17MD004MECHANICAL VIBRATIONS

COURSE CODE	COURSE TITLE	L	P	T	C
17MD004	MECHANICAL VIBRATION				

Objectives

A course in linear and non-linear mechanical vibrations where students acquire the ability to

1. Formulate mathematical models of problems in vibrations using Newton's second law or energy principles
2. Determine a complete solution to mechanical vibration problems using mathematical or numerical techniques
3. Determine physical and design interpretations from the results

Outcomes: Students will be able to

1. Construct the equations of motion from free-body diagrams.
2. Solve for the motion and the natural frequency of free vibrations of (single degree of freedom) damped and undamped motion.
3. Construct the governing differential equation and its solution for a vibrating mass subjected to an arbitrary force.
4. Solve for the motion and the natural frequency of forced vibrations of (single degree of freedom) damped and undamped motion.
5. Obtain the complete solution for the motion of a single degree of freedom vibratory system (damped or undamped) that is subjected to non-periodic forcing functions.
6. Solve vibration problems that contain multiple degrees of freedom.
7. Obtain design parameters and indicate methods of solution for a complicated vibratory problem.
8. Solve non-linear vibration problems.

Skills acquired:

1. Analyze single and multiple DOF system problems
2. Effectively utilize energy methods
3. Estimate modes and mode shapes of vibratory systems
4. Analyze non-linear vibratory systems
5. Explain different vibration measurement instruments

UNIT - I

Single Degree of Freedom Systems: Equation of motion, Natural Frequency, Energy method, Rayleigh method, Viscously damped free vibration, damping models, underdamped, overdamped and critically damped vibrations, Logarithmic decrement, Forced harmonic vibrations, Magnification factor, Rotor unbalance, Transmissibility, Vibration Isolation, Equivalent viscous damping, Sharpness of resonance.

UNIT - II

Two Degrees of Freedom Systems: Generalized and Principal coordinates, derivation of equations of motion, Semi-definite system, Lagrange's equation, Coordinate coupling, Forced Harmonic vibration, Vibration absorber, Tuned absorber and damped absorber, determination of mass ratio.

UNIT - III

Multi Degrees of Freedom Systems: Derivation of equations of motion, influence coefficient method, flexibility and stiffness matrices, Maxwell reciprocal theorem, Modal analysis: undamped and damped systems, Calculation of natural frequencies: Matrix method, Matrix iteration method, Stodola method, Holzer method, Dunkerley method, Rayleigh method, Torsional vibration: Simple systems with one or two rotor masses, Geared rotor system.

UNIT - IV

Continuous systems: Closed form solutions, Vibration of strings, Longitudinal and torsional vibration of rods, Transverse vibration of beams: equations of motion and boundary conditions, Transverse vibration of beams: natural frequencies and mode shapes Continuous systems: Approximate solutions, Rayleigh method, Rayleigh-Ritz method, Galerkin method.

UNIT - V

Vibration Measurement: Vibration measurement system, Vibration transducers: working of displacement transducer, vibrometer, accelerometer; Signal amplifiers, Signal processing: FFT, windowing in FFT, vibration signature analysis, predictive maintenance.

EXPERIMENTS:

1. Determination of natureal frequency of single dof systems
2. Determination ofdamped natural frequency ofvibration ofthevibratingsystemwithdifferent viscousoils.
3. Determinationofsteadystateamplitudeofaforcedvibratorysystem.
4. Staticbalancingusingsteelballs.
5. Determinationofthemagnitudeandorientationofthebalancingmassindynamicbalancing.

6. Fieldbalancingofthethinrotorsusingvibrationpickups.
7. Determination of the magnitude of gyroscopic couple, angular velocity of precession, and representation ofvectors.
8. DeterminationofnaturalfrequencyofgivenstructureusingFFTanalyzer.

TEXT BOOKS:

1. L. Meirovitch, "Fundamentals of Vibration", 3rd Edition, McGraw Hill, 2001.
2. G. K. Grover, "Mechanical Vibrations", 8th Edition, Nem Chand and Bros, 1996.
3. W.T. Thomson, "Theory of vibration with applications", 5th Edition, Prentice Hall, 1997.

REFERENCE BOOKS:

4. S. S. Rao, "Vibration of Continuous Systems", John Wiley & Sons, 2007.
5. J. S. Mehta & A. S. Kailey, "Mechanical Vibrations", 1st Edition, S Chand, 2012.