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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Seventh Semester, B.E. - Automobile Engineering

Semester End Examination; February - 2022

Mechanical Vibrations

Time: 3 hrs *Max. Marks: 100*

Course Outcomes

The Students will be able to:

CO1: Formulate mathematical models of single degree of freedom damped and undamped free vibratory systems and determine their natural frequencies

CO2: Analyze the response of simple single degree of freedom systems subjected to forced vibration

CO3: Explain the working principle of vibration measuring instruments. Determine the whirling speed of shafts and harmonics of general forcing functions using Fourier series.

CO4: Formulate mathematical models and determine natural frequencies and corresponding mode shapes of two degrees of freedom systems

CO5: Use numerical methods to solve multi degree of freedom systems for their natural frequencies and mode shapes

Note: ***I) PART - A*** *is compulsory.* ***Two*** *marks for each question.*

II) PART - B*: Answer any* ***Two*** *sub questions (from a, b, c) for Maximum of* ***18 marks*** *from each unit.*

Q. No.		Questions	Marks
		I : PART - A	**10**
I	a.	List the different types of damping.	2
	b.	What is zero frequency deflection?	2
	c.	What is critical speed?	2
	d.	Explain coordinate coupling.	2
	e.	What are influence coefficients?	2
		II : PART - B	**90**
		UNIT - I	**18**
1	a.	Derive an expression for logarithmic decrement in terms of damping ratio.	8
	b.	A U-tube open to atmosphere at both ends contains a column length *l* of certain liquid. Find the natural period of oscillation of the liquid column.	10
	c.	Determine the natural frequency of the spring mass pulley system shown in Fig. Q1(c).	10

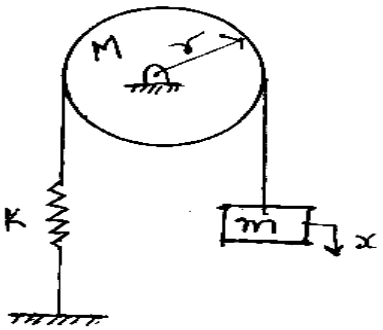

Fig Q 1(c)

		UNIT - II	**18**
2	a.	Explain the term Transmissibility.	4

Contd... 2

b. A machine of mass 1000 kg is acted upon by an external force of 2450 N at a frequency of 1500 rpm. To reduce the effects of vibration, isolator of rubber having a static deflection of 2 mm under the machine load and an estimated ξ = 0.2 are used. Determine; 14

i) The force transmitted to the foundation

ii) The amplitude of vibration of machine

iii) The phase lag

c. A motor of mass 60 kg is mounted on a simple beam that has a stiffness of 39200 N/m at that point. The rotor of the motor has a mass of 10 kg and has an eccentricity of 0.1 mm. What will be the amplitude of vibration of the motor, when it runs at 1460 rpm? Neglect damping, the weight of the beam and the deflection of the motor shaft. 14

UNIT - III **18**

3 a. Explain the working principle of vibrometer. 6

b. A rotor of mass 12 kg is mounted mid way on a 25 mm diameter horizontal shaft supported at the ends by two bearings. The span between the bearings is 900 mm, because of some manufacturing defect the C.G. of the rotor is 0.02 mm away from geometric centre of rotor. If the system rotates at 3000 rpm, determine the amplitude of steady state vibrations and the dynamic force on the bearings. Take E = 200 GPa. 12

c. The static deflection of the vibrometer mass is 20 mm. The instrument when attached to a machine vibrating with a frequency of 125 cpm records a relative amplitude of 0.3 cm. Find out for the machine; 12

i) The amplitude of vibration

ii) The maximum velocity of vibration

iii) Maximum acceleration

UNIT - IV **18**

4 a. Explain the following:

i) Generalized and principle coordinates 8

ii) Normal mode of vibrations

b. Determine the natural frequency of torsional vibrations of a shaft with two circular discs of uniform thickness at the ends. The masses of the discs are M_1 = 500 kg and M_2 = 1000 kg and their outer diameters are D_1 = 125 cm and D_2 = 190 cm. The length of the shaft is l = 300 cm and its diameter d = 10 cm modular of rigidity for the material of the shaft is $h = 0.83\times10^{11}$ N/m^2. 10

c. Explain the basic working principle of dynamic vibration absorber. 10

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UNIT - V **18**

5 a. Using Stodola's method, determine the fundamental natural frequency of the system shown in Fig. Q5(a) given m = 2 kg, k = 20 kN/m. 18

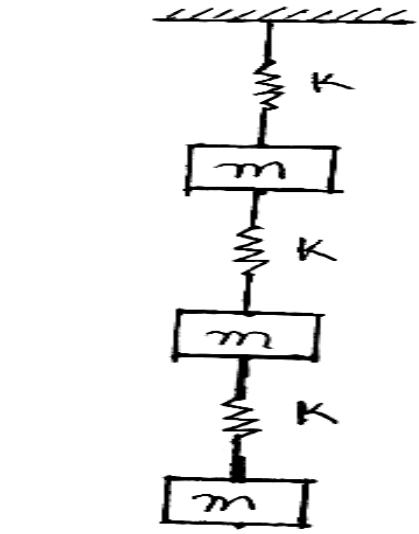

Fig Q 5(a)

b. Find the natural frequencies of the system shown in Fig. Q5(b) by Holzers method. 18
m_1 = 5 kg, m_2 = 10 kg, m_3 = 5 kg, k_1 = 10 N/m, k_2 = 20 N/m.

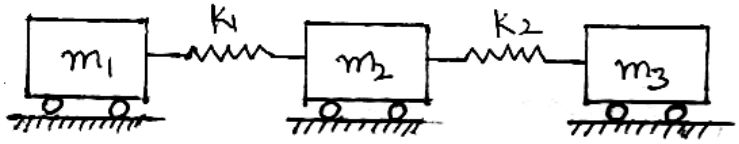

Fig Q 5(b)

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