

Branch Name:	Mechanical Engineering
Semester/Year:	Semester VI / Third Year
Subject Title:	Dynamics of Machinery
Subject Code:	1ET1010602
Pre-requisite:	Theory of Machines

Course Objectives:

1. To develop a solution oriented approach by in depth knowledge of Dynamics of Machinery.
2. To determine unbalance forces and counter them, as these forces may cause adverse effect on the function of the mechanism or machine.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
03	00	02	04	70	30	30	20	150

Subject Contents				
Sr. No	Topic	Total Hours	Weightage (%)	
1	Balancing of Rotating Masses: Concept of static and dynamic balancing, Analysis of effect of unbalanced masses in single and multiple planes in rotating elements, Bearing reactions. Approaches and equipment for measurement of unbalanced masses.	4	10	
	Dynamics of Reciprocating Engines: Single Cylinder Engine: Slider – Crank kinematics (Analytical), Gas force and torque; static and dynamic equivalence of models (for masses); Inertia, shaking force and shaking torque, Analysis of pin forces, balancing. Multi Cylinder Engines: Configurations; Inline Engines: Effect of phase angles, firing order and number of strokes; Shaking forces and moments, inertia torques and determination best configuration / unbalanced mass. Analysis of V and radial engine configurations. Graphical methods may be demonstrated but emphasis should be on analytical approach.	12	25	
2	Introduction to Mechanical Vibrations: Elements of simple harmonic motion, concept of natural frequency, types of vibrations, Basic elements and lumping parameters of a vibratory system, lumping of physical systems, Concept of Degrees of Freedom (DOF).	3	5	

	Single Degrees of Freedom System (Linear and Torsional): Undamped free vibrations, equivalent stiffness, equivalent systems, determination of natural frequency; Coulomb and Viscous damping, Types of dampers, Damping coefficient, damping effects: under, over and critically damped system, Damping factor, damped natural frequency and logarithmic decay; Analytical solution of Forced vibrations with harmonic excitation system and vector representation, Dependence of Magnification Factor, Phase difference and Transmissibility on frequency of excitation for various damping factors, Concept of vibration isolation, effect of base excitation. Two Degrees of Freedom System: Equation of motion and principal mode of vibration, torsional vibrations of two and three rotor system, torsionally equivalent shaft, geared system. Multi degree freedom systems and analysis (Free vibrations): Concepts of normal mode vibrations, natural frequencies, mode shapes, nodes, Correct definition of natural frequency.	12	25
	Vibrations of Continuous Systems (Free Vibrations): Longitudinal vibrations of bar or rod: Equation of motion and solution, Lateral vibrations of beam: Equation of motion, initial and boundary conditions, solution.	4	10
	Rotating Unbalance: Whirling of shafts, Critical speed and its practical importance in the design of shafts, Application of Dunkerley's method and Rayleigh's method for estimating the critical speed of shafts.	4	10
	Vibration Measurement: Introduction to vibration measurement and analysis devices: Vibrometer, velocity pickup, accelerometer, FFT analyser.	2	5
3	Cam Dynamics: Dynamic analysis of force-closed cam follower: Undamped and Damped response, Jump phenomenon: concept, effect of spring force and dead weights.	3	10

Course Outcomes:

The student will be able to

1. Determine unbalanced forces and bearing reactions for a system of rotating masses.
2. Determine unbalanced forces in reciprocating engines.
3. Determine natural frequency of mechanical systems represented in lumped form.
4. Evaluate free and forced vibration of linear multi-degree of freedom models of mechanical systems.
5. Determine critical speed shafts with unbalanced rotors and cam-follower system (to avoid jump).

List of Reference Books:

1. S S Rattan, Theory of machines. Tata McGraw-Hill Education, 2014.
2. Haideri, Farazdak. Dynamics of Machinery, Nirali Prakashan.
3. S S Rao, Mechanical Vibrations, Pearson.
4. R L Norton, Kinematics and Dynamics of Machinery, McGraw-Hill.
5. J.Uicker , Gordon R Penstock & J.E. Shigley, Theory of Machines and Mechanisms, oxford.
6. R S Khurmi, Theory of Machine, S Cahand
7. Kenneth J Waldron , Gary L Kinzel, Kinematics, Dynamics and Design of Machinery, Wiley.
8. V P Singh, Mechanical vibration. Dhanpat Rai & Sons.
9. A G Ambekar, Mechanical vibrations and noise engineering. PHI Learning Pvt. Ltd.

Note: Use of Design data book during the Lectures/Practical sessions is desirable.

List of Practicals:

1. Understand and verify the fundamental laws of static & dynamic balancing
2. Study balancing of reciprocating masses.

3. Study and confirm relation between the period of oscillation and length of pendulum for simple and compound pendulums.
4. Study longitudinal vibrations of spring mass system.
5. To study the undamped free vibration of equivalent spring mass system.
6. To determine the time period and frequency of torsional vibrations of a single rotor system.
7. To determine the time period and frequency of torsional vibrations of two rotors system.
8. Study forced damped vibrations of single degree of freedom system.
9. To determine whirling speed of the shaft and study effect of shaft diameter and end conditions on the same.
10. Study forced lateral vibrations of a beam.
11. Study jump phenomenon in the cam.
12. Vibration measurement and analysis.

E-Resources:

1. <http://nptel.ac.in/courses/112103111/>
2. <http://nptel.ac.in/courses/112101096/>
3. <https://ocw.mit.edu/courses/mechanical-engineering/2-003j-dynamics-and-vibration-13-013j-fall-2002/download-course-materials/>