TEACHING PLAN: MECHANICAL VIBRATION B.TECH 6TH SEM.

SCHOOL OF ENGINEERING AND TECHNOLOGY		**ACADEMIC SESSION: 2022-23**	**FOR STUDENTS' BATCH:2020-2024**
1	**Course code**	**PCC-ME 311**	
2	**Course Title**	**Mechanical Vibration**	
3	**Credits**	**4**	
4	**Learning Hours**	**Contact Hours: 3** **Practical Teaching: 0** **Project, Tutorial, and Assessment: 1** **Total hours: 4**	
5	**Course Objective**	i. To understand the fundamentals of Vibration Theory ii. To be able to do mathematically model and real-world mechanical vibration problems iii. To use computer software programs to investigate and understand vibration problems.	
6	**Course Outcomes**	CO1: Obtain equations of motion to understand the behaviour of oscillatory systems. CO2: Understand the fundamentals of various damping systems to reduce vibration. CO3: Learn various vibration excitations, practical aspects of isolations, and vibration measuring instruments. CO4: Analyse the mathematical modelling of the two degrees of freedom systems and various vibration-absorbing devices. CO5: Understand the characteristics of noise, sound, and its relationship with power and intensity.	
7	**Outline syllabus:** Introduction,Single degree of freedom (SDOF) systems, Free vibrations of SDOF systems, Harmonic excitation of SDOF systems, Two degree-of-freedom systems, Noise, Sound level, and subjective response to sound.		

7.01	**Paper Code**	**Unit**	**Introduction**	**Reference number**	**Teaching methods**
	PCC-ME-311	(I)	INTRODUCTION: Study of Vibrations, Mathematical Modelling, Degree of Freedom, Classification of Vibration, Simple Harmonic Motion.	Singiresu, S. R. (1995). *Mechanical vibrations*. Boston, MA: Addison Wesley. Page no:29-152	Whiteboard, PPT slides, Tutorials, Demonstration
		(II)	Free vibrations of SDOF systems: standard form of a differential equation, free Vibrations of an undammed system, underdamped, critically damped, over damped free Vibrations, coulomb damping, hysteretic damping.	Singiresu, S. R. (1995). Mechanical vibrations. Boston, MA: Addison Wesley.	Whiteboard, PPT slides, Tutorials, Demonstration

				Page no:153-296	
		(III)	Harmonic excitation of SDOF systems: forced response of a viscously Damped system subject to a single-frequency harmonic excitation, frequency-squared Excitations, rotating unbalance, response due to harmonic excitation of support, vibration Isolation, vibration isolation from frequency-squared excitations, practical aspects of Vibration isolation, seismic vibration measuring instruments, seismometers, accelerometers.	Singiresu, S. R. (1995). Mechanical vibrations. Boston, MA: Addison Wesley. Page no:297-402	Whiteboard, PPT slides, Tutorials, Demonstration
		(IV)	Two degree-of-freedom systems: derivation of the equations of motion, natural frequencies, and mode shapes, free response of undamped systems, free vibrations of a system with viscous damping, the harmonic response of two-degree-of-freedom systems, Frequency response, dynamic vibration absorbers	Singiresu, S. R. (1995). Mechanical vibrations. Boston, MA: Addison Wesley. Page no:509-595	Whiteboard, PPT slides, Tutorials, Demonstration
		(V)	Noise: effects, ratings, and regulations, non-auditory effects of noise on people, auditory Effects of noise, noise standards and limits in India, major sources of the noise, industrial noise Sources, industrial noise control strategies, noise control at the source, noise control along the Path, acoustic barriers, noise control at the receiver. Sound level and subjective response to sound: frequency-dependent Human response to sound, sound pressure-dependent human response, decibel scale, Decibel addition, subtraction and averaging, the relationship among sound power, sound intensity and sound pressure level, sound spectra, octave band analysis, loudness.	1.https://www.me.psu.edu/lamancusa/me458/3_human.pdf 2.https://www.mne.psu.edu/lamancusa/me458/4_metrics.pdf	Whiteboard, PPT slides, Tutorials, Demonstration

8	**Course Evaluation**	
8.10	**CA: 20%**	
8.1	**Attendance**	10%
8.12	**Homework**	10%
8.13	**Quizzes**	-
8.14	**Projects**	-
8.15	**Presentation**	-
8.16	**Any other**	-
8.2	**MTE(IA)**	20%
8.3	**End-term examination: 60%**	

9	Text Books & References	
9.1	Text books	1. S. Graham Kelly: Mechanical Vibrations: Theory and Applications 2. Den Hartog, J. P.: Mechanical Vibrations 3. Rao, S. S.: Mechanical Vibrations 4. J. S. Rao, Dr. K. Gupta: Introductory Course on Theory and Practice ofMechanical Vibrations 5. Mechanical Vibrations: G.K.Grover
9.2	References	1. Rosenhouse G. BASIC PRINCIPLES. In: Braun S, editor. Encyclopedia ofVibration [Internet]. Oxford: Elsevier; 2001. p. 124–37. Available from:https://www.sciencedirect.com/science/article/pii/B0122270851000886 2. Norton MP, Drew SJ. VIBRATION GENERATED SOUND | Fundamentals. In: Braun S, editor. Encyclopedia of Vibration [Internet]. Oxford: Elsevier; 2001. p. 1443–55. Available from: https://www.sciencedirect.com/science/article/pii/B0122270851002071 3. Singh R. Chapter 6 - Ultrasonic Testing. In: Singh R, editor. Applied Welding Engineering (Second Edition) [Internet]. Second Edition. Butterworth-Heinemann; 2016. p. 343–55. Available from: https://www.sciencedirect.com/science/article/pii/B9780128041765000268 4.Bein T, Bös J, Mayer D, Melz T. 10 - Advanced materials and technologies for reducing noise, vibration and harshness (NVH) in automobiles. In: Rowe J, editor. Advanced Materials in Automotive Engineering [Internet]. Woodhead Publishing; 2012. p. 254–98. Available from: https://www.sciencedirect.com/science/article/pii/B9781845695613500107
9.3	Video References	1. https://nptel.ac.in/courses/112107212 2. https://nptel.ac.in/courses/112103112

Mapping of Outcomes v. Topics

Course Outcome	Program Outcome												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	2	3	1	2	1		2	2	1	2	3	3	2	2
CO2	3	3	3	3	2	2	1		1	1	1	1	3	3	2	2
CO3	3	3	3	3	3	2	2		2	2	2	2	3	3	2	2
CO4	3	3	3	3	3	2	2		2	1	1	1	3	2	2	1
CO5	3	2	1	1	3	3	2		1	1	1	2	3	2	3	2

QUESTION BANK

1. Give two examples each of the bad and the good effects of vibration.
2. Define Single degree of freedom.
3. Classify vibration.
4. Define damped vibration.
5. What is deterministic vibration.
6. Write the procedure of vibration analysis.
7. Define Viscous Damping.
8. Define Dry-Friction Damping.
9. Define Hysteretic Damping.
10. Define these terms: cycle.
11. Define these terms: amplitude.
12. Define these terms: phase angle.
13. Define these terms: linear frequency.
14. Define these terms: period.
15. Define these terms: natural frequency.
16. What are the three elementary parts of a vibrating system?
17. Define the number of degrees of freedom of a vibrating system.
18. What is the difference between a discrete and a continuous system? Is it possible to solve?

any vibration problem as a discrete one?

19. In vibration analysis, can damping always be disregarded?
20. Can a nonlinear vibration problem be identified by looking at its governing differential equation?
21. What is the difference between deterministic and random vibration? Give two practicals'

examples of each.

22. What methods are available for solving the governing equations in the vibration problem?
23. How do you connect several springs to increase the overall stiffness?
24. Define spring stiffness and damping constant.
25. What are the common types of damping?
26. State three different ways of expressing a periodic function in terms of its harmonics.
27. How can we obtain the frequency, phase, and amplitude of a harmonic motion from the

corresponding rotating vector?

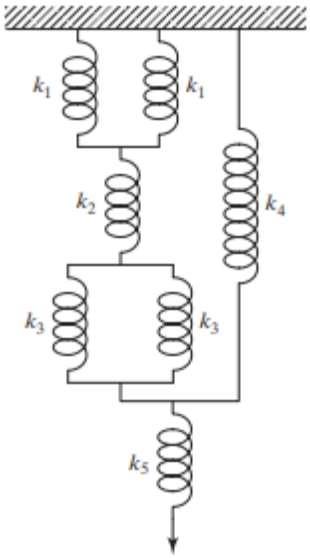
28. How do you add two harmonic motions having different frequencies?
29. What are beats?

30. Define the terms decibel and octave.

31. Explain Gibbs phenomenon.

32. What are half-range expansions?

33. Determine the equivalent spring constant of the system shown in Fig. below



34. Consider two nonlinear dampers with the same force-velocity relationship given by $F = 1000v + 400v^2 + 20v$ with F in newtons and v in meters/second. Find the linearized damping constant of the dampers at an operating velocity of 10 m/s.

35. If the linearized dampers of $F = 1000v + 400v^2 + 20v$ are connected in parallel, determine the resulting equivalent damping constant.

36. What is the equivalent stiffness of a spring?

37. Derive Newton's second equation of motion?

38. Define Momentum.

39. State D-Alembert's Principle.

40. State the Principle of Virtual Displacements.

41. State Equation of Motion of a Spring-Mass System in Vertical Position.

42. Define torsional vibration.

43. Write the application of shock observer in bike.

44. Suggest a method for determining the damping constant of a highly damped vibrating system that uses viscous damping.

45. State the parameters corresponding to m, c, k, and x for a torsional system.

46. What effect does a decrease in mass have on the frequency of a system?

47. What effect does a decrease in the stiffness of the system have on the natural period

Graphical representation of the motion of a harmonic oscillator.

48. A helical spring, when fixed at one end and loaded at the other, requires a force of 100 N to produce an elongation of 10 mm. The ends of the spring are now rigidly fixed, one end vertically above the other, and a mass of 10 kg is attached at the middle point of its length. Determine the time taken to complete one vibration cycle when the mass is set vibrating in the vertical direction.

49. An air-conditioning chiller unit weighing 2,000 lb is to be supported by four air springs. Design the air springs such that the natural frequency of vibration of the unit lies between 5 rad/s and 10 rad/s.

50. The maximum velocity attained by the mass of a simple harmonic oscillator is 10 cm/s, and the period of oscillation is 2 s. If the mass is released with an initial displacement of 2 cm,

find (a) the amplitude, (b) the initial velocity, (c) the maximum acceleration, and (d) the phase angle.

51. Name some sources of industrial vibration.

52. What are the various methods available for vibration control?

53. What is single-plane balancing?

54. Describe the two-plane balancing procedure.

55. What is whirling?

56. What is the difference between stationary damping and rotary damping?

57. How is the critical speed of a shaft determined?

58. What causes instability in a rotor system?

59. What considerations are to be taken into account for the balancing of a reciprocating engine?

60. What is the function of a vibration isolator?