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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Sixth Semester, B.E. - Mechanical Engineering

Semester End Examination; June/July - 2015

Mechanical Vibrations

Time: 3 hrs *Max. Marks: 100*

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

PART - A

1. a. Distinguish between:
(i) Natural frequency and impressed-frequency. 4
(ii) Longitudinal vibration and transverse vibration.

b. Derive the natural frequency of the system shown in Fig. Ql(b) when x, the downward displacement of the block measured from the system's equilibrium position, is used as the generalized coordinate. 10

c. Represent the system shown in Fig. Ql(c) by an equivalent spring-mass system and express its natural frequency- Neglect the mass of the cantilever beam. 6

2 a. A 20 kg mass is resting on a spring of 750 N/m and dash pot of 50 N-s/m. If a velocity of 2 m/s is applied to the mass at rest position, estimate its displacement at the end of 1 s. 12

b. A body of mass 70 kg is suspended from a spring which deflects 2 cm under the load. It is subjected to a damping effect adjusted to a value 0.23 times that required for critical damping. Find the natural frequency of the undamped and damped vibrations and ratio of successive amplitudes for damped vibrations. 8

3 a. The mass *M* of a machine is mounted on an elastic foundation modelled as a spring of stiffness k in parallel with a viscous damper of damping coefficient *C*. The machine has an unbalanced component rotating at a constant speed ω. The unbalance can be represented by a particle of mass m, a distance e from the axis of rotation. Derive the differential equation governing the machine's displacement and obtain its steady-state amplitude. 12

b. A centrifugal compressor of mass 100 kg is supported on isolators having a damping factor of 0.2. It runs at a constant speed of 1500 rpm and has a rotating unbalance of 0.1 kg-m. What should be the stiffness of the isolator if the force transmitted to the foundations is less than 10% of the unbalanced force? What is the dynamic force transmitted to the foundation at operating speed? 8

4 a. The static deflection of the vibrometer mass is 20 mm. The instrument when attached to a machine vibrating with a frequency of 125 cpm records relative amplitude of 0.3 mm. Find out for the machine, 8
(i) The amplitude of vibration (ii) The maximum velocity of vibration and
(iii) The maximum acceleration.

Contd…2

b. The rotor of a turbo super charger weighing 9 kg is keyed to the centre of a 25 mm diameter steel shaft of span 400 mm between the bearings. Determine; (i) the critical speed of shaft
(ii) the amplitude of vibration of the rotor at a speed of 3200 rpm, if the eccentricity is 0.015 mm
(iii) the dynamic force transmitted to the bearings at this speed.
Assume the shaft to be simply supported and that the shaft material has a density of 8 gm/cm^3 and a modulus elasticity of 210 GPa. 12

PART - B

5 a. Briefly explain generalized and principal coordinates. 4

b. Two simple pendulums are connected by a spring as shown in Fig. Q5(b). If $k = 100 N/m$, $m_1 = 2kg$, $m_2 = 5kg$, $L = 0.2\ m$ and $a = 0.1m$, determine the natural frequencies of pendulums and draw their mode shapes. 16

6. a. Determine the influence coefficients of the triple pendulum shown in Fig. Q6(a). 8

b. Determine the fundamental natural frequency of transverse vibration of the system shown in Fig. Q6(b) using Rayleigh's method and verify it using Dunkerley's method. Take EI = $8 \times 10^4\ Nm^2$. 12

7. Using matrix iteration method, determine first two natural frequencies of the triple pendulum given in question 6(a) (i.e. Fig. Q6(a)). 20

8 a. Add the following harmonic motions analytically. 8
$x_1 = 8\sin(\omega t + 30^o)$ and $x_2 = 10\sin(\omega t - 60^o)$

b. Derive equation of motion for a longitudinal vibration of a uniform bar. 12

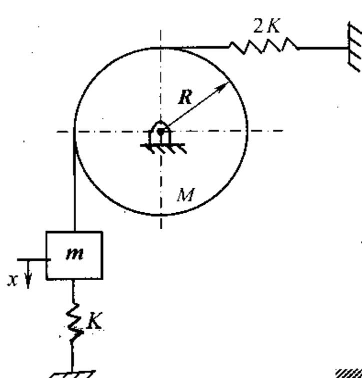

Fig. Q1(b)

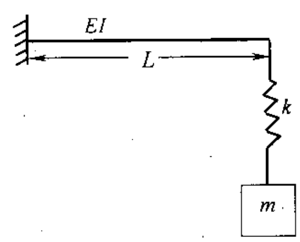

Fig. Q1(c)

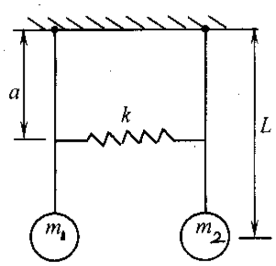

Fig. Q5(b)

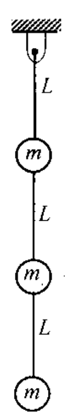

Fig. 6(a)

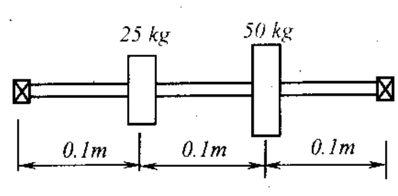

Fig. 6(b)

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