

CIVIL ENGINEERING DEPARTMENT

M.TECH. STRUCTURAL ENGINEERING

**Course of Study & Scheme of Examination
2016-17**



**Maulana Azad National Institute of Technology,
Bhopal**

SCHEME
M. TECH. IN STRUCTURAL ENGINEERING

FIRST SEMESTER

Course Number	Subject	Scheme of Studies Periods per week			Credits
		L	T	P	
STR511	Theory of Elasticity	3	-	-	3
STR512	Advanced Structural Analysis	3	-	-	3
STR513	Advanced Design of Structures	3	-	-	3
	Elective - 1	3	-	-	3
	Elective - 2	3	-	-	3
	Open elective-1	3	-	-	3
STR514	Lab Practice 1	-	-	3	2
STR515	Seminar 1	-	2	-	2
Total credits 22					

SECOND SEMESTER

Course Number	Subject	Scheme of Studies Periods per week			Total Credits
		L	T	P	
STR521	Prestressed Concrete	3	-	-	3
STR522	Structural Dynamics	3	-	-	3
STR523	Theory of Plates & Shells	3	-	-	3
	Elective 3	3	-	-	3
	Elective 4	3	-	-	3
	Open elective2	3	-	-	3
STR524	Lab Practice 2	-	-	3	2
STR525	Seminar 2	-	2	-	2
Total credits 22					

LIST OF DEPARTMENT ELECTIVES

STR531 Soil Structure Interaction	STR537 Advanced Steel Structures
STR532 Composite Structures	STR538 Earthquake Analysis and Design of Structures
STR533 Advanced Finite Element Method	STR539 Design of Foundation Systems
STR534 Analysis of Tall Structures	STR540 Building Design
STR535 Bridge Design	STR541 Mechanics of Composite Material
STR536 Experimental Stress Analysis	STR542 Structural Reliability

LIST OF OPEN ELECTIVES

- STR551 Advanced Mathematics
- STR552 Soft Computing Techniques
- STR553 Probability and Statistical Methods
- STR554 Finite Element Method

THIRD SEMESTER

Course Number	Subject	Scheme of Studies Periods per week			Credits
		L	T	P	
STR611	Major Project Dissertation Phase- I	-	-	-	23
Total credits 23					

FOURTH SEMESTER

Course Number	Subject	Scheme of Studies Periods per week			Credits
		L	T	P	
STR648	Major Project Dissertation Phase- II	-	-	-	23
Total credits 23					

SYLLABUS

M.TECH IN STRUCTURAL ENGINEERING

FIRST SEMESTER

STR511 THEORY OF ELASTICITY

Elasticity, Generalized Hooke's Law, Stress tensor and transformation, Equilibrium equations in Cartesian system, Plane stress and plain strain problems, Strain-displacement relations, Strain tensors and its transformation, Compatibility conditions, Energy principles, Stress function, stresses and strains in polar coordinate system, equation of equilibrium and compatibility in polar system, stresses in rotating cylinder, disc, stress in curved bars, 3D-Elasticity, Normal and tangential stresses on oblique plane, Mohr's circle for evaluation of principal stresses and strains, strain energy in 3D system

References

1. Theory of Elasticity- Timoshenko and Goodier, Tata McGraw-Hill Education.
2. Applied Elasticity- Chi Ti Wang, TataMcgraw Hill.
3. Mechanics of deformable solids- Irving H. Shames, Krieger Publication Co.
4. Elasticity in Engineering- Scholer, Tata McGraw-Hill Education.
5. Applied Theory of Elasticity- Dr. Sadhu Singh, Khanna Publication.

STR512 ADVANCED STRUCTURAL ANALYSIS

Buckling loads of prismatic and non prismatic beam columns, Finite difference and integration methods,

Analysis of frames by Kani's method, Matrix methods of analysis for beams and frames, Flexibility and stiffness methods, Column analogy method

References

1. Matrix Computer Analysis of Structures- Moshe F. Rubinstein, Englewood Cliffs, N.J., Prentice-Hall.
2. Structural Analysis- R.C. Coates, MG Coutie, FG Kong, New York : Wiley, 1972.
3. Analysis of frame structures- J M Gere, W. Weaver, VanNostrand Reinhold, New York
4. Advanced theory of structures- N. C. Sinha, P. K. Gayen, Dhanpat Rai, New Delhi

STR513 ADVANCED DESIGN OF STRUCTURES

Revision of basic concepts of limit state design of prismatic members in flexure, shear and bond. Redistribution of moments in beams. Calculation of deflection due to load, shrinkage and creep. Calculation of crack width. Yield line theory for slabs, Design of flat slabs, design of folded plates and shells.

Load and resistance factor design, Secondary stress analysis of steel structures.

References

1. Design of Steel Structures- N. Subramanian, Oxford University Press, New Delhi
2. Design of R.C.C structures- P. Dayaratnam ,Oxford & IBH *Publishing Co Pvt.Ltd*;

STR514 STRUCTURAL LAB 1

List of Experiments

Properties of fresh and hardened concrete, Concrete mixes of various grades, Demonstration of nondestructive techniques of concrete

STR515 SEMINAR 1

SECOND SEMESTER

STR521 PRESTRESSED CONCRETE

Design of prestressed elements by working stress and limit state approach, design of beams, critical load condition, permissible stresses, various suggested methods of design partial prestressed beams, slabs, design of various type of slabs.

Shear and bond in prestressed concrete, anchorages in prestressing, post tensioned construction. prestressing cable at the centroidal axis, symmetric multiple cable, cable with eccentricity, miscellaneous structures : compression members, tension members, prestressed concrete pavements, folded plate and shells, arches, rigid frames, cylindrical tanks.

References

1. Prestressed Concrete- G. S. Pandit, S.P.Gupta. CBS *Publishers & Distributors Pvt. Ltd.*
2. Prestressed Concrete- N. Krishna Raju, Tata McGraw-Hill Education,
3. Prestressed Concrete- Libby, CBS *Publishers & Distributors Pvt. Ltd.*, New Delhi

STR522 STRUCTURAL DYNAMICS

Structures modeled as a single degree of freedom system, structures modeled as shear buildings, framed structures modeled as discrete multi degree of freedom systems, structures modeled with distributed properties, random vibrations.

References

1. Structural Dynamics Theory and computation- Mario Paz, Springer US

STR523 THEORY OF PLATES AND SHELLS

Cylindrical bending of long rectangular plates, Evaluation of stresses in long rectangular plates, slope and curvature of slightly bent plates, moment-curvature relationship for Pure bending of plates, strain energy in pure bending of plates, symmetrical bending of circular, Biharmonic plate equation, rectangular plates with different boundary conditions, Navier's and Levy's solution for rectangular plates, application of finite difference method for plate problems, different forms of shell structures, membrane analysis of shells, general theory of shells

References

1. Theory and Analysis of Plates- Rudolph Szilard, John Wiley & Sons.
2. Theory of plates and shells- S. Timoshenko & Woinowsky Krieger, Tata McGraw Hill *publishing* company
- 3 Theory of plates- K. Chandrashekhara, Universities Press.
4. Beam plates and Shells- Lloyd Hamilton Donnell, McGraw-Hill *publishing* company.
5. Theory of plates and shells- S.S. Bhavikatti, New Age International (P) Limited

STR524 LAB PRACTICE 2

Flexural strength of various concretes various grades. Establishing relationship between flexural strength and compressive strength of concrete experimentally, Study of various softwares for structural analysis and design.

STR 525 SEMINAR 2

DEPARTMENT ELECTIVES

STR531 SOIL-STRUCTURE INTERACTION

Soil foundation interaction, soil foundation – structure interaction, soil – fluid structure interaction, idealization of soil by various linear and non-linear, isotropic and anisotropic models, soil parameters, interpretation of parameters encountered in various idealized soil models, experimental investigations. Finite difference solution to problems of beams on linear and non – linear winkler models. soil – structure interaction in framed structure, FEM modeling, use of appropriate software packages introduction to dynamic soil structure interaction as well as non linear soil / concrete behavior.

References

1. Dynamic Soil-Structure Interaction- John, P. Wolf, Prentice Hall,
2. Soil-Structure Interaction in Time Domain- John, P. Wolf, Prentice Hall PTR Publication

STR532 DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES

Introduction to steel concrete composite structures their advantages and applications, types of composite beams and their design, types of composite floors & their design, various types of composite columns and their design, study of Indian and European codes.

References

1. Composite structures of steel and concrete- Johnson, R. P., Wiley
2. IS : 11384 and Eurocode -8.

STR533 ADVANCED FINITE ELEMENT METHOD

Overview of linear finite element method, concept of natural coordinate system Isoparametric formulation, numerical evaluation of stiffness matrix and load vector for elements of serendipity and lagrangian family, convergence and compatibility requirement, infinite and interface elements, formulation of geometric and material nonlinearity problems, formulation of dynamic problems, consistent and lumped mass matrices, Implicit and explicit numerical integration, modelling techniques and software packages.

Plate and shell analysis: Plate elements (Kirchoff theory, Mindlin plate element, triangular and rectangular plate elements, conforming and non-conforming elements, Shell elements (flat faced triangular and rectangular elements, degenerated shell elements)

References:

1. Introduction to finite element method- Dr. P.N. Godbole, I K International Publishing House Pvt. Ltd
2. Finite Element Method- C.S. Krishnamurthy, Tata McGraw-Hill Education,
3. Finite Element Method- S.S. Rao, Butterworth-Heinemann
4. Finite Element Method- S.S. Bhavakatti, New Age International

STR534 ANALYSIS OF TALL STRUCTURES

Principles of planning of tall buildings, loads on tall buildings, analysis of tall buildings (with and without shear walls), design of tall buildings, soil structure interaction

References

1. Tall Building Structures – Analysis and Design, Bryan Stafford smith and Alex Coull, Wiley

STR535 BRIDGE DESIGN

Bridge system, planning, economic consideration, aesthetics and selection of type of bridge. loading standards, super structure analysis, design of solid slab bridges, t-beam, girder bridge, bearings, long span bridges, design of box culverts.

References

- 1 Concrete Bridge Practice- Raina, V. K., Shroff *Publishers* and Distributors Pvt. Ltd.
2. Essentials of Bridge Engineering- Victor, D.J., Oxford & IBH *Publishing Co* Pvt.Ltd.
3. Bridge Engineering- Demetrios E. Tonnias, McGraw Hill Professional.

STR536 EXPERIMENTAL STRESS ANALYSIS

Measurement of strains: Basic concepts of theory of elasticity, various types of strain gauges, requirement of an ideal strain gauge, working principle of electrical strain gauge, strain sensitivity, installation procedure for strain gauges, temperature compensation, gauge factor, strain sensitivities, determination of actual strains, strain gauge rosette, strain measuring circuits: Potentiometer and Wheatstone bridges, temperature compensation

Photo elasticity: Plane and elliptically polarized light, stress-optic law, analysis of light vector through plane and circular Polariscopes,, Interpretation of isoclinics and isochromatics,

calibration of photo elastic material, transition from model to prototype, various methods of separation of principal stresses Brittle Coating Method: Concept of brittle coating, various types of coating materials, calibration of coating, threshold strain application of failure theory to brittle coating, advantages and limitations of brittle coating method.

References:

1. Experimental stress analysis- Dr. Sadhu Singh, Khanna *Publishers*.
2. Experimental stress analysis– Dr. A. Mubeen, Khanna *Publishers*.
3. Experimental stress analysis of stress and strain– T.K. Ray, S. Chand & Company Ltd.

STR537 ADVANCED STEEL STRUCTURES

Communication and transmission line steel towers, masts, design of industrial structures, composite steel and in-situ concrete beams and slabs.

References

1. Design of Steel structures- P. Dayaratnam, S. Chand & Company Ltd.
2. Composite Structures- R.P. Johnson, CBS *Publishers* & Distributors.
3. Design of steel structures- N. Subramanyam, Oxford.

STR538 EARTHQUAKE ANALYSIS AND DESIGN OF STRUCTURES

Earth quake ground motion. Structural dynamics. Concepts of earth quake resistant design of reinforced concrete buildings. Seismic analysis and modeling of reinforced concrete building. Earthquake resistant design of reinforced concrete buildings. Earthquake resistant design of masonry buildings. seismic evaluation and retrofitting of reinforced concrete and masonry buildings.

References

1. Earth Quake Analysis and Design of Structures- Pankaj Agrawal and Manish Shrikhande, PHI Learning Pvt. Ltd.

STR539 DESIGN OF FOUNDATION SYSTEMS

Shallow foundations: bearing capacity equations, special footing problems, I.S. codes, design of foundations and computation of settlements. pile foundations: type of piles, estimating pile capacity, pile load tests, negative skin friction, modulus of sub-grade reaction for laterally loaded piles, lateral resistance. Pile group considerations, efficiency, settlement of pile groups, pile caps, I.S. codes well foundations: types, shapes, bearing capacity and settlements,

determination of grip length by dimensional analysis, stability of well foundations by IRC method, construction, tilts & shifts.

Sheet pile structures: types, design / methodology anchors braced sheeting, cofferdams, single well cofferdams, cellular cofferdams, stability of cellular cofferdam, instability due to heave of bottom.

References:

1. Soil Mechanics- Lamb and Whitman, John Wiley & Sons.
2. Soil Engineering - Alam Singh, CBS *Publishers* & Distributors.
3. Foundation Engineering - Bowles McGraw-Hill Higher Education.

STR-540 BUILDING DESIGN

Structural proportioning of Architectural drawing and Grid, Study of Codal provisions, Calculation of loads, systematic design of building elements, study of structural drawing and detailing, use of relevant software's in building design.

References:

1. BIS Codes
2. Relevant software's

STR541 MECHANICS OF COMPOSITE MATERIALS

Classification and characteristics of composite materials, Mechanical Behaviour of composite materials. Lamina and Laminates. Manufacture of Laminated fibre – reinforced. Composite Materials. Macromechanical behaviour of lamina, stress strain relations for anisotropic, orthotropic and isotropic materials. Engineering constants. Stress strain relation for plane stress in orthotropic materials. Invariant properties. Strength of an orthotropic lamina, Experimental determination of strength, biaxial strength theories: Maximum stress theory, Maximum strain theory, Tsai-Hill theory and Tsai-Wu theory. Classical Lamination theory. Special cases of laminate, stiffness, strength of Laminates. Design of Laminates. Bending buckling and vibration of laminated plates. Governing equation. Deflection & buckling. Vibrations.

References:

1. Mechanics of Composite Materials: R.M. Jones, CRC Press
2. Mechanics of Laminated Composite Plates and Shells : J. N. Reddy, CRC Press
3. Principles of composite materials mechanics: Ronald F. Gibson, CRC Press

STR542 STRUCTURAL RELIABILITY

Introduction to Structural Reliability, Basic statics continuous and discrete probability distribution, probability laws, random number generation (Monte Carlo simulations), stochastic processes, formulation of structural reliability problem (limit states), First order reliability methods, system reliability (representation of failures, failure series), probability based acceptance criteria, probability based design

References:

1. Structural reliability analysis and prediction by Robert E. Melchers
2. Introduction to reliability engineering by Lewis, Wiley
3. Structural reliability, analysis and Design by R. Ranganathan, Jaico Publishing House

OPEN ELECTIVE

STR551 ADVANCED MATHEMATICS

Ordinary and partial differential equations: application to boundary value problems, Laplace and wave equations, time dependent equations with vibratory systems.

Theory of complex variables and conformal mappings: complex numbers, the elementary functions, Cauchy's theorem, infinite series. Elementary conformal mapping - conformal transformation of harmonic functions and boundary conditions. matrix theory : system of linear equations, determinate, finite dimensional vector, space matrices- matrix rotation. calculus of tensors with its applications to differential geometry. Application of matrices and tensors to simple problems. Numerical methods in engineering analysis: interpolation and relaxation methods. Methods of minimum potential energy, variational principles, Rayleigh-ritz method, Galerkin's method, Trefftz procedure, Pargers functions. percubation and collection procedures. Solution of linear and nonlinear equations by numerical methods. Numerical integration – Newton cotes, Gauss integration.

References

1. Higher Engg. Mathematics- S Grewa, Khanna *Publishers*
2. Engineering mathematics- S Shastri, PHI Learning Pvt. Ltd
3. Advanced Mathematics for Engineers- Gorakh Prasad ,John Wiley & Sons

STR552 SOFT COMPUTING TECHNIQUES

Artificial neural systems – perceptron – representation – linear separability – learning – training algorithm – the back propagation network – the generalized delta rule – practical considerations – BPN geomatic applications. Hopfield nets – Cauchy training – simulated annealing – the Boltzmann machine. Associative memory – bidirectional associative memory network – geomatic applications.

Counter propagation network and self organizing maps: CPN building blocks – CPN data processing. SOM data processing - adaptive resonance theory network - geomatic applications
Fuzzy logic: fuzzy sets and fuzzy reasoning – fuzzy matrices – fuzzy membership functions – operators decomposition – fuzzy automata and languages – fuzzy control methods – fuzzy decision making

Neuro – fuzzy modeling: adaptive networks based fuzzy interface systems – classification and regression trees – data clustering algorithms – rule based structure identification – Neuro-fuzzy controls – simulated annealing – evolutionary computation - geomatic applications.

References

1. Neural Networks – Algorithms, Applications & Programming Techniques: James Freeman A. and David Skapura, Addison-Wesley
2. Fuzzy Logic with Engineering Applications- Timothy J. Ross, Wiley
3. Artificial Neural Networks- Yegnanarayana B., Prentice Hall India Learning Pvt. LTM.
4. Fundamentals of Neural Networks- Lqurene Fausett, Pearson

STR553 PROBABILITY AND STATISTICAL METHODS

One dimensional random variables: random variables - probability function – moments – moment generating functions and their properties – binomial, Poisson, geometric, uniform, exponential, gamma and normal distributions – functions of a random variable, weighting of observations. Two dimensional random variables: joint distributions– marginal and conditional distributions – functions of two dimensional random variables – regression curve – correlation.

Estimation theory: unbiased estimators – method of moments – maximum likelihood estimation - curve fitting by principle of least squares – regression lines, propagation of systematic and accidental errors, theory of least squares and its application to adjustment problems.

Testing of hypotheses: covariance matrix – correlation matrix – multivariate normal density function – principal components – sample variation by principal components – principal components by graphing.

multivariate analysis: sampling distributions - type i and type ii errors - tests based on normal, t, chi-square and f distributions for testing of mean, variance and proportions – tests for independence of attributes and goodness of fit.

References

1. Probability & statistics for Engineering & the Sciences- Jay L. Devore, Cengage Learning, Inc
2. Applied multivariate methods for data analysis- Dallas E Johnson, Duxbury Resource Center
3. Probability and Statistics for Engineers- Richard Johnson Prentice Hall India
4. Applied Multivariate Statistical Analysis- Richard A. Johnson and Dean W. Wichern, Prentice Hall.

STR554 FINITE ELEMENT METHOD

Introduction to finite elements, terminology used in FEM, energy theorems, element stiffness matrix, shape functions, compatibility and convergence criteria, one dimensional elements such as spring, bar, truss, beam and torsion elements and evaluation of their shape functions, natural coordinate system, shape functions in natural coordinates for one and two dimensional elements, triangular and rectangular elements for plane stress and plane strain problems, 3-D elements for stress analyses, Introduction of commercial software(s) used for stress analysis

References

1. Introduction to Finite Element Method- P.N. Godbole, I K International *Publishing* House Pvt. Ltd
2. Finite Element Analysis Theory and Programming- Krishnamoorthy, C.S, Tata McGraw-Hill Education
3. The Finite Element Method in Engineering- S.S. Rao, Butterworth-Heinemann;
4. The Finite Element Method- Zinkiewicz, O.C. and Taylor, R.L , Oxford
5. An Introduction to Finite Element Method- Reddy, J. N., McGraw-Hill Education