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10AU73

Seventh Semester B.E. Degree Examination, June/July 2018

Mechanical Vibrations 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. Define the following:
i) Natural frequency ii) Amplitude
iii) Resonance iv) Degree of freedom **(04 Marks)**

b. Differentiate between:
i) Free and forced vibration ii) Damped and undamped vibration
iii) Deterministic and random vibration iv) Longitudinal and transverse vibration **(08 Marks)**

c. Add the following vector analytically $x_1 = 3\sin(\omega t + 30^\circ)$ and $x_2 = 4\cos(\omega t + 10^\circ)$, check the solution graphically. **(08 Marks)**

2 a. Determine the natural frequency of spring mass system taking the mass of spring in to account. **(08 Marks)**

b. Determine the equation of motion and natural frequency of the system shown in Fig.Q2(b) by using Newton's method.

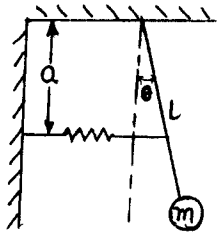

Fig.Q2(b) **(06 Marks)**

c. Find the natural frequency of system shown in Fig.Q2(c).

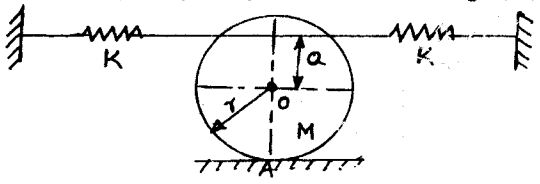

Fig.Q2(c) **(06 Marks)**

3 a. Set up the differential equation for a spring mass damper system and obtain the complete solution for critically damped system. **(10 Marks)**

b. A gun barrel having mass 560 kg is designed with the following data:
Initial recoil velocity 36 m/sec
Recoil distance on firing 1.5 m
Calculate: (i) spring constant, (ii) damping coefficient, (iii) time required for the barrel to return to a position 0.12 m from its initial position. **(06 Marks)**

c. Vibrating system consisting of a mass of 50 kg, a spring stiffness 30 kN/m and a damper. The damping is 20% of critical value. Determine:
i) Damping factor ii) Critical damping coefficient
iii) Logarithmic decrement iv) Ration of two consecutive amplitude. **(04 Marks)**

4 a. Define the term transmissibility. Derive an expression for force transmitted and for the transmissibility for a spring mass damper system subjected to external excitation. **(10 Marks)**

b. A machine of total mass 17 kg is mounted on springs having stiffness K = 11,000 N/cm. A piston within the machine has a mass of 2 kg has a reciprocating motion with stroke 7.5 cm and speed 6000 rpm. Assuming the motion to be SHM. Determine:

i) Amplitude of machine
ii) Transmissibility
iii) Force transmitted to the ground or foundation.

Take $\xi = 0.2$. **(10 Marks)**

PART – B

5 a. Discuss the principle of operation of a vibrometer with a neat sketch. **(05 Marks)**

b. Explain Frahm Tachometer with a neat sketch. **(05 Marks)**

c. The following data relate to a shaft held in long bearings – length of shaft = 1.2 m. Diameter of shaft = 14 mm, mass of a rotor at mid point = 16 kg, eccentricity of centre of mass of rotor from centre of rotor = 0.4 mm. Modulus of elasticity of shaft material = 200 GN/m^2. Determine the critical speed of shaft and the range of speed over which it is unsafe to run the shaft. Neglect the mass of shaft. Consider permissible stress in shaft material = 70×10^6 N/mm^2. **(10 Marks)**

6 a. For the system shown in Fig.Q6(a).

i) Derive the equation of motion.
ii) Set up frequency equation and obtain natural frequencies of the system.
iii) Obtain amplitude ratio.
iv) Obtain modal vectors.
v) Draw mode shapes.

Neglect the inertia of wheels, which supports the masses and friction between wheel and surface.

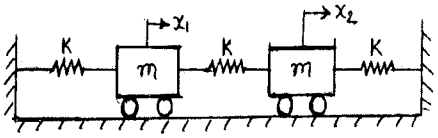

Fig.Q6(a) **(10 Marks)**

b. What is dynamic vibration absorber? Show that when excitation frequency is equal to the natural frequency of absorber system, the amplitude of main system is zero. **(10 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.

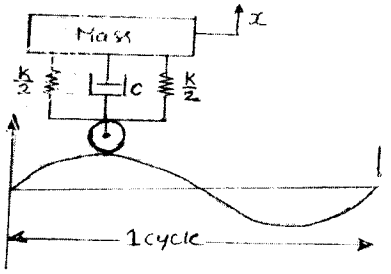

Fig.Q7(a) **(10 Marks)**

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.

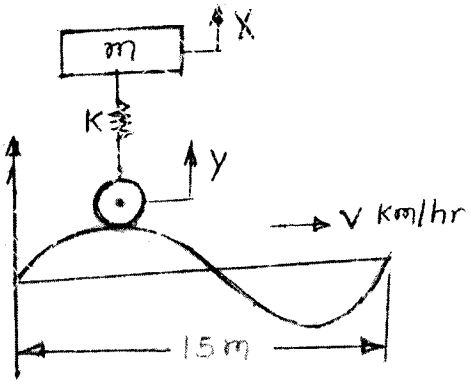

Fig.Q7(b)

(10 Marks)

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

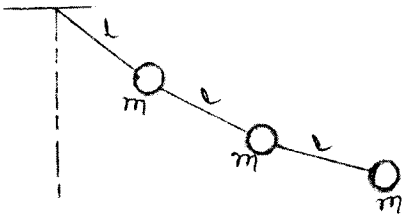

Fig.Q8(a)

(08 Marks)

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

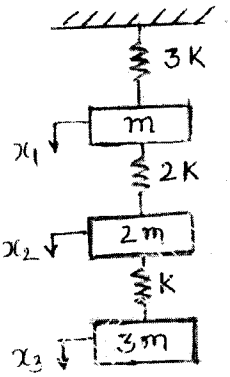

Fig.Q8(b)

(12 Marks)

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