SRM University

M.Tech Automotive Hybrid Systems Engineering

(Collaborative program with NFTDC, Hyderabad)

(Proposed syllabus from the academic year 2015-16)

Core courses

		L	T	P	C
ME2105	**MECHANICAL VIBRATIONS**	**3**	**0**	**2**	**4**
	Total Contact Hours-75				
	Prerequisites (for non-mechanical Engineering students)				
	Basic knowledge on vibrations				
PURPOSE					
To present an overview about mechanical vibrations and its relation to design and analysis of vibrating systems.					
INSTRUCTIONAL OBJECTIVES					
1.	The procedure to derive the governing equation(s) of motion of an SDOF, MDOF, and continuous systems.				
2.	To determine frequencies and mode shapes of a given vibrating system modeled appropriately.				
3.	To analytically determine free and forced response of damped and un-damped SDOF systems.				
4.	To numerically determine the frequencies and mode shapes of MDOF systems				
5.	To perform preliminary vibration analysis of non-linear systems				
6.	Recognize the need for lifelong learning and develop the ability to engage in the same.				

UNIT IMULTI-DEGREE-OF FREEDOM (MDOF) SYSTEMS

Review of SDOF systems – need, mathematical model, free and forced un-damped and damped response - MDOF systems – Derivation of equations of motion of 2-DOF systems using Newton's II Law - 1, 2, and 3-DOF systems using Lagrange's method (just use of the method without proof). Eigen values and eigen vectors – relation to a vibration problem, determination of frequencies and mode shapes using analytical methods for 2-DOF systems and numerical methods (Holzer, matrix iteration methods) for 2 and 3-DOF systems. Un-damped free and forced response of a 2-DOF system using analytical methods; damped free and forced response of 2 and 3-DOF systems numerically (Finite Difference method using MS-Excel or MATLAB)

UNIT II VIBRATION CONTROL

Reduction of vibration at the source (brief mention), Balancing of Rotating Machines - Single-Plane and Two-Plane balancing, Whirling of Rotating Shafts - Modeling of the rotor system, critical speeds, response of the system, Balancing of Reciprocating Engines - Single cylinder engine – unbalanced forces due to gas pressure and inertia of moving parts - Balancing in a multi-cylinder engine (procedure and an illustrative problem). Vibration Isolation (SDOF system) – displacement transmissibility (from support) and force transmissibility (to support), Vibration Absorber - Tuned (un-damped) Vibration Absorber as a 2-DOF system - Damped Vibration Absorber (2-DOF system).

UNIT III ANALYTICAL DYNAMICS

Introduction to variational principles in dynamics - Hamilton's Principle - Lagrange's equation (derivation)

UNIT IV CONTINUOUS SYSTEMS

Transverse Vibration of a String or Cable - Equation of motion, Initial and boundary conditions, frequency equation, first few modes, free vibration of a string with both ends fixed, Longitudinal Vibration of a Bar or Rod and Torsional Vibration of a Shaft or Rod - Equation of motion – comparison with that of string or cable, Bending Vibration of Beams - Equation of motion, initial and boundary conditions, frequency equations for simply supported, cantilever, and fixed-fixed beams.

UNIT V NON-LINEAR VIBRATION

Introduction - Examples of non-linear vibration problems - Approximate Analytical Method – Lindstedt's method - Preliminary analysis of Duffing's and van der Pol's equations.

PRACTICAL 30
TOTAL 75

References:

1. Rao.S.S, "*Mechanical Vibrations"*, 4th Edition, Pearson Education Inc. Delhi 2009.
2. Rao.J.S and Gupta.K, "*Introductory course on theory and practice of mechanical vibrations*", New Age International, New Delhi, 1999.
3. Thomson.W.T, "*Theory of Vibration and its Applications"*,5th Edition, Prentice Hall, New Delhi, 2001.
4. Meirovitch.L, "*Elements of Vibration Analysis"*, 2ndEdition, Mc Graw-Hill Book Co., New York,, 1993.
5. Keith Mobley.R, "*Vibration Fundamentals"*, Plant Engineering Maintenance Series, Elsevier, 2007.