TECHNO INDIA UNIVERSITY
WESTBENGAL

EM 4, Sector V, Salt Lake, Kolkata-700091, West Bengal, India
Phone: +91 9836544416/17/18/19, Fax: +91 33 2357 1097

2-Year Master of Technology (M.Tech) Curriculum and Syllabus for Civil Engineering (CE)

First Semester

Theory

Sl.	Code Number	Subject	Contact Hours L	T	P	Total	Credit Point
1	TIU– IPCE –T11	Bridge Engineering	4	0	0	4	4
2	TIU– IPCE –T13	Structural Dynamics	4	0	0	4	4
3	TIU– IPCE –T15	Theory of Elasticity and Plasticity	4	0	0	4	4
4	TIU– IPCE –T17	Finite Element Analysis	4	0	0	4	4
Total Theory							16

A. Practical

5	TIU– IPCE –L11	Structural Engineering Laboratory	0	0	5	5	5
6	TIU– IPCE –L13	Advanced Software Laboratory	0	0	5	5	5
Total Practical							10

Total of Semester **26**

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Syllabus

Single-degree-freedom systems: undamped and damped free vibration; Response to harmonic and periodic excitations; Response to non-periodic excitations; Numerical evaluation of dynamic response; Generalized single-degree-freedom systems. Elements of analytical dynamics: The principle of virtual work; Principle of D Alembert; Hamiltons principle; Lagrange's equation. Multi-degree-freedom systems: Equation of motion; undamped free vibration; Interpretation of modal orthogonality; Decomposition of response in terms of modal co-ordinates; Modal analysis; Response to external excitations; Rayleigh s quotient and its properties; Systems with proportional damping; Systems with arbitrary viscous damping. Distributed parameter systems: axial and bending vibration of beams; orthogonality of modes; Response to external excitations; Rayleigh s quotient; Approximate methods. Earthquake response of linear systems: Earthquake excitations; Equations of motion; Response spectrum concept; Response spectrum characteristics; Design response spectrum; Modal analysis; Displacement response; Element forces; Modal response contribution; Response history analysis; Response spectrum analysis. Introduction to Random Vibration; Stationary and non-stationery random processes; Ergodic random processes. Narrow band and wide band random processes; Properties of Autocorrelation and Power spectral density functions; Response to arbitrary excitation by Fourier transform method.

Text/ References:

1. Chopra, A.K., Dynamics of Structures: *Theory and Applications to Earthquake Engineering*, Prentice Hall/Pearson Education
2. Clough, R.W. and Penzien, J., *Dynamics of structures*, McGraw Hill, Inc., New York
3. Craig, R.R., Structural Dynamics: *An Introduction to Computer Methods*, Wiley New York
4. Meriovitch, L., *Elements of vibration analysis*, McGraw-Hill
5. Rao, S.S., *Mechanical Vibrations*, Pearson
6. Thomson, W.T., *Theory of Vibration with Application*, CRC Press
7. Newland, D.E., *An Introduction to Random Vibrations*, Spectral and Wavelet Analysis, Courier Dover Publications

Structural Engineering Laboratory (TIU– IPCE –L11)

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; Analysis of experimental data: 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; Instrumentation: mechanical, electrical, electronic system and their calibration, various types of sensors for displacement, velocity, acceleration, pressure, loads, strains, full-field measurements; Data acquisition system and data processing: analog systems, digital systems using personal computers, dynamic measurement, numerical and graphical data processing and archiving; Lab exercises: experiments to illustrate buckling of structural members; load-deformation behaviour of beams, columns, joints, and frames under various loads, mode shapes, natural frequency, damping factors from free and forced vibrations, shake table tests.

Texts/References

1. H.G. Harris and G.M. Sabnis, Structural Modeling and Experimental Techniques, 2nd Ed, CRC Press, 1999.
2. E. Bray and R. K. Stanley, Non Destructive Evaluation, CRC Press, 2002.
3. J.W. Dally and W.F. Riley, Experimental Stress Analysis, McGraw Hill, 3rd Ed, 1991.

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Advanced Software Laboratory (TIU– IPCE –L13)

Introduction and important features of software dealing with numerical computations, analysis and design of structures.

Texts/References

1. Pratap, Rudra. *Getting started with MATLAB: a quick introduction for scientists and engineers*. USA: Oxford University Press, 2010.
2. Srinivas, P., KUMAR, S.K.C.D.R. and Paleti, S., 2010. *Finite element analysis using ANSYS 11.0*. PHI Learning Pvt. Ltd..
3. Khennane, Amar. *Introduction to finite element analysis using MATLAB® and Abaqus*. CRC Press, 2013.

Finite Element Analysis (TIU– IPCE –T17)

Introduction to FEM; governing equation and its solution approximations (e.g. Collocation, Least Squares, Galerkin's method, the Ritz method); introduction to calculus of variations; concept of discretization of structures and shape functions; Lagrangian and serendipity elements; isoparametric formulation. Analysis of framed structures: plane stress and plane strain problems; axisymmetric problems; 3D stress analysis; analysis of plate and shell. Numerical integration and order of integration: error analysis and convergence; computer implementations of algorithms. Application of FEM in dynamics: eigenvalues and orthogonality.

Text/References:

1. R.D. Cook, D.S. Malkus and M.E. Plesha, Concepts and Applications of Finite Element Analysis, John Wiley & Sons, 4th Ed, 2002. Weaver, W. and Gere, J.M., *Matrix Analysis of Framed Structures*, CBS Publisher
2. K.J. Bathe, Finite Element Procedures, Prentice Hall of India Pvt. Ltd., 2002.Kanchi, M.B., *Matrix Methods of Structural Analysis*, Wiley Eastern Limited
3. S.S. Rao, Finite Element Method in Engineering, Butterworth Heinemann, 3rd Ed, 1999.

Bridge Engineering (TIU– IPCE –T11)

Introduction, historical review, engineering and aesthetic requirements in bridge design, introduction to bridge codes of practice, economic evaluation of bridge projects, site investigation and planning, hydraulic calculations for bridges, bridge foundations-open, pile, well and caisson, Piers, abutments and approach structures, superstructures-analysis and design of right, skew and curved slabs, Girder bridges-Types, load distribution, design, orthotropic plate analysis of bridge decks, introduction to long span bridges- cantilever, arch, cable stayed and suspension bridges.

Text/References:

1. Victor, D.J., *Essentials of bridge engineering*, Oxford & IBH Publishing
2. Ponnuswamy, S., *Bridge Engineering*, Tata Mcgraw Hill
3. Jagadeesh, T.R. and Jayaram, *M.A.*, *Design of Bridge Structures*, Phi Learning
4. Bindra, S.P., *Principles and Practice of Bridge Engineering*, Dhanpat Rai Publications

Theory of Elasticity and Plasticity (TIU– IPCE –T15)

Introduction to elasticity theory; Stress analysis: forces and moments, theory of stress, principal stresses and stress invariants, compatibility equations, equilibrium equations; Strain: deformation and velocity gradients, Lagrangian and Eulerian description and finite strain, small deformation theory, principal strains and strain invariants, compatibility conditions; Fundamental physical principles: conservation of mass, linear momentum, angular momentum, and energy, second law of thermodynamics; Constitutive theory: St. Venant's principal, linear elasticity and generalized Hook's law, Stokesian and Newtonian fluids, Navier-Stokes equations, Bernoulli equation, linear viscoelasticity, yield criteria; Applications: Airy stress function, two-dimensional elastostatics problems, torsion.

Text/References:

1. Srinath, L.S., *Advanced Mechanics of Solids*, Tata McGraw Hill
2. Timoshenko, S., *Strength of Materials*, CBS
3. Bruhns, O.T., *Advanced Mechanics of Solids*, Springer
4. Timoshenko, S., and Goodier, J.N., *Theory of Elasticity*, Tata McGraw Hill
5. Chakrabarty, J. *Theory of Plasticity* , Butterworth-Heinemann