DELHI TECHNOLOGICAL UNIVERSITY

SCHEME OF TEACHING AND EVALUATION

MASTER OF TECHNOLOGY IN STRUCTURAL ENGINEERING (STE)

The following alphanumeric coding scheme has been adopted
Core Courses XXXYMN
Elective Courses XXXYCMN
XXX abbreviates a particular M. Tech. program, Y – (5 for M. Tech. 1 st year, 6 for M. Tech. 2 nd year),
C – credit of the course (4/3/2),
MN – Subject code (Odd number for odd semester and even number for even semester courses

Semester-I

	S. No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group A	1	STE501	Structural Dynamics	Core	4	3	0	2	15	25	20	40	-	
	2	STE503	Computational Methods in Structural Engineering	Core	4	3	0	2	15	25	20	40	-	
Group B	3	STE5401/5403/……	Elective 1	Elective	4	3	0	2	15	25	20	40	-	**17**
	4	STE5301/5303/……	Elective 2	Elective	3	3	0	0	15	25	20	40	-	
	5	STE5201/5203/……/ UEC5201/5203/……	Elective 3/University Elective I	Elective	2	2/1	0	0/2	20/15	0/25	30/20	50/40	-	

Semester-II

	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
Group C	1	STE502	Advanced Theory of Structures	Core	4	3	0	2	15	25	20	40	-	**17**

	2	STE504	Finite Element Method of Structural Analysis	Core	4	3	0	2	15	25	20	40	-	
Group D	3	STE5402/5404/……	Elective 4	Elective	4	3	0	2	15	25	20	40	-	
	4	STE5302/5304/……	Elective 5	Elective	3	3	0	0	20	0	30	50	-	
	5	STE5202/5204/……	Elective 6	Elective	2	2/1	0	0/2	20/15	0/25	30/20	50/40	-	

Semester-III

	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**	**Total Credits**
	Track 1													
Group E	1	STE651	Research Project	Core	12	0	0	12	0	-	0	100	0	
	Track 2													
	1	STE601	Major Project I	Core	3	0	0	6	0	-	0	100	0	**12**
	2	STE6401/6403/……	Elective 7	Elective	4	3	0	2	15	25	20	40	-	
	3	STE6301/6303/……	Elective 8	Elective	3	3 / 2	0	0/2	20/15	0/25	30/20	50/40	-	
	4	STE6201/6203/……	Elective 9	Elective	2	2	0	0	20	-	30	50	-	

Semester-IV

	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**	**Total Credits**

Group F	**Track 1**													**12**
	1	STE652+B20	Research Project	Core	12	0	0	12	0	-	0	100	0	
	Track 2													
	1	STE602	Major Project II	Core	12						40	60		

List of Elective Courses

LIST OF ELECTIVES :													
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 1	1	STE5401	Design of Advanced Reinforced Concrete Structures	Elective	4	3	0	2	15	25	20	40	-
	2	STE5403	Design of Advanced Steel Structures		4	3	0	2	15	25	20	40	-
	3	STE5405	Prestressed Concrete Design		4	3	0	2	15	25	20	40	-
	4	STE5407	Cyclone Risk and Hazard Assessment		4	3	0	2	15	25	20	40	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 2	1	STE5301	Theory of Plates & Shells	Elective	3	3	0	0	20	0	30	50	-
	2	STE5303	Theory of Elasticity & Plasticity		3	3	0	0	20	0	30	50	-
	3	STE5305	Stability Analysis of		3	3	0	0	20	0	30	50	-

			Structures										
	4	STE5307	Advanced Building Construction and Management		3	3	0	0	20	0	30	50	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 3	1	STE5201	Seminar	Elective	2	0	0	2	-	100	-	-	-
	2	STE5203	Advanced Concrete Technology		2	2	0	0	20	0	30	50	-
	3	STE5205	Design of Fibre Reinforced Composite Structures		2	1	0	2	15	25	20	40	-
	4	STE5207	Low Cost Housing		2	2	0	0	20	0	30	50	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 4	1	STE5402	Analysis and Design of Bridges	Elective	4	3	0	2	15	25	20	40	-
	2	STE5404	Design of Tall Buildings		4	3	0	2	15	25	20	40	-
	3	STE5406	Wind Engineering		4	3	0	2	15	25	20	40	-
	4	STE5408	Earthquake Resistant Design of Structures		4	3	0	2	15	25	20	40	-
	5	STE5410	Reliability Analysis of Structures		4	3	0	2	15	25	20	40	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 5	1	STE5302	MINOR PROJECT	Elective	3	0	0	-	-	40	-	-	60
	2	STE5304	Soil Structure Interaction		3	3	0	0	20	0	30	50	-

	3	STE5306	Design of Masonry Structures		3	3	0	0	20	0	30	50	-
	4	STE5308	Disaster Mitigation and Management		3	3	0	0	20	0	30	50	-
	5	STE5310	Random Vibration		3	3	0	0	20	0	30	50	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 6	1	STE5202	Durability of Concrete Structures	Elective	2	1	0	2	15	25	20	40	-
	2	STE5204	Building Services		2	2	0	0	20	0	30	50	-
	3	STE5206	Waste to Energy		2	2	0	0	20	0	30	50	-
	4	STE5208	Blast Resistant Design of Structures		2	2	0	0	20	0	30	50	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 7	1	STE6401	Design of Hydraulic Structures	Elective	4	3	0	2	15	25	20	40	-
	2	STE6403	Soil Dynamics		4	3	0	2	15	25	20	40	-
	3	STE6405	Seismic Hazard and Risk Assessment		4	3	0	2	15	25	20	40	-
	4	STE6407	Retrofitting of Structures		4	3	0	2	15	25	20	40	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 8	1	STE6301	Instrumentation and Rehabilitation of Structures	Elective	3	3	0	0	20	0	30	50	-
	2	STE6303	Structural Vibration Control		3	3	0	0	20	0	30	50	-

	3	STE6305	Ground Improvement Techniques		3	3	0	0	20	0	30	50	-
	4	STE6307	Probability & Statistical Methods in Engineering		3	2	0	2	15	25	20	40	-
	S.No.	**Course Code**	**Course Name**	**Type/Area**	**Cr**	**L**	**T**	**P**	**CWS**	**PRS**	**MTE**	**ETE**	**PRE**
Elective 9	1	STE6201	Sustainable Building Technologies	Elective	2	2	0	0	20	0	30	50	-
	2	STE6203	Pre-Fabricated Structures		2	2	0	0	20	0	30	50	-
	3	STE6205	Form Work for Concrete Structures		2	2	0	0	20	0	30	50	-

SEMESTER I

Courses

STE 501 Structural Dynamics

Vibrations and the nature of time dependent phenomena, inertia, dynamic equilibrium and mathematical models of physical systems; Energy storing and dissipation mechanisms. Degrees of freedom; Application of Newton's laws, D'Alembert's principle. Dynamics of Single Degree of Freedom Systems, undamped and damped, free and forced vibrations; Steady-state and transient response, impulse response. Harmonic response and applications to vibration isolation; theory of seismic pickups: Seismometers, accelerometers. Dynamics of Multi-Degree of Freedom Systems, Lagrange's equations; equations of motion for MDOF systems; Algebraic eigenvalue problem and free vibration analysis; Undamped and damped normal modes; Approximate Methods for Vibration Analysis, Rayleigh method, Stodola Method, Holzer Method. Dynamics of Continuous Systems, Hamilton's principle; Axial and transverse vibrations of beams, torsional vibrations of shafts; Normal modes; Free and forced vibration analysis by mode superposition.

Suggested Books:

1. P. Agarwal, M. Shrikhande, Earthquake Resistant Design of structures, Prentice –Hall India, 2006.
2. A. K. Chopra, Dynamics of structures (Vol. 3), New Jersey: Prentice Hall, 1995.
3. S.K. Duggal, Earthquake Resistant Design of Structures, Oxford University Press, 2007.
4. J.W. Tedesco, Ms W.G. Dougal, C.A. Ross, Structural Dynamics Theory and Application, Addison-Wesley, England, 1999.
5. M. Paz , Structural dynamics: theory and computation, Springer Science & Business Media, 2012.

STE 503 Computational Methods in Structural Engineering

Linear Systems and Equations: Exact methods: LU-decomposition, Gauss-elimination methods without and with partial pivoting. Iterative methods: Gauss-Jacobi and Gauss-Seidal methods, Matrix norm, Condition number and Ill-conditioning. Eigen values and Eigen vectors: Largest and Smallest eigen values and eigen vectors by power method. Application to structural engineering problems. Roots of Non-linear Equations: Bisection, Regula Falsi, Secant Newton–Raphson methods, Direct Iterative method with convergence criterion, Newton-Rapson method, Extension of Newton-Raphson and Iterative methods for two variables. Finite Differences and Divided Differences:Operators, Difference table, Propagation of errors, Divided differences with properties. Application to

structural engineering problems. Interpolation: Interpolation Formulae: Newton's forward, backward, Stirling's and Bessel's formulae, Newton's divided difference and Lagrange's formulae, Errors in various interpolation formulae. Inverse Interpolation: Successive approximation and Lagrange's method. Numerical Differentiation: Various formulae for first and second derivative with errors. Application to structural engineering problems. Numerical Integration: Newton-Cotes formulae, General quadrature formula for equidistant ordinates, Trapezoidal, Simpson's 1/3 and 3/8 rules with their geometrical interpretations and errors, Romberg integration and Gaussian quadrature formulae. ODEs: Initial Value Problems :Euler's methods; Runge-Kutta methods; Predictor-corrector methods; ODEs: Boundary Value Problems:Shooting method; Finite differences; Over/Under Relaxation (SOR). Application to structural engineering problems. Regression and Curve Fitting: Linear regression; Least squares; Total Least Squares; Interpolation; Newton's Difference Formulae; Cubic Splines. Computer Algorithms: Numerical Solutions for Different Structural Problems, Fuzzy Logic and Neural Network. Computer programming using MATLAB and its application in solving structural engineering problems.

Suggested Books:

1. S.P. Venkateshan and P. Swaminathan, Computational Methods in Engineering, Ane Books Pvt. Ltd, 2017.
2. S. C. Chapra and R. P. Canale, Numerical Methods for Engineers, Tata McGraw hill, 2016.
3. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India, 1998.
4. M.K. Jain, S.R. Iyengar & R.K. Jain, Numerical Methods for Scientific & Engineering Computation, New Age International Publisher, 2010.

STE5401 Design of Advanced Reinforced Concrete

Review of limit state design and loadings as per applicable codes. Analysis, design and detailing of simple buildings. Analysis, design and detailing of folded plates and cylindrical shells (beam and arch theory). Analysis, design and detailing cylindrical water tanks resting on ground (fixed and hinged boundary conditions at base). Analysis, design and detailing of circular silos including foundations. Analysis, design and detailing of cylindrical chimneys including foundations. Retaining walls: Types of retaining walls, Analysis and design of cantilever type retaining walls, Analysis and design of counterfort and buttress type retaining walls, Analysis and design of Abutments.

Suggested Books:

1. Pillai and Menon, Reinforced Concrete Design, TMH, 2003.
2. S.R. Karve and V.L. Shah, Limit State Theory and Design of reinforced Concrete, VGP, 2014.
3. P. C. Varghese, Advanced Reinforced Concrete Design, PHI, 2015.
4. G. Winter, Design of Concrete Structures, McGraw Hill, 1986.

STE5403 Design of Advanced Steel Structures

Introduction to multi storey buildings, loading, analysis for gravity and lateral loads, computer analysis of rigid frames and advanced structural forms. Introduction to space frames, type of space frames, space trusses, optimality criteria and case studies. Introduction to cold form steel, advantages of cold formed sections, local buckling, beams, axially loaded columns with and without bending and concluding remarks. Introduction to micro-wave towers, types of communication towers, ladders and platforms and codal provisions. Introduction to transmission towers, material properties, ground clearance, tower configurations, factor of safety, loads and their design. Introduction to bridges, steel for bridges, classification of steel bridges, loads and their combinations, analysis and design of plate girder and trussed bridges.

Suggested Books:

1. A.S. Arya and A. Kumar, Design of Steel Structures, Nem Chand and Bros, 2014.
2. Indian Railway Standard, IRS Code of Practice for Design and Construction of Bridges and Structures, Volume - I and II,-Research Design and Standards Organisation, 2004.
3. S.K. Duggal, Design of Steel Structures, 3rd edition, McGraw Hill publication, 2009.
4. IS: 801 Code of Practice for Use of Cold-Formed Light Gauge Steel Structural Members in General Building Construction, Bureau of Indian Standards, 1975.
5. IS: 802 Code of Practice for Use of Structural Steel in Overhead Transmission Line Towers, Bureau of Indian Standards, 1992.

STE 5405 Prestressed Concrete Design

Introduction, Advantages and Types of Pre-Stressing, Pre-Tensioning Systems and Devices, Post-Tensioning Systems and Devices, Concrete and steel properties, Pre-Stressing Steel, Computation of Losses in Pre-stress in pre and post tensioned members. Analysis of Members under Axial Load to get short term and long term un-cracked and cracked response, Calculation of Crack Width and Crack Spacing, Response of Member subjected to Flexure. Numerical method for Calculation of Camber/Deflection ,Composite Construction. Flexural Design of Members strain compatibility and force in tendon approach, Design of Sections for Flexure of One-Way Slabs with bonded and un-bonded tendons, T section / Double T section Floor Beams , Detailing Requirements for Flexure, Control of crack width and deflection. Members subjected to combined axial load and flexure including slender members, Analysis of member subjected to Shear, Modified compression field theory, Torsion, Design for Shear, Design for Torsion, Design for combined flexure , shear and torsion, Transmission of Pre-stress in pre and post tensioned members. Analysis and design of Continuous Beams, Composite Sections, Flat Slabs, Circular Pre-stressing. Design of Pre-Stressed Sleepers, Design of Pre-Stressed Piles

Suggested Books:

1. IS 1343:2012 ,IS 456:2000,IS 3370 Part I to IV , 2009.
2. PCI Design Handbook, ACI 318 Code, CEB-FIP code,BS 8110, 1990.
3. N. Krishna Raju, Pre-Stressed Concrete, Tata McGraw Hill, 2006.
4. T.Y. Lin, Pre-Stressed Concrete Structures, John Wiley and Sons Inc, 2010.

STE5407 Cyclonic Risk and Hazard Assessment

High wind and severe storms: Introduction, types of high wind, hurricanes, typhoons, cyclones Wind Characteristics: Variation of wind velocity with height and roughness, atmospheric circulation-pressure gradient force, Coriolis force, frictional force, geostrophic flow, boundary layer, Static wind effects and building codes with particular reference to IS875(part-I). Tropical Cyclones: General structure of Cyclones, Quantification of Cyclones, Various scales for measuring wind storms, Different types of distribution generally used in wind engineering problems, Probabilistic description of cyclonic wind speed, Exceedance Probabilities, Mean Recurrence Intervals, N-year Speed Estimation from Measured Wind Speeds, wind storm/cyclone hazard in India, wind speed map of India, Frequency of cyclones in India. Cyclonic Microzonation: Cyclone key parameters, Probability distribution of cyclone key parameter, Artificial generation of distribution of velocity at a site using of the cyclone key parameters, Hazard curve, hazard map, Microzonation of Andhra Pradesh and Orrisa. Quantification of damage: Classification of Buildings, Damaging effects of high wind speeds on housing in the coastal region of India Classification of damages according to Indian standard procedure (IS 15499:2004), Impact of Cyclonic Storms and Suggested Mitigation Actions, Different technique used to describe the vulnerability of building. Vulnerability assessment: Concept of vulnerability of houses to cyclonic wind, fragility curve, damage ratio, Direct and component-based approach, Concept of damage probability matrix, Effect of wind directionality on vulnerability of houses. Cyclonic risk assessment, Integrating cyclonic hazard to cyclonic risk, HAZUS.

Suggested Books:

1. E. Simiu & R.H. Scanlan, Wind effects on structures: An Introduction to Wind Engineering, John Wiley, 1986.
2. IS: 15498: Guidelines for Improving the Cyclonic Resistance of Low-Rise Houses and other Buildings/Structures, Bureau of Indian Standard, 2004.
3. N.M. Bhandari, P. Krishna and K. Krishen, Wind storms, damage and guidelines for mitigative measures, Department of Civil Engineering, Indian Institute of Technology, Roorkee, p. 11, Document No. IITK-GSDMA-Wind03-V3.0, 2011.
4. P.K. Goyal, T. K. Datta and V.K. Vijay, Vulnerability of rural houses to cyclonic wind, Int. J. Disaster Resilience in the Built Environment, 2012.
5. “Vulnerability Atlas of India”, BMPTC, Ministry of Urban Affairs and Employment, Government of India, 2007.

6. P.K. Goyal and T.K. Datta, Probability Distributions for Cyclone key Parameters and cyclonic wind speed for the east coast of Indian Region, The International Journal of Ocean and Climate Systems, Vol.2 (3), Multi science, 2011.

STE5301 Theory of Plate & Shells

Bending of long rectangular plates in cylindrical surfaces. Differential equations for cylindrical bending of plates. Cylindrical bending equally loaded free supported rectangular plate, fixed rectangular plate, rectangular plate with a flexible fixed ends. Pure bending plate. The slope and curvature of small deflection plate. Relationship between offensive moments and curvature in pure bending plate. Different cases of pure bending. Symmetrical bending of circular plates. Differential equations for symmetric bending transversely loaded circular plates. Uniform load of plates, concentric, the load at the centre. Plate with a round hole in the centre. Plates on elastic foundation, various cases and applications General theory of shells, Differential equations, Energy method.

Suggested Books:

1. S. Timoshenko & S. Woinowsky-Krieger, Theory of plates and shells, (Vol. 2), McGraw-hill, 1959.
2. S.S. Bhavikatti, Theory of plates and shells, New Age International Private Limited, 2017.
3. K. Chandrashekhara, Theory of plates, Universities press, 2001.
4. R. Szilard, Theory and analysis of plates, Prentice-Hall, 1974.

STE 5303 Theory of Elasticity & Plasticity

Introduction to the general theory of elasticity, Assumptions and Applications of linear elasticity. Analysis of Stress**:** Stress tensors, two-dimensional state of stress at a point, principal stresses in two dimensions, direction cosines, stress components on an arbitrary plane with stress transformation. Principal stresses in three dimensions, stress invariants, equilibrium equations, Mohr's stress circle, equilibrium equations, Numerical examples. Analysis of Strain**:** Types of strain, strain tensors, strain transformation. Principal strains, strain invariants, octahedral strains. Mohr's Circle for Strain, equations of Compatibility for Strain, Numerical examples. Stress-Strain Relations**:** Generalized Hooke's law, transformation of compatibility Condition from Strain components to stress components. Strain energy in an elastic body, St. Venant's principle, uniqueness theorem. Two Dimensional Problems in Cartesian Coordinate System**:** Plane stress and plane strain problems. Stress function, stress function for plane stress and plane strain cases. Torsion of Prismatic Bars**:** General solution of the torsion problem, stress function, torsion of circular and elliptic cross sections. Prandtl's membrane analogy, torsion of thin walled and multiple cell closed sections. Numerical examples. Theory of Plasticity**:** Concept, various materials and their properties, analysis of civil engineering structures as per theory of plasticity.

Suggested Books:

1. S. P. Timoshenko & J.N. Goodier, Theory of Elasticity, McGraw-Hill, 1971.
2. J. Chakrabarty, Theory of plasticity, Butterworth-Heinemann, 2012.
3. A. C. Ugural & S. K. Fenster, Advanced strength and applied elasticity, Pearson education, 2003.

STE5305 Stability Analysis of Structures

Elastic stability: Geometric Non linearity –Basic Concepts. Elastic buckling of bars, Euler's formula, Buckling of continuous beams, buckling of non-prismatic members, effect of shear force on buckling of bars, use of energy method. Analysis of beam-columns with various end conditions, Use of trigonometric series, Buckling of single span portal frames. Torsional buckling: Pure torsion of thin walled open cross section, warping and warping rigidity. Torsional buckling of columns, combined buckling by torsion and flexure, Lateral torsional buckling of beams, lateral buckling of beams in pure bending, lateral torsional buckling of cantilever and S.S. beams, Introduction to buckling of plates.

Suggested Books

1. M. L. Gambhir, Stability analysis and design of structures, Springer Science & Business Media, 2004.
2. A. Chajes, Principles of structural stability theory, Prentice Hall, 1974.
3. G. Gerard, Introduction to structural stability theory, McGraw-Hill, 1961.
4. N. G. R. Iyengar, Elastic Stability of Structural Elements, Macmillan, 2007.

STE5307 Advanced Building Construction and Management

Introduction to building construction, site work and excavation construction methods, Foundation construction methods, structure (concrete) construction methods, structure (steel and wood) construction methods, structure (masonry) construction method Building envelope (roof) systems, building envelope (walls) systems, building envelope design and integration, interior wall and ceiling systems, interior wall and ceiling systems, interior finishes. Speciality construction systems, integrated building design and modelling, construction sequencing Project Scheduling: Construction Scheduling, Work break down structure, activity cost and time estimation in CPM, PERT, RPM (Repetitive Project Modeling) techniques. LOB technique, Mass haul diagrams. Precedence Network Analysis, software in Construction scheduling (MSP, primavera, Construction manager). Construction site management: Site mobilization: demobilization aspects, various Resources management based on funds availability, coordinating, communicating & reporting Techniques, Application of MIS to construction, Training for Construction Managers , Engineers , Supervisors

Suggested Books:

1. C.M.H. Barritt, Advanced Building Construction, Volume 2, Longmans, 1985.

2. H. Fidler, Advanced Building Construction: A Manual for Students, Longmans, Green & Company, 1892.
3. M.P. Calin and C. Chotchal, Project Planning, Scheduling and Control in Construction :An Encyclopedia of terms and Applications, Wiley publication, 1995.
4. K.K. Chitkara, Construction Project Management: Planning Scheduling and Control, Tata McGraw Hill, 2012.

STE5201 SEMINAR

STE5203 Advanced Concrete

Concrete Materials: Cement production, composition, hydration chemistry, Aggregates: Geology of aggregates, Chemical and Mineral admixtures for concrete, High Performance concrete mixture proportioning Concrete Behaviour, Advanced topics in fresh concrete – Rheology, pumping of concrete, Advanced topics in hardened Concrete – Behaviour under various loads, creep & shrinkage, Durability problems of Concrete.

Suggested Books:

1. P. K. Mehta and P. J. M. Monteiro, Concrete: Microstructure, Properties, and Materials, Fourth Edition (Indian Edition), McGraw Hill, 2014.
2. A. M. Neville, Properties of Concrete, Pearson Fifth Edition, 2013.
3. J. Newman & B. S. Choo, Advanced Concrete Technology, Elsevier, 2003.

STE5205 Design of Fibre Reinforced Concrete Structures

Introduction; Types of structural fibers: matrix, fiber and interface; Fiber reinforced concrete (FRC). High-performance concrete; Stress transfer, Bond, Pull-out, Toughening mechanism; Fracture mechanics; Modeling of tensile and flexural behaviors; Behavior under compression; Shear failure theory; Behavior under seismic loading; Composite structural design: Design spirals, Selection Criteria configurations; Laminate design; Mathematical analysis of laminates. Design of single skin panels, Design of composite stiffeners.

Suggested Books:

1. S. B. Singh, Analysis & Design of Fibre reinforced Concrete structures, McGraw-Hill Education, 2015.
2. R.R. Hussain, Fibre reinforced Concrete, VDM Verlag Dr. Müller, 2010.

STE5207 Low Cost Housing

Eco-friendly Planning: Energy Efficient Shelters, Housing Options Today, Site Planning and Use of On-Site Resources, Smaller Houses that Utilize Space and Materials More Efficiently, Working With Nature, Better Window Planning, Balancing Energy and Aesthetic Needs. Eco-friendly Materials: Construction materials –locally available building materials- Soil, Fly ash, Ferrocement, Lime, Fibres, Stone Dust, Red mud, Gypsum,Alternate Wood, Polymer-ADOBE,Cob Rammed Earth, Light Clay, Straw-Bale, Bamboo, Agro-Industrial Waste, Innovative Materials Developed by CBRI, SERC, Structural Properties Of Alternate Building Materials, Earthen Finishes , Earth Plasters, Earth Floors. Cost Effective Construction Techniques: Construction Techniques-Innovative Techniques developed by CBRI, SERC for foundation, superstructure, roofing, pre-fabricated construction techniques, advantage of pre-fabrication areas where pre-fabrication can be introduced, modular contained earth, earth bag construction. Cost Effective Construction Equipments: Equipments-Brick moulding machine, Stablilised soil block making machine and plants for the manufacturing of concrete blocks, M.C.R. tile making machine, Ferrocement wall panel & Roofing channel making machine, R.C.C. Chaukhat making machine.

Suggested Books:

1. Givoni, Man, Climate, Architecture, Van Nostrand, 1976.
2. J. K. Charles, Sustainable Construction: Green Building Design and Delivery, John Wiley & Sons, 2005.
3. L. Elizabeth and C. Adams, Alternative Construction: Contemporary Natural Building Methods, Softcover, Wiley & Sons, 2005.

SEMESTER II

Courses

STE502 Advanced Theory of Structures

Matrix, Vector, identity, symmetric and skew symmetric, sparse, banded and orthogonal matrices, Addition and multiplication of matrices, inverse of a matrix and matrices for translation, scaling and rotation of an object. Indeterminacy, Static and Kinematic indeterminacies, selection of a method of analysis based on indeterminacies, Principle of Superposition, Actions and Displacements, Flexibility and Stiffness methods of analysis, procedural steps of analysis and numbering of joints for minimum band width. Stiffness matrix of plane frame and continuous beam members, transformation of stiffness matrices from member axes to structure axis system and their assembling. Preparation of load vectors, their transformation from member axes to structure axis system and their assembling. Solution of equations for unknown displacements, determination of support reactions and member end forces. Stiffness matrix of plane truss and grid frame members, transformation of stiffness matrices from member axes to global axis system and their assembling. Preparation of load vectors, their transformation from member axes to global axis system and their assembling. Solution of equations for unknown displacements, determination of support

reactions and member forces. Stiffness matrix and rotation transformation matrices for space truss and space frame members. Stiffness matrices for beams curved in plan and elevation, analysis using Sub-structure technique, effect of axial force on flexural stiffness and non-linear analysis of structures

Suggested Books:

1. H.C. Martin, Introduction of Matrix Methods of Structural Analysis, McGraw-Hill, 2005.
2. H. Kardestuncer , Elementary Matrix Analysis of Structures, McGraw-Hill, 1974.
3. W. Weaver Jr. and J.M. Gere, Matrix Analysis of Framed Structures, CBS publishers and distributors, 2004.
4. A. Ghali, A.M. Neville and T.G. Brown, Structural Analysis, Taylor & Francis Ltd, 2003.
5. F.W. Beaufait, W.H. Rowan and P.G. Hoadley, Computer Methods of structural analysis, Prentice Hall, 2000.

STE504 Finite Element Method of Structural Analysis

General concepts of continuum/solid mechanics, State variables, stress, strain-displacement relationships defining different classes of problems, Euler Bernoulli and Timoshenko beam models, Formulation of 3D elasticity, Kirchhoff's plate theory and Mindlin plate theory based plate problems, Principle of total minimum stationary potential Energy, Stress calculation. Rayleigh Ritz method, Variational formulation of continuous systems, Analysis of continuous systems (discretization approach), Mesh generation techniques, Galerkin and other methods of weighted residual, Generalized and natural coordinate models of displacement field, Convergence criteria, Numerical errors and F.E. model refinements. EBBM based beam problem, Plane stress and plane strain problems using generalized coordinate displacement model, Shape functions for Lagrangian family of rectangular elements, triangular elements, r-s-t coordinate method, Area coordinates, Serendipity elements, Tetrahedron and hexahedron elements, Iso-parametric elements, Elements with curved boundaries, Cartesian mapping relationship from local and natural coordinates, Jacobian, Numerical integration methods. Using natural coordinate displacement model stiffness matrix for truss element, TBM based beam problem, Plane stress/plane strain problems using quadrilateral and triangular elements, Determination of load vector, Plate bending problem with rectangular and triangular elements, Hermitian polynomials and a conforming plate bending element, Initial value and eigen value problems, Axisymmetric elasticity problems, Dissimilar elements, Shear locking defect, Under integration and Suitable integration order and infinite and singularity elements issues, Patch tests, Problems in NISA , ANSYS and other FEM software.

Suggested Books:

1. C.S. Krishnamoorty, Finite Element Analysis, McGraw-Hill, 1994.
2. O.C. Zienkiewicz & R. L. Taylor, The finite element method, (Vol. 3) McGraw-hill, 1977.
3. T. J. Hughes, The finite element method: linear static and dynamic finite element analysis, Courier Corporation, 2012.
4. Y.M. Desai, T.I. Eldho and A.H. Shah, Finite Element Method, Pearson publication, 2011.

STE5402 Analysis and Design of Bridges

Introduction, historical/ magnificent bridges; Site Selection, Planning, and Type of Bridges, Loads and Forces; Code Provisions for Design of Steel and Concrete Bridges; Analysis Methods, Grillage Analogy; Theories of Lateral Load Distribution and Design of Superstructure: Slab Type, Beam-Slab, and Box Type. Applied and Self-Induced Horizontal Forces among Bridge Supports in Straight, Curved, and Skewed Decks; Continuous Type and Balanced Cantilever Type Superstructure Temperature Stresses in Concrete Bridge Deck; Different Types of Foundations: Open, Pile, and Well Foundations; Choice of Foundation for Abutments and Piers; Design of Abutments, Piers, Pile/ Pier Caps. Effect of Differential Settlement of Supports; Bridge Bearings; Expansion Joints for Bridge Decks; Vibration of Bridge Decks; Parapet and Railings for Highway Bridges; Construction Methods; Segmental Construction of Bridges; Inspection and Maintenance of Bridges; Health Monitoring and Evaluation of Existing Bridges; Bridge Failure: Case Studies..

Suggested Books:

1. W. F. Chen & L. Duan, Bridge Engineering Handbook: Construction and Maintenance, CRC press, 2014.
2. J. W. Smith, Theory and design of bridges, Petros P. Xanthakos, Wiley Interscience, 1994.
3. V.K. Raina, Concrete bridge practice – analysis, design and economics, Tata McGraw-Hill Publishing Company Ltd, 2002.
4. J. W. Smith, Theory and design of bridges, Petros P. Xanthakos, Wiley Interscience, 1994.

STE5404 Design of Tall Buildings

Design Criteria and Materials : Development of High Rise Structures – General Planning Considerations – Design philosophies – Materials used for Construction – High Strength Concrete – High Performance Concrete – Self Compacting Concrete – Glass – High Strength Steel. Loading: Gravity Loading – Dead Load – Live Load – Live load reduction technique – Impact Load – Construction Load – Sequential Loading. Lateral Loading – Wind load – Earthquake Load. Combination of Loads. Behaviour of Various Structural Systems: Factors affecting growth, Height and Structural form. High rise behaviour of Various structural systems – Rigid frames, braced frames, Infilled frames, shear walls, coupled shear walls, wallframes, tubular structures, cores, outrigger – braced and hybrid mega systems. Analysis and Design: Modeling for approximate analysis, Accurate analysis and reduction techniques, Analysis of buildings as total structural system considering overall integrity and major subsystem interaction, Analysis for member forces, drift and twist, computerised general three dimensional analysis. Stability of Tall Buildings: Overall buckling analysis of frames, wall-frames, Approximate methods, second order effects of gravity of loading, P-Delta analysis, simultaneous first-order and P-Delta analysis, Translational, Torsional instability, out of plumb effects, stiffness of member in stability, effect of foundation rotation.

Suggested Books:

1. B. S. Smith and A. coull, Tall Building Structures, Analysis and Design, John Wiley and Sons, 1991.
2. B.S. Taranath, Structural Analysis and Design of Tall Buildings, McGraw Hill, 2011.
3. T.Y. Lin & B.D. Stotes, Structural Concepts and systems for Architects and Engineers, John Wiley, 1988.
4. S.B. Lynn, Advances in Tall Buildings, CBS Publishers and Distributors, 1986.

STE5406 Wind Engineering

Introduction: Terminology – Wind Data – Gust factor and its determination - Wind speed variation with height– Shape factor – Aspect ratio – Drag and lift. Effect of Wind on Structures: Static effect – Dynamic effect – Interference effects (concept only) – Rigid structure – Aero elastic structure (concept only). Tail buildings – Low rise buildings – Roof and cladding – Chimneys, towers and bridges. Structural System in Tall Buildings: Different types of structural system, Shear walls of various types; frame – Shear wall interaction; staggered wall – beam system. Electrical transmission towers. Application to Design: Design forces on multi-storey building, towers and roof trusses. Response of high – rise structures to lateral loads and design consideration. Introduction to Wind Tunnel: Types of models (Principles only) – Basic considerations – Examples of tests and their use.

Suggested Books:

1. T.V. Lawson , Wind Effects on Buildings, Vols. I and II, Applied Science and Publishers, 1993.
2. A.G. Devenport, Wind Loads on Structures, Division of Building Research, 1990.
3. B.S. Taranath, Analysis and Design of Tall Buildings, CRC press, 2003.
4. P. Sachs, Wind Forces in Engineering, Pergamon Press, 1992.

STE5408 Earthquake Resistant design of Structures

Conceptual Design: Functional planning, Continuous Load Path, Overall form, Simplicity and Symmetry, Elongated Shapes, Stiffness and Strength, Horizontal and vertical Members, Twisting of Buildings, Ductility, Flexible Buildings, Framing Systems, Effect of Non-Structures, Choice of construction Material. Introduction to Earthquake – Resistant Design: Seismic Design Requirement, Regular and Irregular Configurations, Basic Assumptions, Design Earthquake Loads, Basic Load Combinations, Permissible Stresses, Seismic Method of Analysis, Factors in seismic Analysis, Equivalent Lateral Force Method, Dynamic Analysis, Response Spectrum Method, Time History Method, Torsion, Soft and Weak Storey in Construction, Overturning Moments, Other structural requirements, Earthquake Resistant Design Methods, Response Control. Concept of Ductile Detailing, Introduction to Performance Based Design Step-by-Step Procedure for Seismic analysis of a four storied RC Building as per IS 1893 (Part I): 2002: Introduction, Analysis by Equivalent Static Lateral Force Method, Response Spectrum Method, Time History Method. Design and detailing of RC framed building elements (beam, column, shear wall, diaphragm and beam-column joint) as per IS 13920. Introduction to nonlinear analyses methods, Analysis of a building using nonlinear static procedure, Introduction to capacity design concepts and displacement based design methods.

Suggested Books:

1. P. Agarwal and M. Shrikhande, Earthquake resistant design of structures, Prentice-Hall of India, 2006.
2. T. Paulay and M.J.N. Priestley, Seismic design of reinforced concrete and masonry buildings, John Wiley & Sons, 1991.
3. D. J. Dowrick, Earthquake resistant design - A manual for engineers and architects, John Wiley & Sons, 1977.
4. S.K. Duggal, Earthquake Resistant Design of Structures, Oxford University Press, 2013.
5. P. FEMA, Commentary for the Seismic Rehabilitation of Buildings.FEMA-356, Federal Emergency

Management Agency, 2000.
6. A.K. Chopra, Dynamics of structures: theory and applications to earthquake engineering, Prentice hall, 2012.

STE5410 Reliability Analysis of Structures

Introduction to structural safety reliability: Basic statistics: -Introduction; data reduction; histograms; measures of asymmetry; sample correlation. Probability theory: Introduction, random events, random variables, functions of random variables, moments and expectation, common probability distributions, Extremal distribution. Resistance distribution and parameters: Introduction; statistics of properties of concrete and steel, statistics of strength of bricks and mortar, dimensional variations; characterization of variables of compressive strength of concrete in structures and yield strength of steel; allowable stresses based on specified reliability. Probabilistic analysis of loads: Introduction; load as a stochastic process, dead load, live loads, Wind load-introduction; wind speed, return period, estimation of lifetime design wind speed, probability model for wind load. Basic structural reliability: Introduction, computation of structural reliability. Reliability method: Introduction, basic variables and failure surface, first order second moment methods (FOSM). Monte Carlo study of Structural Safety: Concept of monte carlo simulation and applications, case studies using MATLAB System reliability: Series, parallel and mixed system, Modelling of structural system.

Suggested Books:

1. A. Haldar and S. Mahadevan, Probability, reliability and statistical methods in engineering design, John Wiley and Sons, 2000.
2. J.R. Benjamin and C.A. Cornell, Probability, statistics and decisions for civil engineers, John Wiley, 1970.
3. A.H.S. Ang & W.H. Tang, Probability concepts in engineering planning and design, Volume II Decision, Risk & reliability, John Wiley, 1984.
4. A. Papoulis, Probability, random variables and stochastic processes, 3rd Edition, McGraw-Hill, 1991.

STE5302 Minor Project

STE5304 Soil Structure Interaction

General soil-structure interaction problems: Contact pressures and soil-structure interaction for shallow foundations. Concept of sub-grade modulus, effects/parameters influencing subgrade modulus. Analysis of foundations of finite rigidity, Beams on elastic foundation concept, introduction to the solution of beam problems. Analytical Methods of Analysis of Finite Beams on Wrinkler Foundation: Introduction, analysis of finite and infinite beam on wrinkle foundation, method of super position, method of initial parameters and its application to analysis of regular beams, analysis of continuous beams and frames on wrinkle foundation, analysis of frames on wrinkle foundation, analysis of rigid piles with horizontal and vertical loads. Analysis of Beams on Elastic Half Space: Introduction, analysis of Rigid Beams, short beam analysis, long beam Analysis, Analysis of Frame on Elastic Half Space. Dynamic Soil Structure Interaction: Direct and Sub-structure method of Analysis, Equation of Motion for flexible and rigid base, kinematic

interaction, inertial interaction and effect of embedment, Temporal and special variation of external loads including seismic loads, continuous models, discrete models and finite element models. Wave Propagation for SSI: Waves in Semi-Infinite Medium, one two and three dimensional wave propagation, dynamic stiffness matrix for out of plane and in plane motion. Free Field Response of Site: Control point and control motion for seismic analysis, dispersion and attenuation of waves, half space, single layer on half space, modelling of boundaries, elementary, local, consistent and transmitting boundaries. Engineering Application of Soil-Structure Interaction: Low rise residential building, multi-storey building, bridges and dams, soil-pile structure interaction.

Suggested Books:

1. E. Tsudik, Analysis of Structures on Elastic Foundations, J. Ross Publishing, 2012.
2. J. P. Wolf, Dynamic soil-structure interaction, Prentice Hall int., 1985.
3. J. P. Wolf & C. Song, Finite-element modelling of unbounded media, Chichester: Wiley, 1996.
4. S.L. Kramer, Geotechnical earthquake engineering (Vol. 80)- Upper Saddle River, NJ: Prentice Hall, 1996.
5. "Structure Soil Interaction" - State of Art Report, Institution of structural Engineers, 1978.

STE5306 Design of Masonry Structures

Behaviour of Masonry Structures During Past Earthquakes: Common modes of failure, effect of unit shapes and mortar type, effect of roof and floor systems; Common deficiencies. Material Properties: Masonry units- stones, brick and concrete blocks, hollow and solid units; Manufacturing process; Mortar, grout and reinforcement; Various tests and standards. Masonry Under Compression: Prism strength, Failure mechanism, types of construction and bonds; Eccentric loading; Slenderness – effective length and effective height, effect of openings; Code provisions. Masonry Under Lateral Loads: In-plane and out-of-plane loads, bending parallel and perpendicular to bed joints; Shear and flexure behavior of piers; Test and standards; Analysis of perforated shear walls, lateral force distribution for flexible and rigid diaphragms; Arching action; Combined axial and bending actions. Earthquake Resistant Measures: Analysis for earthquake forces, role of floor and roof diaphragm; Concept and design of bands, bandages, splints and ties; Reinforced masonry; Vertical reinforcement at corners and jambs; Measures in random-rubble masonry; Confined masonry; Code provisions. Masonry Infills: Effect of masonry infills on seismic behaviour of framed buildings; Failure modes; Simulation of infills – FEM and equivalent strut; Safety of infills in in-plane action – shear, compression and buckling; Out-of plane action, arching; Code provisions. Retrofitting of Masonry Building: Techniques of repair and retrofitting of masonry buildings; IS: 13935-1993 provision for retrofitting. Advance Concepts: Strength and ductility; Nonlinear pushover analysis; Performance based design; Vulnerability and fragility analysis.

Suggested Books:

1. P. Thomas & M.J. Priestley, Seismic design of reinforced concrete and masonry Buildings, John Wiley & Sons, 1992.
2. R.G. Drysdale, A.A. Hamid & L.R. Baker, Masonry structures: behavior and design, Prentice Hall, 1994.
3. D. Anderson & S. Brzev, Seismic design guide for masonry buildings, Canadian Concrete Masonry Producers Association, 2009.

STE5308 Disaster Mitigation & Management

Introduction to various hazard, vulnerability and risk, hazard estimation, hazard mapping, effect of site conditions on structures, event monitoring, processing and integration of data. Damages: Grade of damages, direct and indirect damages, damage to structures, lessons learnt Management and mitigation of earthquake: earthquake risk and vulnerability in India, traditional housing construction in rural and urban areas, critical areas of concern in earthquake management, past and present initiative in India, disaster management plan, approaches to seismic risk mitigation, seismic strengthening and retrofitting methods, awareness and preparedness, capacity building Management and mitigation of tsunamis: Tsunami Risk Assessment and Vulnerability Analysis, Coastal Zone Management, Tsunami Preparedness, Structural Mitigation Measures, Regulation and Enforcement of Techno-Legal Regime Management and mitigation of cyclones: Understanding cyclone and wind hazard in India, vulnerability and risk assessment, early warning systems, structural mitigation measures, management of coastal zones, disaster risk management and capacity development Management and mitigation of flood (including urban flooding): The Flood Hazard, Flash Floods, urban flooding, structural measures for flood management, design and management of urban drainage system, urban flood disaster risk management, early warning system and communication, capacity development Management and mitigation of landslide: Introduction to landslide hazard, Landslide Vulnerability and Risk in India, Hazard Zonation Mapping, Geological and Geotechnical Investigations, Landslide Risk Treatment, Landslide Monitoring and Forecasting, Capacity building Disaster Management Act : Disaster management policy; Techno legal aspect: Techno-Legal and Techno-Financial work; Model Town and country planning legislation land use zoning regulation, development control regulations and building bye-laws registration, qualification and duties of professionals, disaster response policy.

Suggested Books:

1. P. Blaikie, T. Cannon, I. Davis & B. Wisner, At risk: natural hazards, people's vulnerability and disasters, Routledge, 2014.
2. D. Mileti, Disasters by Design: A Reassessment of Natural Hazards in the United States, Joseph Henry Press, 1999.
3. L. Reiter, Earthquake hazard analysis: issues and insights, Columbia University Press, 1991.
4. K. Aki & P. G. Richards, Quantitative Seismology: Theory and Methods, Volume I: WH Freeman & Co, 1980.
5. National Disaster Management Agency Documents, www. http://ndma.gov.in.

STE5310 Random Vibrations

Basic Theory: Meaning and axiom of probability, events, random variables, discrete and continuous distribution, some examples; Functions of random variables, expectations, characteristic functions; Orthogonality principles, sequence of random variables. Stochastic Processes: Counting process, random walk, Markov chain, Gaussian process, filtered point process, Markov process and non-stationary Gaussian process; Stochastic continuity and differentiation, integral, time average, ergodicity; Correlation and power spectrum; Threshold crossing, peak, envelope distribution and first passage problem. Response of Linear Systems to Random Vibrations: Linear response of single and multiple-degree of

freedom systems subjected to random inputs; Linear response of continuous systems. Response of Non linear Systems to Random Vibrations: Response of nonlinear systems to random inputs; Equivalent linearization and Gaussian closure technique.

Suggested Books:

1. N. C. Nigam & H. Saunders, Introduction to Random Vibration, 1986.
2. Y. K. Lin & G. Q. Cai, Probabilistic structural dynamics: advanced theory and applications, McGraw-Hill Professional Publishing, 2004.
3. P.H. Wirsching, T.L. Paez & K. Ortiz, Random vibrations: theory and practice, Courier Corporation, 2006.
4. Cho W.S. To, Nonlinear random vibration: Analytical techniques and applications, CRC Press, 2011.

STE5202 Durability of Concrete Structures

Concrete and the environment: interaction; Overview of concrete deterioration: alkali-aggregate reaction, corrosion, carbonation. Permeability of concrete and its measurement: penetration of carbon dioxide and chlorides into concrete. Corrosion of steel in concrete - electrochemistry of corrosion, micro and macro cell corrosion, corrosion cells and currents, role of concrete, prevention of corrosion; Corrosion induced longitudinal cracks: nature and properties of corrosion products; Alkali aggregate reaction: reactive minerals, mechanism of deterioration, identification and tests; Codal provisions for durability; Non-destructive testing; repair/rehabilitation of structures.

Suggested Books:

1. K. Li, Durability Design of Concrete Structures: Phenomena, Modelling and Practice, Wiley publication, 2016.
2. G.C. Mays, Durability of Concrete Structures: Investigation, repair, protection, Taylor &Francis, 1991.
3. L.M. Poukhonto, Durability of Concrete Structures and Constructions: Silos, Bunkers, Reservoirs, Water Towers, Retaining Walls, CRC Press, 2003.
4. L. Chris, Durability of Concrete and Cement Composites, Woodhead Publishing, 2007.

STE5204 Building Services

Water requirements for different types of buildings, simple method of removal of impurities, water saving practices and their potential Service connection from mains, sump and storage tank, types and sizes of pipes, special installation in multistoried buildings. Material, types of fixtures and fitting for a contemporary bathroom– taps – quarter turn, half turn, ceramic, foam flow etc, hot water mixer, hand shower Rainwater harvesting to include roof top harvesting, type of spouts, sizes of rainwater pipes and typical detail of a water harvesting pit. Principles of drainage, surface drainage, shape and sizes of drains and sewers, storm water over flow chambers, methods of laying and construction of sewers Traps– shapes, sizes, types, materials and function, Inspection chambers -sizes and construction, Ventilation of House drainage: Anti siphonage pipe, system of plumbing - single stack , one pipe system, one pipe partially ventilating system and two pipe system, grey water recycling and dual plumbing. Types of fixtures and materials: sinks, shower tray, shower temple, bath tub, Jacuzzi, water closets, flushing cisterns, urinals, sinks , wash basins, bidet, etc. Design

of Septic tank, Oxidation pond, Dispersion trench and soak pits. Arrangements of fixtures in a bathroom Treatment system- Root zone treatment system, Decentralized Wastewater Treatment Systems (DEWATS), Soil Bio technology, packaged Bio-Reactor System.

Approaches for solid waste management, Solid wastes collection and removal from buildings. On-site processing and disposal methods, guidelines for municipal solid waste management, e-waste management. Disposal of Wastes: Sanitary land filling, Composting, Vermi-compost, Incineration, Pyrolysis Classification of buildings based on occupancy, causes of fire and spread of fire, Fire fighting, protection and fire resistance, Fire fighting equipment and different methods of fighting fire. Combustibility of materials, Structural elements and fire resistance, Fire escape routes and elements – planning and design. Wet risers, dry risers, sprinklers, heat detector, smoke detectors, fire dampers, fire doors, etc. Application of above studies in current design problems and preparing design layout and details - Plumbing layout of residential and public buildings, Fire fighting layout, Reflected ceiling plan of smoke detectors / sprinklers, etc. Electrical services, illumination and lighting design, Heat ventilation and air conditioning

Suggested Books:

1. S.C. Rangwala, Water supply and sanitary engineering, Charotar publishing house, 2016.
2. C. Shah, Water supply and sanitary engineering, Galgotia publishers, 1998.
3. Technical teachers Training Institute (Madras), Environmental Engineering- Tata McGraw Hill publishing Company Limited, 1983.
4. A. Kamala & D.L.K. Rao, Environmental Engineering, Tata McGraw-Hill publishing company Limited, 1993.

STE5206 Waste to Energy

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications. Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation. Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors. Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Suggested Books:

1. A.V. Desai, Non Conventional Energy, Wiley Eastern Ltd, 1990.

2. K. C. Khandelwal and S. S. Mahdi, Biogas Technology - A Practical Hand Book, (Vol. I & II) - Tata McGraw Hill Publishing Co. Ltd., 1983.
3. D. S. Challal, Food, Feed and Fuel from Biomass, IBH Publishing Co. Pvt. Ltd, 1991.
4. C.Y. WereKo-Brobby and E. B. Hagan, Biomass Conversion and Technology, John Wiley & Sons, 1996.

STE5208 Blast Resistant Design of Structures

Blast Engineering: Explosion Phenomena, Shock Front, Fragmentation,Waves, Ground Shock, and Interaction with Structures. Structural Analysis for Impulsive Loading; Pressure-Impulse (PI) Diagrams; Material Behaviour under High Strain-Rate of Loadings. Blast Resistant Design of Structures; Performance-Based Blast Design; Progressive Collapse; Anti-Terrorism Planning and Design of Facilities. Blast Retrofitting; Indian/ International Standards and Codes of Practice. Numerical Analysis Tools for Blast Analysis using Finite Element (FE) Software and Hydrocodes.

Suggested Books:

1. D.O. Dusenberry, Handbook for blast-resistant design of buildings, John Wiley & Sons, 2010.
2. T. Ngo, P. Mendis, A. Gupta & J. Ramsay, Blast Loading and Blast Effects on Structures, EJSE, 2007.
3. R. W. Clough & J. Penzien, Dynamics of structures, (vol. 2), McGraw-Hill Education, 1993.
4. J.W. Tedesco, W.G. Dougal & C.A. Ross, Structural Dynamics Theory and Application, Addison-Wesley, 1999.
5. A. K. Chopra, Dynamics of structures, (Vol. 3), New Jersey: Prentice Hall, 1995.

SEMESTER III

Courses

STE 651 Research Project

STE 601 Major Project 1

STE 6401 Design of Hydraulic Structures

Project planning of hydraulic structure, site investigation, selection of hydraulic structures (w.r.t foundation), Different types of dam. Design and Construction of Gravity Dams. Design and Construction of Earthen Dams and Rockfill Dams Design & analysis of weirs and barrages. Design and Analysis of different types of spillway and energy

dissipaters.

Suggested Books:

1. P. Novák, A. I. B. Moffat, C. Nalluri & R. Narayanan, Hydraulic structures, CRC Press, 2007.
2. W. P. Creager, J. D. Justin & J. Hinds, Engineering for Dams: Earth, Rock-fill, Steel and Timber Dams, John Wiley & Sons, 1961.
3. S. K. Garg, Irrigation engineering and hydraulic structures, Khanna publishers, 1987.
4. B.Singh, Fundamentals of Irrigation Engineering, Nem Chand & Bros, 1979.

STE 6403 Soil Dynamics

Introduction: Background and lessons learnt from damages in past earthquakes. Wave Propagation: Waves in semi-infinite media – one, two and three dimensional wave propagation; Attenuation of stress waves – material and radiation damping; Dispersion, waves in a layered medium. Dynamic Soil Properties: Stress & strain conditions, concept of stress path; Measurement of seismic response of soil at low and high strain, using laboratory tests; Cyclic triaxial, cyclic direct simple shear, resonant column, shaking table, centrifuge and using field tests - standard penetration test, plate load test, block vibration test, SASW/MASW tests, cross bore hole; Evaluation of damping and elastic coefficients; Stress-strain behavior of cyclically loaded soils; Effect of strain level on the dynamic soil properties; Equivalent linear and cyclic nonlinear models; Static and dynamic characteristics of soils. Ground Response Analysis: Introduction, one, two and three dimensional analyses; Equivalent and nonlinear finite element approaches; Introduction to soil-structure interaction. Liquefaction: Introduction, pore pressure, liquefaction related phenomena –flow liquefaction and cyclic mobility, factors affecting liquefaction, liquefaction of cohesionless soils and sensitive clays, liquefaction susceptibility; State Criteria –CVR line, SSL, FLS; Evaluation of liquefaction potential: characterization of earthquake loading and liquefaction resistance, cyclic stress ratio, Seed and Idriss method; Effects of liquefaction. Earth Pressure: Active and passive earth pressures; Terzaghi's passive wedge theory, numerical methods, earth pressure measurements.; Seismic design of retaining walls: types, modes of failures, static pressure, seismic response (including M-O Method), seismic displacement, design considerations. Ground Improvement Techniques: Densification, reinforcement, and grouting and mixing, drainage; Reinforced earth: application of reinforced earth under static and dynamic loads, determination of properties of reinforcements, composite materials, reinforced earth drains and other applications.

Suggested Book:

1. S. L. Krammer, Geotechnical Earthquake Engineering, Pearson Education, 1996.
2. S. Prakash, Soil Dynamics, McGraw Hill Book Company, 1981.
3. N.S.V. Kameswara Rao, Dynamics soil tests and applications, Wheeler Publishing Co. Ltd., 2000.
4. G. Ranjan and A.S.R. Rao, Basic and Applied Soil Mechanics, New Age Int. Ltd, 2007.

STE 6405 Seismic Hazard and Risk Assessment

Concepts and Components of Seismic Risk: Hazard, vulnerability, exposure and risk; Estimation of risk from

components. Post Earthquake Damage Studies: Earthquake damage surveys, questionnaires and data to be collected, handling and processing of data, classification of damage, estimation of fragility from damage data. Risk Communication: Role of planners, architects, engineers, banks and insurers; Rating of damage assessment, disaster impact analysis. Modelling and Analysis of Structures: Introduction to matrix and finite element procedures, modelling of buildings. Seismic Vulnerability of Buildings and Lifelines: Empirical, analytical, experimental and hybrid approaches, building typology, intensity scales, use of intensity scales for estimating seismic vulnerability, capacity spectrum method, HAZUS methodology, displacement based approach. Assessment of Exposure: Building stock inventory, sources of available information, census data. Behaviour under seismic loading; Composite structural design: Design spirals, Selection Criteria, configurations; Laminate design; Mathematical analysis of laminates. Risk Estimation: Convolution of hazard, vulnerability and exposure to quantify risk, loss ratios,indoor and outdoor casualty rates; Case studies of different projects- RADIUS, HAZUS, PAGER, GEM, EU-RISK.

Suggested Book:

1. S.L. Krammer, Geotechnical Earthquake Engineering, Pearson Education, 1996.
2. "HAZUS-MH, MR1 & MR2 Technical Manual" - FEMA, Federal Emergency Management Agency, Washington, 2006.
3. R. K. McGuire, Seismic hazard and risk analysis, Earthquake engineering research institute, 2004.
4. S. Tesfamariam & K. Goda, Handbook of seismic risk analysis and management of civil infrastructure systems, Elsevier, 2013.

STE 6407 Retrofitting of Structures

Introduction: Terminology; Basic principles of seismic evaluation and retrofitting. Qualitative Methods of Seismic Evaluation: Rapid visual screening procedure (RVSP) and simplified evaluation of buildings; Visual inspection method and non-destructive testing (NDT) method. Quantitative Methods of Seismic Evaluation: Performance based method using nonlinear static push-over analysis (NSP) and non linear dynamic method of analysis (NDP); Estimation of seismic capacity (strength and ductility). Local and Global Methods of Seismic Retrofitting of RC Buildings: System completion; Strengthening of existing components; RC, Steel and FRP Jacketing; Addition of new components – frames, shear walls and braced frames; Introduction to supplemental energy dissipation and base isolation. Re-evaluation of Buildings with Retrofitting Elements: Linear and Non-linear modelling; Modelling of soil and foundations. Seismic Repair and Retrofitting of Earthquake Damaged RC Buildings: Schemes of temporary shuttering damages; Methods of repair and retrofitting. Seismic Evaluation and Retrofitting of RC Bridges: Seismic evaluation and retrofitting techniques for reinforced concrete bridges – columns/piers, cap beams, cap beam-column joint, footing.

Suggested Books :

1. "Seismic Evaluation and retrofit of concrete building" – Vol. I & II"- Applied Technology Council, California, ATC 40, 1996.

2. “Rapid Visual Screening of Buildings for Potential Seismic Hazards”, Federal Emergency Management Agency, Building Seismic Safety Council, Washington, D.C., FEMA 154/155, 2002.
3. M.N. Priestley, F. Seible & G.M. Calvi, Seismic design and retrofit of bridges, John Wiley & Sons, 1996.
4. FEMA-356, “Commentary for the Seismic Rehabilitation of Buildings” Federal Emergency Management Agency, 2000.
5. FEMA, P-695 . “Quantification of Building Seismic Performance Factors”- Federal Emergency Management Agency, 2009.
6. FEMA-440, A., “Improvement of nonlinear static seismic analysis procedures”- . FEMA-440,Redwood City, 2005.

STE 6301 Instrumentation and Rehabilitation of Structures

Study of various transducers, Principle of their working, displacement, velocity, acceleration etc, strain gauge & piezoelectric type of transducers. strain measurements, strain gauges (static and dynamic), calculation of stresses and loads from measurements of strains and deflections. Non-destructive testing of concrete, steel structures, Various NDT tests, codal provisions, Proof Load testing. Corrosion of steel and concrete: Theory and prevention. Cracks in buildings: causes and remedial measures. Assessment and evaluation for structural stability of existing structures. Special concrete constructions: fibre reinforced concrete; fibre wrapping, Special concrete like lightweight concrete, ferro cement, fly ash concrete, High performance concrete, concrete admixtures. Techniques for Rehabilitation of RC, Steel and Masonry structures

. **Suggested Books :**

1. S. Singh, Experimental Stress Analysis, Khanna publishers, 1982.
2. IS: 13935; “Repair and Seismic Strengthening of Buildings- Guidelines”- Bureau of Indian Standard; New Delhi, 1993.
3. SP: 25, “Causes and Prevention of Cracks in Buildings”- Bureau of Indian Standard, New Delhi, 1984.
4. J.P. Boomfield, Corrosion of Steel in Concrete, E& FN SPON, 1997.
5. H.E. Soisson, Instrumentation in industry, John Wiley & Sons, Inc, 1975.

STE 6303 Structural Vibration Control

Structural Control: Historical development of structural control and base isolation, active control, passive control, hybrid control, semi active control; Application to new and existing buildings. Theory of Vibration Isolation: Principle of base isolation; Theory of vibration isolation; Components of base isolation; Advantages and limitations; General Design Criteria; Linear and Nonlinear procedures of isolation design; Application of theory to multiple degree of freedom system. Isolation Devices: Laminated rubber bearing, lead rubber bearing, high damping rubber bearing,

PTFE sliding bearing, friction pendulum system and sleeved pile system; Modelling of isolation bearings; Design process for multilayered elastomeric bearings and buckling behaviour of elastomeric bearings; Isolation system testing. Energy Dissipation Devices: General requirements; Implementation of energy dissipation devices; Metallic yield dampers, friction dampers, viscoelastic dampers, tuned mass dampers, tuned liquid dampers; Shape memory alloy dampers; Modelling, linear and nonlinear procedures; Detailed system requirements; Application to multistorey buildings; Testing of energy dissipation devices.

. Suggested Books :

1. T. K. Datta, Seismic analysis of structure, John Wiley & Sons, 2010.
2. T. T. Soong & M.C. Costantinou, Passive and active structural vibration control in civil engineering, Springer, 2014.
3. R. Skinner, W.H. Robinson, G.H. Mc Verry, An Introduction to Seismic Isolation, John Wiley and Sons, 1993.
4. C. H. Dowding, Blast vibration monitoring and control, Englewood Cliffs: Prentice-Hall, 1985.

STE 6305 Ground Improvement Technique

Introduction: importance and history of ground improvement. Mechanical Modifications: properties of compacted soil, compaction control tests, field compaction, applications. Precompression: technique, procedure, and applications. Sand Drains: method, procedure and applications. Prefabricated vertical drains: method of installation and design. Soil Stabilization: shallow stabilization with additives like lime, fly ash, cement and other materials. Chemical modifications and Grouting. Hydraulic modification: dewatering systems, filtration, drainage and seepage control with geosynthetic. Vibroflotation technique, stone columns, sand compaction piles, dynamic compaction technique, ground freezing, and electro-osmosis. Ground modification by soil reinforcement: reinforcement techniques, use of flexible geosynthetic reinforcement in bearing capacity improvement, slope stability, erosion control, retaining walls and pavements. Difficult soils: collapsible soils, physical parameters and identification, collapse settlement, improvement techniques; expansive soils, general nature, swell test and swelling pressure tests, classification, improvement of expansive soils.

Suggested Books :

1. B. M. Das, Principles of Foundation Engineering, Cengage Learning, 2011.
2. R. M. Koerner, Designing with Geosynthetics, Vol. 1 & 2. Xlibris Corporation, 2012.
3. M.P. Moseley & K. Kirsch, Ground Improvement, Spon Press, 2004.

STE 6307 Probability & Statistical Methods in Engineering

Preliminary data analysis: Graphical representation of data (stem and leaf plot, box plot, Q-Q Plots), frequency

distribution, measure of central tendency-grouped and ungrouped data, measure of dispersion, measure of asymmetry, measure of peakedness, covariance, correlation coefficient. Random events: Sample space and events, Interpretation of probability, Probability axioms, Elementary theorems, conditional probability, Bayes' theorem. Random Variables: Definition of random variables - discrete and continuous; Probability definitions - PMF, PDF, CDF; Moments and expectations. Concept of risk and reliability. Probability Distributions: Discrete distributions - binomial distribution, Poisson's distribution; Continuous distributions – uniform distribution exponential distribution, gamma distribution, Weibull, Normal and lognormal distributions. Extreme value distributions, Multivariate distribution-Bivariate Normal distribution, other bivariate distribution, Transformations to Normal distribution. Model Estimation and Testing: Properties of estimators, sampling distributions-Chi square distribution, t-distribution, F distribution, Parameter estimation-Point estimation, confidence interval estimation, Hypothesis testing-Tests of hypotheses on the mean and variance, Goodness-of-fit tests, fitting theoretical distributions to observed frequency distributions and Tests of goodness-of-fit (chi-square test, Kolmogorov-Smirnov test). Curve fitting: method of least squares, simple linear regression, coefficient of correlation and the sample correlation, multiple linear regression. Principal component analysis. Case study of Monte Carlo simulation.

Suggested Books :

1. A. Haldar and S. Mahadevan, Probability, reliability and statistical methods in engineering design, John Wiley and Sons, 2000.
2. J. R. Benjamin and C.A. Cornell, Probability, statistics and decisions for civil engineers, John Wiley, 1970.
3. A. Papoulis, Probability, random variables and stochastic processes, 3rd Edition, McGraw-Hill, 1991.
4. S.M. Ross, Introduction to Probability and Statistics for Engineering and Scientist, Academic Press, 2004.

STE 6201 Sustainable Building Technologies

Technology, Sustainability & Development**:** Definitions, Dimensions, Interpretations, Concepts and Principles. Economic Development, Energy use and Carbon emissions: Historical trends in energy use and carbon emissions, environmental consequences of fossil energy use, energy conservation, energy efficiency and renewable energy-based development. Energy and Buildings**:** Concept of energy, production of building materials, energy in various building materials energy in buildings due to building technologies, operational energy in buildings. Alternatives to River Sand in Mortars**:** Manufacture sand for mortars, cement-soil-sand mortars, iron ore tailing as replacement for sand. More alternatives to river sand in mortars**:** Filter sand, stabilized mud mortar, water retentivity, demolished brick masonry wastes, pond ash, granulated blast furnace slag. Sustainability and Resources for Buildings**:** Material resources and buildings, material composition of buildings, human resource and sustainability. Green buildings**:** Concept of green building, energy and carbon emission reduction, sustainable resource use and affordability, the green rating systems, constraints of green rating systems, energy conservation building code. New building technologies for affordable housing**:** Initiatives, Introduced Technology/system, Road ahead. Materials and Methods**:** Burnt bricks, stabilized mud block, Alternatives in adobe, Stabilized adobe, Concrete blocks, Alternative cements and mortars, stone in

construction. Design of Walls**:** Some relevant issues. Roofing Technologies**:** Alternative roofing system, roofing system, roof based on curved surfaces. Renewable materials**:** Bamboo in housing and building construction, Building with bamboo, Innovations in bamboo and concrete based construction for sustainable and durable housing, timber and buildings. Construction and Demolition(C&D) Waste**:** Amount and utilization of C&D waste, status of C&D waste utilization standards.

Suggested Books :

1. K.S. Jagadish, Sustainable Building Technologies, BMTPC & I.K. Int. Publishing House Pvt. Ltd, 2019.
2. B. Simon and S. Morse, Sustainability Indicators: Measuring the immeasurable, Earthscan, 1998.
3. M.W. Paul, Sustainable Technology Development, Greenleaf, Sheffield, 2000.
4. D.L. Jayanetti and P.R. Follet, Bamboo in construction: An Introduction, TRADA Technology Ltd. and International Network for Bamboo and Rattan (INBAR), 1998.
5. M. Ashby, Materials and the environment, Elsevier, 2013.

STE 6203 Pre- Fabricated Structures

Types of prefabrication, prefabrication systems and structural schemes- Disuniting of structures- Structural behavior of precast structures. Handling and erection stresses, Application of prestressing of roof members; floor systems two way load bearing slabs. Wall panels, hipped plate and shell structures. Dimensioning and detailing of joints for different structural connections; construction and expansion joints. Production, Transportation & erection- Shuttering and mould design Dimensional tolerances Erection of R.C. Structures. Total prefabricated buildings. Designing and detailing prefabricated units for industrial structures, Multistory buildings and Water tanks, silos bunkers etc. Application of prestressed concrete in prefabrication.

Suggested Books :

1. A.M. Hass, Precast Concrete Design and Applications, Applied Science Publishers, 1983.
2. V. Promyslolw, Design and Erection of Reinforced Concrete Structures, MIR Publishers, 1980.

STE 6205 Form work for Concrete Structures

Introduction to Formwork as a Temporary Structure , Requirements, Selection, and Classification (Types) of Formwork, Formwork Materials, Shoring Towers, and Scaffolds, Formwork Design Concepts Conventional and Proprietary Foundation Formwork, Conventional and Proprietary Wall Formwork, Conventional and Proprietary Column Formwork Slab and Beam Formwork, Formwork for Special Structures such as Shells, Domes, Folded Plates, Overhead Water Tanks, Natural Draft Cooling Tower, Nuclear Reactor, Tunnel, and Lift Shaft. Formwork for Bridge Structures, Cases in Failure of Temporary Support Structures of Bridges, Flying Formworks such as Table Forms,

Tunnel Formwork System, Column Mounted Shoring System, Gang Forms Slipform, Formwork for Precast Concrete, Formwork Failure, Pre -Award and Post –award Formwork Management Issues, Formwork Issues in Multi -Story Building Construction

Suggested Books :

1. K.N. Jha, Formwork for Concrete Structures, First Edition, McGraw Hill, 2012.
2. R.L. Peurifoy and G.D. Oberlender, Formwork for concrete structures, McGraw Hill, 2011.
3. J.R. Robinson, Piers, abutments, and formwork for bridges, Crosby Lockwood, 1964.
4. C.K. Austin, Formwork to concrete, Cleaver -Hume Press, 1960.