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10AU73

Seventh Semester B.E. Degree Examination, Feb./Mar. 2022
Mechanical Vibration and Vehicle Dynamics

Time: 3 hrs. Max. Marks:100

Note: Answer any FIVE full questions, selecting at least TWO questions from each part.

PART – A

1 a. What do you mean by mechanical vibration? Explain the following :
i) Natural frequency ii) Resonance iii) Frequency. **(05 Marks)**

b. Explain representation of harmonic motion in complex form. **(05 Marks)**

c. Add following harmonics analytically and check the solution graphically
i) $x_1 = 3\sin(wt + 30°)$ ii) $x_2 = 4\cos(wt + 10°)$ **(10 Marks)**

2 a. What do you mean by undamped free vibration? Derive differential equation by Newton's method for single spring mass system. **(06 Marks)**

b. Explain equivalent stiffness of spring combination.
i) Spring in Series ii) Spring in parallel. **(04 Marks)**

c. Determine natural frequency and simple pendulum.
i) Neglecting the mass of rod by energy method
ii) Considering the mass of rod by Newton's method. **(10 Marks)**

3 a. What do you mean by Damped free vibration? Name any 4 types of damping and explain dry friction damping. **(06 Marks)**

b. Define logarithmic decrement and derive an expression for logarithmic decrement. **(06 Marks)**

c. A spring mass damper system is having mass of 175kg spring stiffness K = 70000 N/m and damping co-efficient C = 700N-s/m. Determine: i) Natural frequency ii) Damping factor iii) Damped natural frequency iv) Logarithmic decrement. **(08 Marks)**

4 a. Write difference between vibration isolator and vibration absorber. **(02 Marks)**

b. A flywheel of mass moment of inertia 0.1kg-m^2 is suspended from a thin wire of stiffness 1.2 N-m/rad. A periodic torque having a maximum value of 0.6 N-m at a frequency of 4 rad/sec is impressed upon the flywheel. A viscous dash pot applies damping couple of 0.8 N-m at an angular velocity of 2 rad/sec. Determine :
i) Maximum Angular Displacement
ii) Maximum couple applied to dash pot
iii) Critical damping co-efficient
iv) Angle by which the angular displacement lags the torque. **(08 Marks)**

c. A machine has a total mass of 100kg and unbalanced reciprocating parts of mass 2kg which move through a vertical stroke of 80mm with simple Harmonic Motion. The machine is mounted on four springs symmetrically arranged With respect to centre of mass in which machine has single degree of freedom and can undergo vertical displacement only. Neglecting damping calculate the combined stiffness of spring in order that force transmitted to foundation is 1/25 of applied force when the speed of rotation of machine crank shaft is 1000 rpm. When the machine is actually supported on springs it is found that the amplitude of successive free vibration decreases by 25%. Determine :
i) Force transmitted to foundation at 1000 rpm
ii) Force transmitted to foundation at resonance
iii) Amplitude of forced vibration of machine at resonance. **(10 Marks)**

PART – B

5 a. Write difference between vibrometer and Accelerometer with appropriate plots required? **(06 Marks)**

b. What is need of Fullerton Technometer and explain with neat sketch. **(04 Marks)**

c. A disc of mass 4kg is mounted midway between bearings, which may be assumed to be simple supports. The bearing span is 480mm. The steel shaft which is horizontal is 9mm in diameter. The centre of gravity of disc is displaced 3mm from geometric centre. The equivalent viscous damping at the centre of disc shaft may be taken as 49 N.S/m. If shaft rotates at 760mm. Find Dynamic load on the bearing. **(10 Marks)**

6 a. Define :

i) Co-ordinate coupling
ii) Dynamic Vibration absorber
iii) Principle and normal modes of vibration **(06 Marks)**

b. A two degree of freedom vibration system shown in Fig. Q6(b). Determine :

i) Equation of motion ii) Frequency equation and Natural frequencies
iii) Modal vectors iv) Mode shapes.

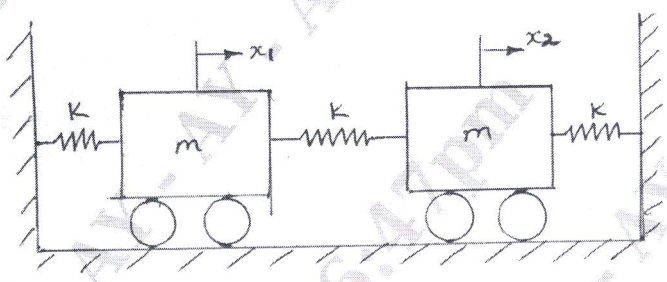

Fig. Q6(b) **(14 Marks)**

7 a. Consider a vehicle driven on a rough road as shown in Fig.Q7(a). It is assumed that the vehicle is constrained to one degree of freedom in vertical direction. Roughness of the road surface is directly transmitted to the suspension system of the vehicle, i.e. the spring constant of tyres is infinite. The tyre do not leave the road surface. Mass of the vehicle when fully loaded is 1000 kg and 250 kg when it is empty. The spring constant is 400 kN/m. The damping factor is 0.5 when the vehicle is fully loaded. The speed is 90 km/hr and the road surface varies sinusoidally with a wave length of 5m and an amplitude of y meter. Determine amplitude ratio of the vehicle when fully loaded and empty.

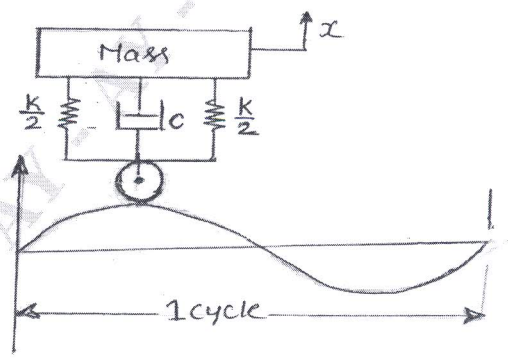

Fig.Q7(a) **(10 Marks)**

b. Determine the critical speed when an automobile trailer is travelling over a road with the road surface varies sinusoidally with a wave length of 15 meters and an amplitude of 0.075 m. The springs of the automobile are compressed 0.125 m under its own weight. Also determine the amplitude of vibration at 50 km/hr.

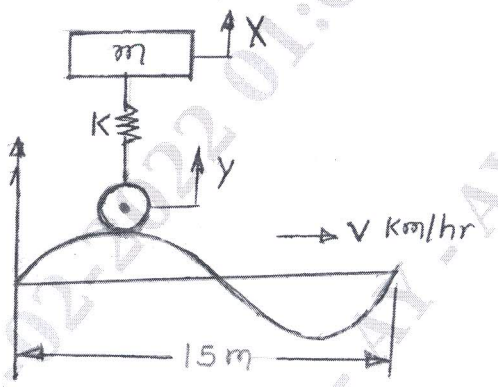

Fig.Q7(b) **(10 Marks)**

8 a. Determine the influence coefficients of the triple pendulum shown in Fig.Q8(a).

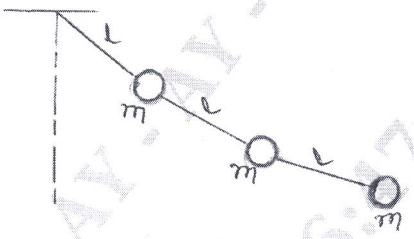

Fig.Q8(a) **(08 Marks)**

b. Using Stadola's method determine the lowest natural frequency of the system shown in Fig.Q8(b).

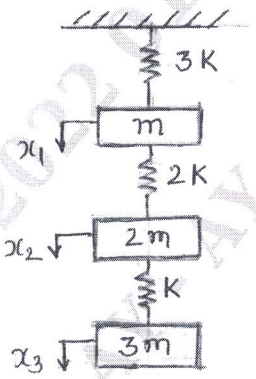

Fig.Q8(b) **(12 Marks)**

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