M.TECH - Structural Engineering
Scheme Of Studies & Examination

First Semester :

			Teaching Schedule				Marks Assesment			
S.No.	Subject code	Subject Name	L	T	P	Total	Theory Exam	Sessional Marks	Practical Marks	Total Marks
1	CE 601	Material Technology	3	1	0	4	100	50	0	150
2	CE 611	Advanced Structural Analysis	3	1	0	4	100	50	0	150
3	CE 613	Analysis and Design of Plates & Shells	3	1	0	4	100	50	0	150
4		Professional Elective-I	3	1	0	4	100	50	0	150
5		Professional Elective-II	3	1	0	4	100	50	0	150
6	CE 671	Structural Engineering Laboratory	0	0	2	2	0	50	50	100
7	CE 681	Computational Laboratory	0	0	2	2	0	50	50	100
8	CE 685	Seminar and Technical Writing-I	0	0	2	2	0	50	50	100
Grand Total			15	5	6	26	500	400	150	1050

M.TECH - Structural Engineering

Scheme Of Studies & Examination

Second Semester :

			Teaching Schedule				Marks			
S.No.	Subject code	Subject Name	L	T	P	Total	Theory Exam	Sessional Marks	Practical Marks	Total
1	CE 610	Structural Dynamics & Earthquake Engineering	3	1	0	4	100	50	0	150
2	CE 612	Stability of Structures	3	1	0	4	100	50	0	150
3		Professional Elective- III	3	1	0	4	100	50	0	150
4		Professional Elective- IV	3	1	0	4	100	50	0	150
5		Professional Elective- V	3	1	0	4	100	50	0	150
6	CE 670	Structural Engineering Design Practice	0	0	2	2	0	25	25	50
7	CE 680	Computational Laboratory-II	0	0	2	2	0	25	25	50
8	CE 689	Seminar and Technical Writing-II	0	0	2	2	0	50	50	100
Grand Total			15	5	6	26	500	350	100	950

M.TECH - Structural Engineering

Scheme Of Studies & Examination

Third Semester :

			Teaching Schedule				Marks			
S.No.	Subject code	Subject Name	L	T	P	Total	Theory Exam	Sessional Marks	Practical Marks	Total
1	CE 691	Seminar and Technical Writing-III	0	0	4	4	0	50	100	150
2	CE 693	Summer Research/Industrial Project	0	0	4	4	0	50	100	150
3	CE 695	Research Project Work I	0	0	8	8	0	100	200	300
4	CE 697	Research Project Review I	0	0	8	8	0	100	200	300
Grand Total			0	0	24	24	0	300	600	900

M.TECH - Structural Engineering
Scheme Of Studies & Examination

Fourth Semester :

			Teaching Schedule				Marks			
S.No.	Subject code	Subject Name	L	T	P	Total	Theory Exam	Sessional Marks	Practical Marks	Total
1	CE 692	Seminar and Technical Writing-IV	0	0	2	2	0	50	50	100
2	CE 694	Comprehensive Viva Voce	0	0	4	4	0	50	100	150
3	CE 696	Research Project Work II	0	0	8	8	0	100	200	300
4	CE 698	Research Project Review II	0	0	4	4	0	50	100	150
5	CE 699	Dissertation	0	0	8	8	0	100	200	300
Grand Total			0	0	26	26	0	350	650	1000

M.D. University, Rohtak (Haryana)
Scheme of Studies & Examination for
Master of Technology in Structural Engineering

The performance of the student of M.Tech Structural engineering Course shall be graded on the basis of percentage of marks and corresponding grades as mentioned below :

A)

Marks		**Grade**	**Marks**
85	<	A+	<100
75	<	A	<85
65	<	B	<75
55	<	C	<65
40	<	D	<55
00	<	F	<40

Letter Grades Performance Division

A+	Excellent First
A	Very Good First
B	Good First
C	Fair Second
D	Pass Third
F	Repeat Fail

Note : The candidate who have passed all the semesters examination in the first attempt obtaining at least 75% marks in aggregate shall be declared to have passed in the first division with distinction mentioned in the degree.

B) Actual percentage of Marks Obtained and Corresponding grades should be mentioned on detailed marks certificate of student. To obtain 'D' grade a student must have secure at least 40% marks in each subject of the semester Examination.

C) Student who earned and 'F' grade or less than 40% marks in any subject shall have reappear in that.

DEPARTMENT OF CIVIL ENGINEERING
(Structural engineering)

M.Tech.

LIST OF PROFESSIONAL ELECTIVES

Sl.No.	Subj. Code	Subjects	L-T-P
1.	CE 602	Optimisation Methods & Its Application in Civil Engineering	3-1-0
2.	CE 604	Finite Element Method	3-1-0
3.	CE 614	Advanced Reinforced Concrete Design	3-1-0
4.	CE 615	Applied Elasticity and Plasticity	3-1-0
5.	CE 616	Advanced Steel Design	3-1-0
6.	CE 617	Bridge Engineering	3-1-0
7.	CE 618	Pre-Stressed Concrete	3-1-0
8.	CE 619	Composite Structures	3-1-0
9.	CE 620	Ground Improvement Techniques	3-1-0
10.	CE 628	Earth Retaining Structures	3-1-0
11.	CE 629	Earthquake Geotechnical Engineering	3-1-0
12.	CE 644	Planning & Design of Airports	3-1-0
13.	CE 645	Geometric Design of Highways	3-1-0
14.	CE 649	Advanced Railway Engineering	3-1-0
15.	CE 656	Design of Hydraulic Systems	3-1-0
16.	CE 660	High Rise Structures	3-1-0

DEPARTMENT OF CIVIL ENGINEERING
(**Structural engineering)**

M.Tech.

SUMMARY OF COURSES

Sub discipline:	**Structural Engineering**	L-T-P
CE 601	Material Technology	3-1-0
CE 604	Finite Element Method	3-1-0
CE 610	Structural Dynamics & Earthquake Engineering	3-1-0
CE 611	Advanced Structural Analysis	3-1-0
CE 612	Stability of Structures	3-1-0
CE 613	Analysis & Design of Plates & Shells	3-1-0
CE 614	Advanced Reinforced Concrete Design	3-1-0
CE 615	Applied Elasticity & Plasticity	3-1-0
CE 616	Advanced Steel Design	3-1-0
CE 617	Bridge Engineering	3-1-0
CE 618	Prestressed Concrete	3-1-0
CE 619	Composite Structures	3-1-0
CE 660	High Rise Structures	3-1-0

CE 601 : MATERIAL TECHNOLOGY

L	T	P
3	1	0

Sessional: 50
Theory: 100
Total: 150
Duration of Exam: 3 Hrs.

Cement and Concrete: Portland cement: chemical composition, hydration of cement, structure of hydrated cement, mechanical strength of cement gel, water held in hydrated cement paste and heat of hydration. Cements of different types. Factors affecting the strength of concrete. Elasticity, shrinkage and creep of concrete ; Durability of concrete: Permeability of concrete. Chemical attack of concrete, air-entrained concrete and thermal properties of concrete. The mechanical test of hardened concrete .Light weight and high density concrete. Mix design. Statistical quality control; Biaxial strength of concrete, Fibre reinforced concrete ;Metals: Behaviour of common constructional metals in tension and compression. True stress-strain curve for mild steel in simple tension. Theories of failure and yield surfaces ; Fatigue properties: Nature of fatigue failure, fatigue strength for completely reversed stresses, fatigue strength with superimposed static stress and factors influencing fatigue strength ; Temperature and Creep properties: Low temperature properties high temperature properties, creep-stress-time-temperature relations for simple tension, mechanics of creep in tension.

Structure of materials and their imperfections. Deformation of crystals and theory of dislocations.

Essential Reading:

1. A.M. Neville, J.J. Brooks, Concrete Technology, Low Priced Edition, Pearson Education, 2004.
2. A J Martin, Mechanical behavior of engineering materials.

Supplementary Reading:

1. S P Timoshenko, Strength of materials- Part II
2. M. S. Shetty, Concrete technology- Theory & Practice, S.Chand & Company New Delhi, 2005

CE 602 : OPTIMIZATION METHODS IN ITS APPLICATIONIN CIVIL ENGINEERING

L	T	P
3	1	0

Sessional: 50
Theory: 100
Total: 150
Duration of Exam: 3 Hrs.

Introduction: Need for engineering optimal design, Optimum design formulation: Design variable, objective function and constraints ; Unconstrained optimization methods Single variable optimization methods: Region elimination method Golden section search, Interval halving method; Gradient based method Newton-Raphson, bisection and secant method. Multi variable optimization methods: Direct search method: Hooke-Jeeve pattern search, rection search. Gradient Based methods:- method, Fletcher-Reeve method ; Constrained optimization methods Kuhn Tucker condition, Penalty functionmethod, Augmented Lagrangian method, sequential unconstrained minimization, cutting plane method ; Introduction to Evolutionary algorithms: Need for evolutionary algorithms, Type of evolutionary methods, Introduction to Genetic algorithm (GA), Difference and similarities between GA and traditional methods. Basic operations of GA: reproduction, crossover, mutation and elitism. Binary coded and Real coded GA ; Application of Optimization techniques: Water resource planning management, Structural Optimization, Transportation planning and Management, Slope stability and optimal dimensioning of foundations. multi-objective optimization models.

Essential Reading:

1. J.S. Arora, Introduction to Optimum Design, Elsevier, 2nd Edition, 2004.
2. K. Deb, Optimization for Engineering. Design: Algorithms & Examples, Prentice Hall
India, 2006

Supplementary Reading:

1. S.S. Rao, Engineering Optimization: Theory & Practice , New Age International (P) Ltd, 3rd Edition, 1996, Reprint : June, 2008.
2. K. Deb, Multi-objective Optimizations using Evolutionary Algor.

CE 604 FINITE ELEMENT METHOD

L	T	P
3	1	0

Sessional: 50
Theory: 100
Total: 150
Duration of Exam: 3 Hrs.

Equations of Equilibrium, Strain displacement relations, Stress strain Relations, Plane stress and plane Strain problems, Basics of finite element method (FEM), different steps involved in FEM, Different approaches of FEM, Direct method, Energy approach, Weighted residual Method; Finite Element modeling of one and two dimensional problems. Isoparametric elements, four node, eight node elements. Numerical integration, order of integration; Bending of plates, rectangular elements, triangular elements and quadrilateral elements,Concept of 3D modeling.

Essential Reading:

1. R. D. Cook, *Concepts and Applications of Finite Element Analysis*, John Wiley, NewYork, 2004.
2. O. C. Zienkiewicz and R. L. Taylor, *Finite Element Method*, Butterworth Heinemann publication, 2000.

Supplementary Reading:

1. C.S. Krishnamoorty, *Finite element methods*, Tata-Mc Graw Hill, Second Edition, New Delhi, 2002.
2. T. R. Chandupatla & A. D. Belegundu, *Introduction to Finite Elements in Engineering*, Prentice Hall of India Pvt. Ltd., New Delhi, 5th Reprint, 1999
3. J. N. Reddy, *An introduction to Linear Finite Element Method*, Oxford University Press, Oxford, 2004.

CE 610 STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING

L	T	P
3	1	0

Sessional: 50
Theory: 100
Total: 150
Duration of Exam: 3 Hrs.

Single degree of freedom system: Equation of motion, Damped and undamped free vibration, Response to harmonic, periodic, impulse load and general dynamic load, Multi-degrees of freedom system: Equation of motion, Free vibration analysis, Dynamic response and modal analysis ; Free and Forced vibration of distributed mass system: Beam ; Analysis of structural response to Earthquakes: Seismological background, Deterministic analysis of Earthquake.

Essential Reading:

1. R. W. Clough and J Penzien, Dynamics of structures , McGraw-Hill, Inc,
2. A K Chropra ,Dynamics of Structures: Theory and Applications to Earthquake Engineering, Prentice Hall of India

Supplementary Reading:

1. M. Paz, Structural Dynamics - Theory and Computation, Van Nostrand, 1985.
2. IS: 1893 - 2002 Criteria for Earthquake Resistant Design of Structures.
3. L. Meirovitch, Elements of Vibration Analysis, 2nd Ed., McGraw-Hill, 1986..

CE 611 : ADVANCED STRUCTURAL ANALYSIS

L	T	P	
3	1	0	Sessional : 50 Marks
			Theory : 100 Marks
			Total : 150 Marks
			Duration of Exam : 3 Hrs.

Methods of structural analysis; flexibility and stiffness matrices; analysis of trusses, beams and frames.

Supplementary Reading:

W.Weaver Jr. and J.M Gere, *Matrix analysis of Frames and Structures,* CBS Publications

Note : In the Semester Examination, the exmainer will set eight questions in all, covering the entire syllabus and the students will be required to attempt only five questions.

.

CE 612 : STABILITY OFSTRUCTURES

L	T	P
3	1	0

Sessional: 50
Theory: 100
Total: 150
Duration of Exam: 3 Hrs.

Torsion of thin walled open sections, warping displacements under pure torsion,- Warping constants for rolled steel section. Strain energy in bending and torsion of members of thin walled open section including the effects of warping. Torsional buckling including the effectsand shear centres coincident) ;Lateral buckling of beams under pure bending central point load through centre of gravity of the section. Cantilever beams with point load at the free end, Application of Rayleigh-Ritz method ; Beam-columns on rigid supports-concentrated and continuous lateral loads with simply supported and built in-ends. Continuous beam with as axial loads. Application of trigonometric series. Inplane buckling of bars ; Approximate calculation of critical loads for bar structures by energy method- a bar on elastic foundation, a bar with intermediate compressive forces, bar under distributed axial loads, a bar with changes in cross section ; Effects of shearing force on the critical load. Buckling of built-up columns. In-elastic in-plane buckling of columns. Tangent and reduced modulus concept, Shan critical loads for rigid frames and triangulated structures, stability functions. Bending of thin plate. Buckling of thin rectangular plates in compression, shear and bending.

Essential Reading:

1. S.P. Timoshenko and J. M. Gere, Theory of Elastic Stability , MC Graw Hill,
2. A. Kumar, Stability of Structures, Allied Publishers Ltd., New Delhi, 1998

Supplementary Reading:

1. M.R.Horns and W.Merchang, The stability of frames, Porgamon press, 1965.
2. M.Gregory , Elastic Instability Civil Engineering series,1967.
3. F.Bleich, Buckling strength of Metal structures,Mc Graw Hill Book co.,1952.
4. T.V Galambos, Structural members and frames, Prentice-Hall INC,

CE 613 : ANALYSIS & DESIGN OF PLATES AND SHELLS

L	T	P	
3	1	0	Sessional : 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam : 3 Hrs.

Pure Bending of Plates: Slope & curvature of slightly bent plates, Relations between bending moments and curvature in pure bending of plates, Strain energy in Pure bending of plates ; Symmetrical bending of Circular plates: Differential equation for symmetrical bending of laterally loaded circular plates, uniformly loaded circular plates, Circular plates with circular hole at center, circular plate concentrically loaded ; Small deflections of laterally loaded plates : Differential equation of the deflection surface, Boundary conditions, Simply supported rectangular plates under sinusoidal load, Navier solution for simply supported rectangular plates, Further applications of the Navier solution, Alternate solution for simply supported and uniformly loaded rectangular plates, Concentrated load on simply supported rectangular plates. Classification of shell structures, importance of membrane theory of shells, shells in the form of a surface of revolution and loaded un-symmetrically with respect to their axes, spherical dome, conical shells, cylindrical shells, Elliptic paraboloid, hyperbolic parabolod and conoids ; General theory of cylindrical shells : Circular cylindrical shell loaded symmetrically with respect to its axis, particular cases of symmetrical deformations of circular cylindrical shells, cylindrical tanks of uniform wall thickness.
Design of spherical domes with/without lanterns at top.

Essential Reading:

1. S. P. Timoshenko and Woinowsky-Kriegar, Theory of plates and shells, Mc Graw Hill International , New Delhi
2. G. S. Ramaswamy, Design and construction of concrete shells Roofs, CBS Publishers, Delhi

Supplementary Reading:

1. D. P. Billington, Thin shell concrete structures, Mc Graw Hill international, New York
2. W. T. Marshall, Design of cylindrical shell roofs, E& FN SPON, London

CE 614 : ADVANCED REINFORCED CONCRETE DESIGN

L	T	P
3	1	0

Sessional: 50
Theory: 100
Total: 150
Duration of Exam: 3 Hrs.

Estimation of crack width and deflection of reinforced concrete beams. Analysis and design of building frames subjected to wind load ; Earthquake forces and structural response.Ductile detailing of RCC frames. Design of beam-column joints ; Design of deep beam.Design of shear walls.

Essential Reading:

1. R. Park and T. Pauley, Reinforced concrete structures, John Wiley and sons
2. A. K. Jain, Reinforced Concrete: Limit State design, Nem Chand and Bros. 1999.

Supplementary Reading:

1. J. Krishna and OP Jain, Plain and Reinforced Concrete, Vol. I I, Roorkee, Nem Chand and Bros.
2. H. Nilson, D. Darwin and C. W. Dolar, Design of Concrete structures, Tata McGraw Hill.
3. T. Paulay and M.J.N. Priestley , Seismic Design of Reinforced Concrete and Masonry.

CE 615 : APPLIED ELASTICITY AND PLASTICITY

L	T	P
3	1	0

Sessional: 50
Theory: 100
Total: 150
Duration of Exam: 3 Hrs.

Plane stress and plane strain problems. General stress and strain equations (Equilibrium and compatibility equations).Two dimensional problems in rectangular coordinates. Stress and strain components, differential equation, equilibrium equations and compatibility equations in polar coordinate. Stress distribution for axisymmetric problems. Pure bending of curved bars, thick walled cylinder. Concentrated force at a point of straight boundary. Force acting on the end of a wedge. Concentrated force acting on a beam. Effect of circular holes on stress distributions in plates. Stress and strain in three dimensions: Principles stresses, maximum shearing stress, principal axes of strain. Stretching of prismatical bar by its own axis. Elementary problems of elasticity in three dimension. Torsion of non-circular prismatic analogies. Torsion of hollow and thin section. Application of energy methods ; Introduction to the theory of plasticity, the yield criteria of metals, stress space representation of yield criteria. stress-strain relations plastic potential, flow rules and maximum work hypothesis. Two dimensional plastic flow problems.Incompressible two dimensional flow, stresses in plastic materials in condition of planestrain, equation of equilibrium the simplest slip-line fields.

Essential Reading:

1. S P Timoshenko and J N Goodier, Theory of Elasticity, Mc Graw Hill
2. W. Johnson and P B Meller, Plasticity of Mechanical Engineers

Supplementary Reading:

1. Theory of plasticity, Hoffman and Sachs

CE 616 :ADVANCED STEEL DESIGN

L	T	P
3	1	0

Sessional: 50
Theory: 100
Total: 150
Duration of Exam: 3 Hrs

Design for tension and compression members, connections, design of plate girders, crane girders and trusses. Multi-storyed buildings. Silos, bins and hoppers. Design of steel tanks and staging. Design of bridges, trusses, lateral bracings, sway brackens and stress reversals. Design of continuous beams and frames by plastic theory ; **Use of reference books and relevant codes of practice are permitted in the examination.**

Essential Reading :

1. K.Mukhanov, *Design of Metal structures.*
2. B Bresler, T Y Lin and J B Scalzi, *Design of Steel structures*.

Supplementary Reading :

1. P Dayaratnam, *Design of Steel Structures*

CE 617 BRIDGE ENGINEERING

L	T	P		
3	1	0	Sessional:	50
			Theory:	100
			Total:	150
			Duration of Exam: 3 Hrs.	

Introduction, historical review, engineering and aesthetic requirements in bridge design. Introduction to bridge codes. Economic evaluation of a bridge project. Site investigation and planning;. Scour - factors affecting and evaluation. Bridge foundations - open, pile, well and caisson. Piers, abutments and approach structures; Superstructure - analysis and design of right, skew and curved slabs. Girder bridges - types, load distribution, design. Orthotropic plate analysis of bridge decks. Introduction to long span bridges - cantilever, arch, cable stayed and suspension bridges. Methods of construction of R.C Bridges, Prestressed concrete bridges and steel bridges Fabrication, Lounching & creation. Design and construction of construction joints (use of relevant codes of practice are permitted in the examination).

Essential Reading:

1. V. K. Raina, Concrete Bridges Practice –Analysis, Design and Economics, Shroff Publications, New Delhi 2nd Ed. 2005.
2. Vazirani, Ratwani and Aswani, Design of Concrete Bridges, Khanna Publishers , 2nd Ed. 2008.

Supplementary Reading:

1. IRC codes for Road bridges- IRS Sec– I , II, III
2. IRS Codes of Practice for Railway bridges.
3. B. M. Das, Principles of Foundation Engineering, Thomson, Indian Edition, 2003.

CE 618 PRE-STRESSED CONCRETE

L	T	P		
3	1	0	Sessional:	50
			Theory:	100
			Total:	150
			Duration of Exam: 3 Hrs.	

Different systems of prestressing, Characteristics of concrete and steel, Other suitable design of section for flexure, shear and torsion. Design of compressive member. Limit state design as per IS code. Comparision of design with respect to British, Australian and American code. Partial prestressing.Stress distribution in end-block of post tensioned section, Magnel's method, Rowe's method and IS code method. Deflection of prestressed structures- short term as well as long term deflections of uncracked and cracked members.Indeterminate structures- Principles of design of prismatic continuous beams of two and three equal, unequal spans with variable moments of inertia, Cap cable, Jaeques Muller's theorem. Prestressing of rigid frames, Composite construction of prestressed and in-situ concrete ; Design of special structures- Circular tanks, Pipes, Mast, and materials, Losses in prestress. Analysis of Railway sleepers.

Essential Reading :

1. Y. Guyen, Prestressed concrete Vol-I & Vol.-II, John Willey & Sons, New York-1960.
2. N. Krishnaraju, Prestressed concrete, Tata McGraw-Hill, New Delhi-2004.

Supplementary Reading :

1. T. Y. Lin and H. Burns Ned, Design of Prestressed concrete structures, John Willey & Sons, New York-1982.
2. S. K. Mallik and A. P. Gupta, Prestressed concrete, Oxford & IBH, New Delhi-1982.
3. E. W. Bennet, Prestressed concrete theory & design, Chapman & Hall, London-1962.

CE 619 COMPOSITE STRUCTURES

L	T	P
3	1	0

Sessional: 50
Theory: 100
Total: 150
Duration of Exam: 3 Hrs.

Introduction: definition, Classification and characteristics of Composite materials, advantages and limitations, Current Status and Future Prospects ; Basic Concepts and characteristics: Homogeneity and Heterogeneity, Isotropy, Orthotropy and Anisotropy; Characteristics and configurations of lamina, laminate, micromechanics and macromechanics. Constituent materials and properties ; Elastic behavior of unidirectional lamina: Anisotropic, separately orthotropic and transversely isotropic materials, stress-strain relations for thin lamina, transformation of stress and strain, transformation of elastic parameters ; Strength of unidirectional lamina: Macromechanical failure theories- Maximum stress theory, maximum strain theory, Deviatoric strain energy theory (Tsai-Hill), Interactive tensor polynomial theory (Tsai-Wu) ; Elastic Behavior of multidirectional laminates: Basic assumptions, Stress-strain relations, load deformation relations, symmetric and balanced laminates, laminate engineering properties ; Bending and vibration of laminated plates: Governing equations, Deflection of simply supported rectangular symmetric angle-ply, specially orthotropic, anti-symmetric cross-ply laminates ; Recent advances: Functionally graded materials, Smart materials.

Essential Reading:

1. R.M. Jones, Mechanics of Composite materials, Taylor and Francis, 1999.
2. I. M. Daniel and O. Ishai, Engineering mechanics of Composite materials, Oxford university press, 1999

Supplementary Reading :

1. P.K. Mallick, Fiber-reinforced Composites, Marcel Dekker Inc, 1988.
2. D. Hull and T. W. Clyne, An introduction to composite materials, Cambridge university press, Second Edition, 1996.
3. J.N. Reddy, Mechanics of laminated composite plates and shells-Theory and Analysis, CRC Press, Boca Raton, Second Edition, 2003.

CE 620 GROUND IMPROVEMENT TECHNIQUES

L	T	P		
3	1	0	Sessional:	50
			Theory:	100
			Total:	150
			Duration of Exam: 3 Hrs.	

Introduction: Engineering properties of soft, week and compressible deposits, Natural on land, off-shore and Man-made deposits. Role of ground improvement in foundation engineering, methods of ground improvement, Selection of suitable ground improvement techniques ; In-situ treatments methods: In-situ densification soils, Dynamic compaction and consolidation, Vibrofloation ,Sand pile compaction, Preloading with sand drains and fabric drains, Granular columns, Micro piles, Soil nailing, Ground Anchors, Lime piles, Injections, Thermal, Electrical and Chemical methods, Electro osmosis, Soil freezing ; Reinforced Soil: The Mechanism, Reinforcement materials, Reinforcement - Soil Interactions, Geosynthetics, Principles, Analysis and Design of Reinforced Retaining Structures, Embankments and
Slopes ; Ground Improvement Techniques for Geotechnical Earthquake Engineering, Case studies on ground improvement techniques.

Essential Reading:

1. R. M. Korner, Design with Geosynthetics, Prentice Hall, New Jersy, 3rd Edn. 2002
2. P. Purushothama Raj, Ground Improvement Techniques, Tata McGrawHill, New Delhi, 1995.

Supplementary Reading:

1. B. M. Das, Principles of Foundation Engineering, Thomson, Indian Edition, 2003.
2. G. V. Rao and G. V. S. Rao, Text Book On Engineering with Geotextiles, Tata McGraw Hill
3. T. S. Ingold and K. S. Miller, Geotextile Hand Book, Thomas Telfrod, London
4. N. V. Nayak, Foundation Design Manual, Dhanpat Rai and Sons, Delhi.

CE 628 EARTH RETAINING STRUCTURES

L	T	P		
3	1	0	Sessional:	50
			Theory:	100
			Total:	150
			Duration of Exam: 3 Hrs.	

Earth Pressure: Fundamental relationships between the lateral pressures and the strain with a back fill. Rankine and Coulomb theories, Active, passive and pressure at rest ; Backfill with broken surface, wall with broken back, concentrated surcharge above the back fill, earth pressure due to uniform surcharge, earth pressure of stratified backfills, saturated and partially saturated backfill. Passive earth pressure in engineering practice. Assumption and conditions, point of application of passive earth pressures ; Bulkheads: Definition and assumptions, conditions of end supports and distribution of active earth pressure and bulkheads, bulkheads with free and fixed earth supports, equivalent beam method, improvements suggested by Rowe, Tschebottarioff's method, Anchorage of bulkheads and resistance of anchor walls, spacing between bulkheads and anchor walls, resistance of anchor plates, Consideration of effects of ground water, seepage, surcharge loading together with possibility of shallow and deep sliding failures on retaining structure ; Sheet Pile wall: Free earth system, fixed earth system, Dead man ; Tunnel and Conduit: Stress distribution around tunnels, Types of conduits, Load on projecting conduits ; Arching and Open Cuts: Arching in soils, Braced excavations, Earth pressure against bracings in cuts, Heave of the bottom of cut in soft clays ; Reinforced earth retaining structures- Design of earth embankments and slopes ; Recent advances in Earth retaining structures.

Essential Reading:

1. B. M. Das, Principles of Foundation Engineering, Thomson, Indian Edition, 2003.
2. J. Bowel, Foundation Engineering , Analysis and Design. McGrwHill

Supplementary Reading:

1. P. Raj, Geotechnical Engineering, Tata McGraw Hill
2. R F Craig, Soil Mechanics, Chapman and Hall(ELBS)

CE 629 EARTHQUAKE GEOTECHNICAL ENGINEERING

L	T	P		
3	1	0	Sessional:	50
			Theory:	100
			Total:	150
			Duration of Exam: 3 Hrs.	

Earthquakes: Causes and characteristics (magnitude, intensity, accelarograms), response spectra, attenuation of ground motion. Estimation of seismic hazards (deterministic and probabilistic) ; Introduction to vibratory motion: Waves in Elastic Medium**;** Dynamics of Discrete: Systems , Vibration of single and multiple degree of freedom systems. Free and forced vibrations (regular and irregular excitation) ; Dynamic properties of soils: Determination of site characteristics, local geology and soil condition, site investigation and soil test, Laboratory and in-situ tests; Site response to earthquake. Seismic Microzonation ; Liquefaction of soils: Fundamental concept of liquefaction, assessment of liquefaction susceptibly from SPT and CPT ; Seismic response of soil structure system, seismic bearing capacity of shallow foundation, design of pile foundation in liquefiable ground. Pseudo-static analysis and design of earth retaining structures and soil slopes. Estimation of earthquakeinduced deformation.

Essential Reading :

1. S.L. Kramer, Geotechnical Earthquake Engineering, Pentice Hall, international series, Pearson Education (Singapore) Pvt. Ltd., 2004.
2. S.Saran, Soil Dynamics and Machine Foundation, Galgotia publications Pvt. Ltd., New Delhi 1999.

Supplementary Reading:

1. A. Ansal, Recent Advances in Earthquake Geotechnical Engineering and Microzonation, Springer, 2006.
2. I. Towhata, Geotechnical Earthquake Engineering, Springer , 2008.20

CE 644 PLANNING AND DESIGN OF AIRPORTS

L	T	P		
3	1	0	Sessional:	50
			Theory:	100
			Total:	150
			Duration of Exam: 3 Hrs.	

Classification of airports- ICAO standards ; Planning for airport- Airport components- Zoning laws ; Runways- orientation and geometric design- Runway patterns ; Taxiways- alignment- geometry and turning radius- exit taxiways ; Aprons- planning and design ; Design principles of critical, semi-critical, non-critical airport pavements- FAA and PCA methods ; Airport hangars- their planning and design criteria ; Airport landscaping, grading and drainage-general aspects ; Airport terminal and amenities ; Airport lighting and marking.

Essential Reading:

1. N.J. Ashford, P.H. Wright, Airport Engineering, 3rd Edition, 1992, John Wiley
2. R.M. Horonjeff, F.X. Mc Kelvey, W.J Sproule, Seth Young, Planning and Design of Airports, TMH International Publishers, Fifth Edition, 2009

Supplementary Reading:

1. Khanna, Arora and Jain, Planning and Design of Airports, Nemchand Bros., 2001
2. Wells, Alexander; Young, Seth, Airport Planning & Management, McGraw Hill,5th Edition, July,2009
3. De N. Richard, & Odoni, Airport Systems: Planning, Design, and Management, McGraw Hill Amedeo, 1st Edition, 2004.

CE 645 GEOMETRIC DESIGN OF HIGHWAYS

L	T	P		
3	1	0	Sessional:	50
			Theory:	100
			Total:	150
			Duration of Exam: 3 Hrs.	

Highway capacities and speeds on rural and urban roads, Special aspects of horizontal and vertical alignments, Interrelationships between geometric elements in rural and urban roads, Variations in geometric standards between plains and hilly regions, Special curves, Design aspects of intersections and grade separations, Traffic rotaries, Flyovers and cloverleaf junctions.

Essential Reading:

1. C. S. Papacostas, P. D. Prevedouros, Transportation Engineering and Planning, PHI Publication, 3rd edition , 2002
2. L.R. Kadiyalli, Traffic Engineering and Transport Planning, Khanna Publishers, 7th edition, 2008.

Supplementary Reading:

1. P.H. Wright, K.K. Dixon, Highway Engineering, John Willey, 2004
2. C.J. Khisty and B. Lall, Transportation Engineering, PHI Publication, 3 ed., 2006 Relevant IRC and other Codes and specifications
3. J.G. Schoon, Geometric Design Projects for Highways: An Introduction, American Society of Civil Engineers (ASCE Press), 2nd Edition, 2002

CE 649 ADVANCED RAILWAY ENGINEERING

L	T	P		
3	1	0	Sessional:	50
			Theory:	100
			Total:	150
			Duration of Exam: 3 Hrs.	

Track and track stresses, Train resistances and hauling power of locomotives ; Railway track components: Important features, Railway curves, Superelevation, Gradients and grade compensation, Points and crossing and their design approaches. ; Construction and maintenance of railway track, Control of train movements; Signals and interlocking, Modernisation of railways and future trends; Track standards and track rehabilitation.

Essential Reading:

1. J.S. Mundrey, Railway Track Engineering, Tata McGraw Hill Co. Ltd., 3rd Edition, 2000.
2. M.M. Agarwal, Railway Track Engineering, Standard Publishers, 1st Ed. 2005.

Supplementary Reading:

1. S. Chandra and Aqarwal, Railway Engineering, Oxford University Press, 1st Ed. Feb 2008.
2. A.D. Kerr, Fundamentals of Railway Track Engineering, Simmons Boardman Pub Co (December 30, 2003)

CE 656 DESIGN OF HYDRAULIC SYSTEMS

L	T	P		
3	1	0	Sessional:	50
			Theory:	100
			Total:	150
			Duration of Exam: 3 Hrs.	

Objectives of hydraulic structures in Water resources systems, preliminary investigation and preparation of the reports, design of water storage structures ; (1)High dams-gravity dams(zonal method design), over flow and non over flow section.(2) Low dams- weirs, earthen dams, vented dams (Barrage), instrumentation and maintenance of dam structures. Collection and conveyance of water. Design of intakes, conveyance system of Irrigation, drinking and hydro power. Design of canal net work. Hydraulic design of pressure pipes, hydrostatic tests on pipes, design of distribution systems- pressure in distribution systems, nomo graphs, Hardy cross and numerical methods, computer added design (CAD).

Essential Reading:

1. Creager, Justin & Hinds, Engineering for Dams, Vols - I, II, III.
2. Varshney, Hydraulic and Irrigation Structures.

Supplementary Reading:

1. *Varshney, Hydraullic and Irrigation Structures.*

CE 660 HIGH RISE STRUCTURES

L	T	P
3	1	0

Sessional: 50
Theory: 100
Total: 150
Duration of Exam: 3 Hrs.

Analysis of tall building frames, Lateral load analysis, multi bay frames, gravity loads, settlement of foundation. Analysis of shear walls - plane shear walls, infilled frames, coupled frames, frames with shear walls. Principle of three dimensional analysis of tall buildings; Perforated cores, pure torsion in thin tubes, bending and warping of perforated cores. Analysis of floor system in tall buildings, Vierendal girders, diagrid floors. Elastic and inelastic stability of frames and shear walls. Analysis of thermal stresses.

Essential Reading:

1. B S Smith & A Coull, Tall Building Structures: - John Wiley & Sons.
2. W. Schueller, High Rise Building Structures: John Wiley & Sons.

CE 670 STRUCTURAL ENGINEERING DESIGN PRACTICE **2 Credits [0-0-2]**

1. Analysis and design of Multi-storey building frames using STAAD. Pro. SAP
2. Analysis and design of Elevated Water Tank using STAAD-Pro., SAP
3. Analysis and design of bridg e decks and other structures using STAAD-Pro., SAP
4. Analysis and design of steel trusses using STAAD-Pro., SAP
5. Dynamic response of structures using PULSE software.

CE 671 STRUCTURAL ENGINEERING LABORATORY 2 credits [0-0-2]

1. Mix design of concrete of different grades & using admixtures.
2. Tensile and Flexural strength of concrete of different grades.
3. Tensile strength of different types of steel rebars, rolled steel sections.
4. Testing of simply supported RCC beams for flexural failure
5. Testing of simply supported RCC beams for shear failure
6. Testing of RCC column
7. Non-destructive testing of concrete including rebound hammer and ultrasonic pulse method.
8. Permeability of concrete
9. Vibration analysis of beams and plates
10. Buckling load of struts.

Essential Reading:

1. A.M. Neville & J.J. Brooks, *Concrete Technology*, Pearson Education, Delhi, 2004.
2. A.R. Santhakumar, *Concrete Technology*, Oxford University Press, 2007, New Delhi

Supplementary Reading:

1. *Structural Engineering laboratory manual.*
2. *Relevant BIS Codes of practice for mix design*, rebar testing, concrete design etc.

CE 680 COMPUTATIONAL LABORATORY - II 2 credits [0-0-2]

Development of Finite Element Programming for analysis of beams, trusses, frames. ; Analysis of plates and shells using commercial softwares.

CE 681 COMPUTATIONAL LABORATORY 2 credits [0-0-2]

Computer programming in C^{++}. ; Development of computer programs to solve problems related to civil engineering using matrix method.

CE 685	**SEMINAR & TECHNICAL WRITING-I**	**2 credits [0-0-2]**
CE 689	**SEMINAR & TECHNICAL WRITING-II**	**2 credits [0-0-2]**
CE 691	**SEMINAR & TECHNICAL WRITING-III**	**4 credits [0-0-4]**
CE 692	**SEMINAR & TECHNICAL WRITING-IV**	**2 credits [0-0-2]**
CE 693	**SUMMER RESEARCH/INDUSTRIAL PROJECT**	**4 credits [0-0-4]**
CE 694	**COMPREHENSIVE VIVA VOCE**	**4 credits [0-0-4]**
CE 695	**RESEARCH PROJECT WORK-I**	**8 credits [0-0-8]**
CE 696	**RESEARCH PROJECT WORK-II**	**8 credits [0-0-8]**
CE 697	**RESEARCH PROJECT REVIEW-I**	**8 credits [0-0-8]**
CE 698	**RESEARCH PROJECT REVIEW-II**	**4 credits [0-0-4]**
CE 699	**DISSERTATION**	**8 credits [0-0-8]**