COURSE CONTENT

MECHANICAL VIBRATIONS									
VI Semester: ME									
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AMED37	Elective	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes:48**		
Prerequisite: Dynamics of Machines								

I. COURSE OVERVIEW:

The Mechanical Vibrations course provides students with a fundamental understanding of vibration phenomena in mechanical systems. It covers the principles of vibration analysis, modeling, and design of mechanical systems subjected to oscillatory motion. Students will learn to analyze single-degree-of-freedom (SDOF) and multi-degree-of-freedom (MDOF) systems, understand vibration measurement techniques, and apply methods to reduce and control vibrations in engineering systems. The course emphasizes both theoretical foundations and practical applications, preparing students for real-world engineering challenges in automotive, aerospace, structural, and industrial systems.

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II. COURSES OBJECTIVES:

The students will try to learn

I. The basic concepts of mechanical vibrations and phenomena of transmissibility.
II. The mechanical systems with/ without damping for 1/ multi degrees of freedom environment.
III. Application of vibration measuring instruments and machine monitoring systems.
IV. The analytical methods in solving problems of vibrations along with mode shapes.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO1 Derive analytical responses of SDOF systems for undamped/damped free vibration, forced excitation, transmissibility, vibration isolation, and shock inputs (impulse, step, ramp, arbitrary convolutions, Laplace solutions).

CO2 Decompose 2-DOF systems into principal modes and evaluate their undamped/damped free and forced responses, and design undamped vibration absorbers.

CO3 Develop matrix formulations using stiffness, flexibility, and influence coefficients; solve eigenvalue problems; interpret normal mode properties; and execute modal analysis for free/forced vibration.

CO4 Model torsional vibrations of multi-rotor and geared systems and interpret discrete-time system behavior with appropriate solution strategies (matrix inversion, matrix iteration).

CO5 Select and interpret vibration measurements using instruments such as vibrometers, velocity meters, and accelerometers and explain their working and applicability.

CO6 Perform frequency-domain diagnostics and numerical vibration solutions using concepts like Rayleigh’s method, Stodola iteration, Rayleigh-Ritz, Raleigh-Stodola, and Holzer/Holzer-type techniques for machine health, root-cause, and failure analysis.

IV. COURSE CONTENT:

Module – I: SINGLE DEGREE OF FREEDOM SYSTEMS (10)

Single degree of freedom systems: Undamped and damped free vibrations; forced vibrations coulomb damping; Response to excitation; rotating unbalance and support excitation; vibration isolation and transmissibility, response to non-Periodic Excitations: Unit impulse, unit step and unit ramp functions; response to arbitrary excitations, the convolution integral; shock spectrum; System response by the laplace transformation method.

Module – II: TWO DEGREE FREEDOM SYSTEMS (09)

Two-degree freedom systems: Principal modes, undamped and damped free and forced vibrations; undamped vibration absorbers.

Module – III: MULTI DEGREE FREEDOM SYSTEMS (10)

Multi degree freedom systems: Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis.

Method of matrix inversion; Torsional vibrations of multi-rotor systems and geared systems; Discrete Time systems; Vibration measuring instruments: Vibrometer, velocity meters and accelerometers.

Module – IV: FREQUENCY DOMAIN VIBRATION ANALYSIS (10)

Frequency domain vibration analysis: Overview, machine train monitoring parameters, data base development, vibration data acquisition, trending analysis, failure node analysis, root cause analysis.

Module – V: NUMERICAL METHODS (09)

Numerical methods: Raleigh‘s stodola's, Matrix iteration, Rayleigh- Ritz Method and Holzer's methods.

V. TEXT BOOKS:

1. G. K. Grover, *Mechanical Vibrationl*, Nemchand & Brothers, 8th Edition, 2009.
2. J.S. Rao and K. Gupta, *Introductory Course On Theory & Practice Of Mechanical Vibrational*, New Age International (p) Ltd , 2nd Edition, 2012.

VI. REFERENCE BOOKS:

1. B.C. Nakra and K. K. Chowdary, *Mechanical Measurements*, 2nd Edition, Tata McGraw-Hill, New Delhi, 2004.
2. Collacott, R.A., *Mechanical Fault Diagnosis and Condition Monitoring*, 1st Edition, Chapman and Hall, London, 2002.

VII. ELECTRONICS RESOURCES:

1. https://nptel.ac.in/courses/112108149.
2. https://www.google.co.in/webhp?sourceid=chrome instant&ion=1&espv=2&ie=UTF8#q=fem%20notes
3. https://www.kth.se/social/upload/5261b9c6f276543474835292/main.pdf.
4. https://akanksha.iare.ac.in/index?route=course/details&course_id=1293

VIII. MATERIALS ONLINE:

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open end experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper - II
9. Lecture notes
10. E-learning readiness videos (ELRV)
11. Power point presentation.