B.E Semester: 6 Automobile Engineering
Subject Name: Dynamics of Machinery (MA601-N)

A. Course Objective:

- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms representing various physic.
- To understand the effect of Dynamics of undesirable vibrations.
- To understand the principles in mechanisms used for speed control and stability control.

B. Teaching / Examination Scheme:

Teaching Scheme				Total Credit	Evaluation Scheme					
L	T	P	Total		Theory		Mid Sem Exam	CIA	Pract.	Total
Hrs	Hrs	Hrs	Hrs		Hrs	Marks	Marks	Marks	Marks	Marks
4	0	2	6	5	3	70	30	20	30	150

C. Detailed Syllabus:

Unit No.	Details
1	**Introduction to Mechanical Vibrations** Elements of simple harmonic motion, concept of natural frequency, types of vibrations, Basic elements and lumping parameters of a vibratory system, lumping of physical systems, Concept of Degrees of Freedom (DOF).
2	**Single Degrees of Freedom System (Linear and Torsional)** Undamped free vibrations, equivalent stiffness, equivalent systems, determination of natural frequency; Coulomb and Viscous damping, Types of dampers, Damping coefficient, damping effects: under, over and critically damped system, Damping factor, damped natural frequency and logarithmic decay; Analytical solution of Forced vibrations with harmonic excitation system and vector representation, Dependence of Magnification Factor, Phase difference and Transmissibility on frequency of 10 20% excitation for various damping factors, Concept of vibration isolation, effect of base excitation.
3	**Two Degrees of Freedom System** Equation of motion and principal mode of vibration, torsional vibrations of two and three rotor system, torsionally equivalent shaft, geared system. Multi degree freedom systems and analysis (Free vibrations): Concepts of normal mode vibrations, natural frequencies, mode shapes, nodes, Correct definition of natural frequency Vibrations of Continuous Systems (Free Vibrations): Longitudinal vibrations of bar or rod: Equation of motion and solution, Lateral vibrations of beam: Equation of motion, initial and boundary conditions, solution. Rotating unbalance: Whirling of shafts, Critical speed and its practical importance in the design of shafts, Application of Dunkerley's method and Rayleigh's method for estimating the critical speed of shafts.

4	**Vibration Measurement** Introduction to vibration measurement and analysis devices: Vibrometer, velocity pickup, accelerometer, FFT analyser
5	**Balancing of Rotating Masses** Concept of static and dynamic balancing, Analysis of effect of unbalanced masses in single and multiple planes in rotating elements, Bearing reactions. Approaches and equipment for measurement of unbalanced masses
6	**Dynamics of Reciprocating Mass** Single Cylinder Engine's Crank: Slider – Crank kinematics (Analytical), Gas force and torque; static and dynamic equivalence of models (for masses); Inertia, shaking force and shaking torque, Analysis of pin forces, balancing. Multi Cylinder Engine's Crank: Configurations; Inline Engines: Effect of phase angles, firing order and number of strokes; Shaking forces and moments, inertia torques and determination best configuration / unbalanced mass. Analysis of V and radial engine configurations. Graphical methods may be demonstrated but emphasis should be on analytical approach.
7	**Cam Dynamics** Dynamic analysis of force-closed cam follower: Undamped and Damped response, Jump phenomenon: concept, effect of spring force and dead weights.

Total hours (Theory):64
Total hours (Practical):32
Total hours:96

D. Lesson Planning:

Sr. No.	Date/Week	Unit	Weight age	Topic No
1	1^{st} ,2^{nd} ,3^{rd}	Unit 1	20%	1
2	4^{th} .5^{th} ,6^{th}	Unit 2	20%	2
3	7^{th} , 8^{th} ,9^{th}	Unit 3	20%	3,4
4	10^{th} .11^{th} . 12^{th}	Unit 4	20%	5,6
5	13^{th} , 14^{th} ,$15^{th,}$,16^{th}	Unit 5	20%	7

E. Instructional Method & Pedagogy

1	At the start of course, the course delivery pattern , prerequisite of the subject will be discussed
2	Lecture may be conducted with the aid of multi-media projector, black board, OHP etc. & equal Weight age should be given to all topics while teaching and conduction of all examinations.
3	Attendance is compulsory in lectures and laboratory, which may carries five marks in overall evaluation.
4	One/Two internal exams may be conducted and total/average/best of the same may be converted toequivalent of 30 marks as a part of internal theory evaluation.
5	Assignment based on course content will be given to the student for each unit/topic and will be evaluated at regular interval. It may carry an importance of ten marks in the overall internal evaluation.
6	Surprise tests/Quizzes/Seminar/Tutorial may be conducted and having share of five marks in the overallinternal evaluation.
7	The course includes a laboratory, where students have an opportunity to build an appreciation for theconcept being taught in lectures. Suggested list of experiment is given below

F. List of Practical:

1	(a) Experimental study of 1 DOF vibrations oscillatory vibrations with rigid link(negligible mass) (b) Experimental study of 1 DOF vibrations oscillatory vibrations with flexible links (string).
2	Experimental investigation of 1DOF vibration in spring mass system.
3	Experimental study of 1 DOF vibrations oscillatory vibrations with rigid inertial link.
4	Study of Tortional vibration in single plate and miulti plate inertial system.
5	Static and Dynamic balancing of rotational system.
6	Soft computing for vibration behaviour observation. Using Sci-Lab.
7	Individual case studies for math model development and analysis by numerical method using Sci Lab / Python.

G. Students Learning Outcomes:

1	The student can identify different areas of dynamic applications dealing with vibration.
2	Can find the applications of all the areas in day to day life.

H. Text Books & Reference Books:

1	S S Rao, Mechanical Vibrations, Pearson.
2	R L Norton, Kinematics and Dynamics of Machinery, McGraw-Hill.
3	J.Uicker , Gordon R Penstock & J.E. Shigley, Theory of Machines and Mechanisms, Oxford.
4	Kenneth J Waldron , Gary L Kinzel, Kinematics, Dynamics and Design of Machinery, Wiley.
5	R L Norton, Design of Machinery, McGraw-Hill.