# SCHEME AND SYLLABUS
# OF

M.Tech Programme in
Civil Engineering
( 2013 Scheme )

## with specialisation in
## STRUCTURAL ENGINEERING

**University of Kerala**

**Thiruvananthapuram**

# M.Tech Programme
# CIVIL ENGINEERING – STRUCTURAL ENGINEERING
# CURRICULUM AND SCHEME OF EXAMINATIONS
## Scheme

## SEMESTER I

| Code No. | Name of Subject | Credits | Hrs / week | End Sem Exam hours | Marks | | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | Internal Continuous Assessment | End Semester Exam | Total | |
| CSM1001 | Advanced Numerical Methods | 3 | 3 | 3 | 40 | 60 | 100 | Of the 40 marks of internal assessment 25 marks for test and 15 marks for assignment. End sem exam is conducted by the University |
| CSC1001 | Structural Dynamics | 3 | 3 | 3 | 40 | 60 | 100 | do |
| CSC1002 | Advanced Theory & Design of RC Structures | 3 | 3 | 3 | 40 | 60 | 100 | do |
| CSC1003 | Advanced Metal Structures | 3 | 3 | 3 | 40 | 60 | 100 | do |
| CSC1004 | Experimental Methods and Instrumentation | 3 | 3 | 3 | 40 | 60 | 100 | do |
| CSC1005 | Theory of Elasticity | 3 | 3 | 3 | 40 | 60 | 100 | do |
| CSC1101 | Structural Engineering and Computational Lab | 1 | 2 | - | 100 | - | 100 | No End Sem Examinations |
| CSC1102 | Seminar | 2 | 2 | - | 100 | - | 100 | do |
| | TOTAL | 21 | 22 | | | | | 7 Hours of Departmental Assistance work |

## SEMESTER II

| Code No. | Name of Subject | Credits | Hrs / week | End Sem Exam hours | Marks | | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | Internal Continuous Assessment | End Semester Exam | Total | |
| CSC2001 | Theory and Design of Plates and Shells | 3 | 3 | 3 | 40 | 60 | 100 | Of the 40 marks of internal assessment 25 marks for test and 15 marks for assignment. End sem exam is conducted by the University |
| CSC 2002 | Analysis and Design of Earth Quake Resistant Structures | 3 | 3 | 3 | 40 | 60 | 100 | do |
| * | Stream Elective I | 3 | 3 | 3 | 40 | 60 | 100 | do |
| * | Stream Elective II | 3 | 3 | 3 | 40 | 60 | 100 | do |
| * | Department Elective | 3 | 3 | 3 | 40 | 60 | 100 | do |
| CCC 2001 | Research Methodology | 2 | 2 | 3 | 40 | 60 | 100 | Of the 40 marks of internal assessment 25 marks for test and 15 marks for assignment End Sem Exam is conducted by the Individual Institutions |
| CSC2101 | Structural Dynamics Laboratory | 1 | 2 | - | 100 | | 100 | No End Sem Examinations |
| CSC2102 | Thesis – Preliminary – Part I | 2 | 2 | - | 100 | | 100 | do |
| CSC2103 | Seminar | 2 | 2 | - | 100 | | 100 | do |
| | TOTAL | 22 | 23 | --- | | | | 6 Hours of Departmental Assistance work |

**List of Stream Electives**

**Stream Elective I**

**CSE 2001 Advanced Pre- Stressed Concrete Design**

**CSE 2002 Forensic Engineering**

**CSE 2003 Structural Optimisation**

**Stream Elective II**

**CSE 2004 Finite Element Method**

**CSE 2005 Composite Structures**

**CSE 2006 Analysis and Design of Substructures**

## SEMESTER III

| Code No. | Name of Subject | Credits | Hrs / week | End Sem Exam hours | Marks | | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | Continuous Assessment | End Semester Exam | Total | |
| | Stream Elective III | 3 | 3 | 3 | 40 | 60 | 100 | End Sem Exam is conducted by the Individual Institutions |
| | Stream Elective IV | 3 | 3 | 3 | 40 | 60 | 100 | do |
| | Non- Dept. (Interdisciplinary) Elective | 3 | 3 | 3 | 40 | 60 | 100 | do |
| CSC3101 | Thesis – Preliminary – Part -II | 5 | 15 | - | 200 | | 200 | No End Sem Examinations |
| | TOTAL | 14 | 21 | | | | | |

**List of Stream Electives**

**Stream Elective III**

1. **CSE 3001 High Rise Structures**
2. **CSE 3002 Engineering Applications of Artificial Intelligence and Expert Systems**
3. **CSE 3003 Random Vibration**

**Stream Elective IV**

1. **CSE 3004 Stability of Structures**
2. **CSE 3005 Structural Reliability**
3. **CSE 3006 Fracture Mechanics**

## SEMESTER IV

| Code No | Subject Name | Credits | Hrs/week | Marks | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Continuous Assessment | | University Exam | | Total |
| | | | | Guide | Evaluation Committee | Thesis Evaluation | Viva Voce | |
| CSC4101 | Thesis | 12 | 21 | 150 | 150 | 200 | 100 | 600 |
| | Total | 12 | 21 | | | | | |

**Note : 6 to 8 hours per week is for department assistance**

**List of Department Electives**

1. CSD 2001 Design of Bridges
2. CHD 2001 Project Planning in Water Resources
3. CRD 2001 Geoinformatics in Civil Engineering

   (Students of Geoinformatics specialization are not allowed to choose CRD 2001 subject as the contents are dealt with in detail in the core papers)
4. CGD2001-Geoenvironment and landfill
5. CTD 2001 Soft Computing Tools for Engineering
6. CTD 2002 Regional Transportation Planning
7. CED 2001 Ecological Engineering
8. CED 2002 Air Pollution Control and Monitoring
9. CED 2003 Environmental Impact Assessment and Risk Analysis

**List of Interdisciplinary Electives**

1. CSI 3001 Finite Element Analysis
2. CSI 3002 Mechanics Of Composites
3. CHI 3001 Fuzzy Sets And Systems In Engineering
4. CRI 3001 Geoinformatics For Infrastructure Development
5. CGI 3001 Geotechnical Engineering For Infrastructure Projects
6. CTI 3001 Fundamentals Of Reliability Engineering
7. CEI 3001philosophy Of Technology
8. CEI 3002 Environmental Management
9. CEI 3003 Environment And Pollution

**CSM 1001 Advanced Numerical Methods**

**Structure of the Course**

Lecture: 3 hrs/ Week Credits: 3

Internal Continuous Assessment: 40 Marks

End Semester Examination : 60 Marks

**Course Objectives**

- To give awareness to different numerical solutions.
- To impart ability to apply mathematics for finding solutions to real-time problems.

**Learning Outcomes**

- Understand various computational methods available to solve practical problems
- Enhance the capacity to select appropriate techniques for tackling problems in engineering and science.

Module I

Introduction to numerical methods- errors in numerical methods-Systems of linear algebraic equations- Elimination and factorization methods-ill conditioned systems- symmetric and banded systems- Gauss Seidel iteration for sparse systems. Eigen Value problems- power method- Jacobi method-Practical examples- Systems of non-linear equations- Newton-Raphson method.

Module II

Langrangean and Hermition interpolation- Quadratic and Cubic splines (Examples with equal intervals only)- Data smoothing by least squares criterion- Non- polynomial models like exponential model and power equation- Multiple linear regression-Numerical integration- Romberg integration- Gaussian quadrature- Newton – Cotes open quadrature- Taylor series expansion of functions- Ordinary differential equations- $1^{st}$ order equations- Solution by use of Taylor series- Euler method and its modifications- Runge- kutta method- Higher order equations of the initial value type- Predictor corrector methods- Milne's method and Hammings method- Stability of solutions.

Module III

Ordinary differential equations of the boundary value type- Finite difference solution- Weighted residual methods for initial value problems and boundary value problems- Collocation method- Sub domain method- Method of least squares- Galerkin's method. Partial differential equations in two dimensions- Parabolic equations- Explicit finite difference method- Crank-Nicholson implicit method- Ellipse equations- Finite difference method- Problems with irregular boundaries.

Note: Stress must be given to structural problems

Assignment must be computer oriented

**References**


1. Chapra S.C. and Canale R.P. "Numerical Methods for Engineers" Mc Graw Hill 2006.
2. Smith G.D. "Numerical solutions for Differential Equations" Mc Graw Hill
3. Ketter and Prawel "Modern Methods for Engineering Computations" Mc Graw Hill
4. Rajasekharan S. "Numerical Methods in Science and Engineering"S Chand & company 2003.
5. Rajasekharan S. "Numerical Methods for Initial and Boundary value problems," Khanna publishers 1989.
6. Terrence .J.Akai "Applied Numerical Methods for Engineers",Wiley publishers 1994.


**Structure of the Question paper**

For the end semester examination there will be three questions from each module out of which two questions are to be answered by the students.

**CSC 1001** **Structural Dynamics**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

**Course Objectives**

- To understand the behaviour of structures under dynamic loads
- To familiarise with the dynamic analysis of structures subjected to time varying loads

**Learning Outcomes**

- Will be equipped with the analytical tools required to determine the dynamic response of structures
- will serve as a pre-requisite to study the subject "Analysis and design of earthquake resistant structures"

Module I

Vibration studies and its importance to structural engineering applications – Types of dynamic loading – Systems with single degree of freedom – Elements of a vibratory system – Mathematical model for single degree of freedom systems- Equation of motion – damping in vibrating system- Undamped and damped free vibration of single degree of freedom system – Logarithmic decrement – Response of single degree of freedom systems to harmonic, impulse, periodic and general loading(Duhamel integral) – Numerical solution of single degree of freedom systems – Central Difference Method – Average acceleration method, Wilson-θ method- Newmark – β method.

Module II

Vibration isolation –Vibration measuring instruments – Methods of vibration control – Tuned mass damper – Multi-degree of freedom systems – Equation of motion – Lumped mass and consistent mass – Shear building concept and models for dynamic analysis – Evaluation of natural frequencies and mode shapes by solution of characteristic equation – Co-ordinate coupling - Orthogonality of normal modes **–** Stodola-Vianello method for the evaluation of natural frequencies and mode shapes – Forced vibration analysis of multi-degree of freedom systems - Mode superposition method of analysis - Response of discrete systems to support motion.

Module III

Distributed mass (continuous) systems – differential equation of motion – Axial vibration of rods – Flexural vibration of single span beams such as simply supported beam, cantilever beam and fixed beam– Evaluation of frequencies and mode shapes – Beam flexure including shear deformation and rotary inertia – Forced vibration of single span beams – Lagrange's equation.

**References**

1. Clough R W and Penzien J, Dynamics of Structures, McGraw Hill, New Delhi.
2. Biggs J M, Introduction to Structural dynamics, McGraw Hill, New Delhi.
3. Mario Paz, Structural Dynamics – Theory and Computation, CBS Publishers and Distributors, Delhi.
4. Mukhopadhyay M, Structural Dynamics - Vibrations and Systems, Ane Books India, Delhi.
5. Humar J, Dynamics of Structures, CRC Press, Netherlands.

6. Anil K Chopra, Dynamics of Structures- Theory and Application to Earthquake Engineering, Pearson Education, New Delhi.
7. Roy R Craig, Structural Dynamics – An Introduction to Computer Method, John Wiley & Sons, Newyork.
8. Thomson W T, Theory of Vibration with Application, Pearson Education, New Delhi.
9. Weaver W, Timoshenko S P, Young D H, Vibration Problems in Engineering, John Wiley & Sons, USA.

**Structure of the question paper**

For the end semester examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.

**CSC 1002 Advanced Theory and Design of RC Structures**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

**Course Objectives**

This course is designed to

- Provide the ability in analysis and design of basic reinforced concrete components
- Study of advanced topics including theory and design of reinforced concrete structures

**Learning Outcomes**

- Understand the theory and design of the main elements in reinforced concrete structures
- Understand the behaviour of reinforced concrete structures
- Carry out calculations on safety verification of reinforced concrete members
- Understand the design of special reinforced concrete members and components

Module I

Review on Basic theory and design philosophies-Advanced theory in Stress-strain characteristics of concrete under uniaxial and multiaxial states of stress - confined concrete- Effect of cyclic loading on concrete and reinforcing steel. Stress block parameters-Failure criteria for concrete. Design concepts-Limit state method-comparison of different codal regulations- design of reinforced concrete members in flexure, flexural shear, torsion-combined with flexure and flexural shear. Analysis and design of compression members-slender columns, including biaxial bending, eccentric tension .Estimation of deflection- immediate and long term deflection- control of cracking, estimation of crack width in RC members, codal procedures on crack width computations

Module II

Design of special RC members- Analysis of shear walls- distribution of lateral loads in uncoupled shear walls, Shear wall frame interactions. Design of concrete corbels, deep beams, ribbed slabs, pile caps.

Module III

Strut and Tie Models- Development- Design methodology- selecting dimensions for struts- ACI Provisions- Applications. RCC beam – column joints- classification – shear strength- design of exterior and interior joints- wide beam joints. Yield line analysis of slabs, yield line mechanisms- equilibrium and virtual work method, Hillerborg's strip method. Limitations of yield line theory
Moment redistribution in continuous beams.

**References**

1. Arthur. H. Nilson, David Darwin and Charles W Dolan, Design of Concrete Structures, Tata McGraw Hill, 2004
2. Park, R. and Pauley, T., “Reinforced Concrete Structures”, John Wiley. 1976
3. Pillai ,S.U. and Menon, D., “Reinforced Concrete Design”, Tata McGraw-Hill.2003

4. Varghese,P.C., “Limit State Design of Reinforced Concrete”, Prentice-Hall. 2005
5. IS 456 –2000, Indian Standard for Plain and Reinforced Concrete- Code of Practice, New Delhi
6. American Concrete Institute, Building Code Requirements for Structural Concrete (ACI 318-02) and Commentary (ACI 318R-02)

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of 60% Design problems and 40 % Theory. There will be three questions from each module out of which two questions are to be answered by the students.

**CSC 1003 Advanced Metal Structures**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

**Course Objectives**

- To familiarise the student with the advances in metal structures and designs procedures.

**Learning Outcomes**

- Application of plastic design philosophy
- Knowledge of the basis of codal provisions and design implications
- Introduction to steel-concrete composite structures and aluminium structures

Module I

Methods of Analysis- Elastic analysis (first order, second order), buckling analysis (linear, inelastic). Sources of non-linearity. First order plastic analysis, second order inelastic analysis.Plastic method of analysis - moment redistribution - static, kinematic and uniqueness theorems -Effect of axial and shear force on plastic moment capacity. Analysis of single and two bay portal frames, gable frames. Plastic design with LRFD concepts - Requirements for plastic design, advantages of plastic design - Plastic design of continuous beams and portal frames.

Module II

Beam to column conn**ect**ions: - Classification. Introduction to semi rigid connections.

Bolted connections - Design of seat angle, stiffened seat angle, web angle and end plate connections. Beam and column splices. Welded connections – Structure and properties of weld metal. Stiffened beam seat connection, web angle and end plate connections- Beam and column splices, Tubular connections - Welds in tubular joints - Curved weld length at intersection of tubes – Weld defects. Case studies on beam to column joint failures.

Industrial buildings: Layout - Sway and non-sway frames, bracings and bents - Rigid frame joints - Knees for rectangular frames and pitched roofs. Fabrication and Erection (Designs not expected)

Module III

Cold Formed Steel Members: Local and post buckling of thin elements - Behaviour under axial, bending and shear forces. (Designs not expected).

Steel – Concrete Composite structures – shear connectors – types of shear connectors– degrees of shear connections – partial and full shear connections – composite sections under positive and negative bending.

Aluminium Structures: Introduction – Stress-strain relationship – Permissible stresses – Design of Tension members, Compression members and Beams.

**References**

1. Gaylord, Design of Steel Structures, McGraw Hill, New York.
2. Dayaratnam, P., Design of Steel Structures, Wheeler Pub.
3. Wie-Wen Yu, Cold-Formed Steel Structures, McGraw Hill Book Company.
4. Lothers, Advanced Design in Steel, Prentice Hall, USA.
5. N. Subramanian, Design of Steel Structures, Oxford University Press.
6. R.P. Johnson, Composite Structures in Steel & Concrete, Blackwell Scientific Publications, UK.

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of 60% Analysis/Design problems and 40 % Theory. There will be three questions from each module out of which two questions are to be answered by the students.

## CSC 1004 Experimental Methods And Instrumentation

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

**Course objectives**

- Design experiments related to stress analysis problems
- Learn methodology for conducting laboratory and field experiments
- Analyse and interpret experimental observations and results

**Learning outcomes**

- Capability to provide suitable instrumentation for conducting experiments
- Acquire capacity to organize laboratory experiments for project and thesis works
- Building capacity to conduct destructive and nondestructive experiments as a practicing engineer

Module I

The measurement system: Purpose Structure and Elements - Characteristics of measurement system - Accuracy, Precision, Repeatability; Calibration – Standards and evaluation; Dynamic Characteristics – zero order, first order and second order instruments.

Measurement of Strain: Electrical resistance strain gauges - Gauge materials - gauge construction – gauge factor; Vibrating wire strain gauges ; strain gauge bridges – Potentiometric and Wheatstone bridge - sensitivity

Force transducers: Load cells different types – design of force transducers; Force balance pressure gauges – construction - sensitivity.

Measurement of displacement: Potentiometers – different types; Linear variable differential transformer – principle and working.

Module II

Measurement of acceleration: Accelerometers - Characteristics of Accelerometers – types-design of accelerometers – calibration techniques - Integration technique for displacement from acceleration.

Photo elasticity- use of polarised light - Maxwell’s law - polariscopes and their use; Photoelastic model materials ; Two dimensional photo elasticity - analysis and reduction of data.

Moire fringe method- techniques and its use.

Module III

Non Destructive Testing Methods: Ultrasonic Methods; Hardness methods - Rebound Hammer ; Core sampling technique; Pullout experiment; Detection of embedded reinforcement .

Indicating & recording elements – Chart recorders – Cathode ray oscilloscope; Computer based data acquisition systems – structure and components.

Statistical Analysis - Errors in measurement - best estimate of true value Normal Distribution - Confidence level.

**References**

1. Bently JP - Principles of Measurement Systems – Longman, 1995
2. Nakra B.C & Chaudhry - Instrumentation Measurement & Analysis - Tata McCraw Hill, 2004
3. Adams L F - Engineering Measurements and Instrumentation – English University Press, 1975
4. Doebelin E O - Measurement Systems Application & Design - McGraw Hill, 2003
5. Dally JW & Riley WF – Experimental stress Analysis - McGraw Hill, 1991

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of 60% problems and 40 % theory. There will be three questions from each module out of which two questions are to be answered by the students.

**CSC 1005** **Theory of Elasticity**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits: 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

**Course Objectives**

- To understand the behaviour of linear elastic solids under loads
- Provide a firm foundation for more advanced courses, for research and practise in civil engineering fields
- To provide the student with various solution strategies while applying them to practical cases

**Learning Outcomes**

- Understand concepts, principles and governing equations in dealing with elastic solids
- Understand the methods for solving elastic boundary value problems
- To obtain skill and capability in civil engineering in analysing and solving problems

Module I

Analysis of stress and strain in 3D:

Definition of stress at a point – Stress tensor – Equilibrium equations – Stress on arbitrarily oriented plane – Transformation of stress – Principal stress - Stress invariants – Octahedral stresses – Traction boundary conditions, Hydrostatic and Deviatoric Stress Tensors.

Strain tensor – Strain displacement relations for small deformations – Compatibility conditions – Strain transformations – Principal strains – Strain invariants.

Stress Strain relations : Generalised Hooke's law – Reduction in number of elastic constants for orthotropic, transversely isotropic and isotropic media. Boundary value problems of elasticity – Displacement, Traction and Mixed types. Navier's Equations, Beltrami-Michell's Equations.

Saint Venant's principle. Uniqueness of Solution

Module II

Two dimensional problems in Rectangular coordinates:

Plane stress and plane strain problems – Airy's stress function - Solution by polynomials – Bending of cantilever loaded at free end., Bending of simply supported beam with udl.

Two dimensional problems in polar coordinates:

General equations- Equilibrium equations, Strain displacement relations and Stress strain relations. Biharmonic equations and Airy's stress functions.

Problems of axisymmetric stress distributions - Thick cylinders - Stress concentration due to circular hole in plates (Kirsch's problem).

Module III

Torsion of prismatic bars:

Saint Venant's Semi inverse and Prandtl's stress function approach – Torsion of Straight bars – Elliptic and Equilateral triangular cross section. Torsion of thin walled open and closed tubes, Membrane Analogy

Plasticity: Basic concepts and yield criteria; Equations of plasticity, Theories of strength, Yield criteria, elasto-plastic analysis of torsion and bending problems.

**References**

1. Timoshenko.S.P and Goodier. J.N., Theory of Elasticity, McGraw Hill, 2010
2. Srinath.L.S., Advanced Mechanics of Solids, Tata Mc Graw Hill, 2008
3. Sokolnikoff. I.S., Mathematical theory of Elasticity, Tata Mc Graw Hill
4. Ameen.M., Computational Elasticity, Narosa Publishing House, 2005
5. Boresi.A.P., Schimidt.R.J., Advanced Mechanics of Materials,John Wiley, 2002
6. T.G.Sitharam ., Applied Elasticity, Interline publishing, 2008
7. Phillips, Durelli and Tsao, Analysis of Stress and Strain, McGraw Hill Book.

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of 60% problems and 40 % Theory. There will be three questions from each module out of which two questions are to be answered by the students.

**CSC 1101 Structural Engineering and Computational Lab**

**Structure of the Course**

Lab : 2 hrs/ Week Credits : 1

Internal Continuous Assessment : 100 Marks

**Course Objectives**

- Practical training for conducting experiments related to structural engineering.
- Ability to solve stress analysis problems.
- Ability to write algorithms for problem solving.

**Learning Outcomes**

- Acquire capacity to organise experiments for project and thesis works.
- Capability to use finite element packages for stress analysis.
- Building capacity to write programs for problem solving.

**Details of experiments:**

1. Review of testing methods of cement, coarse aggregate and fine aggregate as per Indian Standards.
2. Design of concrete mixes as per Indian Standard
3. Study of behaviour of RCC beams
4. Study of behaviour of RCC columns.
5. Accelerated curing experiments for concrete.
6. Study of behaviour of steel beams.
7. Free vibration analysis of steel cantilever beams.
8. Non- destructive testing of concrete
   a) Rebound hammer
   b) Core cutting
   c) Ultrasonic pulse velocity
   d) Pullout test
   e) Detection of embedded reinforcements
9. Photo elastic studies using plane polariscope
10. Analysis of plates using software package.
11. Analysis of shells using software package.
12. Analysis of frames using software package.
13. Writing programs in any high level language for solving computational problems

**CSC 1102** **Seminar**

**Structure of the Course**

Duration : 2 hrs/ Week Credits : 2
Continuous Assessment : 100 Marks

The student has to present a seminar in one of the current topics in the stream of specialisation. The student will under take a detailed study based on current published papers, journals, books on the chosen subject, present the seminar and submit seminar report at the end of the semester**.**

***Distribution of marks***
Seminar Report Evaluation – 40 marks
Seminar Presentation – 60 marks

**CSC 2001 Theory and Design of Plates and Shells**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

**Course Objectives**:

Thin walled structures in the form of plates and shells are encountered in many branches of technology. Such a widespread use of plate and shell structures arises from their intrinsic properties. So it is necessary to study the behaviour of the plates and shells with different geometry under various types of loads.

**Learning Outcomes:**

Understand the behaviour of plates and shells under different types of loads and come up with proper design methods.

Module I

Introduction-Assumptions in the theory of thin plates-Bending of long rectangular plates to a cylindrical surface. Pure bending of plates-Slope and curvature - Relations between bending moments and curvature - Particular cases of pure bending. Symmetrical bending of circular plates-Differential equation-Uniformly loaded circular plates with simply supported and fixed boundary conditions-Annular plate with uniform moments and shear forces along the boundaries

Module II

Small deflections of laterally loaded plates-Differential equation-Boundary conditions-Navier solution and Levy's solution for simply supported rectangular plates-Effect of transverse shear deformation-Anisotropic plates. Theory of folded plates-Design of reinforced concrete folded plates.

Module III

Deformation of shells without bending-definitions and notation- Shells in the form of a surface of revolution, displacements-Membrane theory of cylindrical shells plates. General theory of cylindrical shells-A circular cylindrical shell loaded symmetrically with respect to its axis- stresses in cylindrical shell under dead and snow loads, symmetrical deformation. General case of deformation of a cylindrical shell- cylindrical shells with supported edges- Shells having the form of surface of revolution and loaded symmetrically with respect to their axis. Detailed analysis and design of cylindrical shells- hyperbolic shells- Hyperbolic paraboloid shells-Detailing of reinforcement in shells, edge beams and transfer beams.

**References**

1. Timoshenko S.P. and Krieger S. W., Theory of Plates and Shells, Tata Mc Graw Hill, 1959
2. Chandrashekhara K., Theory of Shells, Universities(India)Press Ltd., 2001
3. Ramaswamy G. S., Design and Construction of Concrete Shell Roofs, CBS Publishers, 2005.
4. Bairagi N. K., Plate Analysis, Khanna Publishers, 1986
5. Kelkar V. S. and Sewell R.T., Fundamentals of the Analysis and Design of Shell Strutures, Prentice Hall Inc., 1987
6. T.K.Varadan & K. Bhaskar, Análysis of plates – Theory and problems, Narosha Publishing Co., 1999.
7. Reddy J N., Theory and Analysis of Plates and Shells, Taylor and Francis, 2006

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students. Use of relevant IS codes may be permitted in the examination hall.

**CSC 2002 Analysis and Design of Earthquake Resistant Structures**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

**Course Objectives**

- To impart awareness about the effect of earthquakes on structures.
- To study IS code provisions for the analysis, design and detailing of earthquake resistant structures

**Learning Outcomes**

- Understand various aspects of earthquake engineering
- Capable of design and detailing of earthquake resistant structures
- Awareness about disaster management due to earthquakes.

Module I

Elements of earthquake engineering- characteristics of ground motion – earthquake intensity and magnitude- recording instruments -seismic zoning- earthquake effects on different types of structures- Effect of architectural features and structural irregularities- review of damages during past earthquakes

Module II

Principles and guidelines for earthquake resistant design of structures- Design lateral forces- Static analysis – Dynamic analysis- Shear walls

Module III

IS Code provision for design and detailing for earthquake resistance- reinforcement detailing for members and joints- design examples. Repair and rehabilitation of damaged structures- case studies- methods for disaster mitigation- Vulnerability assessment and seismic evaluation of structures – vulnerability reduction

**Reference**

1. IS: 1893-2002, Indian Standard criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi
2. IS: 4326-1993, Indian Standard code for practice for Earthquake Resistant Design and Construction of Buildings, Bureau of Indian Standards, New Delhi.
3. IS: 13920-1993, Indian Standard Ductile Detailing of RCC Structures subjected to seismic forces- Code of practice, Bureau of Indian Standards, New Delhi
4. SP: 22-1982, Explanatory Handbook on codes of Earthquake Engineering, Bureau of Indian Standards, New Delhi
5. Pankaj Agarwal and Manish Shrikhande, Earthquake Resistant Design of Structures, Prentice- Hall of India, New Delhi.
6. Anil K Chopra, Dynamics of Structures, Prentice- Hall of India, New Delhi.
7. S. K. Duggal-Earthquake Resistant Design of Structures-Oxford University Press-2007

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of 60% Design or Analysis problems and 40 % Theory. There will be three questions from each module out of which two questions are to be answered by the students.

**CSC 2101** **Structural Dynamics Laboratory**

**Structure of the Course**

Practical : 2 hrs/ Week Credits : 1
Internal Continuous Assessment : 100 Marks
No End Semester Examination

**Course Objectives**

- Ability to identify the response of structures subjected to dynamic loading
- Provide a firm foundation for research and practise in civil engineering
- Ability to solve dynamic problems numerically

**Learning Outcomes**

- Understand concepts and principles involved in structural dynamics
- To train the students to perform experimental work for project and thesis

**Details of Experiments**

1. Dynamics of a three storied building frame subjected to harmonic base motion
2. Dynamics of a single storied building frame with planar asymmetry subjected to harmonic base motion
3. Dynamics of a three storied building frame with planar asymmetry subjected to periodic (non-harmonic) base motion
4. Vibration isolation of a secondary system
5. Dynamics of a vibration absorber
6. Dynamics of a four storied building frame with and without an open ground floor
7. Dynamics of a single span and two span beams
8. Earthquake induced waves in rectangular water tanks (Demonstration only)
9. Dynamics of free standing rigid bodies under base motion (Demonstration only)
10. Seismic wave amplification, liquefaction and soil structure interaction. (Demonstration only)

**Note:** Results obtained from experiments may be numerically verified wherever possible.

**CSC 2102 Thesis Preliminary Part - I**

**Structure of the Course**

Hours/week: 2 Credits: 2

Internal Assessment: 100 Marks

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For the Thesis-Preliminary part I the student is expected to start the preliminary background studies towards the Thesis by conducting a literature survey in the relevant field. He/she should broadly identify the area of the Thesis work, familiarize with the design and analysis tools required for the Thesis work and plan the experimental platform, if any, required for Thesis work. The student will submit a detailed report of these activities at the end of the semester.

***Distribution of marks***

Internal assessment of work by the guide: 50 marks

Internal evaluation by the committee: 50 marks

**CSC 2103 Seminar**

**Structure of the Course**

Duration: 2 hrs/ Week Credits : 2

Continuous Assessment : 100 Marks

The student is expected to present a seminar in one of the current topics in the stream of specialisation. The student will under take a detailed study based on current published papers, journals, books on the chosen subject, present the seminar and submit seminar report at the end of the semester**.**

***Distribution of marks***

Seminar Report Evaluation- 40 marks

Seminar Presentation – 60 marks

**CSE 2001 Advanced Prestressed Concrete Design**

**Structure of the Course**

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination : 60 Marks

**Course Objectives**

- To impart to students the knowledge of methods of prestressing, analysis and design of various prestressed concrete elements under relevant codal provisions

**Learning Outcomes**

- Understand and use suitably the different concepts of prestressing.
- Comprehend the design of various prestressed concrete members used in practice

Module I

Basic concepts and brief history of prestressing, advantages and limitations of prestressing, types of prestressing, prestressing systems and devices, concrete and steel used in prestressed concrete, losses in prestress, analysis of members under flexure,shear and torsion.

Module II

Design of axially loaded members, flexural members – Type I and Type II sections, limiting zone, design of end block, design for shear and torsion, calculation of deflection and crack width, detailing of reinforcement, design of one way and two way slabs, analysis and design of continuous beams.

Module III

Composite construction: Types, analysis and design. Concept of partial prestressing. Circular prestressing: Analysis and design of pipes and water tanks,Design of prestressed concrete bridge decks.

**References**

1. Krishna Raju N., Prestressed concrete, Tata McGraw Hill Company, New Delhi 1998.
2. Mallick S.K. and Gupta A.P., Prestressed concrete, Oxford and IBH publishing Co. Pvt. Ltd. 1997.
3. Rajagopalan, N, Prestressed Concrete, Alpha Science, 2002
4. Ramaswamy G.S., Modern prestressed concrete design, Arnold Heinimen, New Delhi, 1990
5. Lin T.Y. Design of prestressed concrete structures, Asia Publishing House, Bombay 1995.
6. IS 1343: 1980 Indian Standard Code of Practice for Prestressed Concrete
7. IS 456: 2000 Indian Standard Code of Practice for Plain and Reinforced Concrete

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of 60% Design problems and 40% Theory. There will be three questions from each module, out of which two questions are to be answered by the students.

**CSE 2002 Forensic Engineering**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Module I

Failure of Structures: Review of the construction theory – performance problems – responsibility and accountability – causes of distress in structural members – design and material deficiencies – over loading. Environmental Problems and Natural Hazards. Causes of deterioration in concrete and steel structures. Preventive measures, maintenance and inspection.

ModuleII

Diagnosis and assessment of deterioration, visual inspection, non destructive tests, ultrasonic pulse velocity method, rebound hammer method, pull out tests, Bremer test, Windsor probe test, crack detection techniques, etc.

Module III

Methods of repair of cracks, repairing spalling and disintegration, repairing concrete floors and pavements. Repairing of corrosion damage of reinforced concrete. Modern Techniques of Retrofitting. Strengthening by pre-stressing. Repair of steel structures.

**References**

1 .Sidney M Johnson, Deterioration, *Maintenance and Repairs of Structures*, Mc Graw Hill Book Company, New York
2. Dovkaminetzky, *Design and Construction Failures*, Galgotia Publication., NewDelhi
3.Jacob Field and Kennenth L Carper, *Structural Failures*, Wiley Europe

**Structure of the Question paper**

For the end semester examination there will be three questions from each module out of which two questions are to be answered by the students.

**CSE 2003** **Structural Optimization**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

**Course Objectives**

- The ability to identify the importance of optimization in the engineering field
- Should be able to use optimization techniques for real life time applications
- Ability to apply optimization concepts for solving multi task applications

**Learning Outcomes**

- Understand various optimization methods
- Understand capabilities of optimization programmes
- Understand , Analyse various techniques and apply them for real time applications

Module I

Problem formulation with examples- Single Variable Unconstrained Optimization Techniques – Optimality Criteria - Interpolation methods -Gradient Based methods

Module II

Multi Variable Unconstrained Optimization Techniques – Optimality Criteria. Unidirectional Search - Direct Search methods - Simplex method - Gradient based methods - Constrained Optimization Techniques –Classical methods - Linear programming problem

Module III

Indirect methods- Direct methods Specialized Optimization techniques– Dynamic programming, Geometric programming, Genetic Algorithms.

**References**

1. Rao S. S., Engineering Optimisation – *Theory and Practice*, New Age International.
2. Deb, K., Optimisation for Engineering Design – Algorithms and examples, Prentice Hall.
3. Kirsch U., Optimum Structural Design, McGraw Hill.
4. Arora J S. Introduction to Optimum Design, McGraw Hill
5. Rajeev S and Krishnamoorthy C. S., Discrete Optimisation of Structures using Genetic Algorithms, Journal of Structural Engineering, Vol. 118, No. 5, 1992, 1223-1250.

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.

**CSE 2004** **Finite Element Method**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

**Course Objectives**

- To provide an understanding of fundamental knowledge and technique of FEM
- To develop tools to analyse engineering problems using FEM and typical commercial FEA package.

**Learning Outcomes**

- Will be able to analyse and build FEA model for various engineering problems.
- Can be extended to the dynamic analysis of structures

Module I

Basics of elasticity- Equations of equilibrium- Strain-displacement relation- stress-strain (constitutive) relation- Energy principles- Principle of virtual work- Principle of stationary potential energy- Variational formulation- Rayleigh-Ritz method- Introduction to weighted residual methods- Evolution of FEM- Review of direct stiffness method- Outline of the FE procedure.

Module II

Element properties- Displacement functions- convergence requirements- equilibrium and compatibility in the solution- Development of equilibrium equation- Types of finite elements- Development of shape functions for truss, beam and frame elements- CST, LST- Lagrange and Serendipity elements- Plane stress and plane strain problems- Gauss quadrature technique- Development of stiffness matrix for truss and beam elements.

Module III

Development of consistent nodal load vector- patch test- static condensation- Concept of isoparametric formulation- Line element- Plane bilinear element- Subparametric and superparametric elements- Assembly procedure and storage techniques of stiffness matrix, Application of boundary conditions- Solution techniques of equilibrium equation- Introduction to plate and shell elements- Types of 3D elements- Discussion of finite element packages.

**References**

1. Cook R D et al., Concepts and Applications of Finite Element Analysis, John Wiley & Sons, Singapore.
2. Krishnamoorthy C S, Finite Element Analysis- Theory and Programming, Tata McGraw Hill, New Delhi.
3. Bathe K J, Finite Element Procedures in Engineering Analysis, Prentice Hall, New Delhi.
4. Zienkiewicz O C and Taylor R W., Finite Element Method, Elsevier Butterworth-Heinemann, UK.
5. Rajasekharan S, Finite Element Analysis in Engineering Design, Wheeler, New Delhi.
6. Chandrupatla T R and Belegundu A D, Introduction to Finite Elements in Engineering, Pearson Education, New Delhi.
7. Hutton D V, Fundamentals of Finite Element Analysis, Tata McGraw Hill Education Private Ltd.

New Delhi.
8. Mukhopadhyay M and Abdul Hamid Sheikh, Matrix and Finite Element Analyses of Structures, Ane Books Pvt. Ltd., New Delhi.

**Structure of the question paper**

For the end semester examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.

**CSE 2005** **Composite Structures**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

**Course Objectives**:

Composite materials are finding immense application in the field of aerospace, automobile and Civil engineering presently due to its outstanding material capability. It is required for the present structural engineers to know the fundamentals of composite material for designing composite structures in various fields.

**Learning Outcomes:**

- An ability to identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.
- A basic understanding of linear elasticity with emphasis on the difference between isotropic and anisotropic material behavior.
- An ability to predict the failure strength of a laminated composite plate.
- An ability to use the ideas developed in the analysis of composites towards using composites in aerospace design.

Module I

Introduction. Composite Fundamentals, Constituent Materials for Composites, Structural applications of Composite Materials, Manufacturing Processes.Mechanics of Composite Lamina - Review of Basic Equations of Mechanics and Materials and Linear Elasticity in 3D and 2-D plane stress and plane strain - Number of elastic constants and reduction from 81 to 2 for different materials. Stress-Strain Relations for a unidirectional and orthotropic lamina. Effective Moduli of a continuous fibre-reinforced lamina - Models based on mechanics of materials, theory of elasticity. Failure of Continuous Fibre-reinforced orthotropic Lamina. Maximum stress/strain criteria, Tsai-Hill and Tsai-Wu criterion. Hygrothermal effects on material properties on response of composites.

Module II

Mechanical Behaviour of Composite Laminates - Classical Lamination Theory, stress-strain variation, In-plane forces, bending and twisting moments, special cases of laminate stiffness. Laminate strength analysis procedure, Failure envelopes, Progressive failure Analysis. Free-Edge Interlaminar Effects , Analysis of free edge interlaminar stresses, Effects of stacking sequence, Design guidelines.

Module III

Bending, Buckling and Vibrations of Laminated Beams and Plates - Governing equations and boundary conditions, Solution techniques, deflection of composite beams and plates under transverse loads for different boundary conditions, buckling of laminated beams and plates under in-plane loads, vibration of laminated beams and plates under different boundary conditions.

**References**

1. Jones M. Roberts, Mechanics of Composite Materials, Taylor and Francis,1998
2. Reddy, J.N , Mechanics of Laminated Composite Plates: Theory and Analysis,CRC Press, 2003
3. Calcote, L. R., Analysis of Laminated Composite structures, Van Nostrand, 1969

4. Vinson, J. R. and Chou P, C., Composite materials and their use in Structures, Applied Science Publishers, Ltd. London, 1975
5. Agarwal, B.D. and Broutman, L. J., Analysis and performance of Fibre composites. $3^{rd}$ Edn., Wiley, 1990

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.

**CSE 2006** **Analysis and Design of Substructures**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

**Course Objectives**

- Ability to identify the soil-structure interaction
- Ability to select suitable foundation for different types of structures
- Should be able to analyse and design substructures

**Learning Outcomes**

- Basic understanding of type and selection of foundations
- To analyse and design foundations

Module I

Introduction to soil-structure interaction - Soil-structure interaction problems. Contact pressure distrubution beneath rigid and flexible footings on sand and clay - Contact pressure distribution beneath raft. Selection of foundations. Structural design of spread footing, combined Footing and raft foundation.

Module II

Pile foundation: Introduction - Estimation of pile capacity by static and dynamic formulae- Settlement of single pile - Laterally loaded piles - Brom's method - Ultimate lateral resistance of piles - Pile groups - Consideration regarding spacing - Efficiency of pile groups – Pile Cap-Structural Design of Pile and pile cap

Module III

Retaining Walls-Types - Stability analysis of cantilever retaining walls against overturning and sliding-Bearing capacity considerations- Structural design of retaining walls

Introduction to well foundations – Elements of well foundations – Types – Sinking stresses in wells – Design of well cap, Well steining, well curb, cutting edge and bottom plug

**References**

1. Swami Saran, Analysis and design of substructures, Oxford and IBH Publishing Company Pvt. Ltd.
2.Donald P. Coduto, Foundation Design: Principles and Practices, Dorling Kinderseley (India) Pvt. Ltd., 2012
3.Bowles J.E., Foundation Analysis and Design ($4^{th}$ Ed.), Mc.Graw-Hill Book Company, NY, 1988.
4. Varghese P.C, Foundation Engineering,Prentice Hall india ,NewDelhi 2005

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions have to be answered by the students.

**CSC 3101 Thesis Preliminary Part - II**

**Structure of the Course**

Hours/week: 15 Credits: 5

Continuous Assessment: 200 Marks

The Thesis Preliminary Part -II is an extension of Thesis Preliminary Part I. Thesis Preliminary Part II comprises of preliminary thesis work, two seminars and submission of thesis –preliminary report. The first seminar would highlight the topic, objectives and methodology and the second seminar will be a presentation of the work they have completed till the third semester and the scope of the work which is to be accomplished in the fourth semester, mentioning the expected results.

***Distribution of marks***

Internal assessment of work by the guide: 100 marks

Internal evaluation by the committee: 100 marks

**CSE 3001 High Rise Structures**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

**Course Objectives**

- The ability to identify the structural systems for various combinations of gravity and horizontal loading considering their functional use and heights.
- Should be able to analyse the behaviour and drift capacities of various high rise structural forms

**Learning Outcomes**

- Understand behaviour of common high rise structures under gravity and lateral loading
- Understand the drift capabilities of different structural forms

Module I

Definition of tall building-need for constructing tall building-Historic background-factors affecting growth. Design Criteria, Design Philosophy of High Rise structures, Materials, Loading-gravity loading- Dead and live load, live load reduction techniques-sequential loading, Impact loading, Wind Loading, Wind Characteristics, Static and Dynamic wind effects, Analytical and wind tunnel experimental method, Earthquake loading-equivalent lateral force method, modal analysis, Introduction to Performance based seismic design.

Module II

Structural form, Floor systems, Rigid frame Structures- rigid frame behaviour –approximate determination of member forces by gravity loading- two cycle moment distribution, approximate determination of member forces by lateral loading- Portal method, Cantilever method, approximate analysis of drift, Braced frames- Types of bracings-behaviour of bracings-behaviour of braced bents-method of member force analysis-method of drift analysis, Infilled frames- behaviour of infilled frames-stresses in infill-forces in frame- design of infill- design of frame- horizontal deflection.

Module III

Shear wall Structures-behaviour of shear wall structures-proportionate wall systems, non proportionate wall systems- horizontal deflection, Coupled shear walls-behaviour of coupled wall structures-method of analysis, Wall frame structures- behaviour of wall frames, Tubular structures-framed tube structures-bundled tube structures-braced tube structures, Core structures, Outrigger-Braced Structures, Foundations for tall structures-pile foundation-mat foundation, Modelling for analysis for high rise structures – approximate analysis, accurate analysis and reduction techniques, Discussion of various Finite Element Packages for the analysis of High Rise Structures

**References**

1. Bryan Stafford Smith and Alex Coull, Tall Building structures: Analysis and Design, Wiley-Interscience, New York, 1991.
2. Bungale S Taranath, Structural Analysis and Design of Tall Buildings, Tata Mc Graw Hill,1988.
3. Kolousek V, Pimer M, Fischer O and Naprstek J, Wind effects on Civil Engineering Structures. Elsevier Publications.1984.
4. Robert L Wiegel, Earthquake Engineering. Prentice Hall, 1970.

5. ATC40- Seismic evaluation and retrofitting of concrete buildings, Seismic safety commission, California 1996.
6. Wolfgang Schuller , High Rise Building structures, JohnWiley and sons,1977.
7. Mark Fintel, Hand book of concrete engineering Van Nostrand Reinhold, 1985.
8. FEMA 445, Next generation Performance based seismic design guidelines, FEMA, 2006.

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.

**CSE 3002 Engineering Applications of Artificial Intelligence and Expert Systems**

**Structure of the Course**

Lecture: 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

**Course Objectives**

- Introduces the different algorithms that can be applied in Artificial Intelligence.
- Impart an idea about how these algorithms can be used to solve the Civil Engineering problems

**Learning Outcomes**

- Students become aware of expert systems for knowledge representation, neural networks for knowledge organization and search techniques for knowledge manipulation.

Module I

Introduction to AI – Definition – Typical AI Problems – Knowledge representation and search – philosophical issues – Requirements of knowledge representation languages – semantic Networks – Frames – Predicate Logic – Rule Based Systems – Forward and Backward chaining – Comparison of different – representation methods. Expert system & Search – Heuristic – Knowledge Engineering – expert System – Designing an Expert System – Backward chaining – Rule based expert systems – Explanation facilities – Bayers's theorem – case study of MYCIN.

Module II

Search techniques, Breadth first search, depth first search, Heuristic search – Hill climbing, Best – first – search, A* algorithm, Graphs and Tree Representation. Problem solving as search, Planning, Game planning – Minimax and alpha – beta proving. Sewarching AND –OR Graph, Optimal Search – The Best path and Redundant Path

Module III

Computer Vision – Different levels of vision processing – Low level processing edge deletion line filling – depth & Orientation information – Object recognition – Practical vision system.

Advanced Topics – Machine Learning – Introduction – Genetic Algorithm – Neural Networks – Back propagation – Multi layer network – Applications – Software agents – Robots – different types – applications.

**References**


1. Alison Cawsey, The Essence of Artificial Intelligence, Prentice Hall Europe, 1998
2. Charniak & McDermott, Introduction to Artificial Intelligence, International Student Edition, Addison Wesley, 1998.
3. Dan W Patterson, Introduction to Artificial Intelligence and Expert Systems, Prentice Hall of India, New Delhi 1992.
4. Winston, Artificial Intelligence,Addison-Wesley, 1992
5. Nilsson, Principles of Artificial Intelligence,Narosa, 1998
6. Elian Rich, Artificial Intelligence, Mc Graw Hill, 1991
7. Robert J. Schalkoff, Artificial Intelligence an Engineering Approach, Mc Graw Hill, 1990.


**Structure of the Question paper**

For the end semester examination there will be three questions from each module out of which two questions are to be answered by the students.

**CSE 3003** **Random Vibration**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

**Course objectives**

- Study of statistical concepts in vibration analysis
- Learn behaviour of structures subjected to random vibration

**Learning outcomes**

- Capability to solve random vibration problems
- Acquire basic knowledge in nonlinear random vibration analysis

Module I

Probability Theory – Random variables, Probability distribution and density functions – Expected value mean, variance, conditional probability, characteristic functions, Chebyshev inequality, functions of random variable

Module II

Random process - concepts of stationary and ergodicity – nonstationary process – auto and cross correlation and covariance functions – Mean square limit, differentiability and integrability – Spectral decomposition, power spectral and cross spectral density functions – Wiener Khintchine relation - Properties of Guassian, Poisson and Markov process. Broad band and narrow band random process – white noise

Module III

Random vibration - response of linear SDOF and MDOF systems to stationary and nonstationary random excitation. Response of continuous systems – normal mode method-Nonlinear random vibration - Markov vector – equivalent linearisation and perturbation methods - Level crossing, peak and envelope statistics – First excursion and fatigue failures - Applications

**References**


1. Nigam N.C, Introduction to random vibration, MIT press, 1983
2. Lin Y.K, Probabilistic theory in structural dynamics, McGraw Hill, 1983
3. Bendat J.S and Piersol A.G, Random data analysis and measurement procedure, John Wiley, 2011
4. Clough R.W and Penzien J, Dynamics of structures, McGraw Hill, 1975
5. Nigam N.C and Narayanan S, Applications of random vibration, Narosa, 1994.


**Structure of the Question paper**

For the End Semester Examination the question paper will consist of 60% problems and 40 % theory. There will be three questions from each module out of which two questions are to be answered by the students.

**CSE 3004** **Stability of Structures**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

**Course Objectives**

- Provides students a strong background in buckling phenomenon, buckling in columns, beam columns, frames, plates and shells
- Gives an idea of situations where the different structures are susceptible to buckling

**Learning Outcomes**

- Students become aware of the actual situations where stability becomes a governing factor

Module I

Buckling of Columns – Introduction – Concepts of Stability – Methods of Neutral Equilibrium – Euler Column – Eigen Value Problem – Axially Loaded Column – Effective Length Concept and Design Curve

Large Deformation Theory for Columns. The Behaviour of Imperfect Columns. Eccentrically Loaded Column. Inelastic Buckling of Columns- Double Modulus Theory- Tangent Modulus Theory

Energy method for calculating critical loads – Rayleigh Ritz Method – Galerkin Method – Numerical Methods – Matrix Stiffness Method- Flexural Members and Compression Members

Module II

Buckling of Built up Columns, Non-prismatic members- Effect of shear on critical Loads
Beams and Beam Columns – Introduction– Beam Column with Concentrated and Distributed Loads – Effect of Axial Load on Bending Stiffness. Design of Beam Columns- Interaction Formula.
Torsional Buckling. Torsional and Torsional – Flexural Buckling of Columns, Lateral Buckling of Beams. Continuous beams with axial load.

Module III

Buckling of Frames – Introduction – Modes of Buckling – Critical Load Using Neutral Equilibrium Methods.
Stability of a frame by Matrix Analysis
Buckling of Plates – Differential Equation of Plate Buckling – Critical Load of a plate uniformly compressed in one direction. Tension field behavior in Plate Girder Webs Postbuckling behavior of axially compressed plates. Instability of shells

**References**

1. S. P. Timoshenko, J. M. Gere. “Theory of Elastic Stability”, McGraw Hill Book Co.,2009
2. A. Chajes, “Principles of Structural Stability Theory”, Prentice Hall Inc.,1974
3. Iyenger, N.G.R. “Structural Stability of columns and plates”, Affiliated East west press Pvt Ltd., 1990.
4. F. Bleich “Buckling Strength of Metal Structures”, McGraw Hill Book Co., 1975
5. H. G. Allen , P. S. Bulson, “ Background to Buckling”, McGraw Hill Book Co.,1980
6. T. V. Galambos, “ Structural Members and Frames”, Prentice Hall., 1968
7. D. O. Brush and B. O. Almroths,” Buckling of Bars, Plates and Shells”, 1975
8. Ashwini Kumar, “Stability Theory of Structures” Mc Graw Hill Book Co., 1985

**Structure of the Question paper**

For the end semester examination there will be three questions from each module out of which two questions are to be answered by the students.

**CSE 3005 Structural Reliability**

**Structure of the Course**

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination : 60 Marks

**Course Objectives**

- Should be able to identify the uncertainty in structural systems
- Ability to extend reliability analysis concepts from structural elements to structural systems

**Learning Outcomes**

- Understand reliability concept and reliability indices
- Analyse structural systems using reliability method

Module I

General introduction to structural safety and reliability,Concept of uncertainty in reliability based analysis and design, Random variables- Concept and definition, Probability axioms and probability functions, Conditional probability, Common probability density and distribution functions and its descriptors, Correlation between random variables.

Module II

Joint probability distributions, Functions of random variables- Expectation and moments of functions of random variables, Concept of failure of a structure, Reduced variable space and basic definition of reliability index, First order second moment index, Hasofer-Lind reliability index, Rackwitz - Fiessler reliability index. Second order reliability method.

Module III

System reliability, Simulation techniques in reliability estimation, Importance sampling / Variation reduction techniques, Time variant reliability- (introduction alone)

**References**

1.Andrzej S. Nowak & Kevin R. Collins, Reliability of Structures, McGraw-Hill,1999.
2.Robert E. Melchers, Structural Reliability Analysis and Prediction, John Wiley & Sons,1999.
3.R. Ranganathan, Reliability Analysis and Design of Structures, Jaico Publishing House, Mumbai,1999.
4.Ang, A.H.S. and Tang, W.H. (1975). Probability Concepts in Engineering Planning and Design, Vol. 1, Basic Principles, John Wiley, New York,1975.
5.Ang, A.H.S. and Tang, W.H. (1984). Probability concepts in engineering planning and design. Volume II, John Wiley & Sons, Inc., New York, 1984.

**Structure of the Question paper**

There will be three questions from each module out of which two questions are to be answered by the students.

**CSE 3006 Fracture Mechanics**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

**Course Objectives**

- Introduce Fracture Mechanics and its applications to Structural Engineering students

**Learning Outcomes**

- Understand fracture mechanics which has wide applications in Structural Engineering.

Module I

Introduction:- Significance of fracture mechanics, Griffith energy balance approach, Irwin's modification to the Griffith theory, Stress intensity approach, Crack tip plasticity, Fracture toughness, sub-critical crack growth, Influence of material behaviour, I, II & III modes, Mixed mode problems.

Linear Elastic Fracture Mechanics (LEFM):- Elastic stress field approach, Mode I elastic stress field equations, Expressions for stresses and strains in the crack tip region, Finite specimen width, Superposition of stress intensity factors (SIF), SIF solutions for well known problems such as centre cracked plate and single edge notched plate.

Module II

Crack Tip Plasticity:- Irwin plastic zone size, Dugdale approach, Shape of plastic zone, State of stress in the crack tip region, Influence of stress state on fracture behaviour.

Energy Balance Approach:- Griffith energy balance approach, Relations for practical use, Determination of SIF from compliance, Slow stable crack growth and R-curve concept, Description of crack resistance.

LEFM Testing:- Plane strain and plane stress fracture toughness testing, Determination of R-curves, Effects of yield strength and specimen thickness on fracture toughness, Practical use of fracture toughness and R-curve data.

Module III

Elastic Plastic Fracture Mechanics (EPFM):- Development of EPFM, J-integral, Crack opening displacement (COD) approach, COD design curve, Relation between J and COD, Tearing modulus concept, Standard $J_{Ic}$ test and COD test.

Fatigue Crack Growth:- Description of fatigue crack growth using stress intensity factor, Effects of stress ratio and crack tip plasticity – crack closure, Prediction of fatigue crack growth under constant amplitude and variable amplitude loading, Fatigue crack growth from notches – the short crack problem. Introduction to Sustained load fracture. Method of predicting failure of a structural component, Practical significance of sustained load fracture testing.

**References**

1. Ewalds, H.L. & Wanhill, R.J.H., Fracture Mechanics – Edward Arnold Edition
2. Broek, D. Elementary Engineering Fracture Mechanics – Sijthoff & Noordhoff International Publishers.
3. Broek, D. The Practical Use of Fracture Mechanics – Kluwer Academic Publishers.
4. Hellan, D. Introduction to Fracture Mechanics – McGraw Hill Book Company.
5. Kumar, P. Elements of Fracture Mechanics – Wheeler Publishing.
6. Simha, K.R.Y. Fracture Mechanics for Modern Engineering Design, University Press.

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.

**CSC 4101** **Thesis**

**Structure of the Course**

Hours/week: 21 Credits: 12

Continuous Assessment: 300 Marks

End Semester Examination: 300 Marks

The student has to continue the Thesis work done in second and third semesters. There would be an interim presentation at the first half of the semester to evaluate the progress of the work and at the end of the semester there would be a Pre-Submission seminar before the Evaluation committee for assessing the quality and quantum of work. This would be the qualifying exercise for the students for getting approval from the Department Committee for the submission of Thesis. At least once technical paper is to be prepared for possible publication in Journals/Conferences. The final evaluation of the Thesis would be conducted by the board of examiners constituted by the University including the guide and the external examiner.

***Distribution of marks***

Internal evaluation of the Thesis work by the guide: 150 marks

Internal evaluation of the Thesis by the Evaluation Committee: 150 marks

Final evaluation of the Thesis Work by the Internal and External Examiners:

[Evaluation of Thesis: 200 marks+ Viva Voce: 100 marks *(5% of the marks is ear marked for publication in Journal/Conference)* ]– 300 marks

**CSD 2001** **Design of Bridges**

**Structure of the course**

| | |
|---|---|
| Lecture: 3hrs/Week | Credits: 3 |
| Internal continuous assessment: | 40 marks |
| End semester Examination: | 60 marks |

**Course Objectives**

- To understand the theory and design methods of various forms of bridges.

**Learning Outcomes**

- Students should be able to select a particular form of bridge to suit the requirements and analyse,design the same.

Module I

Classification and components of bridge. Review of road and railway bridge specifications and IRC provisions.

Foundation and substructure :Types of foundations, Piers and abutments- Forces on piers and abutments, Design of piers and abutments, bed blocks.

Bearings: Concrete, steel and neoprene bearings, Design of elastomeric pad bearings.

Module II

Bridge decks-Grid analysis- Courbons method-Orthotropic plate theory.

R. C. Bridges: Design of R. C bridge decks-slab bridges- Design of T beam bridges and balanced cantilever bridges. Introduction to – continuous girder bridges, box girder bridges, rigid frame bridges and arch bridges

Module III

Pre- stressed Concrete Bridges: Design of single span bridges- Introduction to various forms-Slab bridges-girder bridges-box girder bridges-Steel bridges: Design of plate girder and Pratt truss bridges, Introduction to suspension bridges and cable stayed bridges.

**References**


1. Johnson Victor D., Essentials of Bridge Engineering, Oxford & IBH Pub. Co.,198
2. Vazirani V. N., Design of Concrete Bridges,Khanna publishers,2004
3. Jagadeesh T.R and Jayaram M.A, Design of Bridge Structures, Prentice Hall,2004
4. Krishnaraju. N, Design of Bridges, Oxford & IBH Pub. Co.,2010
5. Krishnaraju.N,Prestressed Concrete bridges,CBS Publishers,2010
6. IRC 6-2000,IRC 21-2000,IS 800-2007,IRC 18-1985,IRC 24-2001,IRC 83-1987


**Structure of the Question paper**

For the end Semester Examination the question paper will consist of 60% design problems and 40% theory. There will be three questions from each module out of which two questions are to be answered by the students.

**CSI 3001** **Finite Element Analysis**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3

Internal Continuous Assessment : 40 Marks

End Semester Examination : 60 Marks

**Course Objectives**

- To provide an understanding of fundamental knowledge and technique of FEM
- To develop tools to analyse engineering problems using FEM and typical commercial FEA package.

**Learning Outcomes**

- Will be able to analyse and build FEA model for various engineering problems.
- Can be extended to the dynamic analysis of structures

Module I

Basics of elasticity- Equations of equilibrium- Strain-displacement relation- stress-strain (constitutive) relation- Energy principles- Principle of virtual work- Principle of stationary potential energy- Variational formulation- Rayleigh-Ritz method- Introduction to weighted residual methods- Evolution of FEM- Review of direct stiffness method- Outline of the FE procedure.

Module II

Element properties- Displacement functions- convergence requirements- equilibrium and compatibility in the solution- Development of equilibrium equation- Types of finite elements- Development of shape functions for truss, beam and frame elements- CST, LST- Lagrange and Serendipity elements- Plane stress and plane strain problems- Gauss quadrature technique- Development of stiffness matrix for truss and beam elements.

Module III

Development of consistent nodal load vector- patch test- static condensation- Concept of isoparametric formulation- Line element- Plane bilinear element- Subparametric and superparametric elements- Assembly procedure and storage techniques of stiffness matrix, Application of boundary conditions- Solution techniques of equilibrium equation- Introduction to plate and shell elements- Types of 3D elements- Discussion of finite element packages.

**References**

1. Cook R D et al., Concepts and Applications of Finite Element Analysis, John Wiley & Sons, Singapore.
2. Krishnamoorthy C S, Finite Element Analysis- Theory and Programming, Tata McGraw Hill, New Delhi.
3. Bathe K J, Finite Element Procedures in Engineering Analysis, Prentice Hall, New Delhi.
4. Zienkiewicz O C and Taylor R W., Finite Element Method, Elsevier Butterworth-Heinemann, UK.
5. Rajasekharan S, Finite Element Analysis in Engineering Design, Wheeler, New Delhi.
6. Chandrupatla T R and Belegundu A D, Introduction to Finite Elements in Engineering, Pearson Education, New Delhi.
7. Hutton D V, Fundamentals of Finite Element Analysis, Tata McGraw Hill Education Private Ltd. New Delhi.

8. Mukhopadhyay M and Abdul Hamid Sheikh, Matrix and Finite Element Analyses of Structures, Ane Books Pvt. Ltd., New Delhi.

**Structure of the question paper**

For the end semester examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.

**CSI 3002** **Mechanics of Composites**

**Structure of the Course**

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

**Course Objectives**:

Composite materials are finding immense application in the field of aerospace, automobile and Civil engineering presently due to its outstanding material capability. It is required for the present structural engineers to know the fundamentals of composite material for designing composite structures in various fields.

**Learning Outcomes:**

- An ability to identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.
- A basic understanding of linear elasticity with emphasis on the difference between isotropic and anisotropic material behavior.
- An ability to predict the failure strength of a laminated composite plate.
- An ability to use the ideas developed in the analysis of composites towards using composites in aerospace design.

Module I

Introduction. Composite Fundamentals: Definition of composites, Objectives, constituents and Classification of composites based on size (macro, micro, nano);structure (multilayered and multiphase); fibre architecture- linear, 2D, 3D, nd , matrix material (PMC,MMC,CMC, CC). General Characteristics of reinforcement- classification, terminology used in fibre science, General fibres- Glass, carbon, aramid, polyethylene, boron. Polymer matrix composites- Thermoplastics and thermosetting resins; mechanical properties, glass transition. Carbon fibre/epoxy, carbon fibre/PEEK, glass fibre/polyester, phenolic, epoxy, polyimide, cyanate ester composites. Concept of A stage, B stage and C stage. Structural applications of Composite Materials, Manufacturing Processes.

Module II

Macro mechanical behaviour of composite lamina - Review of Basic Equations of Mechanics and Materials and Linear Elasticity in 3D and 2-D plane stress and plane strain - Number of elastic constants and reduction from 81 to 2 for different materials. Stress-Strain Relations for a unidirectional and orthotropic lamina. Effective Moduli of a continuous fibre-reinforced lamina - Models based on mechanics of materials, theory of elasticity. Failure of Continuous Fibre-reinforced orthotropic Lamina. Maximum stress/strain criteria, Tsai-Hill and Tsai-Wu criterion. Hygrothermal effects on material properties on response of composites. Micro Mechanical Behaviour of a Composite Lamina - Introduction, Mechanics of Materials approach to Stiffness, Comparison of approaches to stiffness

Module III

Macro mechanical behaviour of a laminate- Classical Lamination Theory, stress-strain variation, In-plane forces, bending and twisting moments, special cases of laminate stiffness. Laminate strength analysis procedure, Failure envelopes, Progressive failure Analysis. Free-Edge Interlaminar Effects , Analysis of free edge interlaminar stresses, Effects of stacking sequence, Design guidelines.

**References**


1. Jones M. Roberts, Mechanics of Composite Materials, Taylor and Francis,1998
2. Reddy, J.N , Mechanics of Laminated Composite Plates: Theory and Analysis,CRC Press, 2006
3. Calcote, L. R., Analysis of Laminated Composite structures, Van Nostrand, 1969
4. Vinson, J. R. and Chou P, C., Composite materials and their use in Structures, Applied Science Publishers, Ltd. London, 1975
5. Agarwal, B.D. and Broutman, L. J., Analysis and performance of Fibre composites. 3rd Edn., Wiley, 1990


**Structure of the Question paper**

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.