **8 Hrs. / 16 marks**

Non-Linear Programming : Unconstrained programming : One Dimensional Search Techniques: Dichotomous, Fibonacci, Golden section.

Non-Linear Programming : Multivariable problems: Unconstrained, Gradient Techniques, steepest ascent/descent technique, and Newton's method.

Unit IV **9 Hrs. / 18 Marks**

Non-Linear Programming : Constrained Optimization : Lagrangian Multiplier Techniques, Kuhn-Tucker's Conditions, penalty function methods-Interior and Exterior

Dynamic Programming : Principle of optimality, recursive equation

Unit V **8 Hrs. / 16 Marks**

Sequencing Model - n jobs through 2,3 & m machines. 2 jobs through m machines Queuing theory

Unit VI **8 Hrs. / 16 Marks**

Games theory, Benefit-Cost Analysis of Civil Engineering Projects.

Term Work :

1. One exercise on each Unit. Out of these any two problems to be solved using computer.
2. One exercise on formulation of a problem applicable to any field of Civil Engineering, by use of NLP/DP (No solution).
3. Report on one site visit.

Reference books :

1. Operations Research, Hamdy A. Taha
2. Engineering Optimization, S.S.Rao

401005 : ELECTIVE-I FINITE ELEMENT METHOD

Teaching Scheme :
Lecture : 4 Hrs./Week
Practical : 2 Hrs./Week

Examination Scheme :
Theory : 100 Marks
Duration : 3 Hrs.
Term Work : 50 Marks

Unit I **9 Hrs.**

Member approach for truss and beam : Formulation of stiffness matrix using member approach for truss and beam elements, Application to truss and beam Structures not involving unknowns more than three.

Unit II **8 Hrs.**

Member approach for frame and Grid : Formulations of stiffness matrix using member approach for frame and grid elements. Application to frame and grid Structures not involving unknowns more than three.

Unit III **8 Hrs.**

Theory of FEM : Principle of Minimum Potential Energy, Formulation of truss elements using principle of minimum potential energy, Concept of finite element for 2D & 3D elasticity problems, Procedure for descretisation of continuum, Node numbering, Assembly of element equations, Formation of overall banded matrix equation, Boundary conditions & solution of primary unknowns. Use of polynomial displacement function, Pascal triangle, Formulation of element stiffness matrix of 2D element in plane elasticity problem using variational principle. Convergence requirement.

Unit IV **8 Hrs.**

Displacement functions for 1D element such as axially loaded bar element, truss element & beam element, 2D & 3D elements in plane elasticity problems such as CST, LST, and Tetrahedron, Hexahedron elements.

Unit V **9 Hrs.**

Use of shape functions in displacement function. Modified & Concise formulation of element stiffness matrix due to shape function, Area Coordinates for CST element, Isoparametric elements, Natural coordinates for 1D bar element, 2D & 3D elements in plane elasticity problems. Jacobian matrix, Formulation procedure for 2D quadrilateral isoparametric element in plane elasticity

Unit VI **8 Hrs.**

Axisymmetric elements under axisymmetric loadings, Triangular and Quadrilateral elements. Strain displacement and stress strain relations.

Term work : Term work shall consist of at least two assignments on each Unit based on the syllabus and at least two-computer program one each of 1D and 2D problem based on syllabus, using FEM software.

Reference Books :

1. Introduction to the Finite Element Method, Desai & Abel, CBS Publishers & Distributors, Delhi
2. Introduction to Finite Elements in Engineering, T.R. Chandrupatla & A.D.Belegundu, Prentice Hall of India Pvt. Ltd.
3. Matrix, Finite Element, Computer & Structural Analysis, M. Mukhopadhyay, Oxford & IBH Publishing Co. Pvt. Ltd.
4. Finite Element Analysis - Theory & Programming, C.S. Krishnmoorthy,
5. An Introduction to the Finite Element Method, J.N. Reddy, Tata Mc Graw Hill
6. Theory & Problems - Finite Element Analysis, Gorge R. Buchanan, Schaum's Outline Series. TATA Mc Graw Hill Publishing Co. Ltd.
7. The Finite Element Method, O.C. Zienkie Wiz, Tata Mc Graw Hill Publishing Co.
8. Finite Element Analysis, S.S. Bhavikatti, New Age International (P) Ltd

401005 : ELECTIVE-I STRUCTURAL DESIGN OF BRIDGES

Teaching Scheme :
Lectures : 4 Hrs./Week
Practical : 2 Hrs./Week

Examination Scheme :
Theory : 100 Marks
Duration : 3 Hrs.
Term Work : 50 Mark

Unit I **9 Hrs.**

Highway bridges : Different Types, RC & Pre-stressed Bridges, Structural arrangement for slab, T-beam, Box girder, balanced cantilever, Continuous girders, Rigid Frame, Arch, Bow string, Cable stayed bridges, Curved and Skew bridges.

Standard specifications of road bridges, Width of Carriage Way, Clearances, IRC Classification for Live Loads, Dead Load, Impact, Longitudinal and Centrifugal forces, Horizontal forces due to water current, buoyancy effect, Earth pressure and Seismic forces.

Unit II **8 Hrs.**

T-Beam Type Bridge : Components, Number and Spacing of main girders, RC Design of deck slab using load distribution by Pigeoud's curves, IRC Class AA tracked and wheeled vehicle, Design of cantilever slab.

Unit III **9 Hrs.**

Design of Prestressed concrete Girder : Intermediate and end longitudinal girders. Design based on analysis by Courbon's method, Design of End Block, Design of Elastomeric pad bearings.

Unit IV **8 Hrs.**

Railway Steel Bridges : Types, Deck and Through type Truss bridges, Plate girder bridges, Arch bridges.

Classification of Railway tracks, Standard axle and train loads for different tracks, Equivalent UDL, Dynamic effect, Impact factor, Longitudinal forces, Racking forces, and Wind and Seismic forces.

Unit V **9 Hrs.**

Truss Bridges : Structural arrangements for Deck and through type railway bridges, Width and Clearances, Analysis and Design of members of Steel truss bridge, typical connection details at joints.

Unit VI **9 Hrs.**

Bracing Systems in Deck and Through type Truss bridges, Analysis and Design of horizontal truss bracings at chord levels. Various arrangements of Portal bracings, Mechanical bearings, Design of Rocker and Roller bearings.

Term Work :

(i) Term work shall consist of project report on analysis and design with drawing- two full size imperial sheets based on :

(i) Either Unit II or III

(ii) Either Unit V or VI

(ii) Report on one site visit.

Reference Books :

1. Essentials of Bridge Engineering., D. Johnson Victor, Oxford and IBH Co. Pvt. Ltd.
2. Concrete Bridge Practice-Analysis, Design & Economics, V.K.Raina,
3. Design of Bridge Structures, T.R.Jagdish and M.A.Jayram, Prentice Hall of India.
4. Design of Steel Structures Vol. II, Ramchandra, Standard Book House, Delhi.
5. Indian Road Congress-Standard Specifications and Code of Practices for Road Bridges.
6. IRC 18-1985, Design Criteria for Prestressed concrete road bridges (Post-Tension concrete)
7. IS: 1915-1961, Code of Practice for Steel Bridges.

401005 : ELECTIVE-I ARCHITECTURE AND TOWN PLANNING

Teaching Scheme :	Examination Scheme :
Lecture : 4 Hrs./Week	Theory : 100 Marks
Practical : 2 Hrs./Week	Duration : 3 Hrs.
	Term Work : 50 Marks

Unit I **9 Hrs.**

Architecture : Principles of architecture, Qualities of architecture, factors in architecture, Architectural composition, salient features of Gothic and Renaissance architecture, Doric Order, Architectural Design Aids.

Unit II **8 Hrs.**

Building Environment : Building byelaws, plan development stages, activity charts, connectivity matrix, ventilation and air movements, orientation and planning for environment: solar radiation, winds, humidity, clouds, and precipitation, lighting, noise.

Unit III **9 Hrs.**

Landscape Planning and Interior Building Design : Objectives of landscape, Elements of landscape, Material selection: soft landscape and hard landscape, principles of landscape design.

Concepts of Interior Design - lighting, indoors plants, procedure of interior design, interior for residential accommodation of two bedrooms,

Unit IV **8 Hrs**

Town Planning Concepts : Objects of town planning, Principles of town planning, growth of towns, stages in town development, Garden city concept, Three magnet concept, Neighborhood concept, Planning of a neighborhood and its role as a Unit of urban planning, town planning schemes.

Unit V **8 Hrs.**

Development Plan : Scope and purpose of Perspective plan, Development plan, Planning surveys: Demographic, housing, traffic and transportation, land use, drainage and water supply, urban roads-objectives, classification, traffic management.

Acts related with Town Planning : Contents of MRTP,ULC and EPA ,Norms and standards for Urban development plan as per UDPFI guidelines for distribution of land use and infrastructure.

Unit VI **8 Hrs.**

Application of modern techniques in Town Planning : Introduction to GIS, GPS, Remote Sensing, GIS data sources, collecting and entry, GIS data formats and standards, GIS on the Web, Principle of remote sensing, Theory of GPS-space segments, Application of GIS, GPS, Remote sensing in Town Planning.

Term work : Term work shall consist design and drawing of :

(1) Neighborhood Plan.
(2) Land use survey for an area of at least 1 sq.km.
(3) Solar Loads for a residential bungalow/flat.
(4) Report on one site visit.

References Books :

(1) World Architecture, G. K.Hiraskar.
(2) UDPFI Guidelines, Ministry of Urban Affairs and Employment, Govt. of India, New Delhi.
(3) MRTP, ULC, EPA Acts
(4) Remote Sensing, Kieffer and Lillysand.
(5) Town Planning, K.S.Rangwala and P.S.Rangwala.
(6) Building Environment, Dajitha Simha
(7) The GIS Book, George B. Korte P.E.
(8) Manual of Tropical Housing and Building, Koenigsbeger, Ingersoll Orient Longman.

401005 : ELECTIVE-I ADVANCED ENVIRONMENTAL MANAGEMENT

Teaching Scheme :	Examination Scheme :
Lecture : 4 Hrs./Week	Theory : 100 Marks
Practical : 2 Hrs./Week	Duration: 3 Hours
	Term Work : 50 Mark

Unit I **9 Hrs.**

Fundamentals of Environmental Management and ISO 14000 series : Background and development of ISO 14000 series, Environmental Management Plans, Principles and Elements. ISO 14001-Environmental Management Systems Standard. Environmental Law in India: Environmental policy and laws.

Unit II **8 Hrs.**

Environmental Management Acts related to environmental protection : Air, Water, Soil and Hazardous Waste. Water Act 1974 (Prevention & Control of pollution), Air Act 1981 (Air Pollution Prevention & Control of Pollution) Hazardous waste management handling rules - 1989. Municipal Solid Waste Rules- 2000.

Unit III **8 Hrs.**

Air pollution monitoring : Air pollution control acts and regulations, Air quality standards, Pollution indices in air monitoring and Air quality assessment. Air pollution control technologies for oxides of sulphur: Reducing SOx levels through dilution by increasing stack height, use of alternative fuels. Extraction of sulphur from fuels. Reduction of sulphur in combustion process, fuel gas desulphuration.

Air pollution control technologies for oxides of Nitrogen : Emission of nitrogen Oxides. Control technologies for oxides of Nitrogen emissions. Air pollution control technologies for Volatile organics, Hydrocarbons and hydrogen sulphide.

Unit IV **9 Hrs.**

Solid Waste Management : Solid waste characteristics, Solid waste collection and transportation. Solid waste processing and recovery and solid waste disposal.

Hazardous waste management: Types of hazardous waste, Health effects Cradle-to-grave management, treatment methods and disposal.

Biomedical waste: Biomedical waste and their hazards on health and environment. Legal laws on management of medical wastes in India. Collection, treatment and disposal of biomedical wastes.

Unit V **9 Hrs.**

Advance waste water treatment : Carbon adsorption, Ion exchange, sodium and hydrogen cycle. Membrane process. Electro dialysis process, pressure membrane process and membrane performance characterization. Nutrients removal such as nitrogen and phosphourus removal.

Land Treatment Systems : Irrigation, rapid infiltration and overland flow systems. Wetland flow Systems.

Unit VI **9 Hrs.**

Planning and management of impact studies : Conceptual approach for environmental impact studies, proposed development, inter disciplinary team formation, team leader selection and duties. General study management and fiscal control,

Environmental Impacts of Thermal Power Plants and Water Resources projects.

The environmental rules 1999 (sitting for industrial process, methodology for preparing environmental impact assessment role of regulatory agencies and control boards in obtaining Environmental clearance for project. Role of general public in Environmental clearance.

Term Work: Term work shall consist:

A) Detailed report on **any two** of the following
   (1) Industrial water pollution control technologies
   (2) Anaerobic treatment of industrial process wastewaters
   (3) Industrial water pollution control - Applications
   (4) Industrial waste water treatment - Principles
   (5) Pollution control legislations and their implementation
   (6) Distillery spent wash treatment technologies for the next decade
   (7) Pollution control systems for fertilizer industry
   (8) Particulate emission control technology
   (9) Global trend in industrial pollution control
   (10) Pollution control and waste management in sulphuric acid and super phosphate plant
   (11) EIA for any one (Thermal Power Station, Water Resources Project or Express Highways)
   (12) Application of GIS/ remote sensing in environmental planning and management.
   (13) Air quality management for industries
   (14) Hazards wastes- Definition Classification and Treatment

(B) Report on one site visit.

(C) Assignments on above topics.

Reference Books :

1. Anti pollution Acts (3) and commentaries published therorem.
2. Constitution of India [Referred articles from part-III part-IV and part-IV A]
3. Environmental and the last P. Leelakrishanan, (Bullorthworths, Latold edn.)
4. Basic Environmental Technology: Jerry; A. Nathanson.
5. Handbook of Environmental Management and Technology: Gwendolyn Holmes, Ben Ramnarine Singh, Louis Theodore.
6. The ISO 14000 Handbook: Joseph Cascio.
7. ISO 14004- Environmental Management Systems: General guidelines on principles, systems and supporting techniques (ISO 14004:1996 (E)).
8. ISO 14001: Environmental Management Systems: Specification with guidance for use (ISO 14001:1996b(E)) (International organization for standardization-Switzerland)
9. Air Pollution and Control, K.V.S.G. Murli Krishna Kaushal & Co., Kakinada.

[Note: Declarations, comments, cases and research articles published from time to time will be recommended by the concerned teachers]

401005 : ELECTIVE-I GEOINFORMATICS

Teaching Scheme :	Examination Scheme :
Lectures : 4 Hrs./Week	Theory : 100 Marks
Practical : 2 Hrs./Week	Duration : 3 Hrs.
	Term Work : 50 Marks

Unit I **9 Hrs.**

Fundamentals of Remote Sensing : Introduction, Principle of Remote Sensing, Electromagnetic Spectrum, Frequency and Interaction of EMR with the Earth's Surface. Sensors & Platforms, Scanning System, Sensors Resolution, Types of Sensors, Elements of Interpretation of Aerial Photographs & Satellite Imageries

Unit II **8 Hrs.**

Digital Image Processing : Introduction to Image processing, Digital Image, Image Rectification and Transformation, Image Enhancement Techniques, Image Classification,(Supervised and Unsupervised)

Unit III **8 Hrs.**

Global Positioning System (GPS) : Introduction to GPS, Theory of GPS, GPS Space segments, GPS Control and user Segments, GPS- Positioning Methods, Pseudo-ranging, Ionospheric effects, Differential GPS, Accuracy denial, Precise Differential Positioning Surveying, GPS Co-ordinates and heights, GPS instrumentation, softwares, Applications of GPS in Civil Engineering.

Unit IV **9 Hrs.**

Fundamentals of GIS : Introduction to GIS, Definition of GIS, Objectives, Components, Map Projections System, Data Type, Capture and Storage, Rectification of maps, Geographical entities, Attributes, Topology, Spatial Data Analysis and modeling, Digital Elevation Model and TIN, Data Base Management Concepts, Components and Types of Data Base, Relation Data Base and GIS, The Hybrid and Integrated Data Model, Object Oriented DBMS.

Unit V **8 Hrs.**

Geo-informatics software : Integration of Remote Sensing, GIS and GPS, Facilities for Integration and use of Software.

Unit VI **8 Hrs.**

Applications of Geo-informatics : Application of GEOINFORMATICS in irrigation management, Hydropower development, Water supply & sanitation, Floods & drought management, Watershed management, Integrated resources development & management, Ground water management, Communication & Transportation network management, Geotechnical Engineering, Infrastructure Development, Water quality management, Survey & investigations.

Term Work : Term work shall consist of project report on analysis and design with drawing of minimum two full size imperial sheets based on :

1. Comparison of Map, Aerial Photograph & Satellite Imagery
2. Digital Image Processing Techniques
3. Use of global Positioning System (GPS) in static mode for x,y and z measurements
4. Use of GPS in kinematics mode for x,y & z measurements
5. Demonstration of Instruments and Software
6. Applications of geo-informatics

Reference Books :

1. Introduction to Remote Sensing, Campbell J.B., The Guilford Press, London, 1986
2. Principles of Remote Sensing, Curran P.J. Longman, London, 1985.
3. Remote Sensing, Lillysand and Keifer
4. Digital Data: NRSA Hyderabad,

Societies : 1) Indian Society of Remote Sensing, Dehradun.
2) Indian Society of Geomatics, Ahamadabad.

401006 : PROJECT WORK

Practical Scheme :	**Examination Scheme :**
2 Hrs./Week Semester I	**Term Work :100 Marks**
6 Hrs./Week Semester II	**Oral : 50 Marks**

Term work shall consist of a report pertaining to the study carried out on the topic related with Civil Engineering field. The study may consist of any one or more of the following :

1. Critical Survey of Literature.
2. Experimental Investigation.
3. Design and Fabrication of a Model.
4. Design Problems
5. Industrial Assignment/ Field study and Analysis
6. Preparation of Software/ Computer programme for Civil Engineering Applications.

Oral : Oral shall be based on the term work.

401007 : ELECTIVE-II ADVANCED CONCRETE TECHNOLOGY

Teaching Scheme :	**Examination Scheme :**
Lecture : 4 Hrs./Week.	**Theory : 100 Mark**
Practical : 2 Hrs./Week.	**Duration : 3 Hrs.**
	Oral : 50 Marks

Unit I **8 Hrs.**

Cement and its types : General, Hydration of cement, Water requirement for hydration, Alkali aggregate reaction.

Aggregate : Sieve Analysis, Grading curves.

Concrete : Properties of fresh and harden concrete, w/c ratio, w/b ratio, Gel space ratio, Maturity concept, Aggregate cement bond strength etc.

Unit II **8 Hrs.**

Different types of concretes : Light weight concrete, Ultra light weight concrete, Vacuum concrete, Mass concrete, Waste material based concrete, Shotcreting, Guniting, Sulphur Concrete and Sulphur infiltrated concrete, Jet cement concrete (ultra rapid hardening), Gap graded concrete, No fines concrete, High strength concrete, High performance concrete, Under water concreting, etc.

Unit III **9 Hrs.**

Mix design of concrete : Design of high strength concrete mixes, Design of light weight aggregate concrete mixes, Design of fly ash cement concrete mixes, Design of high density concrete mixes.

Advanced non-destructive testing methods : Ground penetration Radar, Probe penetration, Pull out test, Break off maturity method, Stress wave propagation method, electrical / magnetic methods, Nuclear methods and Infrared thermography, Core test.

Unit IV **9 Hrs.**

Fibre reinforced concrete : Historical development of fibre reinforced concrete, Properties of metallic fibre, Polymeric fibres, Carbon fibres, Glass fibres and naturally occurring fibres. Interaction between fibres and matrix (uncracked and cracked matrix), Basic concepts and mechanical properties: Tension and Bending.

Unit V **8 Hrs.**

Properties of hardened FRC : Behaviors under compression, tension and flexure of steel fibres and polymeric fibres. GFRC, SFRC, SIFCON-development, Constituent materials, Casting, Quality control test and Physical properties.

Unit VI **8 Hrs.**

Analysis and Design of Precast Elements : Ferro-cement, Analysis and design of prefabricated concrete structural elements, Manufacturing process of industrial concrete elements, Precast construction, Errections and Assembly techniques.

Term work : Term work shall consist of followings.

1. Testing of special type of cements blended cement such as fly ash, GGBS, low heat cement, rapid hardening cement (**any two**). Tests shall include fineness, consistency, intial and final setting time, soundness and compressive strength, for each materials.
2. Testing of special type of concrete such as blended cement concrete, fibre reinforced concrete. Test shall include compression, tension and flexure, for each type of concrete. 3. Testing of ferro cement for tension and flexure.
4. Non-destructive testing using ultrasonic pulse velocity tester, Rebound hammer.
5. Report on one site visit.

Ground Granulated Blast Furance Stage

Oral Examination : Oral based on above term work.

Reference Books :

1. Concrete Technology, A.M.Neville and Brooks.
2. Properties of Concrete, Murdock.
3. Properties of Concrete, P.K.Mehta.
4. Concrete Technology, M.S. Shetty.
5. Fibre Reinforced Cement Composite, P.N .Balaguru and S.P. Shah

401007 : ELECTIVE- II EARTHQUAKE ENGINEERING

Teaching Scheme :	**Examination Scheme :**
Lectures : 4 Hrs/Week	**Theory : 100 Marks**
Practical : 2 Hrs/Week	**Duration : 3 Hrs.**
	Oral : 50 Marks

Unit I **9 Hrs.**

Introduction to earthquake : Geology of earth, Configuration of tectonic plates in a globe, Influence of Geology on earthquake, Behavior of plates, their motion and effects, Causes of earthquake and their characteristics, Earthquake parameters, magnitudes, intensity, scales, seismic zoning of India, seismic coefficients for different zones, Natural disasters, mitigation and social aspects.

Lessons from past earthquake : Study of damages caused due to past, earthquakes in/ outside India and remedial measures.

Unit II **8 Hrs.**

Theory of vibrations : Vibration- definition, causes, classifications, Introduction to Single Degree of Freedom (SDOF). Response of Structures to different types of systems like free, forced, damped, un-damped vibrations. Three Degrees of Freedom (TDOF) forced un-damped vibrations, derivations of related equations and solution of problems. Response of Structure due to earthquake ground motion, mode shapes, Three Degree of systems of vibration.

Unit III **8 Hrs.**

Lateral Load Analysis of Building : Floor Diaphragm action. Moment resisting frames and shear wall.

Unit IV **9 Hrs.**

Seismic Design of RC Structures : Effect of earthquake on RC Structure, IS provision, Seismic coefficient method. Basic requirement, estimation of story shear, effect of unsymmetrical geometry and masses, mass center and stiffness center, estimation of story shear and tonsional moments for unsymmetrical buildings. IS code provision to response spectrum, Modal analysis for RCC frame, Design of multistoried building, Concept of ductile detailing, IS-13920 provisions for RC frame.

Unit V **8 Hrs.**

Seismic Foundation Design : Type of forces generated due to earthquake, Effects on different types of foundation, Design of RCC isolated footing for earthquake loading, Liquefaction, causes and its remedial measure.

Introduction of Different Control Systems : Passive (base isolation) and Active controls Systems, Bracing system, TMD etc and some latest invention (concepts only)

Unit VI **8 Hrs.**

Restoration and Retrofitting : Evaluation of existing buildings, aging, weathering, development of cracks, improper load path, Asymmetry. Materials and equipments for restoring and retrofitting, Methodology of retrofitting for walls, slabs roofs columns, foundations etc. for buildings in stones, bricks RCC.

Term work : Term work shall be based on the above syllabus consisting of followings:

(1) Fifteen Problems on different topics of above syllabus

(2) Two full imperial sheets based on projects of RC multistory building or isolated footing for earthquake loadings

Notes : Design should confirm to latest IS 1893, 4326, 13920, 13827, 13828, 13935

Oral Examination : Oral is based on term work.

Reference Books :

(1) Dynamics of Structure by Clough R.W. and Penzin J. McGraw Hill Civil Engineering Series

(2) Dynamics of Structure by Anil K Chopra, Prentice Hall India Publication

(3) Dynamics of Structure by Mario Paz, CBSPD Publication

(4) Earthquake Resistant Design by David J. Downik, John Wiley and Sons Publication

(5) Earthquake Tips NICEE, IIT, Kanpur

(6) Elements of Earthquake Engineering by Jaikrishna and Chandarsekaran.

(7) Geo-technical Earthquake Engineering by Kramer S. L. Prentice Hall India Publication

(8) Introduction to Structural Dynamics by John M. Biggs

(9) Mechanical Vibrations by V. P. Singh

401007 : ELECTIVE-II ADVANCED TRANSPORTATION ENGINEERING

Teaching Scheme :	**Examination Scheme :**
Lecturers : 4 Hrs./Week.	**Theory : 100 Marks**
Practical : 2 Hrs./Week.	**Duration : 4 Hrs.**
	Oral : 50 Marks.

Unit I **8 Hrs.**

Transport System Planning : Transport policy, process, types of surveys, OD matrix, Travel demand forecasting trip generation, modal spilt analysis, trip distribution, route assignment analysis, Transport Networks, network flow analysis.

Unit II **9 Hrs.**

Urban Transport Technology : Classification, mass and rapid transit system, personal rapid transit system, bus system, automated highways, urban goods movement, broad classification of urban goods movements, demands, external commodity movements, inter industry consignment, house hold based consignment, Introduction to Intelligent Transportation System (ITS), Public Transport policy, intermediate public transport, non motorized transport facilities for elderly population, women & children.

Unit III **8 Hrs.**

Transport Economics & Financing : Vehicle operations cost, running cost, pollution cost, value of travel time, road damage cost, congestion cost, accident cost economic evaluation, various economic studies.

Transportation plans - Benefit cost method, Net present value method, First year rate of return method, and Internal rate of return method & comparison of various methods. Pavement Management System.

Highway Financing : Pay as you go method, credit financing, private financing, BOT, BOOT, dedicated road funds, road pricing, tolls, private provisions, advantages& limitations.

Unit IV **9 Hrs.**

Traffic Systems : Traffic impacts, traffic studies, level of analysis, traffic analysis process, basic traffic theory, intersection studies, turning movements, flow, delays, and queuing, signal design, grade separated intersection, parking studies, Traffic generation and parking, parking and entrance facilities, parking demand surveys and requirements, parking facilities, traffic safety and traffic regulations, instrumentation of traffic monitoring, road safety, statutory accident records, site investigation conflict studies, driver behavior studies.

Unit V **8 Hrs.**

Study of flexible pavement : Highway pavements and airport pavements, Flexible pavements studies, performance studies, surface, surface characteristics of pavements, profile measurements, pavement unevenness, skid resistance, its measurements, IRC, AASHO guide to design of pavement, pavements failure, maintenance strategy Freezing of soil, B.C. soil, desert soil etc. Strengthening of pavement - Types of overlays flexible over flexible, rigid over flexible. Overlay design by Benkelmen method, mechanization in pavement construction.

Unit VI **8 Hrs.**

Study of rigid pavement : Concept of rigid pavement, comparison of rigid pavement over flexible pavement, Stress distribution in layered media, one and two layered system, joints in rigid pavement, longitudinal construction joints, design as per IRC guidelines, design of joints, dowel bars, temperature reinforcement, pavement failure, maintenance strategy strengthening of rigid pavement, types of overlays, flexible over rigid, rigid over rigid, mechanization in pavement construction.

Term work : The term work shall consist of following :

1. Conducting any three types of traffic surveys.
2. Exercise on economic analysis
3. Exercise on evaluation of existing flexible/rigid pavement for strength/roughness/deflection
4. Comparison of flexible and rigid pavement
5. Design of Flexible pavement including overlay design
6. Design of Rigid pavement
7. Report on one site visit.

Oral : Oral examination shall be based on term work.

Reference Books :

1. Traffic Engineering and Transport Planning, L R Kadiyali.
2. Understanding Traffic System, Michel A Taylor, William Young, PeterW Bonsall.
3. Principles of Urban Transport Systems Planning, B. G.Hutchinson.

4. Introduction to transport planning, M. J. Bruton.
5. Transport Networks, Potts Oliver (Academic Press).
6. Modem Construction Equipment's and methods, Frank Harries.
7. Fundamentals of Transportation Engineering, C. S. Papacostas.
8. Pavement analysis and Design, Huang Y H, Prentice Hall,
9. Fundamentals of Traffic flow Theory, Drew, McGraw-Hill Book Company.

401007 : ELECTIVE-II ADVANCED STRUCTURAL DESIGN

Teaching Scheme :	Examination Scheme :
Lectures : 4 Hrs./Week	Theory : 100 Marks
Practical : 2 Hrs./Week	Duration : 3 Hrs
	Oral : 50 Marks

Unit I **9 Hrs.**

Design of microwave steel towers and Hoarding Structures subjected to dead load, live load and wind load. Design of castellated beams.

Unit II **8 Hrs.**

Design of solid web and open web portal frames. Design of tension and compression members and its footing subjected to uni-axial and bi-axial bending.

Unit III **8 Hrs.**

Design of cold-formed light gauge steel Structures subjected to tension and flexure.

Unit IV **9 Hrs.**

Limit State Method of design : Design of flat slab, Design of circular slab using yield line theory.

Unit V **8 Hrs.**

Analysis and Design of Intz tank, Circular tanks, Analysis and design of staging subjected to earthquake forces using seismic coefficient method.

Unit VI **8 Hrs.**

Limit State Method of Design : Grid Slab using Kirchoff's method of analysis, Design of counter fort retaining walls.

Term work : Term-work shall consist of following:

1. Design of Complete project one from each section (Two Full imperial sheets for each project with structural detailing.).
2. Two sites visit, one for steel Structures and one for RCC Structures.

Note : Designs should confirm to IS Codes: 456, 800, 801, 802, 875, 3370, 1893-13920.

Oral : Oral examination shall be based on term work.

Reference Books :

(1) Advanced Reinforced Concrete Design, P. C. Varghese, Prentice Hall India.
(2) Advanced Reinforced Concrete Design, Krishna Raju, CBSRD publication.
(3) Ultimate strength Design for Structural Concrete, Ramakrishnan V and Arthur P. D.
(4) RCC Analysis and Design, Sinha and Roy, S. Chand and Co. New-Delhi
(5) Design of Steel Structures Vol.-II, Dr. Ramachandra, Standard Publications New Delhi.
(6) Comprehensive Design of Steel Structures, Punmia B. C. and Jain, Standard Book House
(7) Guide for Structural use of steel work in Buildings-INSDAG Calcutta.
(8) Steel Designer's Manual - E L B S Publication

401007 : ELECTIVE-II CONSTRUCTION MANAGEMENT

Teaching Scheme :	Examination Scheme :
Lectures : 4 Hrs./Week	Theory : 100 Marks
Practical : 2 Hrs./Week	Duration : 3 Hours
	Oral : 50 Marks

Unit I **8 Hrs.**

General : Construction Industry-Nature, Characteristics, Size and Structure. Role in economic development of nation, Employment generation, Infrastructure development. CIDC's role in gearing up the construction sector.

Construction management : Necessity, Application of management function viz. Planning, Organizing, Staffing, Leading and controlling to the construction (with reference to a case study). Viewpoints of clients Contractors, Consultants (related to a successfully completed and a failed project)

Construction Manager : Role, qualities, Ethics, Duties, Responsibilities, Authorities.

Unit II **8 Hrs.**

Resource Management : 4 M's in Construction-Money, Machine, Material and Management Definition by International Federation of Purchasing and Material Management. Objectives, Functions. Qualities of material manager, Material forecasting, inventory control: Necessity, Techniques such as ABC, EOQ, HML, VED, SDE, etc. MUSIC-3d rule, lead-time, safety stocks, materials evaluation using different indices. JIT, MRP, Use of Materials Management Systems (MMS).

Unit III **8 Hrs.**

Project Appraisal and Development : Project feasibility analysis based on Technical, Financial, Social Benefits, benefit cost analysis - capitalization, Annuity, Break even analysis. Ecological and Environmental Assessment studies (with one case study)

Financial Management : Types of finance, Objectives of financial management. Working capital, Methods of raising funds, role of lenders engineer. FDI in construction. Role of WB, ADB, CIDB, ICRA etc.

Unit IV **9 Hrs.**

Disaster Management : (For the disasters like flood, Tsunami, Earthquake, drought, cyclones, famine, terrorist attacks, etc.) - Meaning, significance, causes and defects, disaster preparation, mitigation, reconstruction and rehabilitation, activities that prevent disaster, reduce the chances of a calamitous event, risk analysis and identification of major hazards, on site & off site emergency planning.

Unit V **8 Hrs.**

Legal Aspects and Laws Applicable to Construction Industry : Works contract act. Child labour act. Workman's compensation act. Employees provident fund act 1952. Minimum wages act. Payment of bonus act 1965. Maternity leave act. Indian Arbitration Act of 1994. Training: Necessity, Methods, Training programmes.

Unit VI **8 Hrs.**

Risk Management : Introduction-Principles, types, Origin, Costs of Risks Evaluation, Risks control-Role of risk manager, Risk mitigation methods. CIDC policies for construction risk mitigation. RAMP handbook.

Applications of MIS : Systems Developments, Data Processing, Flow charting. DBM, Data communication.

Term work : The term work shall consist of following:

1. Assignment based on EOQ considering discounts offered for bulk purchase.
2. Assignment based on ABC, HML, VED, SDE etc, MUSIC-3D matrix based on it.
3. Drawing site layout for a construction work for minimum 3 stages of the work.
4. Assignment based on use of Risk Assessment tables.
5. Preparation of a safety programme for a construction work.
6. Visit to construction site of any major work and preparing visit report.
7. Presentation of the case studies.

Oral : Oral examination shall be based on term work.

Reference Books :

1. Construction Management, S. Seetharaman, S. B. Nath Market N. Delhi.
2. Construction Management and Planning, Sengupta, Tata Mc Graw Hill publication.

3. Purchasing and Inventory Control, K. S. Menon, Wheeler Publication.
4. Professional Construction Management, Barrie-Paulsion, Mc Graw Hill Institute .
5. Inventory Control, L. C. Zhamb.
6. Hand Book of Management, P. Gopal Krishnan.
7. Material Management, Rustogi.
8. Risk Management in Civil/Mech/Structural Engineering, M. James, Thomas Telford Publication. 1996.
9. Practical Risk Management in Construction Industry, Loeslie Edwards, Thomas Telford Publication, 1995.

401007 : ELECTIVE-II INTEGRATED WATER RESOURCES PLANNING & MANAGEMENT

Teaching Scheme :	Examination Scheme :
Lectures : 4 Hours/Week	Theory : 100 Mark
Practical : 2 Hours/Week	Duration : 3 Hrs.
	Oral : 50 Marks

Unit I **9 Hrs.**

Introduction : World water resources, water resources in India, water as finite resource, variability of water in time & space, history of water resources development, water infrastructure-problems and perspectives, present institutional framework for water management.

Water Laws : Constitutional provisions, National Water Policy, riparian rights / ground water owner ship, prior appropriation, permit systems, acquisition and use of rights, scope for privatization.

Economics of Water : Water as economic good, intrinsic value, principles of water pricing & water allocation, capital cost, opportUnity cost, internal rate of return, benefit cost analysis, principles of planning and financing of water resources project.

Unit II **8 Hrs.**

Probabilistic and Statistical Methods : Statistical parameters, mean, mode, median, standard deviation, kcurtosis, probability, random events, random variable,

functions of random variables, moments and expectations, common probabilistic distributions (normal, lognormal, poission, extrem value, log-pearson etc.) estimation of parameters, goodness of fit tests, regression and correlation analysis.

Systems Engineering : Systems Engineering. Concepts, optimizing techniques, conventional (LP, NLP, DP...) and evolutionary (ANN, fuzzy logic, genetic algorithm), simulation, applications of soft computing techniques for water resources planning and management

Unit III **8 Hrs.**

Flood Management : Causes of floods, structural and non-structural measures, mitigation plan, flood damage assessment, use of geoinformatics

Drought Management : Types of droughts, severity index, drought forecasting, damage assessment, mitigation plan, use of geoinformatics.

Unit IV **8 Hrs.**

Basin Scale Hydrology : Estimation of surface water, estimation of ground water draft/recharge.

Supply and Demand Based Management : Surface water storage potential, usable ground water, import/export of water (interbasin water transfer), recycling and reuse, consumptive & non consumptive demands, irrigation demand estimation, water utilization, irrigation efficiency, water management in irrigation sector, demand estimation in hydro/thermal/nuclear power sector, estimation & forecasting of water demands of domestic & industrial sector, navigation and recreational water demands.

Unit V **8 Hrs.**

Environmental Management : protection of vital ecosystem, water requirements for environmental management, aquaculture, minimum flows, water quality management for various uses.

Social Impact of Water Resources Development : direct/ indirect benefits, employment generation, industrial growth, agro-industry, enhanced living standards, education & health, co-operative movement, management of rehabilitation & resettlement, control of water logging, salinity, & siltation of storages.

Unit IV **8 Hrs.**

Basin Planning & Management : Perspective plan for basin development & management, Decision support system for Integrated Water Resources Management (IWRM), use of Geoinformatics, Artificial Neural Networks in water resources planning, development & management

Term Work : The term work shall consist of minimum nine assignments from following:

Group I - All assignments are compulsory

(1) Basin selection, schematization of water network, basin morphological parameters
(2) Data collection & analysis (Surface water /Ground water, Water infrastructure)
(3) Rainfall runoff analysis
(4) Estimation of surface water resources in the basin
(5) Estimation of ground water available in the basin

Group II - Any two of the following

(6) Preparation working table for reservoirs
(7) Working table for irrigation scheduling
(8) Estimation of crop water requirements
(9) Estimation of various water demands & their projections

Group III - Any two of the following

(10) Decision Support System for IWRM
(11) Perspective plan for basin development & management
(12) Use of geoinformatics, ANN,

Oral : Oral examination shall be based on term work.

TEXT BOOKS/ REFERENCES :

1. Water Resources Systems Engineering, D. P. Loucks, Prentice Hall India
2. Optimization: Theory and Applications, S S Rao, Wiley Eastern, 1980.
3. Systems Approach to Water Management, A. K. Biswas, McGraw Hill
4. Water Resources Systems Planning and Management, Chaturvedi, M.C.
5. Design of Water Resources Systems, Arthur Mass et al, MacMilan 1962.
6. Economics of Water Recourses Planning, L. D. James & R.R.Leo, McGraw Hill
7. Watershed Shed Management V.V. Dhrava Narayana, G Sastry, U.S. Patnaik.
8. Water Resources Design, Planning Engineering and Economic, Edward Kuiper, Butterworth & Co.
9. ANN in Hydrology; Govinda Raju & Ramachandra Rao, PHI
10. Handbook of Applied Hydrology, Ven Te Chow, McGraw Hill

401007 : ELECTIVE-II
ADVANCED ENGINEERING GEOLOGY WITH ROCK MECHANICS

Teaching Scheme :	Examination Scheme :
Lectures : 4 Hours/Week	Paper : 100 Marks
Practical : 2 Hours/Week	Duration : 3 Hours
	Oral : 50 Marks

Unit I **8 Hrs.**

Introduction : Importance of geological studies in engineering investigations, Precaution necessary to avoid misleading conclusions likely to be drawn while interpreting drilling data with particular ref. to R.Q.D. Dependence of design on geological features of project site. Case histories illustrating economics made possible by proper geological studies & wasteful expenditure or difficulties resulting from their neglect. Engineering. Characteristics of rocks of major rock formations of India. Engineering Geology of the Deccan Trap Basalts, Factors affecting strength & water-tightness. Stability of cuts & ability to stand without supports, Significance of commonly occurring features like gas cavities, jointing, weathering, hydrothermal alteration, volcanic breccias, techylytes, dykes, fractures, field Structures of flows, stratigraphic sequence of flows etc. in various civil engineering. Projects.

Unit II **8 Hrs.**

Dams: Strength & water tightness of Deccan trap rocks from foundation point of view. Physical properties such as

compressive strength, water absorption etc. of basalts. Effect of weathering & hydrothermal alteration on the engineering. Properties of rocks. Deterioration of rock masses on exposure to atmosphere & suitable treatment for such rocks. Illustrative case histories.

Foundation Treatment : Foundation investigations during construction for determining the foundation treatment for adverse geological features. Determination of foundation levels/cut off levels for earth dams. Correction of adverse features by means of grouting. Grout ability of rocks. Consolidation grouting for improving strength of weak &fragmented rocks. Curtain grouting for preventing leakage through foundation rocks. Determining depths & zones of consolidation & curtain grouting. Relation of zones of grouting with height Of dams. Foundation treatment for fractures having different manifestation, jointed rocks, tachylytes & dykes. Typical case histories.

Erosion of Tail Channels : Erosion of tail channel as factor in selecting site for spillway. Causes of rapid erosion of tail channels of side spillways. Geological conditions leading to tail channel erosion. Case histories.

Unit III **9 Hrs.**

Tunneling : Variations in methodology of investigation for different types of tunnels for different purposes, location, spacing, angles & depths of drill holes suitable for different types of tunnels. Difficulties introduced by tachylytes, volcanic breccias, tuffs, inter-trappean beds, fractures, dykes, hydrothermal alteration, flow contacts &unfavorable field characters. Computing Structures discontinuities in rock

masses, R. Q. D. joint frequency index, R.M.R. values, Q. system, and standup time. Limitations of these. Dependence of protective measures such as gUniting, rock bolting, shotcreting, steel fibre shotcreting, permanent steel supports, lagging concreting & contact grouting above permanent steel supports on geological conditions. Suitability of T.B.M.& road headers. Experience of some important tunnels in deccan trap rocks.

Bridges : Investigation for bridge foundation, difference in objectives of investigation of dam foundation & investigation of bridge foundation. Computing safe bearing capacity for bridge foundation based on nature & Structures of rock. Foundation settlements. Case histories.

Unit IV **8 Hrs.**

Ground water conditions in Maharashtra : Ground Water condition in Maharashtra with reference to Deccan trap area. Water bearing characters of different type of basalts, volcanic breccias, tachylytic basalt, dykes, fractures, weathering products &older alluvium. Geological factors governing natural recharge. Geological aspects of multi aquifer system, deep seated water & deep drilled tube wells. Geological aspects of conservation of water & artificial recharge. Dependence of success of such schemes as percolation tanks & watershed development on geological conditions &necessity of geological studies for such schemes. Study of case histories.

Geology of Soil Formation : Residual & transported soils, Rock weathering conditions favorable for decomposition & disintegration. Influence of climate on residual &

transported soils in Deccan Trap Rivers & its engineering characteristics. Effect of deposition of calcium Carbonate, Scarcity of sand in the rivers in the Deccan trap area.

Unit V **8 Hrs.**

Geophysical Investigation : Seismic and electrical resistivity methods of exploration as applied to engineering investigations.

Rock Mechanics : General principles of rock mechanics. Dependence of physical properties of rocks on geological characters, Testing methods. Mechanical properties of Deccan trap rocks. Calculations of R.Q.D. Joint frequency index, R.M.R.Q. system, standup time calculations. Bieniawaski's geo-mechanical classification etc.

Unit VI **9 Hrs.**

Construction Material : Deccan Trap basalts as construction material. Use of compact basalt & amygdaloidal basalts as rubble for masonry & metal for concrete & pavement quality concrete. Study of case histories.

Urban Geology : Influence of geological factors upon urban development & planning.

Faults : Faults & their civil engineering significance.

Earthquakes : Seismicity in Maharashtra, Earthquakes in area of major projects like dams and reservoirs -geological significance.

Term Work: Term shall consist of followings.

1. Study of geological features in Deccan Basalts (4 Practical)
2. Logging of drill cover, preparation of Litho logs & interpreting, drilling data. Calculation of R. Q. D. & joint frequency index preparing geological cross sections from drill hole data & using them for designing of civil engineering Structures. (6 Practical)
3. Use of Electrical Resistivity method for determining depth of bedrock. (1 Practical)
4. Site visit: Study of geological aspects of engineering projects & writing a report based on the studies carried out during visits to civil engineering projects.

Oral : Oral examination shall be based on term work.

Reference books :

1. P. W. D. Handbook, Chapter 6, Part-II 'Engineering Geology, Gupte R. B., Government of Maharashtra.
2. Rock Mechanics in Engineering, Jaeger, Cambridge University Press London
3. Principles of Rock Mechanics, Goodmann
4. Engineering Classification of jointed Rock Masses, Bieniawski Z. T.
5. Engineering. Geology, Goodmann
6. Tunnels: Planning, Design, Construction, Megaw T. M & J. V. Bartlett, John Willey & Sons .
7. Dynamic Earth- Introduction to Physical Geology, Skinner B. J., John Willey & Sons

401008 : DAMS AND HYDRAULIC STRUCTURES

Teaching Scheme :
Lectures : 4 Hrs/Week
Practical : 4 Hrs/Week

Examination Scheme :
Theory : 100 Marks
Duration : 3 Hours
Term Work : 25 Marks
Oral : 50 Marks

Unit I **8 Hrs.**

Watershed Structures : Definition, types, demarcation, elements of water shed: soil, slope, topography, climate, rainfall data, land use, land cover, soil conservation and water conservation structures, limitations of water shed management, application of remote sensing and G.I.S. to water shed management

Dams : General types of dams like gravity dams, earthen dams, arch dams, roller compacted concrete dams, balloon dams, rock fill dams, Col grout masonry dams, choice of dams, height, capacity and submergence and rehabilitation of dams, silting of reservoirs. Selection of dam site, geological considerations forest conservation act & environmental protection act.

Dam safety : I.S. guide lines and recommended practices, inspection of dams, dam instrumentation like stress meter, strain meter, uplift cell inclinometer, seismographs piezometers, sensors; maintenance & strengthening of dams.

Unit II **9 Hrs.**

Reservoir planning : Types, developments, Storage and diversion works, Purpose: Single and multipurpose, Investigation for locating a reservoir, Selection of site,

estimation of required storage, mass curves, reservoir losses, reservoir operation, economics of reservoir planning, benefit cost ratio, price escalation of projects, application of optimization techniques, systems approach.

Gravity Dams : Components of gravity dams like galleries, force acting, stability and design of gravity dams, elementary profile & practical profile, low and high dams, construction of gravity dams, preparation of foundation, grouting, concrete & masonry for dams,

Unit III **9 Hrs.**

Earth Dams : Elements of an earth dam, basic design consideration, design criteria, homogenous & zoned dam section, rock toe, pitching, causes of failures, piping and its prevention, sloughing, construction of earth dams, river diversion.

Spillways & Gates : Spillway capacity, flood absorption disposal, different types of spillways, principles of design and construction of Ogee spillway. Energy dissipation below spillways. Types of gates like vertical gates, radial gates, automatic gates, fuse gates. Operation of gates

Unit IV **8 Hrs.**

Dams & Appurtenant works : Inlet Structures, lake tapping, control Structures such as head regulators, discharge measuring Structures.

Diversion Head Works : Selection of site, layout of work, types of weirs and barrages, design for subsurface flow, safety against piping and uplift. Uplift theories such as Bligh, Lane and Khosla theories, Design of weirs on permeable foundations.

Unit V **8 Hrs.**

Canal : Type of canals, canal alignment, transit Losses. Design of lined & unlined channels, various types of canal lining, and economics of lining. Canals in alluvium, design of stable channels in alluvium, the regime method, cross-section of irrigation channels in cutting, filling, partial; canal operation & automation.

Canal Structures : Cross drainage works, necessity, types and selection, merits and demerits, basic principles of design of cross-drainage work. Falls & escapes, their types, cross regulatories.

Unit VI **8 Hrs.**

River Training & Bank Protection : Objectives of river training, methods of river training, principles of design and construction of protection works, various measures of protection work.

Hydropower : Types of hydropower such as runoff river plant, storage type, pumped storage type, tidal, mini & micro. General layout of different types, assessment of power potential, main components of hydro- power schemes, under ground powerhouse. Types & selection of turbines, cavitation.

Term Work : Minimum seven assignments (as per the list given below).

Group I : All Assignments Compulsory.

1. Marking catchments area on a Topo-sheet and working out average annual rainfall and determining yield by various methods.

2. Stability analysis of gravity dam.
3. Stability analysis of earth dam.
4. Design of spillway and stilling basin.
5. Design of canals.

Group -II : Any one of the following:

1. Design and analysis of a weir on permeable foundation.
2. Any one type of cross drainage works.
3. Any one type of canal fall and standing wave flume.

Group -III : Any one of the following:

1. To develop a Unit hydrograph and to draw a flood hydrograph for given two or three successive storms of a water resources project.
2. Benefit cost analysis of a water resources project.
3. Any one type of river training work.
4. A typical layout of a high head hydropower plant, function of the components and details of cost of constructions.
5. A report based on visits to any irrigation project during the second semester.

Oral : Oral examination shall be based on term work.

Text Books :

1. Irrigation, Water Resources & Water Power Engg. Dr. P. N. Modi, Standard Book House.
2. Irrigation and Water Power Engineering, Punmia and Pande, Standard Publication.
3. Irrigation Engineering, G. S. Birdie and Das, Dhanpat Rai and Sons.
4. Irrigation Engineering & Hydraulic Structures, S.K. Garg

Reference Books :

1. Hydrology and Water Resources, R. K. Sharma, Dhanpat Rai and Sons.
2. Theory and Design of Irrigation Structures -Vol. I, II, III, Varshney, Gupta, Nemchand and Brothers.
3. River Behavior Management and Training, C. B. I. P. Vol. I (1989).
4. Irrigation Theory and Practice, Michael, Vikas Publication House.
5. Irrigation Structures, Milos Holy, C. B. I. P.
6. Water Management, Jaspal Singh, M. S. Acharya, and Arun Sharma, Himanshu Publication.
7. Design of Earth Dams, A. L. Goldin and L. N. Rasskazor.

401009 : TRANSPORTATION ENGINEERING-II

Teaching Scheme :	Examination Scheme :
Lectures : 4 Hrs/Week	Theory : 100 Marks
Practical : 2 Hrs/Week	Duration : 3 Hours
	Term Work : 25 Marks
	Oral : 50 Marks

Unit I **9 Hrs**

Highway Engineering

Introduction : Role of transportation, Scope of road transportation, Highway development in India. Necessity of highway planning and development plans e.g. Bombay plan Lucknow plan.

Classification of road : Classification of roads, road patterns, planning surveys and preparation of master plan based on saturation system, Determination of road length by 3rd road development plan.

Traffic Engineering : Traffic characteristics-road user characteristics, vehicular characteristics (only name and significance)

Traffic studies: Name of various studies and their uses, Accident studies-objectives, causes of accident, condition and collision diagram, and measures for the reduction in accidents. Traffic regulation and control devices-traffic signs, traffic signals (types merits and demerits) road markings. Traffic islands, types of road intersections (sketch, merits and demerits). Parking facilities.

Unit II **9 Hrs.**

Highway Engineering :

Highway alignment : Basic requirements of an ideal alignment and factors controlling it, Engineering survey for highway location, Special requirements for hill roads,

Geometric design and Traffic Engineering : Design controls and criteria for geometric design, Cross sectional elements, Sight Distance requirements, Stopping distance, Overtaking sight distance, Overtaking Zones with IRC recommendations, Attainment of Super elevation, Radius of curves, methods of introduction of extra widening, Widening of pavement on horizontal curves, Horizontal transition curves- Objects, necessity, types of transition curves, length and shift of transition curves. Design of vertical alignment, Gradient and its type, IRC recommendations, Grade compensation on horizontal curve, Vertical curves: - Crest and sag curves, types of summit curves, Length of summit curve for SSD and OSD. Requirements, Types of valley curves, Length of valley curve for comfort and Head Light Sight Distance criteria.

Highway Drainage : Importance of highway drainage, Subsurface, and surface drainage systems and design, scope of Arboriculture for highway.

Unit III **8 Hrs.**

Highway Engineering :

Highway Materials : Importance and properties of Sub-grade, and pavement component materials. Behavior of materials interaction, Tests on aggregates, bitumen types, test on bitumen, Modified Binders, Bitumen mix design by Marshall Stability Test

Pavement Design : Pavement as a Structure : Objects and Requirements, Types of Pavements Structures, Functions of Pavement Components Factors Affecting Pavement Design, C.B.R. method, IRC 37-2001, Guidelines for Design Of Rigid Pavements: Factors affecting Design & Analysis of Stress- Wheel Load Stress & Temp. Stress, Critical Combination of Stress, IRC 58- Design Guidelines, types of joints, Requirements of Joints.

W.B.M. : General, materials generally used for WBM, size & Grading requirements of coarse aggregates. Requirements of screening & binding material, construction, and maintenance.

Unit IV **8 Hrs.**

Airport Engineering :

Introduction : Advantages and limitations of air transportation. Aeroplane component parts and important technical terms.

Airport Planning : Aircraft characteristics, which influence judicious and scientific planning of airports, Selection of sites, survey and drawings to be prepared for airport planning.

Airport Layout : Characteristics of good layout, runway configuration, airport obstruction, Location of terminal buildings, Aprons and Hangers. Zoning requirements regarding permissible heights of constructions and landing within the airport boundary.

Runways and Taxiways : Runway orientation, wind coverage, use of wind rose diagram, Basic runway length, Corrections for elevation, temperature and gradient as per ICAO and FAA recommendation. Airport classification by ICAO.

Heliport : Advantages of helicopters, Characteristics of Helicopters, Nature of helicopter transport and site selection for Heliport.

Unit V **8 Hrs.**

Bridge Engineering :

Introduction : Classification of bridges, Components of bridges, Preliminary data to be collected during investigation of site for bridges, Economical span, Afflux, HFL, Scour depth and clearance, Locations of piers and abutments, Factors influencing the choice of bridge super Structure, approach roads.

Loads on Bridges : Brief specifications of different loads, forces, and stresses coming on bridges, IRC load specification, requirements of Traffic in the design of Highway bridges

SubStructure : Abutment, Piers, and wing walls with their types based on requirement and suitability.

Unit VI **8 Hrs.**

Bridge Engineering :

Types of Bridges : Culvert: Definition, Waterway of Culvert and types, Temporary Bridges: Definition, materials used, brief general ideas about timber, floating and pantoon bridges, Movable Bridges: Bascule, Cut boat, Flying, Swing, lift, transporter and transverse bridges; their requirement and suitability, Fixed Span Bridges: Simple, Continuous, cantilever, Arch, Suspension, Bowstring Girder type and rigid frame and cable stayed bridges, materials for super Structure.

Bearing : Definition, purpose and importance, types of bearings with their suitability, introduction to different techniques of erection of bridge super Structure and maintenance of bridges.

Term work : Performance of set of experiments based on following topics:

1. **Aggregate Testing :** (*Any Six*) Aggregate Impact Value, Aggregate Crushing Strength, Los Angeles Abrasion Test, Flakiness index and Elongation index, Specific Gravity, Water absorption, Stripping Value, Soundness.
2. California Bearing Ratio (C.B.R.Test)
3. **Tests on Bitumen :** (*Any Six*) Penetration, Ductility, Softening Point, Flash Point & Fire Point, Specific Gravity, Viscosity test, Bitumen extraction test, Marshall Stability test.
4. Technical visits to Bridge site or Airport.

Oral : Oral examination shall be based on the term work.

Reference Books :

1. Highway Engineering, S. K. Khanna and C.E.G. Justo, Nem Chand and Brothers,
2. Principles of Transportation Engineering, G.V. Rao Tata MacGraw Hill Publication
3. Principles and practices of Highway Engineering, Dr. L.R. Kadiyali, Khanna Publishers.
4. Principles of Transportation Engineering, Partha Chakraborty, Animesh Das, Prentice Hall of India Pvt. Ltd., New Delhi.

5. Principles and practice of Bridge Engineering, S.P. Bindra, Dhanpatrai and Sons, Delhi.
6. Essentials of Bridge Engineering, D. Johnson and Victor, Oxford and IBH publishing co. Pvt. Ltd., New Delhi.
7. Airport planning and design, S.K. Khanna, M.G. Arora, S.S. Jain, Nem Chand and Brothers, Roorkee.
8. I.S. 1201 to 1220-1978,IS 73, IS 2386 Part I to V, I. R.C-58, IRC-37

401010 : FOUNDATION ENGINEERING

Teaching Scheme :

Lectures : 4 Hrs/Week

Examination Scheme :

Theory : 100 Marks

Duration : 3 Hours

Unit I — 8 Hrs.

Soil Exploration and Investigation : Purpose and planning of exploration programme. Subsurface exploration- Trial pits, Methods of borings. Geophysical methods- Seismic refraction method and Electrical resistivity method. Disturbed and undisturbed sampling. Field testing- SPT, DCPT, SCPT and its correlation. Pressure meter test.

Unit II — 8 Hrs.

Settlement Analysis : Elastic settlement, Pressure bulb, Contact pressure, Elastic settlement of bases (Elastic Mechanism and Janhbu's Method). Effect of lowering of water table.

Consolidation Settlement : Introduction, Spring analogy, Terzaghi's consolidation theory, Laboratory consolidation test. Determination of coefficient of consolidation- Square root of time fitting method and Logarithm of time fitting method. Time factor, Actual time and Cv relationship. Rate of settlement and it's application in shallow foundation. Normal consolidation, over consolidation and preconsolidation pressure, I.S. criteria- Total and Differential settlement, Tolerable settlement.

Unit III — 9 Hrs.

Bearing Capacity : Modes of shear failure. Terzaghi's bearing capacity analysis and Bearing capacity factors. Henson's and Mayorhoff's equations and Skempton method- Strip, Rectangular and Circular footings. Effect of water table and depth on bearing capacity. Bearing capacity of layered soil. Effect of eccentricity. Presumptive bearing capacity.

Shallow Foundation : Footing Types, I.S. criteria for minimum depth of foundation. Allowable soil pressure-use of SPT blow count. and I.S. chart. Plate Load Test, Perimeter shear concept. Floating foundation.

Unit IV — 9 Hrs.

Pile Foundation: Introduction, Pile classification, Pile installation- Cast in situ, Driven pile. Load carrying capacity of pile by static method, Dynamic methods-Engineering News formula, Modified ENR formula. Pile load test and Cyclic pile load test. Group action- Feld rule, Rigid block method. Negative skin friction. Settlement of pile group in cohesive soil by approximate method. Micro piles.

Piers and Caissons : Drilled piers & Method of installation and use of drilling mud. Components of well foundation. Types of Caissons, Pneumatic Caisson- Sinking and Sand island method. Caisson disease.

Unit V **8 Hrs.**

Sheet piles : Strutting for excavations, Pressure distribution, Materials and types of sheet piles, Design of cantilever sheet pile- Approximate method, Anchored sheet piles-Free earth support and Fixed earth support.

Foundation on Black Cotton Soils : Characteristics of black Cotton Soils, problems, Swelling potential, Under reamed piles - Design principles and Techniques (Maximum two bulbs). Stone columns, Preloading technique.

Unit VI **8 Hrs.**

Earthquake Geotechnics : Types of Earthquakes, Seismic waves, Location of Earthquakes, Strength of an Earthquake, Strong Ground Motion, Factors Influencing Ground Motion, Seismic Hazards. Liquefaction, Effect of Liquefaction on Built Environment. Evaluation of Liquefaction Susceptibility, Liquefaction Hazard Mitigation.

Geosynthetics : Geosynthetics Types, Properties, Functions, Functional Requirements. Reinforced Soil-Mechanism, Reinforcement concept. Applications - Reinforced soil Structures with vertical faces, Reinforced soil embankments, Reinforcement of soil beneath foundations.

Text Books :

1. Geotechnical Engineering by Shashi K Gulati & Manoj Dutta, Tata McGraw-Hill
2. Geotechnical Engineering, C. Venkatramaiah.

3. Foundation Engineering, B.J.Kasmalkar, PVG Publication, Pune
4. Foundation Design, Teng W.C., Printice Hall, New Delhi

Reference Books :

1. Basic and Applied Soil Mechanics by Gopal Ranjan & A. S. Rao, New Age
2. Foundation Engineering, J.F.Bowles, McGraw Hill Publication
3. Foundation Design and Construction, M.J.Tamlinson, Pitman, New Delhi
4. I.S.codes : 459, 1080, 498, 1888, 1892,1904, 2720, 2950, 2974, 3616, 4968, 6403, 8763.
5. Foundation Engineering Handbook Edited by Hans F. Winterkorn and Hsai - Yang Fang, GALGOTIA Booksource Publishers, New Delhi.