NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (FIRST SEMESTER)

Specialization in

Structural Engineering

ADVANCED SOLID MECHANICS

CODE: CI42111 (CI)

L	T	P	Credits
3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40

Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective:

- To analyze the transformation of stresses and strains in 3D.
- To study engineering properties of materials, force-deformation, and stress-strain relationship.
- To understand the plastic behaviour of deformable bodies.

Course Content:

Theory of 3D Stresses: Introduction to stress tensor components, Equilibrium equations, Stress transformation, Principal stresses, Boundary conditions. Theory of 3D Strains: Introduction to strain tensor components, Strain transformation, Principal Strains, Compatibility. Stress-strain relationship, Generalized Hooke's law, Strain-energy, St. Venant's principle. Plane problems in Cartesian and polar coordinates, Stress functions, axisymmetric problems, Stress concentration, Unsymmetrical bending and Torsion. Theory of Failure. Introduction to plasticity for metals.

Course Outcome:

Upon completion of this course, student should be able to,

- Solve the advanced practical problems related to the theory of elasticity, concepts of stress and strain, strain energy, and failure criteria.
- Propose materials and structural elements to the analysis of complex structures.

Text Book/Reference Book:

1. M. Filonenko-Borodich, 'Theory of Elasticity', University Press of the Pacific, 2003.
2. L.S.Srinath, 'Advanced Mechanics of Solids', 3rd ed., McGraw-Hill Education, 2009.
3. S.P. Timoshenko and J. N. Goodier, 'Theory of Elasticity', 3rd ed., McGraw-Hill Education, 2010.

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (FIRST SEMESTER)

Specialization in

Structural Engineering

NUMERICAL METHODS

CODE: CI40112(CI)

L	T	P	Credits
3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40

Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective:

This course attempts to give a broad background of numerical methods common to various branches. The course covers solution of initial and boundary value problem for ordinary and partial differential equation using different methods. In addition, response surface methodology is discussed to establish relationship between input and output variables and the adequacy of model is tested by various techniques.

Course Content:

INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS

Single step methods: Taylor series method Euler and modified Euler methods Fourth order Runge-Kutta method for solving first and second order equations Multistep methods: Milne's and Adam's predictor and corrector methods.

BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS

Finite difference solution of second order, ordinary differential equation, Finite difference solution of one dimensional heat equation by explicit and implicit methods, One dimensional wave equation and two dimensional Laplace and Poisson equations.

RESPONSE SURFACE METHOD (RSM)

Approximating Response Functions, the Sequential Nature of RSM, Objectives and Typical Applications of RSM, RSM and the Philosophy of Quality Improvement, Product Design and Formulation (Mixture Problems), Robust Design and Process Robustness Studies

STATISTICAL MODELS

Linear regression models, least square estimators, hypothesis testing in multiple regression, test on individual regression coefficient and group of coefficient, confidance intervals in multiple regression. Prediction of New Response Observations, Model Adequacy Checking, Residual Analysis, Scaling Residuals, Influence Diagnostics, Testing for Lack of Fit, Fitting a Second-Order Model.

Couse Outcome:

At the end of this course students will be able to solve initial and boundary value problem and using response surface method they can develop linear and non-linear relationship between different inputs and output.

Text Book/Reference Book:

1. Gerald, C.F, and Wheatley, P.O, "Applied Numerical Analysis", Sixth Edition, Pearson Education Asia, New Delhi, 2002.
2. Balagurusamy, E., "Numerical Methods", Tata McGraw-Hill Pub.Co.Ltd, New Delhi, 1999.
3. Burden, R.L and Faires, T.D., "Numerical Analysis", Seventh Edition, Thomson Asia Pvt. Ltd., Singapore, 2002.
4. Myers, R.H., Montgomery, D.C., 2002. Response Surface Methodology, Process andProduct Optimization using Designed Experiments. Second ed.. Wiley.

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (FIRST SEMESTER)

Specialization in

Structural Engineering

STRUCTURAL DYNAMICS

CODE: CI42113(CI)	L	T	P	Credits
	3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40

Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective:

The primary objective of this course is to equip the student with the knowledge of characterizing the vibration and/or structural dynamic behavior of complex structures.

To determine various properties natural frequency, mode shapes and other important parameters

To develop the soft skills for necessary to accomplish professional objectives

Course Content:

Introduction to structural dynamics

Overview of structural dynamics, loading classification, Structural models, Formulation of equation of motion, Functional elements of discrete parameter systems, Equation of motion, Examples

Single Degree of Freedom (SDOF) systems

Equations of motion, free vibration response, forced harmonic vibrations, General dynamic loading, Numerical analysis, Exercise

Multi Degree of Freedom (MDOF) systems

Equations of motion, free vibration response, Numerical analysis for eigenvalue analysis, Forced vibration response, Numerical analysis for response analysis, Exercise

Basics of Earthquake Engineering

Indian standards, Response Spectrum Concepts, Different analysis methods, Ductile detailing of buildings, Examples

Couse Outcome:

The ability to apply knowledge of mathematics, science and engineering

The ability to analyse and interpret data

The ability to design a system or component under dynamic loading to meet socio-economic needs.

Text Book/Reference Book:

1. Chopra, A.K., Dynamics of Structures – Theory and Applications to Earthquake Engineering, 3rd ed., Pearson-Prentice Hall, New Jersey, 2007.

2. IS-1893-Part I, Criteria for Earthquake Resistant Design of Structures, Bureau of Indian standards, New Delhi, India, 2002.

3. J. L. Humar, Dynamics of Structures, 2nd ed., A. A. Balkema Publishers, 2002.

4. L. Meirovitch, Elements of Vibration Analysis, 2nd ed., McGraw-Hill, 1986.

5. Paz, M. and Leigh, W., Structural Dynamics – Theory and Computation, 5th ed., Springer, New York, 2004.

6. W. Clough and J. Penzien, Dynamics of Structures, 2nd ed., McGraw-Hill, 1993.

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (FIRST SEMESTER)
Specialization in
STRUCTURAL ENGINEERING

ELECTIVE I: ADVANCED PRE-STRESSED CONCRETE

CODE: CI42131(CI)

L	T	P	Credits
3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40

Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective:

To provide the basic concepts of prestressing.
To analyze and design the prestressed structure for the society considering with economy
To become familiar with professional and contemporary issues in the design and fabrication of prestressed concrete members.

Course Content:

Need for prestressing; Materials used; Pretensioning and Post-tensioning methods; Systems of prestressing, Behaviour of prestressed concrete beams; Loss of prestress; bursting forces in anchorage zone; Design methods; Partial prestressing; Analysis and design of continuous beams. Need of composite construction; Design methods for composite beams, slabs, columns and box –girders; Prestressed concrete water tanks, Prestressed concrete superstructures.

Couse Outcome:

To have an overall understanding of properties and behavior of Prestressing material.
Ability to analyse and design and the prestressed structure and prestressed concrete superstructure.

Text Book/Reference Book:

- Prestressed concrete by N .Krishna, Raju Prestressed concrete , McGraw Hill Education pvt., New Delhi, 5th Ed. 2012
- Prestressed concrete by T. Y. Lin, CBS Publisher and Distributer; 3rd Ed. 2004
- Limit-state Design of Prestressed Concrete [by] Y. Guyon. Translated by P. Chambon and F.H. Turner 2nd Ed. 1953

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (FIRST SEMESTER)

Specialization in

Structural Engineering

ELECTIVE I: ADVANCED STRUCTURAL ANALYSIS

CODE: CI42132 (CI)	L	T	P	Credits
	3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40

Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective:

- To equip students with different methods of analysis using matrix approach.
- To develop an understanding to analyze general 2D and 3D structures.
- To perform manual analysis of structures and compare them with those obtained from software.

Course Content:

Force and displacement methods of analysis, Flexibility and stiffness matrix methods of analysis for bars, trusses, beams, grids and space frames. Co-ordinate Transformation matrix. Development of algorithm for analysis of different types of structures by matrix method. Application of Structural Analysis software.

Couse Outcome:

Upon completion of this course, the student should be able to

- Analyze different structures by using flexibility and stiffness methods.
- Understand the background algorithm of different structural analysis software.

Text Book/Reference Book:

4. D.Maity, 'Computer Analysis of Framed Structures', 1st ed., I.K.International, Bengaluru, 2007.
5. Pandit and Gupta, 'Structural Analysis: A Matrix Approach', 2nd ed., McGraw-Hill, New Delhi, 2008.
6. A. Kassimali, 'Matrix Analysis of Structures', 2nd ed., Cengage Learning, 2012.
7. P.K.Singh, 'Matrix Analysis of Structures', 1st ed., Cengage Learning, New Delhi, 2013.

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (FIRST SEMESTER)
Specialization in
Structural Engineering

ELECTIVE II: ADVANCED CONCRETE TECHNOLOGY

CODE: CI42133 (CI)	L	T	P	Credits
	3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40
Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective: Concrete is the second largest material after water consumed by the society. Advanced concrete technology shall equip the students with latest knowledge in the field of concrete technology for its application at sites.

Upon successful completion of course and with field experience, each student should be able to: Test and identify good materials for making good concrete, Mix design of cost effective and durable concrete, Knowledge of latest advances in concrete technology

Course Content:

Concepts of concrete mix design; High strength concrete; High density and light weight concretes; Concreting under extreme weather conditions; Behaviour of concrete under aggressive environmental conditions; Admixtures; Polymers in concrete; Fibre reinforced concrete; Fracture mechanics of concrete; Self Compacting Concrete, Shrinkage compensating concrete, Pervious Concrete, Internal curing of concrete, Engineered Cementitious Composites, Non destructive test on concrete.

Course Outcome: Upon successful completion of course and with field experience, each student should be able to: Test and identify good materials for making good concrete, Mix design of cost effective and durable concrete, Knowledge of latest advances in concrete technology

Text/References

- Neville A.M., 'Properties of concrete', 5th ed., Pearson.
- Zongjin Li, 'Advanced Concrete Technology', Wiley.
- Dyer, 'Concrete durability', CRC.

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (FIRST SEMESTER)

Specialization in

Structural Engineering

Elective II: THEORY OF STRUCTURAL ELASTIC STABILITY

CODE: CI42134(CI)

L	T	P	Credits
3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40

Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective:

To introduce the fundamentals of concepts of stability, buckling of columns, buckling of beam-columns and frames, buckling of thin rectangular plates, and torsional and lateral-torsional buckling.

Course Content:

FUNDAMENTAL CONCEPTS: Concept of stability, instability and bifurcation, different forms of structural instability, analytical approaches of stability analysis.

COLUMNS: Governing differential equation, cases of standard boundary conditions, effective length concept, elastically restrained column, column with geometric imperfections, eccentrically loaded column, large deflection analysis. Inelastic Buckling.

BEAM-COLUMNS & FRAMES: Standard cases of beam columns, continuous columns and beam columns, single-storey frames, frames with sway and no-sway, buckling analysis using stiffness method, Haarman's method

ELASTIC BUCKLING OF THIN PLATES: Governing differential equation and boundary conditions, Equilibrium and energy approach, Post-buckling analysis.

LATERAL-TORSIONAL BUCKLING: Torsional buckling, torsional-flexural buckling, lateral buckling of beams with symmetric I-section.

Couse Outcome:

The students are expected to be able to apply the theory of elastic stability, to study the buckling of beams, columns, frames and plates.

Text Book/Reference Book:

1. *Ashwini Kumar, Stability of Structures, Allied Publishers, New Delhi, 1998.*
2. *Alexander Chajes, Principles of Structural Stability Theory, Prentice-Hall, 1974.*
3. *N.G.R. Iyengar, Elastic Stability of Structural Elements, Macmillan India, 2007.*
4. *S.P. Timoshenko and J.M. Gere, Theory of Elastic Stability, McGraw-Hill, 2nd edition, 1961.*

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (FIRST SEMESTER)

Specialization in

Structural Engineering

Elective II: THEORY OF PLATES AND SHELLS

CODE: CI42135(CI)	L	T	P	Credits
	3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40

Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective:

To introduce the fundamentals of classical theory of elastic plates and shells, address limitations and differences, introduce nomenclature, and present analytical and approximate solution techniques.

Course Content:

PLATES: Basic equations of plate bending theory: strain-curvature relations, stress and moment resultants; Governing equation for deflection of plates using equilibrium and energy approach, boundary conditions; Bending of isotropic rectangular and circular plates, Bending of orthotropic plates, Approximate Techniques (Ritz and Galerkin methods), Finite Difference Method, Buckling of plates, Shear deformable theories for laminated plates.

SHELLS: Classification of shell, Membrane stresses in shells, bending stresses in singly curved and doubly curved shells, Introduction to various structures such as hyperbolic paraboloid shells, elliptic paraboloid and barrel roofs, Analysis of folded plates.

Couse Outcome:

The students are expected to be able to apply the theory of plates and shells, to problems involving various geometries and boundary conditions in civil engineering and other related fields.

Text Book/Reference Book:

1. *J. N. Reddy, Theory and Analysis of Elastic Plates and Shells, CRC Press, 2nd edition, 2006*
2. *S.P. Timoshenko and S.W. Krieger, Theory of Plates and Shells, McGraw-Hill, 1959*
3. *S.S. Bhavikatti, Theory of Plates and Shells, New Age Internationals, 2nd edition, 2015*
4. *R. Szilard, Theory and Analysis of Plates, Prentice Hall Inc., 1974*

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (FIRST SEMESTER)

Specialization in

Structural Engineering

ADVANCED CONCRETE TECHNOLOGY LAB

CODE: CI42121(CI)	**L**	**T**	**P**	**Credits**
	0	**0**	**3**	**2**

TOTAL MARKS: 125; TOTAL PASS MARKS: 50% of Total Marks; MIN. PASS MARKS (ESE): 25

Teacher's Assessment: 75; End Semester Examination: 50

Experiments to be performed (Min 10 experiments)

S.N.	Name of Experiment
1	To determine the workability of concrete mix of given proportion and W/C by slump test, compacting factor, Rheology and Electrical resistivity.
2	To determine the effect of W/C on compressive strength of concrete.
3	To determine the effect of W/C on flexural strength of concrete.
4	To design concrete mix by Maximum Density Method
5	To design concrete mix by IS code Method
6	To design concrete mix by ACI code Method.
7	To determine the effect of type of curing on compressive strength of concrete
8	To know the effect of superplasticiser on the compressive strength and workability of concrete.
9	To know the effect of sand content on compressive strength and workability of concrete
10	To compare compressive strength of 100 mm cube, 150 mm cube and 150 mm cylinder
11	To know the effect of fibres on compressive strength and workability of concrete
12	To know the effect of fibres on flexural strength
13	To know the effect of carbonation on compressive strength concrete and carbonation depth
14	To know the effect of wetting and drying cycles on compressive strength of concrete
15	To perform Non-destructive testing of concrete
16	To determine fineness of cement by Blain's Permeability Apparatus.

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (FIRST SEMESTER)

Specialization in

Structural Engineering

EXPERIMENTAL STRESS ANALYSIS LAB

CODE: CI42122(CI)	L	T	P	Credits
	0	0	3	2

TOTAL MARKS: 125; TOTAL PASS MARKS: 50% of Total Marks; MIN. PASS MARKS (ESE): 25

Teacher's Assessment: 75; End Semester Examination: 50

Course Objective:

To introduce the fundamental concepts of experimental stress analysis techniques necessary to design models, instrumentation schemes and data analysis for experimental studies.

Course Content:

SIMILITUDE AND STRUCTURAL MODELS: Dimensional analysis, Buckingham's Pi theorem, scale factors and dynamic similitude; Uses and applications of models: types of model investigation, indirect and direct models, elastic and inelastic models (steel, concrete and masonry), size effects.

EXPERIMENTAL DATA ANALYSIS AND PLAN: Error and uncertainty in experiment, measurement systems, accuracy in models and reliability of results; test planning, design and implementation: testing sequence and experimental plan, loading systems, devices, actuators and their control.

INSTRUMENTATIONS: Various types of sensors for displacement, velocity, acceleration, pressure, loads, strains, full-field measurements.

PHOTOELASTICITY: Transmission photoelasticity, introduction to 3-D photoelasticity, digital photoelasticity, photoelastic coatings and brittle coatings

STRAIN GAUGES: Introduction, strain sensitivity, bridge sensitivity, rosettes, strain gauge selection and bonding.

DATA ACQUISITION SYSTEM AND DATA PROCESSING: Analog systems, digital systems using personal computers, dynamic measurement, numerical and graphical data processing and archiving.

Experiments List:

1. To determine the tensile strength of steel and aluminium using UTM and plot the stress-strain curve.
2. Study of resistance type strain gauge and displacement type transducer.
3. Study of LVDTs.
4. Study of Photoelastic bench.
5. Determination of modulus of elasticity by pure bending model using strain gauges for concrete, steel, aluminium and wood beam.
6. Study of load-deformation/buckling of steel, aluminium and wood column.
7. Study of load-deformation/buckling of steel, aluminium and wood frame.

Couse Outcome:

The students are expected to be able to design experimental model. Analyse experimental data and develop logical conclusions based on comparisons of experimental results to that of theoretical results.

Text Book/Reference Book:

1. *K. Ramesh, e-Book on Experimental Stress Analysis, IIT Madras, 2009. URL:http://apm.iitm.ac.in/smlab/kramesh/book_5.htm*
2. *W.N. Sharpe (Ed.), Springer Handbook of Experimental Solid Mechanics, Springer, 2008*
3. *J.W. Dally and W.F. Riley, Experimental Stress Analysis, McGraw-Hill, 1991*
4. *L.S. Srinath, M.R. Raghavan, K. Lingaiah, G. Gargesa, B.Pant, and K.Ramachandra, Experimental Stress Analysis, Tata Mc-Graw Hill, 1984.*

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (SECOND SEMESTER)

Specialization in

Structural Engineering

ADVANCED STRUCTURAL DESIGN

CODE: CI42211(CI)

L	T	P	Credits
3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40

Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective:

To cultivate the basic knowledge related to the analysis and design of structures and various fundamental aspects.
To provide the basic concepts of detailing of structures and applicability on structures.
To develop the skills of students for becoming a design professional in designing concepts of structures and serve the society.

Course Content:

Concrete Structures:
Flat slab, Grid floors, long cylindrical shell roof, Intz tank with continuity analysis, Design of RCC bridge deck (slab type, beam type and box girder type), Design of piers and bearings, Design of cellular box abutments.
Steel Structures:
Cold formed steel structures, Open web sections and castellated beams.
Introduction to prefabricated structures
Precast Concrete.

Couse Outcome:

The ability to apply knowledge of mathematics, science and engineering
The ability to analyse the structure and design a system or component to meet desired needs
The ability to provide economical and efficient design that meets societal needs while maintaining compatibility with environmental, energy and safety goals.

Text Book/Reference Book:

1. *D.J.Victor. Essentials of Bridge Engineering. 6th ed. Oxford Publication, 2007.*
2. *Gregory J. Hancock, Thomas Murray, and Duan S. Ellifrit. Cold Formed Steel Structure to the AISI Specification. CRC Press, 2001.*
3. *IS: 456:2000. Plain and Reinforced Concrete- code of Practice. Bureau of Indian Standards, Manak Bhavan, 9, Bahadur Shah Zafer Marg, New Delhi, 110002, India, 2000.*
4. *IS: 801:1975.Code of Practice for Use of Cold-Formed Light Gauge Steel Structural Members in General Building Construction. Bureau of Indian Standards, Manak Bhavan, 9, Bahadur Shah Zafer Marg, New Delhi, 110002, India, 2000.*
5. *Jaikrishna and O.P.Jain. Plain and RCC Design of Structure. 8th ed. Nemchand and Bros Publication, 1980.*
6. *N. Krishnaraju. Advanced Reinforced Concrete Design. 2nd ed. CBS Publication, 1986.*
7. *P.K. Das and S.N.Shrimani. Handbook for Design of Castellated Beams. Indian Edition Series.1986.*

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (SECOND SEMESTER)

Specialization in

Structural Engineering

FINITE ELEMENT METHOD

CODE: CI42212(CI)

L	T	P	Credits
3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40

Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective:

To introduce the fundamentals of FEM, understand how it works, implement (code) the method, Understand the capabilities of FEM

Course Content:

Introduction: Historical background, basic concept of the finite element method, steps in finite element analysis;
Variational methods: calculus of variation, the Rayleigh-Ritz and Galerkin methods; finite element analysis of 1-D problems: formulation by different approaches (displacement, potential energy and Galerkin), Derivation of elemental equations and their assembly, application of boundary conditions; Element properties: Natural coordinates, interpolation functions, isoparametric formulation, numerical integration (1-D and 2-D), mesh refinement, convergence criteria; analysis of truss, bending of beams and plane frame analysis; Finite element analysis of 2-D problems: finite element modelling of single variable problems, triangular and rectangular elements, Plane stress and plane strain problems; Bending of plates; Eigen value and time dependent problems; discussion about preprocessors, postprocessors and finite element packages.

Couse Outcome:

The students are expected to be able to apply basics of FEM to solve 1D and 2D problems in solid mechanics and to write computer program based on finite element methods.

Text Book/Reference Book:

1. *J. N. Reddy, An introduction to the Finite Element Method, McGraw-Hill, New York, 2006*
2. *R. D. Cook, D. S. Malkus and M. E. Plesha, Concepts and Applications of Finite Element Analysis, Fourth Edition, Wiley, India, 2003.*
3. *K. J. Bathe, Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs, NJ, 1996*
4. *Fish and Belytschko, A First Course in Finite Elements, John Wiley, 2007.*

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (SECOND SEMESTER)

Specialization in

Structural Engineering

SEISMIC ANALYSIS AND DESIGN OF STRUCTURES

CODE: CI42213(CI)

L	T	P	Credits
3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40

Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective:

To cultivate the basic knowledge related to the seismic analysis and design of structures and various fundamental aspects.
To provide the basic concepts of seismic detailing of structures and applicability on structures.
To develop the skills of students for becoming a seismic design professional in designing concepts of structures and serve the society of seismic region.

Course Content:

Design forces for buildings

Introduction; Fundamentals of analysis techniques, Equivalent static method; Mode superposition technique; Dynamic inelastic-time history analysis; Advantages and disadvantages of these methods; Determination of lateral forces as per IS1893 (Part 1) – Equivalent static method, Model analysis using response spectrum

Earthquake resistant design of RCC building

Determination of lateral forces on an intermediate plane frame using Equivalent static methods and Model analysis using response spectrum; Analysis of the intermediate frame for various load combinations as per IS1893 (Part 1); Identification of design forces and moments in the members; Design and detailing of typical flexural members ,typical column, footing and detailing of an exterior joint as per IS13920.

Steel Buildings

Behavior of steel; Materials and workmanship; Steel frames – unbraced, braced; Ductile design of frame members; Flexural members; Frame members subjected to axial compression and bending; Connection design and joint behavior; Steel Panel zones; Bracing members

Seismic protection of structures

Introduction; Considerations for seismic isolation; Basic elements of seismic isolation; seismic-isolation design principle; Feasibility of seismic isolation; Seismic dampers; Seismic vibration control-Seismic Strengthening Measures.

Ductility considerations in earthquake resistant design of RCC buildings

Introduction; Impact of ductility; Requirements for ductility; Assessment of ductility– Member/element ductility, Structural ductility; Factor affecting ductility; Ductility factors; Ductility considerations as per IS13920.

Couse Outcome:

The ability to apply knowledge of mathematics, science and engineering
The ability to analyse the structure and design a system or component to meet desired seismic design needs.
The ability to provide economical and efficient design that meets societal needs while maintaining compatibility with environmental, energy and safety goals..

Text Book/Reference Book:

1. *Earthquake resistant design of structures by Pankaj Agarwal and Manish Shrikhande, Prentice-Hall of India, 2006.*
2. *Seismic design of reinforced concrete and masonry buildings by T.Paulay and M.J.N.Priestley, John Wiley & Sons, 1991.*
3. *Earthquake resistant design of structures by SK Duggal , Oxford University Press.2007*
4. *The seismic design handbook, Edited by F.Naeim, Kluwer Academic publishers,2001.*

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (SECOND SEMESTER)

Specialization in

Structural Engineering

ELECTIVE III: CONSTRUCTION PLANNING AND MANAGEMENT (OPEN ELECTIVE)

CODE: CI40271(CI)	L	T	P	Credits
	3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40

Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective: Construction industry is second largest job provider, next to service industry. Construction management shall equip the students with effective management tools for effectively managing construction sites.

Course content: Objectives and functions of project management, project feasibility reports, Planning for construction projects, Cost control in construction-importance, objectives of cost control, cost control systems. Economics of Project management, Economic analysis of engineering projects, economic studies, sensitivity analysis, Introduction to Management Information System (MIS)- definition, outline of MIS. Scheduling Job layout and Line of balance, project management through networking PERT, CPM, Importance, causes of Accidents safety measures, responsibility for safety, safety benefits to various parties. Quality control in construction: Importance, Elements of quality, Quality Assurance Techniques, Quality Control Circles. Total Quality Management in construction, Introduction, Elements of TQM, Approaches to total quality, difference between traditional management and TQM, Applications and constants of TQM in construction process. Economic analysis of engineering projects, economic studies, sensitivity analysis, Introduction to Management Information System (MIS)- definition, outline of MIS Classification of construction equipments, earth moving equipments, hauling equipments, hoisting equipments, aggregate and concrete production equipments, pile driving equipments, time and motion studies, waiting line theory, Need for mechanisation, financing aspects, factors affecting selection of construction equipments, cost of owning and operating the construction equipment, role of operation research in equipment management, equipment maintenance.

Course Outcome: With the knowledge of the subject and field experience, students should be able to understand various important aspects related to construction projects like phases of construction projects along with their importance. They shall be able to discharge their duties as a project manager at site. They shall be able to plan, schedule and control various construction resources like Men, materials and equipments increasing overall performance of their company.

Name of Text/Reference Books:

1. Chitkara, 'Construction project management', McGraw Hills.
2. Jha, 'Construction project management', Pearson.
3. S. Seetharaman, 'Construction Engineering and Management' Umesh Publications.
4. Construction Planning Equipment and Methods – Peurify/ Schexnayder, McGraw Hill.

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (SECOND SEMESTER)
Specialization in
Structural Engineering

ELECTIVE III: STRUCTURAL HEALTH MONITORING, REPAIRS AND REHABILITATION OF STRUCTURES

CODE: CI42231(CI)	L	T	P	Credits
	3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40
Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective:

This course deals repairs and rehabilitation of different structures under different loading conditions. The failure mechanisms of structures, damage assessment using destructive and non-destructive testing and their solution using various techniques. In addition, the course also describes the various advanced method used for the structural health monitoring using application of different types of sensor, and smart materials.

Course Content:

STRUCTURAL HEALTH MONITORING

An Overview of Structural Health Monitoring, Structural Health Monitoring and Smart Materials, Structural Health Monitoring versus Non Destructive Evaluation, Overview of Application Potential of SHM, Notable Applications of SHM in Civil Engineering and instrumentation.

REPAIRS AND REHABILITATION OF STRUCTURES

Mechanisms of structural damages, cause of structural damages, assessment procedures of evaluating a damaged structure, strength assessment of damaged structure by destructive and non-destructive method. Engineered demolition techniques, repair and retrofitting methods, epoxy injection, shoring, and grouting, jetting, jacketing techniques.

Corrosion protection techniques, corrosion inhibitors, corrosion resistant steels, coating to reinforcement, cathodic protection.

Damages and structural failures (residential public and industrial), their repairs and rehabilitation. Maintenance, repair and rehabilitation of concrete pavements and bridges.
Maintenance, repair and rehabilitation of liquid retaining structures.
Case studies and their analysis.

Couse Outcome:

At the end of this course the student will be able to understand the failure mechanisms of structure and suggest proper rehabilitation method. With the concept of structural health monitoring the accuracy of data collection and their analysis will provide better understanding for the design.

Text Book/Reference Book:

1. 1. Smart Materials and Structures, Gandhi and Thompson. Springer Science & Business Media, 31-May-1992 - Technology & Engineering.
2. Concrete structure: Protection, Repair and Rehabilitation, Woodson R. .
3. Bridge and Highway structure Rehabilitation and Repair, Khan M. A. McGraw-Hill Professional (1 April 2010).
4. CPWD Handbook on Repair and Rehabilitation of RCC buildings.

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (SECOND SEMESTER)

Specialization in

Structural Engineering

ELECTIVE III: ADVANCED FOUNDATION ENGINEERING

CODE: CI42232(CI)

L	T	P	Credits
3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40

Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective:

Develop an understanding to use the concepts of geotechnical engineering for design of shallow and deep foundations and implement the concepts in engineering problems in real time practice for benefit of society.

Course Content:

Soil Exploration: Introduction, soil exploration, analysis and interpretation of soil exploration data, estimation of soil parameters for foundation design.
Shallow Foundations: Methods for bearing capacity estimation, total and differential settlements of footing and raft, code provisions. Design of individual footings, strip footing, combined footing, rigid and flexible mat, buoyancy raft, basement raft, underpinning.
Pile Foundations: Estimation load carrying capacity of single and pile group under various loading conditions. Pile load testing (static, dynamic methods and data interpretation), settlement of pile foundation, code provisions, design of single pile and pile groups, and pile caps.
Well Foundations: Types, components, construction methods, design methods.
Foundation on Rocks: Code provisions for design of foundations resting on rocks.
Soil-Foundation Interaction: Idealized soil, foundation and interface behavior. Elastic models of soil behavior; Elastic-plastic and time dependent behavior of soil. Beams and plates on elastic foundation.
Reinforced Earth: Geotechnical properties of reinforced soil, shallow foundation on soil with reinforcement, design considerations.

Course Outcome:

Able to design various types of shallow and deep foundations and will develop the understanding to solve engineering problems in real time practice for benefit of society.

Text Book/Reference Book:

1. A.P.S. Selvadurai, "Elastic Analysis of Soil-Foundation Interaction", Elsevier Scientific Publishing Company, Amesterdam – Oxford – New York, 1979.
2. Nainan P. Kurian "Design of Foundation Systems: Principles and Practices", Alpha Science International Ltd, Harrow, UK Third Edition, 2005.
3. Joseph Bowles, "Foundation Analysis and Design", McGraw-Hill Book Company, 5th Edition 2005.
4. V.N.S. Murthy, "Advanced Foundation Engineering", CBS Publishers and Distributors, First Edition 2011.

Pre-requisites:

Soil Mechanics and Foundation Engineering

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (SECOND SEMESTER)

Specialization in

Structural Engineering

ELECTIVE IV: RELIABILITY ENGINEERING (OPEN ELECTIVE)

CODE: CI40272(CI)

L	T	P	Credits
3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40

Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective:

Introduction to the concepts of uncertainty and reliability, Probability basics and random variables, Simulation techniques, Reliability analysis, Reliability-based design, System reliability, Introduction to advanced concepts.

Course Content:

General introduction to structural safety and reliability. Concept of uncertainty in reliability based analysis and design.

Random variables. Probability axioms and probability functions. Conditional probability. Common probability distributions. Correlation between random variables. Random vectors and functions of random variables.

Reliability Methods, Failure Surface & Definition of Reliability in Std. Normal Space (Cornell's Reliability Index), First Order Reliability Method (FORM) Hasofer-Lind's Definition of Reliability Rackwitz-Fiessler Algorithm Asymptotic Integral, Second Order Reliability Method (SORM).

Couse Outcome:

At the end of this course the student will be able to understand the concept related to the probability models and how to evaluate structural reliability using different methods.

Text Book/Reference Book:

1. Andrzej S. Nowak & Kevin R. Collins, "Reliability of Structures", McGrawHill.
2. R. Ranganathan, "Reliability Analysis and Design of Structures", Jaico.
3. Robert E. Melchers, "Structural Reliability Analysis and Prediction", John Wiley & Sons.
4.Haldar A & Mahadevan S. Reliability Assessment Using Stochastic Finite Element Analysis, John-Wiely & Sons Inc., New York, USA, 2000.

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (SECOND SEMESTER)

Specialization in

Structural Engineering

ELECTIVE IV: GROUND IMPROVEMENT TECHNIQUES

CODE: CI42233(CI)

L	T	P	Credits
3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40

Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective:

The soils at construction sites are not always totally suitable for supporting physical infrastructure such as buildings, bridges, highways, tunnels and dams. Under these conditions, soil needs to be treated using ground improvement techniques. Similarly specific types of soil improvement techniques are required in the case of expansive soils and collapsible soil and in the case of earthquake prone areas. T h e course addresses various ground improvement techniques along with principles, design issues and construction procedures.

Course Content:

Ground Improvement and Geosynthetics Principles of ground improvement, mechanical modification. Properties of compacted soil. Hydraulic modification, dewatering systems, stone column, preloading and vertical drains, electro-kinetic dewatering, chemical modification, Modification by admixtures, stabilization using industrial wastes, grouting, soil reinforcement principles, properties of geo-synthetics, applications of geo-synthetics in bearing capacity improvement, slope stability, retaining walls, embankments on soft soil, and pavements, filtration, drainage and seepage control with geo-synthetics, geo-synthetics in landfills, soil nailing and other applications of geo-synthetics.

Couse Outcome:

At the end of this course students will be able to solve initial and boundary value problem and using response surface method they can develop linear and non-linear relationship between different inputs and output.

Text Book/Reference Book:

1. Manfired R. Hausmann, Engineering Principles of Ground Modification, McGraw-Hill Pub, Co., 1990.
2. M C. R. Davies, F.Schlosser Ground improvement geosystems.
3. Koerner, R. M., Designing with geosynthetics, Prentice Hall Inc. 1998

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (SECOND SEMESTER)

Specialization in

Structural Engineering

ELECTIVE IV: EARTHQUAKE HAZARD ANALYSIS

CODE: CI42234(CI)	L	T	P	Credits
	3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40

Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

Course Objective:

To cultivate the basic knowledge related to the seismic hazard analysis and fundamental aspects of Earthquake Engineering.

To provide the basic concepts of risk assessments and various types of risks.

To develop the skills of students for becoming a professional in Seismic hazard analysis concepts of structures and serve the society of seismic region.

Course Content:

Engineering Seismology (Definitions, Introduction to Seismic hazard, Earthquake Phenomenon), Seismotectonics and Seismic Zoning of India, Earthquake Monitoring and Seismic Instrumentation, Characteristics of Strong Earthquake Motion, Estimation of Earthquake Parameters, Magnitude Indicators, Segmentation, Deterministic Seismic Hazard Analysis (DSHA), Probabilistic Seismic Hazard Analysis (PSHA), Earthquake Source Characterization, Gutenberg-Richter recurrence law, Predictive relationships, temporal uncertainty, Probability computations, Seismic Hazard Curve, Logic tree methods, Microzonation.

Couse Outcome:

The ability to apply knowledge of mathematics, science and engineering

The ability to analyse for seismic hazard and risk assessment.

The ability to develop the ground motions based on the seismic hazard analysis that meets societal needs while maintaining compatibility with environmental, energy and safety goals.

Text Book/Reference Book:

1. Earthquake resistant design of structures by Pankaj Agarwal and Manish Shrikhande, Prentice-Hall of India, 2006.

2. Seismic design of reinforced concrete and masonry buildings by T.Paulay and M.J.N.Priestley, John Wiley & Sons, 1991.

3. Kramer, S. L. (1996), Geotechnical Earthquake Engineering, Prentice Hall, New Jersey.

4. Reiter, L., (1990), Earthquake Hazard Analysis: Issues and Insights, Columbia University Press, New York

NATIONAL INSTITUE OF TECHNOLOGY RAIPUR

M.TECH. CIVIL (SECOND SEMESTER)

Specialization in

Structural Engineering

ELECTIVE IV: NON-LINEAR ANALYSIS

CODE: CI42235(CI)

L	T	P	Credits
3	1	0	4

TOTAL MARKS: 150; TOTAL PASS MARKS: 60; MIN. PASS MARKS (ESE): 40

Teacher's Assessment: 20; First Examination: 15; Second Examination: 15; End Semester Examination: 100

COURSE OBJECTIVE:

1. This course will provide an introduction to fundamental concept of geometric and material nonlinearity.
2. This course will train the candidates to solve the simple structural problems considering geometric and material nonlinearity.

SYLLABUS:

Stresses and Strains: Introduction, The Stress–Strain Behavior, Analysis of Stress, Mohr's Representation of Stress, Analysis of Strain Rate, Concepts of Stress Rate. Isotropic, orthotropic and anisotropic materials and their stress-strain relationship.

Nonlinear structural analysis: material and Geometric nonlinearities in structural analysis. Nonlinear constitutive equations.

Nonlinear geometric response of trusses for moderate and large displacements. Prestressed cable structures and cable nets. Nonlinear geometric response of beams and frames; P-Δ effect; stability of structures. Nonlinear section response; axial force-moment interaction diagrams. Effect of shear

Plasticity models: Basis of plasticity theory. Invariants of stress and strain tensors. Yield criterions (Tresca, Huber-von Mises / Hill), isotropic hardening, kinematic hardening, Drucker-Prager model. Rate-dependent plasticity. General statements of plasticity problems. Flow rules. Particular Stress–Strain Relations, The Total Strain Theory, Theorems of Limit Analysis.

Plastic Analysis of Beams and Frames: Introduction, Limit Analysis of Beams, Limit Analysis of Plane Frames, Displacements in Plane Frames, Variable Repeated Loading, MinimumWeight Design, Influence of Axial Forces, Limit Analysis of Space Frames.

Nonlinear material response: Truss element with nonlinear material. FE approximations for plasticity problems and FE algorithms for solution of plasticity problems

Solution strategies for nonlinear equilibrium equations; Newton-Raphson, secant stiffness and constant stiffness methods; load-step and displacement control strategies. Convergence of nonlinear FE solvers.

Solution technique of nonlinear systems of equations in SOFTWARES.

COURSE OUTCOME:

1. After successful completion of this course candidate will able solve the simple structural problems considering geometric and material nonlinearity.

TEXT BOOK / REFERENCE BOOKS:

1. Theory of Plasticity (3rd ed., 2006), J. Chakrabarty, Elsevier.
2. Plasticity Theory (Revised Edition, 2008), acob Lubliner.
3. Mathematical theory of plasticity, Hill R., (Oxford, 1998) (ISBN 0198503679)(KA).
4. Finite Elements in Plasticity- Theory & Practice, D. R. J. Owen and E. Hinton, Pineridge Press.
5. Plasticity-Mathematical Theory and Numerical Methods, W. Han B. Daya Reddy, Springer.
6. The Thermo-Mechanics of Plasticity and Fracture, G. A. Maugin, Cambridge University Press.

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M.TECH. CIVIL (SECOND SEMESTER)
Specialization in
Structural Engineering

COMPUTER APPLICATIONS LAB

CODE: CI42221(CI)	L	T	P	Credits
	0	0	3	2

TOTAL MARKS: 125; TOTAL PASS MARKS: 50% of Total Marks; MIN. PASS MARKS (ESE): 25
Teacher's Assessment: 75; End Semester Examination: 50

To develop the MATLAB applications for Finite Element Method on structural analysis

a) Static analysis

1. Modeling of truss

2. Modeling of beam and frame

3. Modeling of three dimensional building

b) Dynamic analysis

1. Modeling of truss

2. Modeling of beam and frame

3. Modeling of three dimensional building

c) Earthquake response analysis

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M.TECH. CIVIL (SECOND SEMESTER)
Specialization in
Structural Engineering

STRUCTURAL DYNAMICS LAB

CODE: CI42222(CI)	L	T	P	Credits
	0	0	3	2

TOTAL MARKS: 125; TOTAL PASS MARKS: 50% of Total Marks; MIN. PASS MARKS (ESE): 25
Teacher's Assessment: 75; End Semester Examination: 50

Course Objective:

The primary objective of this course is to equip the student with the knowledge of characterizing the vibration and/or structural dynamic behaviour of complex structures.
To determine various properties natural frequency, mode shapes and other important parameters
To develop the soft skills for necessary to accomplish professional objectives

LIST OF EXPERIMENT:

- Free Transverse Vibration and Determination of Natural Frequency.
- Dynamics of a three storied building frame subjected to harmonic base motion.
- Dynamics of a one-storied building frame subjected to harmonic base motions.
- Dynamics of a three storied building frame subjected to periodic (non-harmonic) base motion.
- Dynamics of a truss subjected to periodic (non-harmonic) base motion.
- To determine the response of the SDOF system under undamped free vibration using Software Program.
- To determine the response of the SDOF system under damped free vibration using Software Program.
- To determine and plot Dynamic Amplification Factor vs. Frequency Factor using Software Program.
- To determine the response SDOF system under forced undamped vibration using Software Program.
- To determine the response of SDOF system under forced damped vibration using Software Program
- Continues beam analysis using Software Program and manual calculation.
- Analysis of the building using Software Program.
- Modal analysis of the structure using Software Program
- Equivalent static method of analysis using Software Program.

Course Outcome:

The ability to apply knowledge of mathematics, science and engineering
The ability to analyse , interpret data and to design a system or component under dynamic loading to meet desired needs
The ability to design and conduct experiments on structures under vibrations.

Manuals/Text Book/Reference Book:

8. *A.K.Chopra." Dynamics of the Structure- Theory and Application to Earthquake Engineering". Prentice hall, New Jersey, 1995.*
9. *Computer and Structures, Inc. (CSI). SAP2000. Berkeley (CA, USA): Computer and Structures, Inc., 2000.*
10. *Pankaj Aggrawal and Manish Shrikhande. "Earthquake Resistant Design of Structures". PHI Learning Pvt. Ltd., 2014.*
11. *Mario Paz and William Leigh. "Dynamics of Structures: Theory & Computation". Kluwer Academic Publishers, 2004.*