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10AU73

Seventh Semester B.E. Degree Examination, Jan./Feb. 2021
Mechanical Vibrations and Vehicle Dynamics

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions, selecting at least TWO full questions from each part.*
2. Missing data may be suitably assumed.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Explain the following:
i) Free vibrations ii) Forced vibrations iii) Simple harmonic motion iv) Resonance. **(04 Marks)**

b. The motion of particle is represented by the equation $x = 10\sin\omega t$. Show the relative positions and magnitudes of the displacement, velocity and acceleration vectors at a time $t = 0$ for the case when (i) $\omega = 1.0$ rad/sec (ii) $\omega = 0.5$ rad/sec. **(08 Marks)**

c. Add the following harmonical motions analytically and check the solution graphically,
$x_1 = 4\cos(\omega t + 10^0)$
$x_2 = 6\sin(\omega t + 60^0)$ **(08 Marks)**

2 a. Determine the natural frequency of a spring mass system where the mass of the spring is also to be taken into account. **(10 Marks)**

b. A cylinder of mass M and radius r rolls without slipping on a cylindrical surface of radius R as shown in fig. Q2(b). Find the natural frequency for small oscillations about the lowest point. **(10 Marks)**

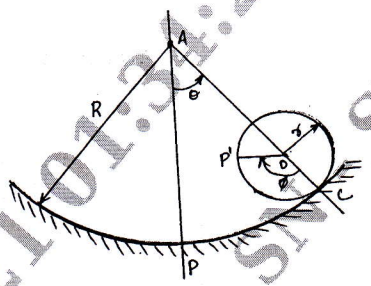

Fig.Q.2(b)

3 a. A body of mass 10kg is suspended from a helical spring having a stiffness of 2N/mm. A damper having resistance of 5N at a velocity of 0.1m/sec is connected between mass and the fixed end of the spring. Determine (i) Ratio of successive amplitude (ii) Amplitude of body after 10 cycles if the initial displacement is 15mm. **(08 Marks)**

b. Obtain the differential equation of motion for the system shown in Fig. Q3(b) and find: (i) Critical damping co-efficient (ii) Damping ratio (iii) Natural frequency of damped oscillations (iv) Natural frequency of undamped vibration. **(12 Marks)**

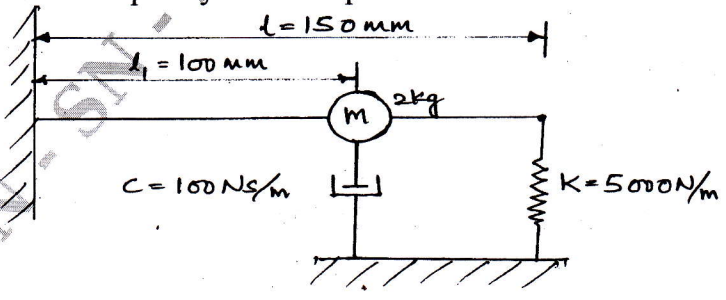

Fig.Q.3(b)

4 a. Discuss with neat sketch forced vibrations with rotating unbalance. Derive an expression for steady state amplitude and phase angle. **(10 Marks)**

b. An air compressor of 450 kg operates at a constant speed of 1750 rpm. Rotating parts are well balanced. The reciprocating part is 10 kg and crank radius is 100 mm. The mounting introduces a viscous damping of damping factor 0.15. Specify the spring for the mounting such that only 20% of the unbalanced force is transmitted to the foundation. Determine the amplitude of transmitted force. **(10 Marks)**

PART – B

5 a. Explain working principle of vibrometer. **(05 Marks)**

b. A seismic instrument has natural frequency of 6Hz. What is the lowest frequency beyond which the amplitude can be measured within 2% error? Neglect damping. **(05 Marks)**

c. Obtain an expression for whirling of shaft with air damping. **(10 Marks)**

6 a. Define the following : (i) Principal mode and normal mode of vibration; (ii) Generalized co-ordinates and principal co-ordinates ; (iii) Dynamic vibration absorber. **(06 Marks)**

b. A two degrees of freedom vibrating system is shown in the Fig.Q.6(b). Determine : (i) The two natural frequencies of vibrations (ii) Ratio of amplitudes of motion m_1 and m_2 for the modes of vibration (iii) modal vector and modal shapes iv) Locate the modes for each mode of vibration. Given : $m_1 = 2kg$, $m_2 = 1kg$, $k_1 = 40$ N/m and $k_2 = 20$N/m **(14 Marks)**

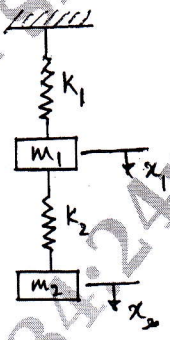

Fig.Q.6(b)

7 a. Derive an expression for transmissibility of engine mounting. **(10 Marks)**

b. A 75 kg engine is mounted on the springs of stiffness $K = 11.76 \times 10^3$ N/m with an assumed damping factor of $y = 0.20$. A 2 kg piston within the engine has a reciprocating motion with a stroke of 0.08 m and a speed of 3000 cpm. Assuming the motion of the piston to be harmonic, determine the amplitude of vibration of the engine and the vibratory force transmitted to the foundation. **(10 Marks)**

8 a. Briefly explain the following : i) Maxwell reciprocal theorem ii) Dunkerley's method iii) Stodola's method. **(15 Marks)**

b. A shaft carries 3 discs of mass 15kg, 25kg and 35kg. The deflection of shaft under each disc when all the three discs are in position is 1.75×10^{-5}m , 3.25×10^{-5}m and 3×10^{-5}m respectively. Determine the fundamental natural frequency of transverse vibration. **(05 Marks)**

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