# MECHANICAL VIBRATIONS

**Course Code: 15ME2201**

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**Course Outcomes:**

At the end of the course, a student will be able to

**CO1:** determine the natural frequency of transverse vibrations of the shaft and torsional vibrations of rotor systems.

**CO2:** analyze the mathematical modeling of the two degrees of freedom systems and explain about the working principle of vibration absorber.

**CO3:** compute the natural frequencies and mode shapes of a multi degree of freedom system and explain the modal analysis of a vibrating system.

**CO4:** select the numerical methods to determine natural frequencies of the beam and rotor systems.

**CO5:** describe the vibration measurement by using transducers and vibration exciters.

**UNIT – I** (10-Lectures)

Transverse vibrations, single concentrated load, uniformly distributed load, several loads, Dunkerley‘s method, energy method, whirling of shafts. Torsional vibrations – single rotor, two-rotor, three-rotor systems, torsionally equivalent shaft, geared system.

**UNIT – II** (10-Lectures)

Two degree of freedom systems – Principal modes of vibration – two masses fixed on tightly stretched string – double pendulum – torsional system with damping – forced vibration with harmonic excitation – undamped dynamic vibration absorber – untuned viscous damper

**UNIT – III** (10-Lectures)

Multi degree of freedom systems – exact analysis - free vibrations – equations of motion – influence coefficients - generalized co-ordinates –

Co-ordinate coupling – natural frequencies and mode shapes – eigenvalues and eigenvectors - orthogonal properties of normal modes – modal analysis.

**UNIT – IV** (10-Lectures)

Multi degree of freedom systems – Numerical methods – Rayleigh`s method – Dunkerley`s method – Stodola's method – Rayleigh Ritz method – Method of matrix iteration – Holzer's method for natural frequencies of multi rotor systems.

**UNIT – V** (10-Lectures)

Continuous systems – vibration of strings – longitudinal vibrations of bars – torsional vibrations of circular shafts - lateral vibration of beams Critical speeds of shafts – Critical speed of a light shaft having a single disc – without damping and with damping. Critical speed of a shaft having multiple discs – secondary critical speed

**TEXT BOOK:**

Rao S.S., "*Mechanical Vibrations*", 4e, Pearson Education Inc., 2004

**REFERENCES:**

1. G.K. Grover, "*Mechanical Vibrations*", Nemchand & Bros, Roorkee, 8e, 2009
2. William T Thomson & Marie Dillon Dahleh, "*Theory of Vibrations with application*", 5e, Pearson Education Publication, 2007
3. Tse, Morse and Hinkel, "*Mechanical Vibrations*", Chapman and Hall, 1991
4. Den Hartog J.P., "*Mechanical Vibrations*", McGraw Hill, 1986
5. V.P.Singh, "*Mechanical vibrations*", 3e, DhanpatRai & Co., 2006