COMPUTER AIDED STRUCTURAL ENGINEERING

SCHEME

SEMESTER II

Sl. No.	Course Number	Subject	Hrs/Week			Evaluation Scheme (Marks)					Credits $L+\left(\frac{T+P}{2}\right)$
						Sessional Exam (internal)			ESE	Total	
			L	T	P	TA	CT	Sub. Total			
1	MCE 201	Numerical Methods in Engineering	4	0	0	25	25	50	100	150	4
2	MCE 202	Finite Element Analysis	4	0	0	25	25	50	100	150	4
3	MCE 203	Computer Aided Design	3	1	0	25	25	50	100	150	3.5
4	MCE 204	Theory of Plates and Shells	3	1	0	25	25	50	100	150	3.5
5	MCE 205	Elective-II	3	1	0	25	25	50	100	150	3.5
6	MCE 206	Elective-III	3	1	0	25	25	50	100	150	3.5
7	MCE 207	Seminar-II	-	-	2	50	-	50	0	50	1
8	MCE 208	Computer Application Lab	-	-	4	25	25	50	100	150	2
Total			20	4	6			400	700	1100	25

MCE 205. Elective II

MCE 205.1	Bridge Engineering
MCE 205.2	Foundation Engineering
MCE 205.3	Structural Optimisation

MCE 206. Elective III

MCE 206.1	Structural Stability.
MCE 206.2	Earthquake Resistant Design.
MCE 206.3	Mechanics of Composite Structures.

SYLLABUS

MCE 201 NUMERICAL METHODS IN ENGINEERING

(4 hr/week)

Module I

Solution of Linear and Non-linear Equations

Review of Gaussian Elimination and Cholesky methods – Storage schemes – Substructure concept – submatrix equation solver. Non linear system of equations : Newton Raphson , modified Newton Raphson Methods – Alpha constant method.

Module II

Solution Techniques for Eigen Value Problems

Introduction – Forward iteration, inverse iteration, Jacobi, Given's method. Transformation of generalized Eigen value problem to a standard form – Sturm sequence property – static condensation – determinant search method – Rayleigh Ritz method – Subspace iteration method.

Module III

Interpolation and integration

Lagrange – Hermitian and cubic spline methods – Isoparametric style of interpolation. Numerical Integration using Gaussian quadrature – Weights and Gauss points – Application to deflection of beams and plates – Finite Difference to Eigenvalue problems – Buckling load of columns.

Module IV

Solution of Equilibrium Equations in Dynamics and Boundary Integral Element Method

Solution of Equilibrium Equations in dynamics: Introduction – direct inegration methods – central difference method – Houbolt method – Wilson method – Newmark method. Boundary Inrtegral Element method. Introduction – formulation – fundamental solution – beam problems – Laplace and Poisson's equations – calculation of influence coefficients – boundary elements.

References: -

1. Rajasekaran S, Numerical Methods in Science and Engineering – A practical approach, AH Wheeler & Co.
2. Bathe K J, Finite Element Procedures in Engineering Analysis, Prentice Hall Inc.
3. James M L, Smith G M, and Wolford J C, Applied Numerical Methods for Digital computation, Harper and Row Publishers.
4. Krishnamoorthy E V and Sen S K, Computer Based Numerical algorithms, Afiliated East West Press.
5. Stanton R C, Numerical Methods for Science and Engineering, Prentice Hall of India.

6. Banerjee P K and Butterfield R, Boundary Element Methods in Engineering Science, Mc Graw Hill Book Co.
7. M.K Jain,S.R.K Iyengar,R.K Jain Numerical Methods for Scientific and Engineering Computation

MCE 202 FINITE ELEMENT ANALYSIS

(4 Hr/week)

Module I

Introduction to FEM-Historical development-Idealization of actual structures-Mathematical model-General procedure of FEA-Displacement approach. Solution techniques.

Finite element analysis- -Energy principles- Principle of Stationary Potential Energy-Complementary Energy - Variational approach -Stable- Unstable- Neutral equilibrium-Virtual work- Principle of virtual forces – Principle of virtual displacements.

Module II

Shape functions-Lagrangian and Hermition Interpolation – Polynomials – General coordinates-Area coordinates-Compatibility -C0 and C1 elements-convergence criteria-conforming & nonconforming elements – Patch test-**Substructuring**-treating internal nodes.

Module III

Stiffness matrix-Bar element-Beam element-Plane stress and plane strain problems-Triangular elements - Constant Strain Triangle-Linear Strain Triangle- **Isoparametric elements**-Numerical Integration.-Gauss Quadrature.

Module IV

General plate bending elements- Plate bending theory – Kirchhoff's theory – Mindlin's theory – locking problems- preventive measures – reduced integration – selective integration-spurious modes.

Axysymmetric elements- Introduction to shell elements

Stability analysis-geometric stiffness matrix-buckling of columns-Eigen value approach.

Module V

Programing concepts-matrix formulation-assembling-imposing boundaryconditions-solution techniques-band width minimization-Gauss elimination-Frontal solver-Skyline technique.

References: -

1. O C Zienkiewicz,.Finite Element Method, fourth Edition,McGraw Hill,
2. 2. R.D.Cook, Concepts and Applications of Finite Element Analysis, John Wiley & Sons.
3. Stephen P.Timoshenko & Krieger,S.W., Theory of Plates and Shells, McGraw Hill.

4. C.S.Krishnamoorthy ,Finite Element Analysis,Tata McGraw Hill .New Delhi,1987.
5. S.Rajasekharan, Finite Element Analysis,Wheeler Publishing Co., &Sons.1993.
6. T.Kant, Finite Element Methods in Computational Mechanics,Pergamons Press.
7. K.J.Bathe, Finite Element Procedures in Engineering Analysis.,Prentice Hall,
8. Mukhopadhyay M.,Matrix Finite Element Computer and Structural Analysis,Oxford & IBH,1984.
9. Irving H.Shames,Energy &Finite Element Methods in Structural Mechanics.
10. Desai C.S. & Abel J.F., Introduction to Finite Element Methods, East West Press.

MCE 203 COMPUTER AIDED DESIGN

(4 hr/week)

Module I

COMPUTER AIDED STRUCTURAL ANALYSIS AND DESIGN

History and overview of CAD– advantages of CAD over manual drafting and design – hardware requirements – computers and workstation, elements of interactive graphics, input/out put display, storage devices in CAD, and an overview of CAD software – 2D Graphics, 3D Graphics.

Module II

Popular CAD packages ,Type of structure, Unit systems, structure geometry and Co-ordinate systems - global co- ordinate system, Local co-ordinate systems –Relationship between Global and Local co-ordinate systems Edit Input-Command Formats-Text Input. Graphical Input Generation-"Concurrent" Verifications- Library-Geometry-Generation– Dimensioning-loading- Analysis.

Module III

INFORMATION MANAGEMENT AND COMPUTERS

Construction activities- The critical path method- Definitions of terms and symbols- Steps in critical path scheduling- Developing a critical path schedule - Determining free float- Determining total cost of project - Manual versus Computer analysis of critical path methods.

Popular packages in Construction Management and MIS.

Module IV

Information types and uses - General application software's- Civil engineering packages, Project management software, advanced structural engineering software's, Expert systems for construction.

References: -

1. Sujith Kumar Roy & Subrata Chakrabarty, Fundamentals of Structural Analysis, S Chand $ Company Ltd., New Delhi.

2. B.Sengupta & H. Guha Construction Management and Planning, Tata Mc Graw Hill Publishing Co. Ltd, New Dehi.
3. R.L Peurifoy, Constuction Planning, Equipment and methods, Tata Mc Graw Hill Publishing Co. Ltd, Kogakusha.
4. Mikell P. Groover & Emroy W Zimmers,Jr, CAD/CAM Computer Aided Design and Computer Aided Manufacturing
5. Reference Manuals of Packages.
6. L S Sreenath, CPM – PERT.

MCE 204 THEORY OF PLATES AND SHELLS

(4hr/week)

Module I

Plates- Introduction- classification of plates- thin plates and thick plates – small deflection theory and large deflection theory

Pure bending of plates – slope and curvature of slightly bent plates – relation between bending moment and curvature in pure bending – stresses – variation– plates subjected to lateral loadings -small deflection theory of thin plates – Love- Kirchhoff's theory – assumptions– derivation of fourth order differential equation

Module II

Solution techniques for fourth order differential equation – boundary conditions – simply supported, built- in and free edges – Navier's and Levy's solution for simply supported rectangular plates – uniformly distributed and concentrated load.

Module III

Strain energy – pure bending of plate – bending of plates by lateral loads – Mindlin's theory – assumptions - equilibrium equations – stress variations – comparative study with Love- Kirchhoff's equations.

Module IV

Circular plates – polar coordinates – differential equation of symmetrical bending of laterally loaded circular plates- uniformly loaded circular plates – circular plates loaded at the centre.

ModuleV

Classical theory of Shells – Structural behaviour of thin shells – Classification of shells – Singly and doubly curved shells with examples – Membrane theory and bending theory of doubly curved shells.

References: -

1. Lloyd Hamilton Donnell, Beams,plates and shells, Mc Graw Hill, New York.
2. Timoshenko, W Krieger, Theory of plates and shells, Mc Graw Hill.

3. Owen F Hughes, Ship structural design, John Wiley & Sons, New York, 1983.
4. William Muckle, Strength of ship structures, Edqward Arnold Ltd, London, 1967.
5. Gol'oenveizen, Theory of elastic thin shells, Pergaman press, 1961.
6. J Ramachandran, Thin shell theory and problems, Universities press.

MCE 205.1 BRIDGE ENGINEERING (ELECTIVE II)

4 hrs/week)

Module I

Historical development of bridges- Investigation for bridges- need for investigation- selection of site- economical span- subsoil exploration- investigation report- importance for proper investigation-Design of RCC bridges**-** IRC loading- types of bridges- components of bridges- analysis and design of slab bridges- T- beam bridges.

Module II

Design of steel and PSC bridges-plate girder bridge- pre stressed bridges(simply supported case only)

Module III

Bearings- importance of bearings- bearings for slab bridges- bearings for girder bridges- Substructure- different types- materials for piers and abutments- substructure design.

Module IV

Construction methods- inspection and maintenance of bridges-case studies of recently constructed major bridges-critical studies of failure of major bridges.

References: -

1. Raina V.K (1991), Concrete Bridge Practice- Analysis, design & economics, Tata Mc-GrawHill, publishing company, New Delhi.
2. Raina V.K (1988), Concrete Bridge Practice- Construction Maintenance & Rehabilitation, Tata Mc-GrawHill, publishing company, New Delhi.
3. Victor D.J (19991), Essentials of Bridge Engineering, Oxford & IBH publishing company, New Delhi.
4. Ponnuswami S (1993), Bridge Engineering, Tata Mc-GrawHill, publishing company, New Delhi.
5. Krishna Raju N (1996), Design of Bridges, TataMcGrawHill, publishing company,
   New Delhi.
6. Relevant IS Codes, and IRC Codes.

MCE 205.2 FOUNDATION ENGINEERING (ELECTIVE II)

(4 hrs/week)

Module 1

Subsurface exploration programme for industrial structures, interpretation of soil parameters on tests on undistrurbed soil samples.

Module 1I

Theories of failure for soils-use of different foundation models-different methods of design of shallow foundation for axial and eccentric loads.]

Module 1II

Design of raft foundations for industrial structures-conventional methods- Winkler's hypothesis-finite difference-Yield line analysis for footings and rafts.-Design of axially and laterally loaded piles- design of pile group- design of well foundation.

Module 1V

Design of machine foundations subjected to different type of loads- framed and massive foundations-methods of isolated foundation variations.

Module V

Design of foundation for tall structures-water tank, chimney, antenna towers and radar units.

Introduction to special types of foundations-Hyperbolic-paraboloid shells (design not expected).

References: -

1. Hyoslev M J J S, Subsurface exploration and sampling of soils for Civil Engineering, Army corps of Engineers, 1949.
2. Winterkorn H F, Fang H Y, Foundation Engineering Hand Book, Van Nostand Reinhold Company, 1975.
3. Zeevaert, Foundation Engineering for difficult sbsoil conditions, Van Nostand Reinhold Company, 1975.
4. Bowles J E, Foundation analysis and design, McGraw Hill Company, 1968.
5. Szechy K, Foundation Engineering, Springer Verlag, 1965.
6. Kany M, Design of raft Foundations, Elihelm Earnest and Schn, 1974.
7. Godman L J, Karol R H, Theory and Practice of Foundation Engineering, MeMillan, 1968.
8. Ninan P Kurian, Design of Foundation systems (Principles and Practice), Narosa Publishing House.
9. Ninan P Kurian, Modern Foundations (Introduction to advanced techniques), Tata McGraw Hill Publishing Company.
10. Peck, Hanson and Thornbourn, Foundation Design.
11. Relevant IS Codes

MCE206.1 STRUCTURAL STABILITY(ELECTIVEIII)

(4hr/week)

Module I

Introduction to stability analysis-Stable, unstable and neutral equilibrium-Stability Criteria's. Fourth order Elastica-large deflection of bars differential equation for generalized bending problems-elastic instability of columns-Euler's theory-assumptions-limitations. Energy principles.

Module II

General treatment of column. Stability problem as an Eigen value problem-various modes of failure for various end conditions- both ends hinged-both ends fixed-one end fixed other end free- one end fixed other end hinged-Energy approach-Rayleigh Ritz-Galarkin's method- Elastica-large deflection of bars.

Module III

Beam column-beam column equation-solution of differential equation for various lateral loads-udl and concentrated loads-Buckling of frames - Energy method - solutions for various end conditions-bottom fixed- bottom hinged –horizontal compression members.

Module IV

Stability of plates-inplane and lateral loads- boundary conditions-critical buckling pressure-aspect ratio-finite difference method- Introduction to torsional buckling, lateral buckling and inelastic buckling.

Module V

Finite element application to stability analysis- finite element stability analysis-element stiffness matrix –geometric stiffness matrix-derivation of element stiffness matrix and geometric stiffness matrix for a beam element.

References: -

1. Ziegler H, Principles of structural stability, Blarsdell, Wallham, Mass, 1963.
2. Thompson J M, G W Hunt, General stability of elastic stability, Wiley,New York.
3. Timoshenko, Gere, Theory of elastic stability, Mc Graw Hill, New York.
4. Don O Brush, B O O Almorth, Buckling of Bars, plates and shells,
5. Cox H L, The buckling of plates and shells, Macmillam, New York, 1963.
6. O C Zienkiewicz ,.Finite Element Method ,fourth Edition,McGraw Hill,
7. R.D.Cook ,Concepts and Applications of Finite Element Analysis,JohnWiley &Sons.

MCE 206.2 EARTHQUAKE RESISTANT DESIGN OF STRUCTURES
(Elective III)

(4 hr/week)

Module 1

Introduction to earthquakes, seismic waves, earthquake magnitude, earthquake intensity, earth quake ground motion, peak ground acceleration, attenuation, duration, ground motion measurements,earthquake occurance , design spectrum, concept of earth quake – resistant design, response reduction factors, building configurations, flexible and rigid floor diaphragms, effect of torsion, seismic codes. provisions of IS 1893 and IS 13920

Module 1I

Behaviour of buildings and structures during past earthquakes,and lessons learnt;confined concrete,the capacity of design method,design and detailing of ductile frame-shear wall systems-Seismic behaviour and design of beams,columns shear walls,and joints.Study of IS:13920.Repair materials and retrofitting techniques.

Reference: -

1. Bruce A. Bolt, Earth quakes, W.H. Freeman and Company, Newyork
2. David A Fanella, Seismic detailing of Concrete Buildings, Portland Cement
3. Association, Illinois.
4. Repair and Strengthening of Reinforced Concrete, Stone and Brick Masonry
5. Buildings, United Nations industrial Development Organization, Vienna.
6. T. Pauly and M.J.N Priestley, Seismic Design of Reinforced Concrete and
7. Masonry Buildings, John Wiley and sons Inc.
8. Steven L. Kramer, Geotechnical Earthquake Engineering, Pearson Education.
9. Park and paulay, R C structures.
10. Relevant IS Codes.

MCE 207 SEMINAR II

(2hr/week)

Each student is required to present a technical paper on a subject approved by the department. The paper should be on a recent advancement/trend in the field of structural engineering. He/she shall submit a report of the paper presented to the department.

MCE 208 COMPUTER APPLICATION LAB

(4hr/week)

Application of software like SAP, NISA, STAAD/STRAP, AUTOCAD etc. in modeling, simulation, analysis, design and drafting of structural / mechanical components using the concepts given in MCE 111.The student has to practice the Structural Analysis and Project Management Packages by working out problems in.

1. Analysis and design of steel trusses, Steel and RCC framed structures.
2. Analysis and design of multi-storied framed structures.
3. Analysis and design of RCC and steel water tanks.
7. Project Management for Turn key projects related to Civil Engineering applications.
8. 2D & 3D Design and Drawings of Residential and Commercial Buildings