B.E. (Mechanical) (Sem VII) (CB) Date - 22/11/19

Paper / Subject Code: 42854 / Mechanical Vibrations (DLOC - III)

[Total Marks: 80]

(3 Hours)

N.B.: 1. **Question No.1** is **compulsory**
2. Attempt **any three** from the remaining five questions
3. **Assume suitable data wherever required**, with proper justification

1. Attempt **any four** of the following. **All sub-questions carry equal marks.** 20

(a) A spring-mass system having 2 Hz natural frequency is disturbed by applying an initial displacement of (+2) cm and an initial velocity of (-5) cm/s. Calculate the displacement, velocity and acceleration amplitudes. Also, find the corresponding phase differences.

(b) In a very long elastic beam, two point loads viz. 10 N and 50 N, act at two different locations *i* and *j* separated by some distance apart, between the supports. Given that the deflection at either location due to unit load at the same location is 2 mm, and that the deflection at some location due to unit load at other location is 1 mm; calculate the net deflection in both the locations, using Rayleigh's principle. Assume that the deflections are very small compared to the length of the beam.

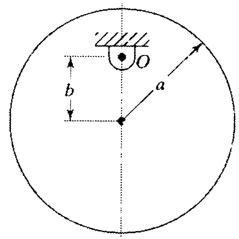
(c) For a spring-mass-damper system, m = 50 kg, k = 5000 N/m. Find the value of the damped natural frequency when the viscous damping coefficient equals half of the critical damping coefficient.

(d) Calculate the transmissibility at 60 Hz for a 10 tonnes chiller unit supported by eight springs with 8 cm static deflection. Also find the % isolation.

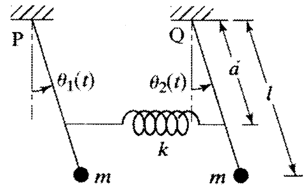
(e) A spring-mass system with m = 0.5 kg and k = 10,000 N/m, with negligible damping, is used as a vibration pick-up. When mounted on a structure vibrating with an amplitude of 4 mm, the total (absolute) displacement of the mass of the pick-up is observed to be 12 mm. Find the frequency of the vibrating structure.

(f) Write a short note on the phase-plane technique of non-linear vibrations.

2. (a) A uniform circular disc is pivoted at point *O*, as shown in the figure. Find the natural frequency of the system. Also find the maximum frequency of the system by varying the value of *b*. 10

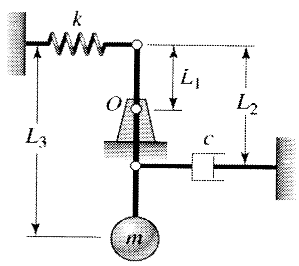


(b) For the given 2 d.o.f. system, derive the equations of motion using Lagrange's method. Also find the natural frequencies of the system. 10

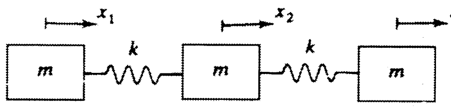


3. (a) Develop a sequence of three mathematical models of a motorcycle with a rider, in the order of increasing complexity, for investigating vibration in the vertical direction. Supplement your models with proper labeling, and a short description of the same. 10

(b) For the given system, the pendulum oscillates about the pivot at O. Distances are given as— $L_1 = 0.1$ m, $L_2 = 0.2$ m, and $L_3 = 0.3$ m. Also, $m = 1$ kg, $k = 1000$ N/m, and $c = 20$ Ns/m. Estimate the value of the damped natural frequency in Hz, for small angular oscillations. **10**



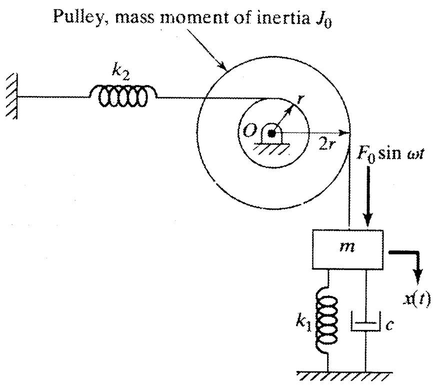
4. (a)



For the given spring-mass system, determine the natural frequencies of vibration using Holzer's method. Given: mass $m = 1$ kg, and stiffness $k = 1$ N/m. **10**

(b) An air compressor of mass 50 kg is mounted on an elastic support and operates at a speed of 1000 rpm. It has an unbalanced mass of 2 kg at a radial distance (eccentricity) of 0.1 m from the axis of rotation. If the damping factor of the elastic support is 0.1, determine the following: (a) the spring constant of the elastic support which transmits no more than 25% of the unbalanced force to the foundation, and (b) the magnitude of the force transmitted to the foundation. **10**

5. (a)



Find the steady state response of the system shown in figure, for the following data: **10**

$k_1 = 1000$ N/m, $k_2 = 500$ N/m
$c = 500$ N-s/m, $m = 10$ kg
$r = 5$ cm, $J_0 = 1$ kg-m^2
$F_0 = 50$ N, $\omega = 20$ rad/s.

(b) Write a short note on—Condition and vibration monitoring techniques. **5**

(c) State and explain the significance of Duffing's equation, and briefly describe the associated parameters. **5**

6. (a) Derive the equation to find peak frequency ratio for the case of frequency-squared excitations. **5**

(b) Determine the necessary stiffness and the damping constant of an accelerometer if the maximum error is to be limited to 3 percent for measurements in the frequency range of 0 to 100 Hz. Assume that the suspended mass is 0.05 kg. **10**

(c) Write a short note on—Limit cycle, in non-linear vibration theory. **5**
