20MD006 MECHANICAL VIBRATIONS

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Course Objectives: students acquire the ability to

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

Outcomes: Students will be able to

- Construct the equations of motion from free-body diagrams.
- Solve for the motion and the natural frequency of free vibrations of (single degree of freedom) damped and undamped motion.
- Evaluate the natural frequency of forced vibrations of (single degree of freedom) damped and undamped motion.
- Analyze the non linear and random vibrations in the systems.

UNIT – I **L - 12**

Single Degree of Freedom Systems: Equation of motion, Natural Frequency, Energy method, Rayleigh method, Viscous 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 **L – 12**

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 **L – 12**

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 **L – 12**

Non – linear vibrations: Introduction, Sources of Non linearity, Qualitative and Quantitative methods for non linear vibration analysis, Free and Forced vibrations of SDOF and MDOF with non linearities, Chaos

UNIT – V **L – 12**

Random Vibrations: Introduction, Behavior of Random variable, joint probability distributions, Fourier Transforms, power spectral density, mean square value of response

LAB COMPONENT:

1. Determination of natural frequency of single DOF systems
2. Determination of damped natural frequency of vibration of the vibrating system with different viscous oils.
3. Determination of steady state amplitude of a forced vibratory system.
4. Static balancing using steel balls.
5. Determination of the magnitude and orientation of the balancing mass in dynamic balancing.
6. Field balancing of the thin rotors using vibration pickups.
7. Determination of the magnitude of gyroscopic couple, angular velocity of precession, and representation of vectors.
8. Determination of natural frequency of given structure using FFT analyzer.
9. Analysis of Non – Linear vibrations using MATLAB.
10. Analysis of Random Vibrations using MATLAB.

TEXT BOOKS:

1. S. Graham Kelly, “Mechanical Vibrations Theory and practice”, Cengage Learning, 2012
2. L. Meirovitch, “Fundamentals of Vibration”, 3rd Edition, McGraw Hill, 2001.
3. G. K. Grover, “Mechanical Vibrations”, 8th Edition, Nem Chand and Bros, 1996.

REFERENCE BOOKS:

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