Gyanmanjari Innovative University

Course Syllabus
Gyanmanjari Institute of Technology
Semester-4 (B.Tech)

Subject: Vibration and Structural Dynamics - BETAE14308

Type of course: Professional Elective Courses

Prerequisite: Basic Concepts of Engineering Mathematics, Engineering Physics, Material Science and Metallurgy, Basic of Aeronautical Engineering

Rationale: The main objective of this course is to understand the working of the Vibration and Structural Dynamics. This subject addresses the understanding and functioning of the different Vibration and its mechanics regarding the system.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks		Practical Marks		CA	
CI	T	P	C	ESE	MSE	V	P	ALA	
3	0	2	4	60	30	10	20	30	150

Legends: CI-Classroom Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE- Mid Semester Examination; V – Viva; CA - Continuous Assessment; ALA- Active Learning Activities.

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Course Content:

Unit No	Course content	Hrs.	% Weightage
1	**Fundamentals of Single and Multi-Degree of Freedom Vibrations:** Introduction and basic concepts, Equation of motion, Types and methods of vibration analysis, Single-Degree of Freedom (SDOF) systems, Free, damped, and forced vibrations, Sinusoidal motion and beat phenomenon, Multi-Degree of Freedom (MDOF) systems, Two-Degree of Freedom (TDOF) systems, Undammed and damped free vibrations, Forced harmonic vibrations, Semi-definite systems, Vibration absorber and control methods, Lagrange's equation and applications, Case studies and recent research findings	13	30 %
2	**Undammed and Damped Vibration:** Undammed vibration introduction, Natural frequency, undammed frequency, relation between damped and undammed frequency, critically damped vibration, Examples on damped and undammed Vibration.	08	20 %
3	**Vibration:** **Free Vibration:** Introduction, Types of damping, Differential equation of damped free vibration, Logarithmic decrement, Examples on free vibration. **Force Vibration:** Source of excitation, Equation of motion with harmonic force, Response of Rotating unbalance system, Support motion, Vibration Isolation, Transmissibility, forced vibration with coulomb, structural and viscous damping, Vibration measuring Instruments.	15	30 %
4	**Continuous system:** Lateral vibration of string, Longitudinal vibration of bars, and Transverse vibration of beams. Integration of Practical Applications	9	20 %

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1	**Study of Basic Vibration Motion:** Students will study vibration motion using a mass, spring, damper model. Calculate natural frequency and observe sinusoidal and beat motion. Prepare short notes with theory, equations, and graphs A PDF report of work will be uploaded on the GMIU portal.	10
2	**Continuous System Vibration** Students will study vibrations of strings, bars, and beams. They will compare lateral, longitudinal, and transverse motions. A short PDF report with equations and sketches will be uploaded on the GMIU portal.	10
3	**Case study:** Students will prepare a brief PDF report containing theoretical background, calculations, and diagrams, highlighting applications of vibration absorbers in real-world engineering systems such as machine foundations, vehicle suspensions, and rotating equipment. The final report will be uploaded on the GMIU portal.	10
	Total	30

Suggested Specification table with Marks (Theory):60

Distribution of Theory Marks (Revised Bloom's Taxonomy)						
Level	**Remembrance (R)**	**Understanding (U)**	**Application (A)**	**Analyze (N)**	**Evaluate (E)**	**Create (C)**
Weightage	30%	30%	40%	-	-	-

Course Outcome:

After learning the course, the students should be able to:	
CO1	Understand and analyze single-degree of freedom systems under free, damped, and forced vibrations.
CO2	Examine multi-degree of freedom systems to determine natural frequencies, mode shapes, and absorber effects.
CO3	Evaluate damping and external excitation effects on vibration response and isolation methods.
CO4	Analyze vibration behavior in continuous systems and relate concepts to real-world engineering applications.

List of Practical:

Sr. No	Descriptions	Unit No	Hrs.
1	**Study of Hydraulic System:** To understand the components and working of an aircraft hydraulic system.	1	4
2	**Damped Free Vibration Test:** To study the effect of damping and calculate the damping coefficient and logarithmic decrement.	1	4
3	**Forced Vibration Experiment:** To determine the frequency response and identify resonance in a forced vibration setup.	1	2
4	**Two-Degree of Freedom (TDOF) System Analysis:** To find natural frequencies and mode shapes of a two-mass spring system.	2	4
5	**Vibration Absorber Experiment:** To study the working of a tuned vibration absorber and measure vibration reduction.	2	4
6	**Transmissibility and Vibration Isolation:** To determine transmissibility ratio and analyse vibration isolation efficiency.	2	2
7	**Whirling Speed of Shaft:** To find the critical speed of a rotating shaft and verify theoretical predictions.	3	2

8	**Longitudinal Vibration of Bars:** To study natural frequencies of a bar under fixed and free boundary conditions.	3	4
9	**Transverse Vibration of Beams:** To determine natural frequency and mode shapes for a simply supported beam.	4	2
10	**Lateral Vibration of String:** To verify the relation between frequency, tension, and mass per unit length for a vibrating string.	4	2
		Total	30

Instructional Method:

The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

From the content 10% topics are suggested for flipped mode instruction.

Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory

The internal evaluation will be done on the basis of Active Learning Assignment

Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

Reference Books:

[1] Mechanical Vibration| By V P Singh.

[2] Vibration Fundamentals & Practice | By S S Rao.

[3] Engineering Vibration | By Inman D J | Pearson Education

[4] Introductory Course on Theory and Practice Mechanical Vibration | By Rao J.S., & Gupta, K. | New Age International (P) Ltd.

[5] Mechanical Vibration Theory and Practice | By Shrikant Bhave | Pearson Education