GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: PG

Branch: Machine Design

Subject Code : ME02078061

Subject Name : Advanced Vibrations and Acoustics

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	Nil
Rationale:	Its critical role in optimizing the design and performance of mechanical systems by identifying and mitigating unwanted vibrations and noise, which can significantly impact equipment lifespan, user comfort, and overall operational efficiency across various industries like aerospace, automotive, manufacturing, and construction, ultimately leading to improved product quality and safety concerns through proactive maintenance and fault detection.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT level
1	Students will be able to predict response of a SDOF system, damped or undamped, subjected to simple arbitrary base or force excitations.	understand
2	Students will be able to prepare mathematical models of mechanical system for its dynamic analysis.	apply
3	Students will be able to estimate natural frequencies of mechanical system using computational methods.	analize
4	Students will be able to understand the basics of acoustics, psychoacoustics, equal loudness contours, dBA scale, loudness, pitch and timbre.	Evaluate

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

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Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Fundamentals of mechanical vibrations:** Sources of vibration, Free Vibration, Forced vibration, Natural frequency, Equivalent system, Energy method, Response to an initial disturbance, Duhamel's integral, Stiffness modeling, Non linear stiffness, Damped models, single degree of freedom system with viscous damping, Logarithmic decrement, General excitation-Duhamel's integral, Harmonic excitation, Mechanical Impedance, System identification from frequency response	14	30
2.	**Two Degree of Freedom Systems:** Free vibration of spring coupled system, Two degrees of freedom mass coupled systems, Forced vibrations of undamped system, Undamped vibration absorbers, Forced damped vibrations, Vibration Isolation	4	10
3.	**Multi degree of freedom systems:** Closed couple systems, Far coupled systems, Orthogonality of mode shapes, Modal analysis, Forced vibration, Using Lagrange's equation to derive equation of motion	6	15
4.	**Numerical methods:** Approximate methods for fundamental frequency, Dunkerley's lower bound approximation, Rayleigh's upper bound approximation, Matrix method	4	10
5.	**Continuous systems:** System governed by wave equation, solution of wave equation for free and forced vibrations, Free and forced vibration of beams	5	10
6.	**Fundamentals of Acoustics:** Plane acoustic waves, Sound speed, characteristic acoustic impedance of elastic media, sound intensity, dB scale, Transmission Phenomena, transmission from one fluid medium to another, normal incidence, reflection at the surface of a solid, standing wave patterns, Symmetric Spherical waves, near and far fields, simple models of sound sources, sound power, determination of sound power and intensity levels at a point due to a simple source, Psychoacoustics, Speech, mechanism of hearing, thresholds of the ear – sound intensity and frequency, loudness, equal loudness levels, loudness, pitch and timbre, beats, masking by pure tones, masking by noise.	12	25
	Total	**45**	**100**

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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**
-	**10**	**30**	**30**	**30**	**-**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Theory and Practice of Mechanical Vibrations, J. S. Rao, K. Gupta, New Age International Publishers
2. Mechanical Vibrations S. S. Rao, Pearson Education
3. Mechanical Vibrations S. G. Kelly, McGraw-Hill International editions
4. Engineering Vibration D. J. Inman, Prentice Hall
5. Fundamentals of Acoustics Lawrence E Kinsler, Austin R Frey, John Willey & Sons, Fourth Edition, 2000

(b) Open-source software and website:

1. NPTEL courses
2. Scilab Software

Suggested Course Practical List:

List of Experiments:

1. Experiments based on single degree of freedom systems;
2. Experiments based on two degree of freedom systems.
3. Experiments on lateral vibration of beams.
4. Draw the Campbell diagram using computer software (like MATLAB, Labview, Scilab).
5. Modal analysis using computer software (like MATLAB, Labview, Scilab).
6. Experiments based on analysis of vibration spectra, vibration signal captured by accelerometer and FFT analyzer.
7. Experiments based on Noise analyses.

List of Laboratory/Learning Resources Required:

Suggested Project List:

Major Equipment:

1. Universal Vibration experimental set up.
2. Accelerometer , Microphone, FFT analyzer.

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