USN

10ME72

Seventh Semester B.E. Degree Examination, Dec.2018/Jan.2019
Mechanical Vibrations

Time: 3 hrs. Max. Marks:100

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.

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Define : (i) Resonance
(ii) Phase difference
(iii) Natural frequency **(06 Marks)**

b. Explain the concept of vibration with Simple Harmonic Motion. **(04 Marks)**

c. Represent the periodic motions given in the Fig.Q1(c) by harmonic series:

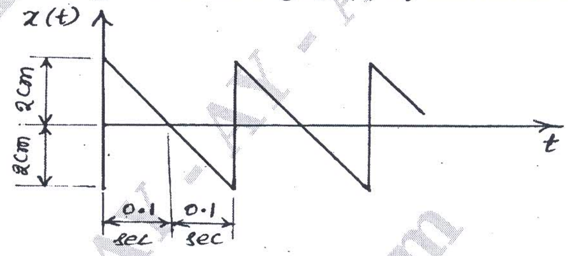

Fig.Q1(c) **(10 Marks)**

2 a. Derive natural frequency of spring mass system considering the effect of mass of spring. **(10 Marks)**

b. Determine the natural frequency of the vertical bar assuming the mass of the bar as 'm' with two unstretched springs as shown in the Fig.Q2(b). Is there any limitation on the value of 'K'. **(10 Marks)**

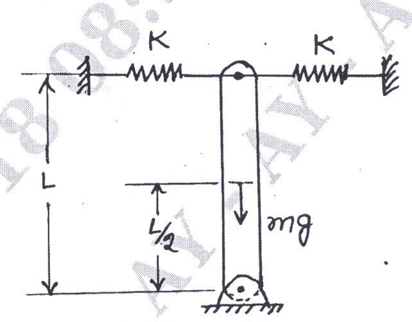

Fig.Q2(b)

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

b. The disc of a torsional pendulum has a moment of inertia of 600 kg-cm^2 and is immersed in a viscous fluid. The brass shaft, which carries the disc is attached to it. When the pendulum vibrates, the observed amplitudes on the same side of the rest position for successive cycles are 9°, 6° and 4°. Determine (i) Logarithmic decrement (ii) Damping torque/unit velocity (iii) The periodic time of vibration (iv) The frequency if the disc is removed from the fluid. Assume for the brass shaft, $G = 4.4 \times 10^{10}$ N/m^2, d = 0.10m, l = 0.40 m, moment of inertia of disc = 0.06 kg-m^2. **(10 Marks)**

4 a. Explain briefly the excitation due to rotating unbalance and reciprocating unbalance. **(10 Marks)**

b. A weight of 54 N is suspended by a spring with a stiffness of 1100 N/m. It is forced to vibrate by a harmonic force of 5 N. Assuming a viscous damping of 77 N-s/m, find (i) Amplitude at resonance (ii) Phase angle at resonance (iii) Damped natural frequency (iv) Frequency at which maximum amplitude occurs (v) Peak amplitude. **(10 Marks)**

PART – B

5 a. Derive an expression for deflection of the shaft with a disc at the centre with an eccentricity from the shaft axis neglecting damping. **(10 Marks)**

b. A vertical shaft 14 mm diameter rotates in long bearings and a disc of mass 16 kg is attached to the mid span of the shaft. The snap of the shaft between the bearings is 1.2m. The mass centre of the disc is 0.4 mm from the axis of the shaft. Neglecting the mass of the shaft and taking the deflection as for beam fixed at both ends, determine the critical speed of rotation. Also determine the range of speed over which the stress in the shaft due to bending will not exceed 70×10^6 N/m^2. Take E = 200 GN/m^2. **(10 Marks)**

6 a. Derive expressions for natural frequencies of the system shown in the Fig.Q6(a) and sketch the mode shapes. **(12 Marks)**

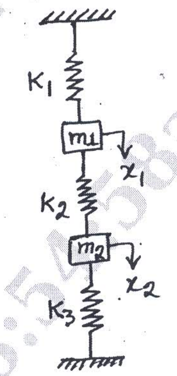

Fig.Q6(a)

b. A motor drives a centrifugal pump through gearing, the pump speed being one-third of the motor. The shaft from the motor to the pinion 60mm diameter and 300 mm long. The moment of inertia of the motor is 400 kg-m^2. The impeller shaft is 100 mm diameter and 600mm long. The moment of inertia of the impeller is 1500 kg-m^2. Neglecting the inertia of the gears and the shaft determine the frequency of torsional vibration of the system. The modulus of rigidity of the shaft material is 80 GN/m^2. **(08 Marks)**

7 a. A simply supported beam subjected to UDL and concentrated loads as shown in the Fig.Q7(a). Determine the fundamental natural frequency of transverse vibration by Dunkerley's method. Take diameter of the shaft as 180 mm and E = 2×10^{11} N/m^2. **(10 Marks)**

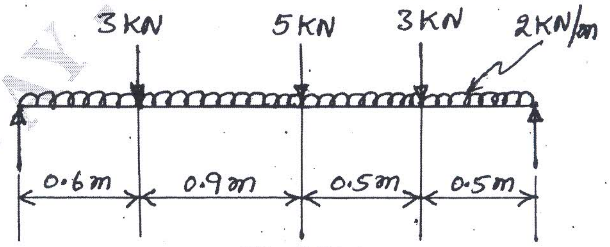

Fig.Q7(a)

b. Determine the natural frequency of the system shown in the Fig.Q7(b) by using Rayleigh's method. **(10 Marks)**

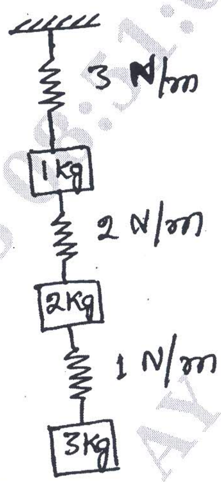

Fig.Q7(b) **(10 Marks)**

8 a. Explain signal analysis and dynamic testing of machines and structures. **(10 Marks)**
b. Explain experimental modal analysis. **(10 Marks)**

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