राष्ट्रीय प्रौद्योगिकी संस्थान जमशेदपुर
NATIONAL INSTITUTE OF TECHNOLOGY JAMSHEDPUR
An Institution of National importance under MHRD, Government of India
Department of Civil Engineering

2018

CURRICULA AND SYLLABI

M.TECH (STRUCTURAL ENGINEERING)

NIT,Jamshedpur

8/6/2018

PG PROGRAMME COURSE STRUCTURE

DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY JAMSHEDPUR

JAMSHEDPUR-831014, JHARKHAND

DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY JAMSHEDPUR
JAMSHEDPUR-831014, JHARKHAND, INDIA
COURSE STRUCTURE & DETAILED SYLLABI FOR M. TECH. (STRUCTURAL ENGINEERING)

Sl. No.	Subject Code	Name of the Subject	L	T	P	C
		SEMESTER I				
1	CE4101	Advanced Numerical Analysis & Computer Programming	4	0	0	4
2	CE4125	Advanced Structure Analysis	4	0	0	4
3	CE4126	Advanced Reinforced Concrete Design	4	0	0	4
4		Elective I	4	0	0	4
5		Elective II	4	0	0	4
6	CE4137	Structural Engineering Laboratory	0	0	2	1
		SEMESTER II				
1	CE4201	Finite Element Method	4	0	0	4
2	CE4225	Structural Dynamics and Earthquake Resistant Design	4	0	0	4
3	CE4226	Advance Steel Design	4	0	0	4
4		Elective III	4	0	0	4
5		Elective IV	4	0	0	4
6	CE4237	Structural Engineering Design Practice Laboratory	0	0	2	1
		SEMESTER III & IV				
1	CE4325	Seminar				4
1	CE4326	Dissertation Module - I (to be continued next Semester)				16
2	CE4425	Dissertation Module - II (contd. from III Semester)				20

Total Credits: 82

Elective Subjects: I & II

Sl. No.	Subject Code	Name of the Subject	L	T	P	C
1	CE4127	Applied Elasticity and Plasticity	4	0	0	4
2	CE4128	Soil Structure Interaction	4	0	0	4
3	CE4129	Advanced Concrete Technology	4	0	0	4
4	CE4130	Prestressed Concrete Design	4	0	0	4
5	CE4131	Bridge Engineering	4	0	0	4
6	CE4132	Continuum Mechanics	4	0	0	4
7	CE4133	Management of Quality and Safety in Construction	4	0	0	4
8	CE4134	Construction Engineering Practices	4	0	0	4
9	CE4135	Project Planning and Control	4	0	0	4
10	CE4136	Structures in Fire	4	0	0	4

Elective Subjects: III & IV

Sl. No.	Subject Code	Name of the Subject	L	T	P	C
1	CE4227	Structural Connections and Composite Structures	4	0	0	4
2	CE4228	Structural Optimization	4	0	0	4
3	CE4229	High Rise Structures	4	0	0	4
4	CE4230	Stability of Structures	4	0	0	4
5	CE4231	Design of Plates and Shells	4	0	0	4
6	CE4232	Reliability Methods in Civil Engineering	4	0	0	4
7	CE4233	Performance-Based Seismic Design	4	0	0	4
8	CE4234	Offshore Structures	4	0	0	4
9	CE4235	Composite material and Structure	4	0	0	4
10	CE4236	Disaster Management Mitigation & Preparedness Programme	4	0	0	4

DETAILED SYLLABI OF COURSES

SEMESTER I

Advanced Numerical Analysis & Computer Programming **CE4101**

4 - 0 - 0: 4 Credits **Prerequisites: None**

Section A – Advance Numerical Analysis

Solution of large Simultaneous equations [Cholesky's method], Iterative methods, Curve fitting, Numerical integration, Interpolation and Approximation, Solution of Non-linear equations, Newton's – Raphson method, Convergence and Divergence, Solution of Ordinary Differential equations and partial differential Equations, Euler method and Runga-Kutta method, Interpolation and Extrapolation, Finite Difference method, Eigen value problems, Initial and Boundary Value Problems, Variational and weighted residual methods, Introduction of Finite element methods.

Section – B Computer Programming

Introduction to the digital computer, FORTRAN 77/90/95 language/ (C/C++ Language), Flow charts and Computer program, Arithmetic and Assignments statements, Control statements, Do statements, Input/ Output Declarations, Comments type, dimension, equivalence, Data sub-programmes, Function and sub-routines, Simple computer programme or sub-routines for:

1. Inversion of a square symmetric matrix
2. Cholesky's method
3. Gauss-seidel iteration.
4. Solution of a non-linear equation by Newton-Raphson Method
5. Solution of Ordinary Differential equation by Rungakutta method.
6. Numerical differential.
7. Numerical Integration.

Text/ Reference Books:

1. Numerical Methods in Science and Engineering - S. Rajasekaran
2. Numerical Methods for Scientific and Engineering Computation - M. K. Jain, R. K. Iyengar and Jain
3. Numerical Mathematical Analysis - James B. Scarborough, Oxford and IBH Publishing.
4. Schafer, Michael, Computational engineering: introduction to numerical methods, Springer Verlag, Berlin.
5. Grewal, B.S., Numerical methods in engineering and science, Khanna Publishers, Delhi.
6. Rajasekaran, Numerical Methods in Science & Engg., S Chand Publication, 1983.
7. James B. Scarborough: Numerical Mathematical Analysis, Oxford and IBH Publishing, 1955.
8. S.S. Sastry : Introductory Methods of Numerical Analysis, PHI Learning (2012).
9. Akai T J: Applied Numerical methods for Engineers, John Wiley & Sons New York, 1994
10. Chapra S.C. and Canale R.P. Numerical methods for Engineers, Tata Mc.Graw Hill Publishing Co. Ltd.
11. Gerald: Applied Numerical Analysis, Pearson Education, New Delhi, 2003
12. Krishnamurthy E V and Sen S. K. :Numerical algorithms, East- West Press Pvt Ltd., New Delhi.1986
13. Rajasekharan S. Numerical methods in Science and Engineering , Wheeler & Co.Pvt. Ltd., New Delhi, 1986
14. Rao S.S. Optimisation theory and applications, Wiley Eastern Ltd., New York. 1979

Advanced Structure Analysis **CE4125**

4 - 0 - 0: 4 Credits **Prerequisites: None**

Introduction, variational principles; Indeterminacy Statically and kinematic indeterminacy, Stiffness and Flexibility method of analysis for truss , Determinate and indeterminate beams and frame, Non linear material and geometric problems & application to stress analysis, Introduction to composite materials and structures, Introduction of Finite element techniques, Special topics

Text/ Reference Books:

1. T.S. Thandavamoorthy, Structural Analysis, Oxford University Press.
2. 2.Devdas Menon, Advanced Structural Analysis, Narosa Publishing House
3. M B Kanchi, Matrix Methods of Structural Analysis, New Age International
4. G. S. Pandit and S. P. Gupta, Structural Analysis : A Matrix Approach, Tata McGraw-Hill
5. R. D. Cook, Concepts and Applications of Finite Element Analysis, John Wiley& Sons, New York
6. W. Weaver Jr. and J.M Gere, Matrix analysis of Frames and Structures, CBS Pub and Distributors.

Advanced Reinforced Concrete Design **CE4126**

4 - 0 - 0: 4 Credits **Prerequisites: None**

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

Text/ Reference Books:

1. N Subramanian: Design of Reinforced Concrete Structures, Oxford University Press.
2. R. Park and T. Pauley, Reinforced concrete structures, John Wiley and sons.
3. A. K. Jain, Reinforced Concrete: Limit State design, Nem Chand and Bros. 1999.
4. J. Krishna and OP Jain, Plain and Reinforced Concrete, Vol. I I, Roorkee, Nem Chand and Bros.
5. H. Nilson, D. Darwin and C. W. Dolar, Design of Concrete structures, Tata McGraw Hill
6. T. Paulay and M.J.N. Priestley , Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley & Sons Inc.

ELECTIVE: I & II

Applied Elasticity and Plasticity **CE4127**

3 - 0 - 0: 3 Credits **Prerequisites: None**

Elasticity: Introduction to tensor analysis; Three dimensional stress and strain analysis. Two dimensional problems in cartesian, polar and curvilinear co-ordinates, bending of a beam, thick cylinder under pressure, complex variable, harmonic and bi-harmonic functions. Torsion of rectangular bars including hollow sections, bending problems. Energy principles, variational methods and numerical methods.Plasticity: Basic concepts and yield criteria. Equations of plasticity, elasto-plastic analysis of torsion and bending problems, torsion of a bar of oval section (Sokoloskey's method), problems of spherical and axial symmetry, slip lines and plastic flow, strain hardening.

Text/ Reference Books:

1. Theory of Elasticity – S P Timoshenko and J N Goodier, McGraw Hill.

2. Computational Elasticity – M Ameen, Narosa Publishing House.
3. Advanced Mechanics of Solids – L S Srinath, Tata McGraw-Hill
4. Theory of Plasticity – J Chakrabarty, Elsevier Butterworth-Heinemann
5. Advanced Mechanics of Materials – A P Boresi and R J Schmidt, John Wiley & Sons, Inc.

Soil Structure Interaction **CE4128**

4 - 0 - 0: 4 Credits **Prerequisites: None**

General soil-structure interaction problems, Stress distribution in soils, Pressure bulb, 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. Curved failure surfaces, their utility and analytical/graphical predictions from Mohr-Coulomb envelope and circle of stresses. Earth pressure computations on retaining walls and their design, friction circle method, Earth pressure distribution on walls with limited/restrained deformations, Dubravo's analysis. Earth pressures on sheet piles, braced excavations. Design of supporting system of excavations. Arching in soils, Elastic and plastic analysis of stress distribution on yielding bases. Analysis of conduits, Design charts for practical use. Modern concept of analysis of piles and pile groups. Axially, laterally loaded piles and groups. Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap ; Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, Interaction analysis, Pile-raft system, Solutions through influence charts .Uplift capacity of piles and anchors.

Text/ Reference Books:

1. N.P. Kurien, Design of Foundation Sytems : Principles & Practices, Narosa, New Delhi 1992,
2. E.S. Melerski, Design Analysis of Beams, Circular Plates and Cylindrical Tanks on Elastic Foundation,
3. Taylor and Francis, 2006.
4. L.C. Reese, Single piles and pile groups under lateral loading, Taylor & Francis, 2000
5. G. Jones, Analysis of Beams on Elastic foundation, Thomas Telford, 1997.

Advanced Concrete Technology **CE4129**

4- 0 - 0: 4 Credits **Prerequisites: None**

Constituents of concrete-cements, Aggregates, water and admixtures performance enchanting materials-flyash, silica fume, PFA, RHA, metakaoin, calcined principles of proportioning concrete mixes. High performance concretes. Special concrete-light weight concrete, heavy weight concrete, shotCrete, vaccum processed concrete, pre-placed aggregate concrete, roller compacted concrete, sifcon, fibre reinforced concrete, matcon, compact reinforced concrete, ferrocement, epoxy/polymer composites, sulphur impregnated concrete, non-destructive testing and evaluation 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 super imposed 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.

Text/ Reference Books:

1. A.R. Santhakumar, Concrete Technology, Oxford University Press, 2007, New Delhi.
2. A.M. Neville, J.J. Brooks, Concrete Technology, Low Priced Edition, Pearson Education, 2004.
3. A J Martin, Mechanical behavior of engineering materials.
4. S P Timoshenko, Strength of materials- Part II
5. M. S. Shetty, Concrete technology- Theory & Practice, S. Chand & Company New Delhi, 2005

Prestressed Concrete Design **CE4130**

4 - 0 - 0: 4 Credits **Prerequisites: None**

Early developments, advantages and applications, methods of achieving prestress and materials. Classification in types 1,2 and 3. Mechanics of prestressed concrete design: Magnel's inequalities, kern distances, choice of sections for flexural members, tendon profiles in post tensioned and pre tensioned members, reversal of moments. Limit state design for flexure and shear. Losses in prestress, deflections. Prestress-cast-in-situ composites. Indeterminate structures: continuous beams and portals, secondary moments, concordant and transformed tendon profiles. Anchorage zone stresses. Review of IS code.

Text/ Reference Books:

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

Bridge Engineering **CE4131**

4- 0 - 0: 4 Credits **Prerequisites: None**

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.

Text/ Reference Books:

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.
3. IRC codes for Road bridges- IRS Sec –I , II, III

4. IRS Codes of Practice for Railway bridges.
5. B. M. Das, Principles of Foundation Engineering, Thomson, Indian Edition, 2003.

Continuum Mechanics **CE4132**

4 - 0 - 0: 4 Credits **Prerequisites: None**

Vectors and tensors, analysis for stresses, principal stresses and principal planes, stress invariants, equation of equilibrium, octahedral stresses, analysis of strains, principal strains, octahedral strains, large deformations and finite strains, elgerian, lagrangian and almansi, green's and cauchy's strain tensors compatibility equations, elastic stress-strain equations, generalized hookean law, principle of virtual work, nonlinear constitutive laws, hypo and hyper elastic solids, two dimensional plane stress, plane strain and axi-symmetric formulations, Cartesian and polar coordinate systems, three dimensional elasticity for isotropic and anisotropic solids, boundary valve problems, torsion and bending theory. Material yield criteria-von mises, tresca, Mohr-coulomb, drucker-parger etc, isotropic and kinematics hardening, normality principle, plastic flow rule, plastic potential, elasto-plastic stress-strain relations-prandti-rauss equations, levy-mises relations, hardening modulus, generalized elasto-plastic stress-strain relations.

Text/ Reference Books:

1. Wai-Fah-Chen & Atef F. Saleeb, Constitutive Equations for Engineering Materials John Wiley & Sons Inc.
2. Ray M. Bowen, Introduction to Continuum Mechanics for Engineers, Dover Pub.
3. 3.J.N.Reddy, Principles of Continuum Mechanics, Cambridge University Press

Management of Quality and Safety in Construction **CE4133**

4 - 0 - 0: 4 Credits **Prerequisites: None**

Quality policy in construction industry-Consumer satisfaction- Ergonomics-Time of completion Statistical tolerance, Taguchi's concept of quality-contract and construction programming-inspection procedures, Quality assurance/Quality control programme and cost implication, Different aspects of quality-appraisals-failure mode analysis-stability methods and tools-Influence of drawings-detailing, Specifications-standardization-Bid preparation-construction activity-Environmental safety-social and environmental factors.

Text/ Reference Books:

1. Clarkson H.Oglesby,productivity improvement in construction, Mcgraw Hill,2000.
2. James,J.O Brain, construction inspection handbook-quality assurance and quality control,Van Nostrand, newyork,1989.
3. Juran frank, J.M.and gryana,F.M.quality planning and analysis ,tata McGraw Hill,1982.
4. Kwaku A., Tenah and jose M.Guevera, fundamental of cinstruction management and organization PHI 1995.

Construction Engineering Practices **CE4134**

4 - 0 - 0: 4 Credits **Prerequisites: None**

Reinforced and prestressed concrete construction-Prefabricated structures, Production of ready mixed concrete-productivity analysis-Economics of formwork-Design of farmwork and their reusability, Modular construction practices-fibonacci series, its handling and other reliable proportioning concepts, Modular coordination-standardization-system building-advantages, Lamination and advantages of modular construction-concepts implementation procedures.

Text/ Reference Books:

1. Allen E. & Iano, J. fundamentals of building construction material and method, John Wily and
   Sons, 2011.
2. Cameron K. Andres, Ronald C. Smith, principals and practices of commercial construction, 8th edition, Prentice Hall, 2009.

Project Planning and Control	**CE4135**
4 - 0 - 0: 4 Credits	**Prerequisites: None**

Need for Planning Monitoring & Control, project organization and work-breakdown structures, Gantt chart & limitations, network representation of projects, AON & PDM based network analysis, relevance of outputs for decision making, schedule compression and crashing strategies, resource allocation and leveling, Project monitoring using mile stones and earned value, forecasting, schedule, specifications in contracts, delay analysis methods, introduction to concepts of PERT, LSM, Simulation and TOC for project scheduling.

Text/ Reference Books:

1. O'Brien, J., Plotnick, F., (2009) CPM in Construction Management, McGraw-Hill Professional.
2. Callaghan. M.T., Quackenbush, D.G. and Rowings, J.E. (1992) Construction Project Scheduling, McGraw-Hill.
3. Harris, R.B. (1978) "Precedence and Arrow Network Techniques for Construction" John Wiley and Sons.

Structures in Fire	**CE4136**
3 - 1 - 0: 4 Credits	**Prerequisites: None**

Introduction to Fire Safety and, Codes and Standards , Effect of Fire on (Construction) Materials and, Structures, Problem solving with overall fire safety, fire resistance and related to code.
Fire Safety in Buildings (Objectives of Fire Safety and Strategies for Controlling Fire), Case Study: Lessions from Past Disasters for Improved Fire Safety
Evaluation of Fire Resistance, Standard Fire Tests & Calculation Methods: Pre-flashover Fires, Post-flashover Fires, and Time-Temperature Curves for Structural Fire Design, Structural Design/Analysis using Fire Design Codes/ Standard Codes in Indian Context , Fire Resistance Evaluation – Standard Fire Tests & Calculation Methods
Design principles of fire resistant walls, Classification of buildings based on occupancy, types of construction as per National Building code of India; Fire zones; General Requirements of fire protection for all individual occupancies, Life safety aspects of building fires – Exit Requirements as per NBC of India, Requirements other than general requirements for buildings of different occupancy classification.
Material Properties of Concrete at Elevated Temperatures, rational calculations, Behaviour of concrete Structures in Fire, Calculation Methods for Evaluating Fire Resistance of Concrete Structures, Strategies for Overcoming Fire Hazard in Modern (High Strength) Concrete Structures
Behaviour of Steel Structures in Fire, and Strategies for Enhancing Fire Resistance , Calculation Methods for Evaluating Fire Resistance of Steel and Composite Members

Text/ Reference Books:

1. Buchanan, A. H. (2001), "Structural design for fire safety", John Wiley & Sons
2. Drysdale, D.D. (1999), "Introduction to Fire Dynamics", John Wiley and Sons
3. Smith and Harmathy. Design of Buildings for Fire Safety
4. National Building Code of India, Part – IV and VII
5. Linger, L. Modern Methods of Material Hand ling
6. Merchant, E. W. A Complete Guide to Fire and Buildings
7. Jain, V. K. Fire Safety in Buildings. New Age International (p) Ltd., New Delhi

Structural Engineering Laboratory **CE4137**

0 - 0 - 2: 1 Credits **Prerequisites: None**

Mix design of concrete of different grades & using admixtures, Tensile and Flexural strength of concrete of different grades, Tensile strength of different types of steel rebars, rolled steel sections, Testing of simply supported RCC beams for flexural failure, Testing of simply supported RCC beams for shear failure, Testing of RCC column, Non-destructive testing of concrete including rebound hammer and ultrasonic pulse method, Permeability of concrete.

Text/ Reference Books:

1. A.R. Santhakumar, Concrete Technology, Oxford University Press, 2007, New Delhi
2. A.M. Neville & J.J. Brooks, Concrete Technology, Pearson Education, Delhi, 2004.
3. Structural Engineering laboratory manual.
4. Relevant BIS Codes of practice for mix design, rebar testing, concrete design

SEMESTER -II

Finite Element Method **CE4201**

4 - 0 - 0: 4 Credits **Prerequisites: None**

Finite element techniques, discretization, energy and variational approaches, basic theory, displacement, force and hybrid models, shape function theory, use of parametric and local coordinates, convergence criteria, numerical integration. Element formulation, 2-D elements, plate-bending elements, introduction to 3-D elements, shell elements, interface elements, boundary elements, infinite elements. Applications, plain stress and plain strain problems, axisymmetric solids, plate and shell structures, and temperature and flow problems, non-linear problems, introduction to iterative and incremental procedures for material and geometrically non-linear problems, examples from plain stress and stability. Programming, organization of FEM programme, efficient solver, input/output, plotting and mesh generation aspects, pre and post-processors with graphic package for FEM, time dependent problems by explicit and implicit schemes.

Text/ Reference Books:

1. R Dhanraj & Prabhakaran Nair, Finite Element Methods, Oxford University Press, 2007, New Delhi.
2. J.N. Reddy, An Introduction to Nonlinear Finite Element Analysis, Oxford University Press, 2007, New Delhi.
3. R. D. Cook, Concepts and Applications of Finite Element Analysis, John Wiley& Sons, New York

4. C. S. Krishnamoorthy, Finite Element analysis-Theory and Programming, Tata McGraw Hill.
5. O. C. Zienkiewicz and R. L. Taylor, The Finite Element Method, McGraw Hill Publishing Company
6. M. Petyt, Introduction to finite element vibration analysis, Cambridge University Press, UK.
7. T. R. Chandrupatla & A. D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall of India, Pvt. Ltd., New Delhi.

Structural Dynamics and Earthquake Resistant Design **CE4225**

4 - 0 - 0: 4 Credits **Prerequisites: None**

Single degree of freedom system: Equation of motion, Damped and undamped free vibration, Response to harmonic, periodic, impulse load and general dynamic load, Duhamel's integral; 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, Wind and earthquake forces, stationary, non stationary & random processes; behaviour of chimneys, bridges and high rise buildings, structural ductility.

Text/ Reference Books:

1. R. W. Clough and J Penzien, Dynamics of structures, McGraw-Hill, Inc.
2. 2. A K Chropra , Dynamics of Structures: Theory and Applications to Earthquake Engineering, Prentice Hall of India.
3. S.K. Duggal, Earthquake Resistant Design of Structures, Oxford University Press, 2007, New Delhi.
4. Pankaj Agarwal and Manish Shrikhande, Earthquake Resistant Design of Structures, Prentice Hall of India.
5. M. Paz, Structural Dynamics - Theory and Computation, Van Nostrand, 1985. 149 Department of Civil Engineering, www.nitrkl.ac.in
6. IS: 1893 - 2002 Criteria for Earthquake Resistant Design of Structures.
7. L. Meirovitch, Elements of Vibration Analysis, 2nd Ed., McGraw-Hill, 1986.

Advanced Steel Design **CE4226**

4 - 0 - 0: 4 Credits **Prerequisites: None**

Design for tension and compression members, connections, design of plate girders, crane girders and trusses. Multi-storeyed 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.

Text/ Reference Books:

1. 1.N. Subramananian, Design of Steel Structures, Oxford University Press, 2007, New Delhi.
2. 2.K.Mukhanov, Design of Metal structures, University Press Of The Pacific
3. P Dayaratnam, Design of Steel Structures, S. Chand Group
4. B Bresler, T Y Lin and J B Scalzi, Design of Steel structures, John Wiley & Sons

ELECTIVE: III and IV

Structural Connections and Composite Structures **CE4227**

4 - 0 - 0: 4 Credits **Prerequisites: None**

Joints in reinforced concrete frame works, portals and gables, beam-column and column-slab joints, connection between prefabricated units. Analysis of framed, seated and continuous beam to column connections in steels structures, shear transfer in square knees, straight haunched knees. Steel-concrete composite structures: design philosophy, shear connection, simply supported composite beams and slabs. Continuous composite beams, Elastic and inelastic design considerations. Composite column and frames, Design of beam-column joints and rigid joints jointed composite frames. Concrete infilled thin walled closed steel sections; FRP composites.

Text/ Reference Books:

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

Structural Optimization **CE4228**

4 - 0 - 0: 4 Credits **Prerequisites: None**

Introduction and scope, simultaneous failure mode and design, classical external problems and calculus of variation, variational principles with constraints, linear programming, integer programming, nonlinear programming, dynamic programming, geometric and stochastic programming. Applications to sections, trusses and frames, dynamic design with frequency constraint, design of layouts.

Text/ Reference Books:

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
3. 143, Department of Civil Engineering, www.nitrkl.ac.in
4. S.S. Rao, Engineering Optimization: Theory & Practice , New Age International (P) Ltd, 3rd Edition, 1996.
5. K. Deb, Multi-Objective Optimization Using Evolutionary Algorithms, John Wiley, 2003.

High Rise Structures **CE4229**

4 - 0 - 0: 4 Credits **Prerequisites: None**

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

Text/ Reference Books:

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

Stability of Structures **CE4230**

4 - 0 - 0: 4 Credits **Prerequisites: None**

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 effects of Wagner's effect, flexural torsional buckling (with centroid and 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, Shanley's contribution, elastic critical loads for rigid frames and triangulated structures, stability functions. Bending of thin plate; Buckling of thin rectangular plates in compression, shear and bending

Text/ Reference Books:

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
3. M.R.Horns and W.Merchang, The stability of frames, Porgamon press, 1965.
4. M. Gregory, Elastic Instability, spon's Civil Engineering series, 1967.
5. F. Bleich, Buckling strength of Metal structures, Mc Graw Hill Book co.,1952
6. T.V Galambos, Structural members and frames, Prentice-Hall INC, 1968.

Design of Plate and Shells **CE4231**

4 - 0 - 0: 4 Credits **Prerequisites: None**

Classification of plates, governing equations, boundary conditions, analysis of rectangular and circular plates, buckling of plates, design criteria and code specifications. Classification of shells, membrane theory for shells of revolution with ax symmetric and non-symmetric loading, bending analysis of shells of revolution for ax symmetric loading, membrane and bending theories of cylindrical shells, theory of edge beams, doubly curved shells, membrane theory and design of hyperbolic shells, buckling of shells, design applications. Analysis and design of folded plates, codal specifications, practical considerations, computer applications.

Text/ Reference Books:

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
3. D. P. Billington, Thin shell concrete structures, Mc Graw Hill international, New York

4. W. T. Marshall, Design of cylindrical shell roofs, E& FN SPON, London

Reliability Methods in Civil Engineering **CE4232**

4 - 0 - 0: 4 Credits **Prerequisites: None**

Spatial variability and geotechnical reliability, uncertainties in geotechnical engineering, Quantitative Analysis of Variability: Statistical parameters, mean, standard deviation, skewness and kurtosis. Reliability based design methods: Traditional Design Approach, Reliability-Based Design Approach; Monte Carlo simulation, First order reliability method (FORM), First order second moment (FOSM) and higher order approach. Implementation of reliability approach using spread sheet and other computer language. Application of reliability method; slope stability, retaining wall and shallow foundation. Advances in reliability methods.

Text/ Reference Books:

1. Reliability based Design in geotechnical engineering, Computations and Applications,(2008) K.K. Phoon , Taylor and Francis, London.
2. Haldar, A. and Mahadevan, S. (1999). Probability, Reliability and Statistical Methods in Engineering Design. John Wiley, New York.
3. Ang, A., W. H. Tang, (1984) Probability Concepts in Engineering Planning and Design – Volume, II: Decision, Risk and Reliability. Wiley and Sons, New York

Performance-Based Seismic Design **CE4233**

4 - 0 - 0: 4 Credits **Prerequisites: None**

Introduction: Introduction on Seismic Hazard, Development of design theory of earthquake resistance, Analysis method of earthquake responses, Review of damages in past earthquakes; Seismic Performance: Introduction, Global Performances, Local Performances – Structural and Non-structural Performances, Building Performance Levels, Seismic Hazard levels, Performance Objectives; Modelling Nonlinearity for Structural Elements: Introduction – point plasticity, spread plasticity, Limit Analysis, Stress-strain Characteristics, Effective Flexural Rigidity, Modelling of Moment-curvature Relation and Moment-rotation Relation, Modelling Shear Force-Deformation Behaviour, Modelling Axial force-deformation Behaviour, Modelling Non-linear behavior of Structural Walls; Nonlinear Static Analysis: Introduction, Lateral Load Pattern, Target Displacements, Displacement Coefficient Method, Capacity Spectrum Method; Introduction to Nonlinear Dynamic Analysis: Properties of restoring force, Hysteretic Characteristics, Direct analysis method, Frequency spectrum and its application; Introduction to Seismic Retrofit, Computer programs (NONLIN, PERFORM-3D, SAP2000NL etc.) to perform inelastic pushover and dynamic analyses for structures Subjected to earthquake loadings. Methods of plastic design using AISC and FEMA Specifications.

Text/ Reference Books:

1. Displacement-Based Seismic Design of Structures – M.J.N. Priestley, G.M. Calvi, M.J. Kowalsky, IUSS Press.
2. FEMA 356: Prestandard and Commentary for the Seismic Rehabilitation of Buildings – Federal Emergency Management Agency
3. ATC-40: Seismic Evaluation and Retrofit of Concrete Buildings (Volume 1) – Applied Technology Council
4. FEMA 445: Next-Generation Performance-Based Seismic Design Guidelines – Applied Technology Council

Offshore Structures **CE4234**

4 - 0 - 0: 4 Credits **Prerequisites: None**

Types of offshore structures and conceptual development - Analytical models for jacket structures – Materials and their behaviour under static and dynamic loads - Statutory regulations - Allowable stresses - Various design methods and Code Provisions - Design specification of API, DNV, Lloyd's and other classification societies - Construction of jacket and gravity platforms. Operational loads - Environmental loads due to wind, wave, current and buoyancy - Morison's Equation - Maximum wave force on offshore structure - Concept of Return waves - Principles of Static and dynamic analyses of fixed platforms - Use of approximate methods - Design of structural elements. Introduction to tubular joints - Possible modes of failure - Eccentric connections and offset connections - Cylindrical and rectangular structural members – In plane and multi plane connections - Parameters of in-plane tubular joints - Kuang's formulae - Elastic stress distribution - Punching shear Stress – Overlapping braces - Stress concentration - Chord collapse and ring stiffener spacing - Stiffened tubes - External hydrostatic pressure - Fatigue of tubular joints - Fatigue behaviour - S-N curves - Palmgren-Miner cumulative damage rule - Design of tubular joints as per API Code. Corrosion - Corrosion mechanism - Types of corrosion - Offshore structure corrosion zones – Biological corrosion - Preventive measures of Corrosion - Principles of cathode protection systems - Sacrificial anode method and impressed current method – Online corrosion monitoring - Corrosion fatigue.

Text/ Reference Books:

1. Dawson, T. H., Offshore Structural Engineering, Prentice Hall, 1983.
2. API RP 2A, Planning, Designing and Constructing Fixed Offshore Platforms, API.
3. McClelland, B & Reifel, M. D., Planning & Design of fixed Offshore Platforms, Van Nostrand, 1986.
4. Graff, W. J., Introduction to Offshore Structures, Gulf Publ. Co.1981.
5. Reddy, D. V & Arockiasamy, M., Offshore Structures Vol.1 & 2, Kreiger Publ. Co.1991.
6. Morgan, N., Marine Technology Reference Book, Butterworths, 1990.
7. B.C Gerwick, Jr. Construction of Marine and Offshore Structures, CRC Press, Florida, 2000.

Composite material and Structure **CE4235**

4 - 0 - 0: 4 Credits **Prerequisites: None**

Introduction to Composite Materials: Definition of composite material, Types/classification of composites, Classification based on matrix and Fibres, Prepegs, Advantages and Applications. Fabrication methods of composites, Processing of FRP Composites

Micromechanical Analysis of Composite Strength and Stiffness: Volume and Weight fraction, Longitudinal Strength and stiffness, Transverse Modulus, Inplane Shear Modulus, Problems on Micromechanical Analysis.

Elastic Properties of the Unidirectional Lamina: Stress-Strain Relationship, Engineering Constants, Transformation of Stress and Strain, Transformed Reduced Compliance

Analysis of Laminated Composites: Basic Assumptions, Strain-Displacement Relationship, Stress-strain Relations, Laminate Stiffness, Determination of Lamina Stresses and Strains, Types of Laminate Configuration. Laminate Engineering Constants, Interlaminar Stresses

Analytical method of Laminated Plate: Classical Laminate Plate theory, Bending of Rectangular Plates with two simply supported edges, Shear Deformation in Laminated plates. Interlaminar Stresses

Hygothermal Effects in Laminates: Introduction, Effect of Hygothermal forces on Mechanical behaviour, Micromechanics of Hygothermal properties

Failure Theories and Strength of a Unidirectional Lamina: Introduction, Micromechanics of Failure of Unidirectional Lamina, Anisotropic Strength and Failure theories, Choice of Failure Criteria.

Text/ Reference Books:

1. R.M. Jones, Mechanics of Composite Materials, 2nd Edition., McGraw Hill, 1999.
2. P.K. Mallick, Fibre Reinforced Composites, 2nd edition Marcel Dekker Inc, USA
3. Issac M Daniel and Ori Ishai, Engineering Mechanics of Composite Materials, Oxford University Press, 1994.
4. Madhujit Mukhopadhyay, Mechanics of Composite Material and Structures, University Press (India) Pvt Ltd Hyderabad.

Disasters Mitigation Management and Preparedness **CE4236**

3 - 1 - 0: 4 Credits **Prerequisites: None**

Introduction-definitions, perception, types of disasters, disasters cycle and disaster phases**.**
Classification: Man made and natural disasters, frequencies of occurrences and historical records.
Impact of Disasters and its estimation-Physical and mental impact, environmental impact, sociological impact, impact in various sectors of development, e.g..- Health, industry, agriculture, rural and urban development, tourism, education, transportation etc. Hazard, risk and vulnerability analysis.
Disaster Prediction Mechanism
-Basic principles of Disaster Mechanism
-Forecasting Models, predictive techniques, increasing or decreasing trends and historical records
-Development of warning systems for various natural disasters (Floods, cyclones, droughts, earthquakes, landslides, tsunamis etc
Rescue, relief and rehabilitation for affected regions
-individuals,
-Human and other biological groups,
-Organizations
Delicate and sensitive industries and infrastructures,
-Corporate Disaster Preparedness Programme
-Pre-emptive transport of above and agricultural products and other essential commodities to safer places.
Mitigation or Impact Minimization Measures
-Increasing Resilience-ways and means
-Decreasing vulnerability-ways and means
-Preparedness and training
-Designing disaster proof packages, containers, emergency shelters and special infrastructures
-Post Disaster Management System

Text/ Reference Books:

1. Waugh, Willium L. Jr (2000). Living with Hazards, Dealing with Disasters: An Introduction Emergency Management Armonok, New York, ME Sharpe
2. Dr.G.Vijayan Iyer, Disaster Management and Mitigation , Technical bulletin , Madras University, 2002
3. Dr.G.Vijayan Iyer, Unsafe Conditions, World Congress on Sustainable Development, Jan, 2000 by Tata Mc Graw Publications, 2000.

4. Cutter, S. L. (2006). "Moral hazard, Social catastrophe: The changing face of vulnerability along the hurricane coasts." The Annals of the American Academy of Political and Social Science, 604(1), 102-112.
5. Clark, G. E., Moser, S. C., Ratick, S. J., Dow, K., Meyer, W. B., Emani, S., et al. (1998). "Assessing the Vulnerability of Coastal Communities to Extreme Storms: The Case of Revere, MA., USA". Mitigation and Adaptation Strategies for Global Change, 3(1) 59-82.