



# GUJARAT TECHNOLOGICAL UNIVERSITY

**Bachelor of Engineering**

**Subject Code: 3160109**

**Semester –VI**

**Subject Name: Theory of Vibration**

**Type of course:** Professional elective course

**Prerequisite:** Engineering Mechanics

**Rationale:** This course is of basic level. It introduces fundamentals of vibration, vibration of single Degree of Freedom (DoF) system, 2-DoF and multi-DoF systems, and continuous systems such as bars and beams, and whirling of shafts.

### Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA (M)	ESE (V)	PA (I)		
3	0	2	4	70	30	30	20	150

### Content:

Sr. No.	Content	Total Hrs	Weightage
1	<b>Vibration Terminology:</b> Introduction and basic concepts of vibration, Importance of vibration, Definitions, Methods of Vibration analysis, Types of vibrations, Periodic and Harmonic Motion, Beats, Representation of harmonic motion in complex form	04	10%
2	<b>Undamped Free Vibrations:</b> Introduction, Derivation of differential equations, Torsional Vibrations, Equivalent stiffness of spring combinations, Simple & Compound pendulum	04	10%
3	<b>Damped Free Vibrations:</b> Introduction, Types of damping, Differential equations of damped free vibrations, Logarithmic decrement	04	10%
4	<b>Forced Vibrations:</b> Introduction, Sources of excitation, Equations of motion with harmonic force, Response of rotating and reciprocating unbalanced system, Support motion, Vibration Isolation, Vibration Transmissibility, Vibration measuring instruments, Frequency measuring device, Concept of Critical speed of shaft, Response to arbitrary loading: Duhamel's integral, Impulse Loading	09	20%
5	<b>Two degrees of freedom systems:</b> Introduction, Principal modes of vibrations, Torsional Vibrations, Co-ordinate coupling, Vibrations of undamped two degrees of freedom systems, Vibrations of damped two degrees of freedom systems, Undamped Forced vibrations with harmonic excitation, Vibration absorbers, Difference between vibration absorber and vibration isolator	08	20%
6	<b>Multi Degree of freedom systems:</b> Derivation of equations of motion ,influence coefficient method Properties of vibrating systems: flexibility and stiffness matrices, reciprocity theorem, Eigen Values and Vectors, Modal analysis.	08	15%
7	<b>Vibration of Continuous Systems:</b> Vibration of strings, Longitudinal and torsional	08	15%



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vibration of rods, Transverse vibration of beams: equations of motion and boundary conditions, Transverse vibration of beams: natural frequencies and mode shapes, Rayleigh Method, Rayleigh-Ritz method, Galerkin's Method		
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### Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30	30%	20%	10%	10%	0

**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. 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, Dhanpat Rai & Co., 2006
6. Rao S.S., "Mechanical Vibrations", 4e, Pearson Education Inc., 2004

### Course Outcomes:

Upon completion of this course students should be able:

Sr. No.	CO statement	Marks % weightage
CO1	To understand the basic terminologies, concepts and behaviour of vibrations in machines.	30%
CO2	To understand the determination of frequencies and other parameters in free and forced vibrations.	40%
CO3	To determine vibratory responses of SDOF and MDOF systems to harmonic, periodic and non-periodic excitation.	35%
CO4	To analyze vibrations in different continuous system and find approximate solution.	15%

### List of Experiments:

1. To investigate the relation  $T = 2\pi \sqrt{L/g}$  for simple pendulum.
2. To determine Radius of Gyration of the given compound pendulum.
3. To verify the theoretical frequency of the longitudinal vibrations of a spring mass system with experimental frequency.
4. To compare the experimental frequency of the undamped free vibrations of an equivalent spring mass system with the theo. Frequency.



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5. To study forced vibrations of an equivalent spring mass system.
6. To compare the theoretical frequency of the torsional vibrations (undamped) of a single rotor system with experimental frequency.
7. To study free vibrations of a two rotor system and determine the natural frequency.
8. To study the phenomena of whirling of shafts and find the critical speed.
9. To verify the Dunkerley's rule.
10. Study of vibration measuring instrument.

### **List of Open Source Software/learning website:**

<https://nptel.ac.in/>