CE6102 STRUCTURAL DYNAMICS

Prerequisite: Nil

Course Objectives:

1. To understand the basics of dynamic loading and response and to mathematically formulate dynamic equation of equilibrium of structural systems.
2. To get familiarised with the free vibration analysis of single degree of freedom systems.
3. To understand response of single degree of freedom systems to harmonic loading, periodic loading and general dynamic loadings.
4. To understand free vibration analysis of multi degree of freedom systems and to study its response.
5. To get familiarised with dynamic analysis of distributed parameter systems.
6. To get familiarised with the practical vibration analysis viz. modelling of different types of structures, determination of natural frequency by approximate methods etc.

Total Hours: 42 Hrs.

Module 1: (11hours)

Over view: Basic features of dynamic loading and response – models for dynamic analysis – lumped mass, generalized displacements and finite element models; Formulation of equation of motion – Direct equilibration, principle of virtual displacement and Hamilton's principle. Degrees of freedom – Translational and rotational systems - mass moment of inertia.

Generalized single degree of freedom systems: rigid body assemblage – determination of characteristic properties.

Free vibration of single degree of freedom system: Solution of equation of motion, undamped free vibration – Damped free vibration, critically damped, under damped and over damped systems, Negative damping.

Module 2: (11hours)

Single degree of freedom system: Response to harmonic loading, Undamped system, damped system, response to periodic loading -Fourier series expansion of the loading- response to Fourier series loading Exponential form of Fourier series loading and response; Complex frequency transfer functions

Response to impulsive loads; Suddenly applied load, sine wave impulse, rectangular impulse, triangular impulse, spike loading, approximate analysis

Response to general dynamic loading: Duhamel integral for undamped system – unit impulse response function – numerical evaluation, response of damped system- numerical evaluation, Numerical analysis in the frequency domain, fast Fourier transform analysis.

Module 3: (11hours)

Multi degree of freedom system: Two degree of freedom system – equation of motion, characteristic equation, frequencies and mode shapes, coordinate coupling and choice of degree of freedom, orthogonality of modes, natural coordinates, superposition of natural modes , response of two degree of freedom system to initial excitation, beat phenomenon, response to harmonic excitation

Multi- degree of freedom system – analysis of multi- degree of freedom system- mode superposition analysis.

Distributed Parameter System: Partial differential equation of motion - Axial vibration of prismatic bars - Elementary case of flexural vibration of beams - Beam flexure including axial force effects.

Module 4: (9hours)

Practical Vibration Analysis: Determination of frequency by Rayliegh's method, beam flexure – selection of shape- improved Rayleigh's method.

Framed structures – Shear building concept and models for dynamic analysis, discrete parameter system by Rayleigh's method , improvement of frequency, Stodola method for discrete parameter system, reduction of second and higher modes- Stodola method for continuous parameter system.

References.

1. Clough,R.W. and Penzien, J., Dynamics of structures, McGraw Hill
2. Chopra, A.K., Dynamics of structures – Theory and Application to Earthquake Engg., Prent. Hall.
3. IS 1893 – Criteria for Earthquake Resistant Design of Structures.
4. SP 22: Explanatory Handbook on Codes for Earthquake Engineering.
5. Meirovitch L., Elements of Vibration Analysis, Mc.Graw Hill.
6. Thomson W.T., Theory of Vibration with Applications, CBS Publ.
7. Craig, Jr. R.R., Structural Dynamics, John Wiley.
8. Hurty, W.C. and Rubinstein M.F., Dynamics of Structures, Prentice Hall.

Assessment Methods:
Continuous Assessment: 50 Marks (Test 1: 20; Test 2: 20; Assignments/Tutorials: 10), End Semester Exam: 50 marks

Course Outcomes:
The student will be able to:
1. Mathematically model a structural system for dynamic analysis of the system.
2. Carry out free vibration analysis of single degree of freedom.
3. Analyse a single degree of freedom systems to subjected to harmonic loading, periodic loading and general dynamic loadings.
4. Perform free vibration forced vibration analyses of multi degree of freedom.
5. Expose the students to the practical vibration analysis viz. modelling of different types of structures, determination of natural frequency by approximate methods etc.