GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICAL ENGINEERING (19)
DYNAMICS OF MACHINERY
SUBJECT CODE: 2161901
B.E. 6th SEMESTER

Type of course: Under Graduate

Prerequisite: None**.**

Rationale: The course aims to introduce fundamentals of forces induced due and responsible for the the motion of parts of mechanism / machine. This forces most of the time are unwanted and may cause adverse effect on the function of the mechanism or machine. Hence, the techniques to determine them and counter them are required to be learned.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% We
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.	3	10%
2	**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.	7	20%
3	**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).	2	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	10	20%

	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.	**5**	**10%**
	Multi degree freedom systems and analysis (Free vibrations): Concepts of normal mode vibrations, natural frequencies, mode shapes, nodes, Correct definition of natural frequency.	**4**	**5%**
	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.	****	
4	**Cam Dynamics:** Dynamic analysis of force-closed cam follower: Undamped and Damped response, Jump phenomenon: concept, effect of spring force and dead weights.	**4**	**10%**

**** Should be Cover during laboratory sessions.**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**15**	**15**	**10**	**10**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. S S Rao, Mechanical Vibrations, Pearson.
2. R L Norton, Kinematics and Dynamics of Machinery, McGraw-Hill.
3. J.Uicker , Gordon R Penstock & J.E. Shigley, Theory of Machines and Mechanisms, Oxford.
4. Kenneth J Waldron , Gary L Kinzel, Kinematics, Dynamics and Design of Machinery, Wiley.
5. R L Norton, Design of Machinery, McGraw-Hill.

Course Outcome:

After learning the course the students should 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. Determine critical speed shafts with unbalanced rotors and cam-follower system (to avoid jump).

List of Experiments:

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.

Design based Problems (DP)/Open Ended Problem:

1. Design a shock absorber for required performance.
2. Develop instrumentation with computer interface for various vibration setup in laboratory and validate the same.
3. Develop dynamic models of different types of vehicles and analyse the same.

Major Equipment:

1. Static and dynamic balancing setup of rotating masses.
2. Vib-Lab setup.
3. Whirling of shaft setup.
4. Cam dynamics setup.
5. Oscilloscope.

List of Open Source Software/learning website:

1. www.nptel.ac.in/

Active Learning Assignments (ALA):

Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work - The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.