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10ME/MR72

Seventh Semester B.E. Degree Examination, June/July 2017

Mechanical Vibrations

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. Assume missing data suitably.

PART – A

1 a. Define: i) Deterministic and random vibration, ii) Linear and non-linear vibration. **(04 Marks)**

b. Split $x(t) = 5\sin(\omega t + 30°)$ into two simple harmonic motions, one with 60° phase lead and other with 45° phase lag. **(06 Marks)**

c. Represent the following periodic motion into harmonic motion.

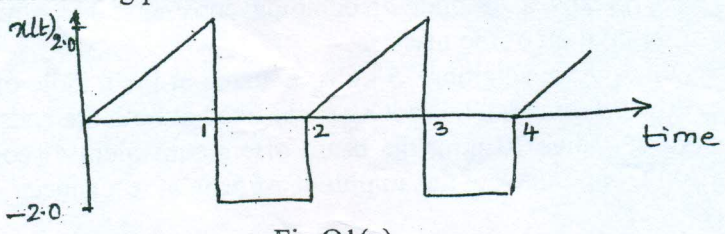

Fig.Q1(c) **(10 Marks)**

2 a. A metallic wire of 2 mm dia and 30 m long is fixed at upper end and carries a mass M at its lower end. It is observed that the longitudinal vibration of mass in 4 cps. When an extra 2 kg is coupled to mass M, the longitudinal frequency reduces to 3.94 cps. Find the Young's modulus of the wire. **(10 Marks)**

b. Find the natural frequency of the mass.

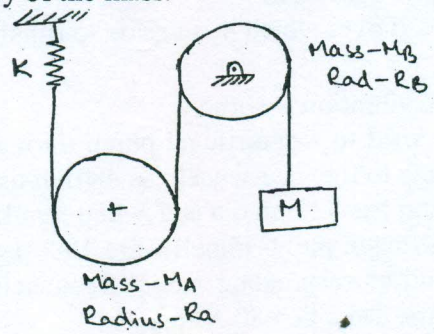

Fig.Q2(b) **(10 Marks)**

3 a. Derive an expression for displacement of under damped vibration system with initial velocity $\dot{x}_0$ and initial displacement X. **(10 Marks)**

b. What is the value of C such that the system of Fig.Q3(b) is critically damped if M = 10 kg and K = 5 kN/m.

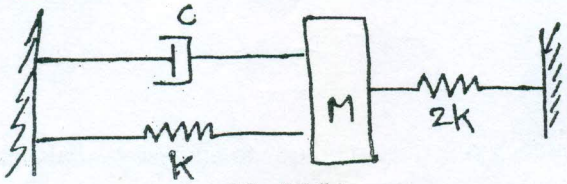

Fig.Q3(b) **(06 Marks)**

c. The spring-damper system is subjected to vibration as shown in Fig.Q3(c). Discuss the result. **(04 Marks)**

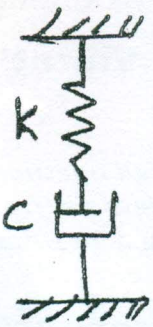

Fig.Q3(c)

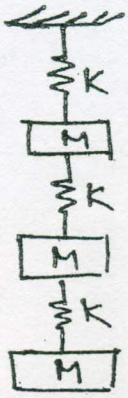

Fig.Q7(a)

4 a. A spring-mass-damper system is subjected to harmonic excitation of $F\sin\omega t$, having maximum value of 250 N with a frequency of 5 Hz. If the mass is 10 kg, spring with spring constant 2 kN/m and a dashpot of damping constant 50 N-s/m, determine the complete solution for the motion of the mass. **(10 Marks)**

b. A reciprocating pump weighing 75 kg is mounted at the middle of a steel plate of thickness 12 mm, width 500 mm and 2.5 m long span, fixed at both the ends. If the rotating unbalance mass is 2 kg at radius 20 mm, the beam offers equivalent viscous damping of 75 N-s/m. Take E = 200 GPa. Calculate the amplitude of plate at resonance. **(10 Marks)**

PART – B

5 a. Explain with a neat sketch, the working principle of Frahm's reed Tachometer. **(06 Marks)**

b. A 1.2 m long vertical steel shaft of 22 mm diameter supported by two bearings at its ends, carries a disc of mass 25 kg at its mid span. The eccentricity of centre of gravity of the disc from the centre of the rotor is 0.2 mm. The modulus of the elasticity for the shaft material is 200 GPa and the permissible stress is 80 N/mm^2. Determine:

i) The critical speed of the shaft

ii) The range of speed over which it is unsafe to run the shaft. Neglect the mass of the shaft. **(14 Marks)**

6 a. Explain the dynamic vibration absorber. **(06 Marks)**

b. An IC engine is coupled to a centrifugal pump through a pair of gears. The shaft from the flywheel of the engine to the gear wheel has 48 mm dia and is 800 mm long. The shaft from the pinion to the pump has 32 mm dia and is 280 mm long. Pump speed is 4 times the engine speed. MI of the flywheel, pump impeller are 1000 kg-m^2 and 18 kg-m^2 respectively. Find the modal shapes and corresponding modal frequencies of Torsional vibration. Neglecting inertia effects of gears. Take G = 80 N/mm^2. **(14 Marks)**

7 a. Determine the fundamental natural frequency and mode shapes using Maxwell's reciprocal theorem. [Refer Fig.Q7(a)] **(10 Marks)**

b. A shaft 40 mm dia and 2.5 m long has a mass of 15 kg per meter length. It is simply supported at the ends and carries three masses 90 kg, 140 kg and 60 kg at 0.8 m, 1.5 m and 2 m respectively from the left support. Taking E = 200 GPa, find the frequency of the transverse vibration using Dunkerley's method. **(10 Marks)**

8 a. Write short notes on:

i) Spectrum analysers

ii) Band pass filter **(10 Marks)**

b. Explain any two frequency response methods to analyse modal shapes. **(10 Marks)**

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