

**MASTER OF TECHNOLOGY  
(STRUCTURAL AND CONSTRUCTION ENGINEERING)**

**Curriculum Book**



**DEPARTMENT OF CIVIL ENGINEERING  
DR B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY  
JALANDHAR – 144 011**

**REVISED SCHEME OF FULL TIME M. TECH. PROGRAMME  
IN  
STRUCTURAL AND CONSTRUCTION ENGINEERING**

**SEMESTER – I**

Course Code	Course Title	Hrs/week			Credits
		L	T	P	
CE	CORE-I	3	0	0	3
CE	CORE-II	3	0	0	3
CE	CORE-III	3	0	0	3
CE	CORE-IV	3	0	0	3
CE	CORE-V	3	0	0	3
CE	Elective-I	3	0	0	3
CE	Lab-I	0	0	3	2
CE-	Lab-II	0	0	3	2
	TOTAL	18	0	6	22

**SEMESTER – II**

Course Code	Course Title	Hrs/week			Credits
		L	T	P	
CE	CORE-VI	3	0	0	3
CE	CORE-VII	3	0	0	3
CE	CORE-VIII	3	0	0	3
CE	CORE-IX	3	0	0	3
CE	Elective-II	3	0	0	3
CE	Elective-III	3	0	0	3
CE	Lab-III	0	0	3	2
CE	Lab-IV	0	0	3	2
	TOTAL	18	0	6	22

**SEMESTER – III**

Course Code	Course Title	Hrs/week			Credits
		L	T	P	
CE	Independent Study	3	0	0	3
CE	Dissertation Part-I	0	0	0	6*
	TOTAL	3	0	0	09

\* The credits shall be managed with Project Part II.

**SEMESTER – IV**

Course Code	Course Title	Hrs/week			Credits
		L	T	P	
CE	Dissertation Part II	0	0	24	12*
	TOTAL	0	0	24	12

\* The result of Project Part I & II shall be forwarded cumulatively after evaluation of dissertation

**Grand Total of Credits = 65**

**LIST OF CORE COURSES FOR M. TECH. (STRUCTURAL AND CONSTRUCTION ENGINEERING)**

Course Code	Course Title	Hrs/week			Credits
		L	T	P	
CE 501	Advanced Solid Mechanics	3	0	0	3
CE 503	Structural Dynamics	3	0	0	3
CE 505	Finite Elements Analysis	3	0	0	3
CE 507	Advanced Structural Analysis	3	0	0	3
CE 509	Quantitative Methods in Construction Management	3	0	0	3
CE 502	Advanced Reinforced Concrete Design	3	0	0	3
CE 504	Analysis and Design of Foundations	3	0	0	3
CE 506	Earthquake Resistant Design of Structures	3	0	0	3
CE 508	Advanced Construction Practices	3	0	0	3

**LIST OF LAB WORK COURSES FOR M. TECH. (STRUCTURAL AND CONSTRUCTION ENGINEERING)**

Course Code	Course Title	Hrs/week			Credits
		L	T	P	
CE-521	CAD Laboratory	0	0	3	2
CE-523	Material Testing Laboratory	0	0	3	2
CE-520	Foundation Engineering Laboratory	0	0	3	2
CE-522	Concrete Structures Laboratory	0	0	3	2

**LIST OF ELECTIVES FOR M. TECH. (STRUCTURAL AND CONSTRUCTION ENGINEERING)**

Sr. No.	Course Code	Course Title	Hrs/week			Credits
			L	T	P	
1.	CE 510	Quality and Safety Management in Construction	3	0	0	3
2.	CE 512	Construction Economics and Finance	3	0	0	3
3.	CE 514	Repair and Retrofitting of Structures	3	0	0	3
4.	CE 603	Pre-stressed Concrete Design	3	0	0	3
5.	CE 605	Infrastructures Development Projects	3	0	0	3
6.	CE 607	Analysis and Design of Tall Buildings	3	0	0	3
7.	CE 609	Construction Methods and Equipment	3	0	0	3
8.	CE 611	Design of Industrial Structures	3	0	0	3
9.	CE 613	Advanced Steel Design	3	0	0	3
10	CE 615	Soil Dynamics and Machine Foundations	3	0	0	3
11	CE 617	Construction and Contract Management	3	0	0	3
12	CE-618	Geoenvironmental Engineering	3	0	0	3
13	CE-619	Landfill and Ash ponds	3	0	0	3
14	CE-620	Solid and Hazardous Waste Management	3	0	0	3
15	ID-601	Research Methodology	3	0	0	3
16	CE-621	Concrete Mechanics	3	0	0	3
17	CE-622	Recent Advances in Construction Materials	3	0	0	3
18	CE-624	Composite Materials	3	0	0	3
19	CE-625	Simulation & Modelling	3	0	0	3
20	CE-630	Site Investigations and Ground Improvement	3	0	0	3
21	CE-632	Engineering Behaviour of Soils	3	0	0	3
22	CE-633	Geosynthetics	3	0	0	3

State of stress in a body. Tensor notations, Differential equations of equilibrium, Invariants of the stress tensor, Theory of strain, Displacement components, strain components and relation between them, Generalised Hooke's law, Solution of the elasticity problem in terms of displacements, Basic equations of the theory of elasticity, Lamé's equations, Plane problem in cartesian co-ordinates, Plane problem in polar co-ordinates, Shrink fits, Rotating disks with uniform thickness, Plate with hole, Torsion in prismatic bars, Saint Venant's method, Solution of torsion problem in terms of stresses Strain energy, Elastic plastic behaviour, Design philosophy, Linear elastic and plastic behaviour, Tresca and Von Mises yield criteria, Visco-elastic behaviour.

**Books Recommended:**

1. Timoshenko S P and Goodier J N "Theory of Elasticity" McGraw Hill, New York, 2002.
2. Housner G W and Vreeland J R "The Analysis of Stress and Deformation" Mcmillan London, 1998.
3. Srinath L S "Advanced Mechanics of Solids" Tata Mcgraw Hill, New Delhi, 2000.
4. Westergaard H M "Theory of Elasticity and Plasticity" Harvard University Press, Cambridge, 1998.
5. Kazimi S M A "Solid Mechanics" Tata McGraw Hill, New Delhi, 1999.

Concept of degrees of freedom and constraints, Equations of motion, Newton's Law and D'Alembert's Principle, Response of single degree of freedom systems to initial conditions, Response to harmonic excitation, Dynamic amplification factor, Transmissibility, Base Isolation, Response to non harmonic excitations such as impulse, step loading and blast loading, Duhamel's Integral, Earthquake response analysis, Response spectrum, Theory of vibration pick – ups, Estimation of dynamic characteristics through experimental investigations, Multi degree of freedom systems, Orthogonality of mode shapes, Mode superposition method for seismic analysis.

**Books Recommended:**

1. Clough R W, Penzien J, "Dynamics of Structures", McGraw-Hill, Inc, New York, 1991.
2. Chopra A K "Dynamics of Structures: Theory and Applications to Earthquake Engineering" Prentice Hall (India) Private Ltd, New Delhi, 2000.

3. Roy Creig Jr. "Structural Dynamics: An Introduction to Computer Methods", John Wiley & Sons, New York, 1981.
4. James M L, Smith G M, Woford J C and Whaley P W "Vibration of Mechanical and Structural Systems : With Microcomputer Applications", Happer & Row, Publishers, New York, 1989.
5. Rao S S, "Mechanical Vibrations", Pearson Education, New Delhi, 2004.

**CE-505      Finite Element Analysis      [3 0 0 3]**

Structural stiffness analysis, Introduction, Matrix Algebra and Gaussian Elimination, The structural element, One Dimensional Problems, Trusses, Assembly and analysis of a structure; Transformation of co-ordinates. Finite elements of a column, Element characteristics, Two Dimensional Problems, Plane stress and plane strain, Interpolation Functions, Numerical Integration and Modelling Considerations, Element characteristics, Two Dimensional Isoparametric Elements, Assessment of accuracy, Some practical applications. Axi-Symmetric stress analysis, Some improved elements in two dimensional problems, Beams and Frames, Bending of plates, Techniques for Nonlinear Analysis, Three Dimensional Problems in Stress Analysis, Heat Conduction and Seepage Problems

**Books Recommended:**

1. Zienkiewicz O. C., "The Finite Element Method" Mcgraw Hill, London, 1991.
2. Abel J F and Desai C A "Finite Element Method" Van Nostrand Reinhold, New York., 2004.
3. Reddy, J.N., "An Introduction to the Finite Element Method", Tata McGraw Hill, New Delhi, 2003.
4. Bathe K J "Finite Element Procedures" prentice Hall of India Private Limited, New Delhi, 1997.
5. Chandrupatla T R and belegundu A D "Introduction to Finite Elements in Engineering" Prentice Hall of India Private Limited, New Delhi, 1997.

**CE-507      Advanced Structural Analysis      [3 0 0 3]**

Basic concepts, Degree of static and kinematic indeterminacy, Matrix algebra, Solution of simultaneous equations by Gaussian Elimination, Flexibility and Stiffness Matrices, System Approach: Development of stiffness matrix, Applications of stiffness method to continuous beams, trusses and frames. Effect of temperature, and prestrain. Element Approach: Element stiffness, 2D truss element and beam element, Transformation matrix, Assembly of global stiffness matrix, Storage requirement of stiffness matrix i.e. full storage, banded storage and skyline storage, Effect of node and element numbering, Boundary conditions, Application of

stiffness method to beams, trusses and frames. Computer applications, Material and geometrical non-linearity, Application of Virtual work and energy principles.

**Books Recommended:**

1. Pandit G S and Gupta S P “Matrix Analysis of Structures” Tata McGraw Hill, New Delhi, 2003.
2. Gere W and Weaver J M “Matrix Analysis of Structures” CBS Publishers, New Delhi, 2002.
3. Rajasekaran S and Sankarasubramanian G “Computational Structural Mechanics” Prentice Hall India, New Delhi, 2001.
4. Vazirani V N and Ratwani M M “Advanced Theory OF structures and Matrix Method” Khanna Publishers, New Delhi, 1995.

**CE-509                      Quantitative Methods in Construction Management                      [3 0 0 3]**

Introduction and concepts of probability and statistics, Optimization through Linear programming- Need for linear programming, Linear programming model, dual problem, dynamic programming. Transportation model, solution of Transportation model, Assignment problems, solution of assignment problem. Queuing theory- waiting line models, deterministic model, probabilistic model, Decision theory- decision analysis, decision under uncertainty, Nature of Games, Games model, solution of Games model, simulations as applied to construction- simulation models, steps in simulation, Monte carlo simulation. Modifications and improvement on CPM/PERT techniques.

**Books Recommended:**

1. Verma M “Construction Planning and Management Through System Techniques” Metropolitan Book Company, New Delhi, 1985.
2. Chitkara K K “Construction Project Management – Planning, Scheduling and Controlling” Tata McGraw Hill, New Delhi, 2000.
3. O’Brien J “CPM in Construction Management” McGraw Hill, New York, 1999.
4. Harris R B “Precedence and Arrow Networking Techniques for Construction” John Wiley & sons, New York, 1999.
5. Levy S “Project Management in Construction” McGraw hill, New York, 2000.

**CE-521                      CAD Laboratory                      [0 0 3 2]**

Introduction to various research and design softwares and their applications



Design of concrete mixes for high strength and high performance of flyash concrete

**CE-502 Advanced Reinforced Concrete Design****[3 0 0 3]**

Deflections of Reinforced Concrete Beams and Slabs; Estimation of Crack Widths in Reinforced Concrete Beams; Inelastic Analysis of Reinforced Concrete Beams and Frames; Design of Shear Walls, Cast-in-Situ Beam-Column Joints, Deep Beams, Chimneys, Ribbed Slabs; Design of Reinforced Concrete Members for Fire Resistance; Software Applications, Vierendeel Girders, Concrete Trusses.

**Books Recommended:**

1. Varghese P C “Advanced Reinforced Concrete Design” Prentice-Hall of India Pvt. Ltd., New Delhi, 2001.
2. Krishna Raju N “Advanced Reinforced Concrete Design” CBS Publishers and Distributors, New Delhi, 1988.
3. Park R and Paulay T “Reinforced Concrete Structures” John Wiley and Sons, New York, 1975.
4. SP 208 “Examples for the Design of Structural Concrete with Strut – and – Tie Models” Editor: Karl – Heinz Reineck, American Concrete Institute, Michigan, 2003.
5. Leet, Kenneth M and Bernal D “Reinforced Concrete Design” McGraw Hill, London, 1998.

**CE-504 Analysis and Design of Foundation Structures****[3 0 0 3]**

Introduction to shallow and deep footings, Design of strap, Raft and combined footings, Design of pile footings, Caps for piles, design of different components of well foundations, Footings subjected to eccentric loading, uplift and overturning, Soil-Structure interaction, Sub grade reaction method, Geotechnical design considerations, Site and soil conditions, Soil liquefaction, Evaluating the liquefaction potential by Standard Penetration Tests, by Cone Penetration Tests, by Shear Wave Velocity, Liquefaction of clayey soil, Mitigation of Liquefaction Hazard by site modification, Mitigation of Liquefaction Hazard by Structural Design, Seismic Settlement, Subsidence and Differential Compaction, Fault Rupture, Lateral Seismic Earth Pressures.

### **Books Recommended:**

1. Saran S “Analysis and Design of Sub-Structures” Oxford and IBH, New Delhi, 1996.
2. Bowls J E “Foundation Analysis and Design” Mc Graw Hill, New York, 1988.
3. Peck R B, Henson W E and Thorn burn W T “Foundation Engineering” John Willey and Sons, New York, 1984.
4. Teng W C “Foundation Design” Prentice Hall, New Delhi, 1992.
5. Naeim F “The Seismic Design Hand Book”, Kluwer Academic Publishers, London, 2001.
6. Krammer S “Geotechnical Earthquake Engineering” Pearson Education Pvt. Ltd. New Delhi, 2003.

### **CE-506 Earthquake Resistant Design of Structures [3 0 0 3]**

Behaviour of buildings and structures during past earthquakes and lessons learnt, goals of earthquake resistant design. Linear static procedure for seismic load calculation – IS 1893 – 2002, combination of gravity and seismic action. Multimodal and Multidirectional response spectrum analysis. Earthquake resistant measures at planning stage: Geotechnical and architectural considerations, irregularities, earthquake resistant measures in sloping roofs, staircase, foundations and general construction details IS : 4326 –1993, principals of earthquake resistant design – behaviour of concrete and steel, confined concrete, the capacity design method; Study of IS 13920 – 1993, behaviour of masonry structures during earthquakes, analysis and behaviour of masonry infilled RC frames, earthquake resistant measures in masonry buildings.

### **Books Recommended:**

1. Dowrick D J “Earthquake Resistant Design for Engineers and Architects” John Wiley and Sons, New York, 1987.
2. Dowrick D J “Earthquake Risk Reduction” John Wiley and Sons, New York, 2003.
3. Englekirk R E “Seismic Design of Reinforced and Pre-cast Concrete Buildings” John Wiley and Sons, New York, 2003.
4. Pauley T and Priestley M J N “Seismic Design of Reinforced Concrete and Masonry Buildings” John Wiley and Sons, New York, 1992.
5. Key D “Earthquake Design Practices for Buildings” Telford Publishers, London, 1990.

### **CE-508 Advanced Construction Practices [3 0 0 3]**

Concrete Construction Methods, Formwork Design and Scaffolding; Slip Forms and other moving forms; Pumping of Concrete; Grouting and Mass Concreting Operations(roller

compacted concrete); Ready-Mix Concrete; Various Methods of Handling and Placing Concrete, Accelerated curing, Hot and cold weather concreting, Under water concreting, Prestressing. Steel and Composite Construction Methods, Fabrication and erection of structures including heavy structures, Prefab construction, Industrialised construction and Modular coordination. Special Construction Methods, Construction in Marine Environments, High Rise Construction, Bridge Construction including Segmental Construction, Incremental Construction and Push Launching Techniques; Geosynthetics; Safety, Quality Measures and Reliability

### **Books Recommended:**

1. Neville A M and Brooks J J “Concrete Technology”, Pearson Education Asia, Singapore, 1994.
2. Neville A M “Properties of Concrete”, Pearson Education, New Delhi, 2004.
3. Peurifoy R L “Construction Planning, Equipment and Methods” McGraw Hill Ltd., New York, 2002.

### **CE-520 Foundation Engineering Laboratory [0 0 3 2]**

Plate load test, Standard penetration test, Static cone penetration test, Dynamic cone penetration test Triaxial shear test, Large shear box test and testing of Geotextiles and geofibres.

### **CE-522 Concrete Structures Laboratory [0 0 3 2]**

Testing of PCC and SFRC samples under compression and flexural testing under static and fatigue loading.

### **CE-510 Quality and Safety Management in Construction [3 0 0 3]**

Introduction to quality: Planning and control of quality during design of structures. Quantitative techniques in quality control. Quality assurance during construction. Inspection of materials and machinery. In process inspection and test. Preparation of quality manuals, check-list and inspection report. Establishing quality assurance system. Quality standards/codes in design and construction. Concept and philosophy of total quality management (TQM). Training in quality and quality management systems (ISO-9000). Concept of safety. Factors affecting safety; Physiological, Psychological and Technological.

Planning for safety provisions. Structural safety. Safety consideration during construction, demolition and during use of equipment. Management of accidents/injuries and provision of first aid. Provisional aspect of safety. Site management with regard to safety recommendations. Training for safety awareness and implementation. Formulation of safety manuals. Safety legislation, standards/codes with regard to construction. Quality vs Safety. Case Studies.

### **Books Recommended:**

1. Fox A J and Cornell H A “Quality in the Construction Projects” American Society of Civil Engineers, New York, 1992.
2. Hellard R B “Total Quality in Construction Projects: Achieving Profitability with Customer Satisfaction” Thomas Telford, London, 1993.
3. Davies V J and Thomasin K “Construction Safety Handbook” Thomas Telford, London, 1997.
4. Thorpe B “Quality Assurance in Construction” Gower, Aldershort, 1996.
5. NICMAR “Safety Management in Construction Industry – A Manual for Project Managers” NICMAR, Mumbai, 1998.
6. NICMAR “Handbooks of Safety in Construction” Vol. 1 to 6. NICMAR, Mumbai, 1998.

### **CE-512 Construction Economics and Finance [3 0 0 3]**

Construction accounting, Income statement, Depreciation and amortization, Engineering economics, Time value of money, discounted cash flow, NPV, ROR, PI, Bases of comparison, Incremental rate of return, Benefit-cost analysis, Replacement analysis, Break even analysis, Risks and uncertainties and management decision in capital budgeting. Taxation and inflation. Work pricing, cost elements of contract, bidding and award, revision due to unforeseen causes, escalation. Turnkey activities, Project appraisal and project yield. Working capital management, financial plan and multiple source of finance. International finance, Budgeting and budgetary control, Performance budgeting, appraisal through financial statements, Practical problems and case studies.

### **Books Recommended:**

1. Palmer W J “Construction Accounting and Finance” McGraw hill, New Delhi, 1994.
2. Kuehal S C “Corporate Finance” Tata McGraw Hill, New Delhi, 1995.
3. Block S B and Geoffery A H “Foundations of Financial Management” McGraw Hill, London, 2001.
4. Singh H “Construction Management and Accounts” Tata McGraw Hill, New Delhi, 1993.

**CE-514      Repair and Retrofitting of Structures****[3 0 0 3]**

Principles of retrofitting, objective and principles of intervention, design steps for intervention, criteria for repair and retrofitting, repair materials and techniques, seismic vulnerability evaluation of buildings, feasibility assessment, design considerations, analytical and experimental techniques, retrofit design and implementation, techniques of retrofitting and improving structural integrity of masonry buildings, codes of practices for repair and retrofitting, techniques of retrofitting of RC buildings and structural elements, retrofitting of bridges and dams and heritage structures, retrofitting of structures by seismic base isolation, case studies of retrofitting of structures.

**Books Recommended:**

1. Bungey J H “Testing of Concrete in Structures” Surrey University Press London, 1989.
2. Paulay T & Prestley “Seismic Design of Reinforced Concrete Structures and Masonry Buildings” John Wiley and Sons London, 1992.
3. ATC-40 (Vol. 1 & 2) “Seismic Evaluation and Retrofitting of Concrete Buildings” Applied Technology Council California, 1996.
4. FEMA – 273 “NEHRP Guidelines for Seismic Rehabilitation of Buildings” Building Seismic Safety Council Washington, 1997.
5. FEMA – 310 “Handbook for Seismic Evaluation of Buildings – a pre standard” Building Seismic Safety Council Washington, 1998.
6. Krammer S “Geotechnical Earthquake Engineering” Pearson Education pvt. Ltd. New Delhi, 2003.

**CE-601      Independent Study****[3 0 0 3]**

This is a seminar oriented subject in which the student is required to select a topic of his interest related to recent developments and the state-of-the art in the field under study in consultation with a designated faculty advisor. The student shall be required to carry out a comprehensive literature survey on the selected topic and compile a detailed report and present a minimum of two seminars comprising of one mid-term seminar and one end-semester comprehensive seminar. A continuous evaluation of the student performance in terms of seminar presentation and final report shall be carried out.

Definition, Basic Principles, Types of prestressing, Systems of prestressing, Loss of prestress, materials used, Advantages and disadvantages. Critical load condition, Permissible stresses, Various suggested methods of design, Dimensionless Design variables, Solution of equations, Design Procedure based on flexure, Minimum weight design, Cable layout and profile of tendons, Design by load balancing method, Code provisions. Allowable stress considerations, Non-dimensionalised allowable stress equations and their solution, Shrinkage Stresses. Two span continuous beams and their analysis, Application of moment distribution method, Design of continuous beams, Continuous beams with variable section. One way and two way slabs, Beam and slab construction, Principal Stresses, failure due to shear, combined bending and shear, Bond, Prestressing cable at the centroidal axis, Symmetric multiple cable, cable with eccentricity, Inclined cables, Spalling and bursting stresses. Compression members, Tension members, Prestressed Concrete Pavements, Folded plates and Shells, Arches, Dams, Rigid frames, Cylindrical tanks.

**Books Recommended:**

1. Raju N K “Prestressed Concrete” Tata McGraw Hill, New Delhi, 2001.
2. Rajagopalan N “Prestressed Concrete” Narosa, New Delhi, 2002.
3. Dayaratnam P “Prestressed Concrete” Oxford & IBH, New Delhi, 2001.
4. Lin T Y “Prestressed Concrete” John Wiley and Sons, New York, 2002.
5. Nawy E G “Prestressed Concrete : A Fundamental Approach” Prentice Hall, New Delhi, 1995.
6. I.S. : 1343 – 1980 CODE, BIS New Delhi

Introduction: Meaning and Scope. Impact on economic development, standard of living and environment. Reasons for rise of public sector and government in infrastructural activities. Changed socio-economic scenario and current problems and related issues. Emerging trends in project contracting, from labour contracting to EPF turnkey jobs. Policies on infrastructure Development: A historical review of the Government policies on infrastructure. Current public policies on transportations, power and telecom sectors. Plans for infrastructure development. Reforming infrastructure: Reasons for and need of reforms: operations, maintenance and financial, technological and methodological considerations, Role of World Bank and other multilateral funding agencies in reform movement. Private Sector Participation: Options in infrastructure development and management. Commercial

principles options and mechanisms of involvement. Joint Sector, corporatiozation, privatization and other means of financing. Experience of other countries.

Mechanisms: BOT, BOOT, BOO and other mechanisms. Experience of other countries and in India thus far. General guidelines on making Joint Ventures and private sector participation. Construction and Infrastructure: Construction component of various infrastructure sectors. Highway, ports and aviation, power, telecom, railways, irrigation. Current scenario, future needs, investment needed, regulatory framework, government policies and future plans. Technological and methodological demands and innovations on in constructors, construction Management: Construction Management in infrastructure development projects. Training of construction managers. New trends in management and construction projects. Construction materials and machinery required for various types of infrastructure development projects. Innovations in technologies, methodologies and management in construction of infrastructure projects. International designs and specifications and techniques of project execution.

#### **Books Recommended:**

1. Vaid K “Construction and Infrastructure Development – Issues and Challenges” NICMAR, 2003.
2. India Infrasturcture Report 2001 & 2002, Oxford University Press, New Delhi, 2001/02
3. NICMAR, Construction Business Opportunities in Infrastructure Development in India, NICMAR, Mumbai, 2001.
4. Parikh K S “India Development Report 1999-2000” Oxford University Press, New Delhi, 1999.
5. Rakesh Mohan Committee “The India Infrastructure Report” National Council of Applied Economic Research, New Delhi, 1996.

#### **CE-607      Analysis and Design of Tall Buildings      [3 0 0 3]**

Principles of Planning, Technological Planning, Mechanical systems, Fire rating, local consideration, structures elements, types of structural systems for tall buildings, Shear Walls and their arrangement. Loads on Tall Buildings, Gravity loads, live loads, wind loads and seismic loading, Code Provisions. Discussion of relevant codes of practices and loading standards. Analysis off Tall Buildings with and without Shear Walls, Approximate analysis for gravity loads, lateral loads. Analysis of tube-in-tube constructional and 3-Dimensional analysis of shear core buildings, stability, stiffness and fatigue, factor of safety and load

factor, Design of Tall Buildings Procedures of elastic design, ultimate strength design and limit state design of super structures including structural connections.

**Books Recommended:**

1. Schumelles W “High rise Building Structures” John Wiley and Sons, New York, 1977.
2. Ghali A “Structural Analysis: A Unified Classical and Matrix Approach” E & F Spon, London, 1999.
3. Taranath B S “Structural Analysis & Design of Tall Buildings” McGraw – Hill International, New York, 1988.
4. Brester B and Lin T Y “Steel Structures” John Wiley and Sons, New York, 1981.
5. Coull and Stafford S “Tall Buildings with Particular Reference to Shear Wall Structures” Pergamon Press, New York, 1967.

**CE-609 Construction Methods and Equipment [3 0 0 3]**

Factors affecting selection of equipment technical and economic, construction engineering fundamentals, Analysis of production outputs and costs, characteristics and performances of equipment for Earth moving, Erection, Material transport, Pile driving, Dewatering, Concrete construction (including batching, mixing, transport and placement) and Tunneling.

**Books Recommended:**

1. Purifoy R L and Clifford J S “Construction Planning, Equipment and Methods: McGraw Hill, New York, 2002.
2. Verma M “Construction Equipment and its Planning and Application” Metropolitan Book company, New Delhi, 1994.
3. Singh J “Heavy Construction Planning, Equipment and Methods” Oxford and IBH, New Delhi, 1992.
4. NICMAR ‘Millennium Directory of Construction Equipment and Machinery Manufactured in India’ CIRC, NICMAR, 2001.

**CE-611 Design of Industrial Structures [3 0 0 3]**

Planning of industrial structures, Design of braced and unbraced industrial portals in steel, Design of gantry girder, Design of single and multi bay industrial sheds in steel and concrete. Design of tie rods, sag rods, grit angles and purlins under action of dead, live and wind loads. Design of chimneys under combination of dead load, wind load and temperature stresses., Design of masts and cooling towers, Design of storage structures like bunkers and silos using Airy’s and Jensen’s theories. Design of large span roof structures and suspension roof



structures, Machine foundations, Design of foundations for impact and rotary and reciprocating type machines. Analysis and design of Vierendeel Girders.

**Books Recommended:**

1. Krishna Raju N “ Advanced Reinforced Concrete Design” CBS Publishers, New Delhi, 2001.
2. Chandra R “Design of Steel Structures” Vol. II, Standard Publishers, Delhi, 1991 .
3. Dayaratnam. P, “ Design of Steel Structures” Wheeler Pulishers, Allahabad, 1996.

**CE-613                      Advanced Steel Design                      [3 0 0 3]**

Plastic Design, Plastic Hinge, Plastic Collapse Load, Plastic Analysis of Frames; Wind Loads on Industrial Buildings, Braced and Unbraced Industrial Frames; Transmission Line Towers, Analysis by Tension Coefficients, Member Selection; Steel Tanks and Stacks, Different Configurations and components of Elevated Circular Tanks; Steel Stacks, Design Considerations; Design in Light Gauge Steel; Aluminum Structures; Residual Stresses

**Books Recommended:**

1. Dayaratnam P “Design of Steel Structures” Wheeler Publishers, Allahabad, 1996.
2. Arya A S and Ajmani J L “Design of Steel Structures” Nem Chand & Bros., Roorkee, 1996.
3. Raz S A “Structural Design in Steel”, New Age International Publishers, New Delhi, 2002.
4. Neal B G “Plastic Analysis of Structures” Chapman Hall, London, 1977

**CE-615                      Soil Dynamics and Machine Foundations                      [3 0 0 3]**

Nature of dynamic loads, stress conditions on Soil elements under E.Q. loading, Theory of vibrations, Behaviour of retaining walls during earthquakes, modification of Coulomb’s theory, Modified Culmann’s construction, Analytic solution for C-  $\phi$  soils, Indian Standard Code of Practice, General, Failure Zones & ult. B.C. criteria for satisfactory action of a footing, Earthquakes loads on footings. Dynamic analysis for vertical loads, Theory, criterion of liquefaction, factor affecting, Laboratory studies on liquefaction in Triaxial shear and Oscillatory simple shear, Evaluation of Liquefaction Potential, Vibration table studies, Liquefaction behaviour of Dense sands, Introduction, Criteria for a satisfactory M/C foundation, Methods of analysis, Degrees of freedom of a Block foundation, soil spring

stiffness, vibrations of a block I.S. for design of reciprocation M/c design procedure for Block Foundation, Vibration Isolation & Screening of Waves.

**Books Recommended:**

1. Barken D D “Dynamics of Bases and Foundations” McGraw Hill, New York, 1962.
2. Saran S “Soil Dynamics and Machine Foundations”, Galgotia Publications Pvt. Ltd, New Delhi, 1999.
3. Rao N D V K “Vibration Analysis and Foundation Dynamics” Wheeler Publishing Div. of A. H. Wheeler & Co. Ltd. New Delhi, 1998.
4. Prakash S “Soil Dynamics” McGraw Hill Book Company, New York, 1981.
5. Richart F E, Hall J R and Woods R D, “Vibrations of Soils and Foundations”, Prentice Hall International, N Jersey, 1970.
6. Krammer S “Geotechnical Earthquake Engineering” Pearson Education Pvt. Ltd. New Delhi, 2003.

**CE-617 Construction and Contract Management [3 0 0 3]**

Project cost estimation, rate analysis, overhead charges, bidding models and bidding strategies, Qualification of bidders, Tendering and contractual procedures, Indian Contract Act 1872, Definition of Contract and its applicability, Types of contracts, International contracts, Conditions and specifications of contract. Contract administration, Claims, compensation and disputes, Dispute resolution techniques, Arbitration and Cancellation Act 1996, Arbitration case studies, Professional ethics, Duties and responsibilities of parties, Management Information systems, Risk analysis, Value engineering.

**Books Recommended:**

1. Prakash V A “Contract Management in Civil Works Projects” NICMAR, 1997.
2. Richard C “Construction Contracting” John Wiley & sons, New York, 1986.
3. Ashworth A “Civil engineering Contractual Procedures” Longman, Harlow, 1998.
4. McCaffer R and Baldwin A N :Estimating and Tendering for Civil engineering works” Thomas Telford, London, 1991.
5. Thomas R “Construction Contract Claims” Macmillan, London, 1993.

**CE-618 Geoenvironmental Engineering****[3 0 0 3]**

**Sources and effects of subsurface contamination;** Physical, Chemical and biological characteristics of solid wastes; Soil-waste interaction; Contaminant transport; Laboratory and field evaluation of permeability; Factors affecting permeability; Waste disposal on land.

**Types of landfills :** Siting criteria; waste containment principles; Types of barrier materials; Planning and design aspects relating to waste disposal in landfills, in ash ponds and tailing ponds, and in rocks.

**Environmental monitoring around landfills;** Detection, control and remediation of subsurface contamination; Engineering properties and geotechnical reuse of waste, demolition waste dumps; Regulations; Case studies.

**CE-619 Landfills and Ash Ponds****[3 0 0 3]**

Integrated solid waste management of municipal solid waste, hazardous waste, coal ash and other wastes; Landfilling practice for different types of solid wastes; Municipal solid waste landfills: acceptability of waste; planning, design, construction, operation and closure including management of leachate and gas.

Hazardous waste landfills: waste compatibility and acceptability; planning, design, construction, operation, closure and environmental monitoring.

Ash ponds: Slurry disposal versus dry disposal; Engineering properties of bottom ash, fly ash and pond ash; planning and design; incremental raising of height by upstream and downstream methods; closure and reclamation.

**CE-620 Solid and Hazardous Waste Management****[3 0 0 3]**

Municipal Solid Waste : Generation, Rate Variation, characteristics (Physical, Biological and Chemical); Management Options for Solid Waste, Waste Reduction at the Source, Collection techniques, Materials and Resources Recovery / Recycling. Transport of Municipal Solid Waste, Routing and Scheduling, Treatment, Transformations and Disposal Techniques (Composting, Vermi Composting, Incineration, Refuse Derived fuels, Landfilling). Norms, Rules and Regulations. Economics of the on-site v/s off site waste management options. Integrated waste management.

**CE-621 Concrete Mechanics****[3 0 0 3]**

Introduction, Theological modeling of fresh concrete, Constitutive Equations: Nonlinear elasticity, plasticity, visco-elasticity and fracture mechanics of hardened concrete, confinement and ductility, Moisture diffusion: Permeability of Concrete, Drying creep and shrinkage cracking, solid and structural mechanics of reinforced concrete, Skew bending, modified compression field and unified theories of R.C. Beams under bending, shear and torsion, Bond-slip and phenomenon of cracking in reinforced concrete: Statical and dynamical analysis of R. C. Structures, Trends.

**CE-622 Recent Advances in Construction Materials****[3 0 0 3]**

Foams and light weight materials, fibre reinforced concrete. Types of fibres, workability, mechanical and physical properties of fibre reinforced concrete, Industrial waste materials in concrete, their influence on physical and mechanical properties and durability of concrete, Concrete at high temperature, High strength concrete, changes in concrete with time, corrosion of concrete in various environments, corrosion of reinforcing steel, electro chemical process, measures of protection, Ferro-cement, materials and properties polymers Civil Engineering Polymers, fibres and composites, fibre reinforced plastic in sandwich panicles, modeling. Architectural use and aesthetics of composites. Adhesives and sealants. Structural elastomeric bearings and resilient seating. Moisture barriers, polymer foams and polymers in building Physics, Polymer concrete composites.

**CE-624 Composite Materials****[3 0 0 3]**

Definition of Composite Materials, Classification of Composite Materials, Role of matrix in a composite materials, Polymer matrices, Classification of Polymer, Metal Matrices, Ceramic matrices, Comparison of polymer matrix, Metal matrix and ceramic Matrix, Role of fibres in composites, Comparison of Fibres, Role of interface in the fibre matrix composite. Characterization of composites, Analysis of an Orthotropic Lamina and laminated Composites, Elastic properties of Unidirectional Laminate, cross ply laminate, Angle ply laminates, Short fibre composite materials, Experimental Characterization of Composites.

**Introduction:** Mathematical models, numerical models and Physical models. Deterministic and stochastic models. Concepts of simulation.

**Competitive situations:** Optimization, Single and multiple objectives optimizations, Pareto optimal solutions. Introduction to linear and geometric programmings. Zero degree and single degree of difficulty.

**Growth and Decay processes:** Discrete and continuous systems. Differential and Integral equation approach, Fibonacci growth.

**Probability Distributions:** Binomial and Poisson distributions, Normal, Lognormal and pareto distributions.

**Generation of random numbers:** Uniform variable, normal and lognormal variables.

**Queing theory:** Montecarlo methods, solutions of Laplace equations in two dimensions.

**CE-630 Site Investigations and Ground Improvement****[3-0-0]**

Site Investigations: Planning of investigation programmes, Information required for planning different stages of investigations. Geophysical methods: electrical resistivity, and seismic refraction methods. Methods of site investigations: Direct methods, semi-direct methods and indirect methods, Drilling methods. Boring in soils and rocks, methods of stabilizing the bore holes, measurement of water table, field record. Field tests: In-situ shear test, in-situ permeability test, SPT, DCPT, SCPT, in-situ vane shear test, pressure meter test, plate load test. Codal provisions.

Sampling techniques, Sampling disturbances, storage, labeling and transportation of samples, sampler design, influence on properties.

Report writing. Safety measures.

Geotechnical Processes:

Principles of compaction, Laboratory compaction, Engineering behaviour of compacted clays, field compaction techniques- static, vibratory, impact, Earth moving machinery, Compaction control.

Shallow Stabilization with additives: Lime, flyash, cement and other chemicals and bitumen.

Deep Stabilization: sand column, stone column, sand drains, prefabricated drains, electro-osmosis, lime column. soil-lime column. Grouting : permeation, compaction and jet. Vibro-floatation, dynamic compaction, thermal, freezing. Dewatering systems

1. Peck R B, Hanson W B and Thorn burn T H “Foundation Engineering” John Wiley and Sons Inc, New York, 1974
2. Teng W C “Foundation Design” Prentice Hall of India Pvt. Ltd., New Delhi, 1977
3. Bowles J E “Foundation Analysis and Design” McGraw Hill, New York, 1982
4. Saran S “Analysis and Design of Substructures”, Oxford & IBH Publishing Co. (P) Ltd., New Delhi, 1996
5. Coduto, Donald P “Foundation Design”, Pearson Education International, New Jersey, 2001

### **CE-632 Engineering Behaviour of Soils**

**[3-0-0]**

Origin, nature and distribution of soils. Description of individual particle. Clay mineralogy, clay-water-electrolytes. Soil fabric and structure.

Effective stress principle. Steady state flow in soils. Effect of flow on effective stress. Determination of coefficient of permeability.

Consolidation, one, two, three and radial consolidation. Variation of effective stress during consolidation. Various consolidation tests and determination of parameters.

Stress-path. Triaxial and direct shear tests. Shear behaviour of granular soils. Factors affecting shear behaviour. Determination of parameters.

Shear behaviour of fine grained soils. Porepressure parameters. UU, CU, CD tests. Total and effective stress-strength parameters. Total and effective stress-paths. Water content contours.

Factors affecting strength : stress history, rate of testing, structure and temperature.

Anisotropy of strength, thixotropy, creep. Determination of in-situ undrained strength.

Stress-strain characteristics of soils. Determination modulus values.

Critical state model.

Engineering Behaviour of soils of India : Black cotton soils, alluvial silts and sands, laterites, collapsible and sensitive soils, aeolin deposits.

### **Books Recommended**

1. Mitchell, James K., (1993), “Fundamentals of soil Behaviour”, 2<sup>nd</sup> Edition, John Wiley and sons.
2. Das, B.M., (1997), “Advanced soil Mechanics”, Taylor and Francis.
3. Lambe, T.W., and Whitman, R.V., (1987), “Soil Mechanics”, John Wiley and Sons
4. Gulhati, Shashi K., and Datta Manoj (2008), “Geotechnical Engineering, Tata Mcgraw-Hill Company Ltd.
5. Coduto, Donald P (2002), “Geotechnical Engineering, Principles and Practices”, Pearson Education International, New Jersey.

### **CE-633 Geosynthetics :**

**[3-0-0]**

Geosynthetics and Reinforced Soil Structures:

Types and functions; Materials and manufacturing processes; Testing and evaluations; Principles of soil reinforcement; Design and construction of geosynthetic reinforced soil retaining structures - walls and slopes; Codal provisions; Bearing capacity improvement; embankments on soft soils; Indian experiences.

Geosynthetics in Pavements:

Geosynthetics in roads and railways; separations, drainage and filtering in road pavements and railway tracks; overlay design and construction; AASHTO and other relevant guidelines; trench drains.

Geosynthetics in Environmental Control:

Liners for ponds and canals; covers and liners for landfills - material aspects and stability considerations; Landslides - occurrences and methods of mitigation; Erosion - causes and techniques for control.

1. Rao G V and Raju S “Engineering with Geosynthetics” Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1990.
2. Ranjan G and Rao A S R “Basic and Applied Soil Mechanics” International Publishers, New Delhi, 2000.
3. Koerner R M “Designing with Geosynthetics” Prentice-Hall, N. J., U.S.A., 1986.
4. Saran, S., (2006), “Reinforced soil and its Engineering Applications”, I.K. International Pvt. Ltd.
5. Jones, C.J.F.P. (1985), “Earth Reinforcement and soil structures”, Butterworth and co. (Publishers) Ltd., London, England.