 40+40+40+36+12

T.E Mech. VI CBSGS

Q. P. Code: 17183

26.5.17

Con.

(REVISED COURSE)

[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) Derive the differential equation for a simple harmonic motion. Hence, represent displacement, velocity and acceleration in the form of rotating vectors. Indicate clearly the magnitude of the vectors and the relative phase differences.

(b) A spring of mass m_s and stiffness **k** fixed at one end is connected to a lumped mass **m**. The spring is inclined to the direction of movement of mass by an angle α. Find the time period of vibration of the system, for small amplitudes.

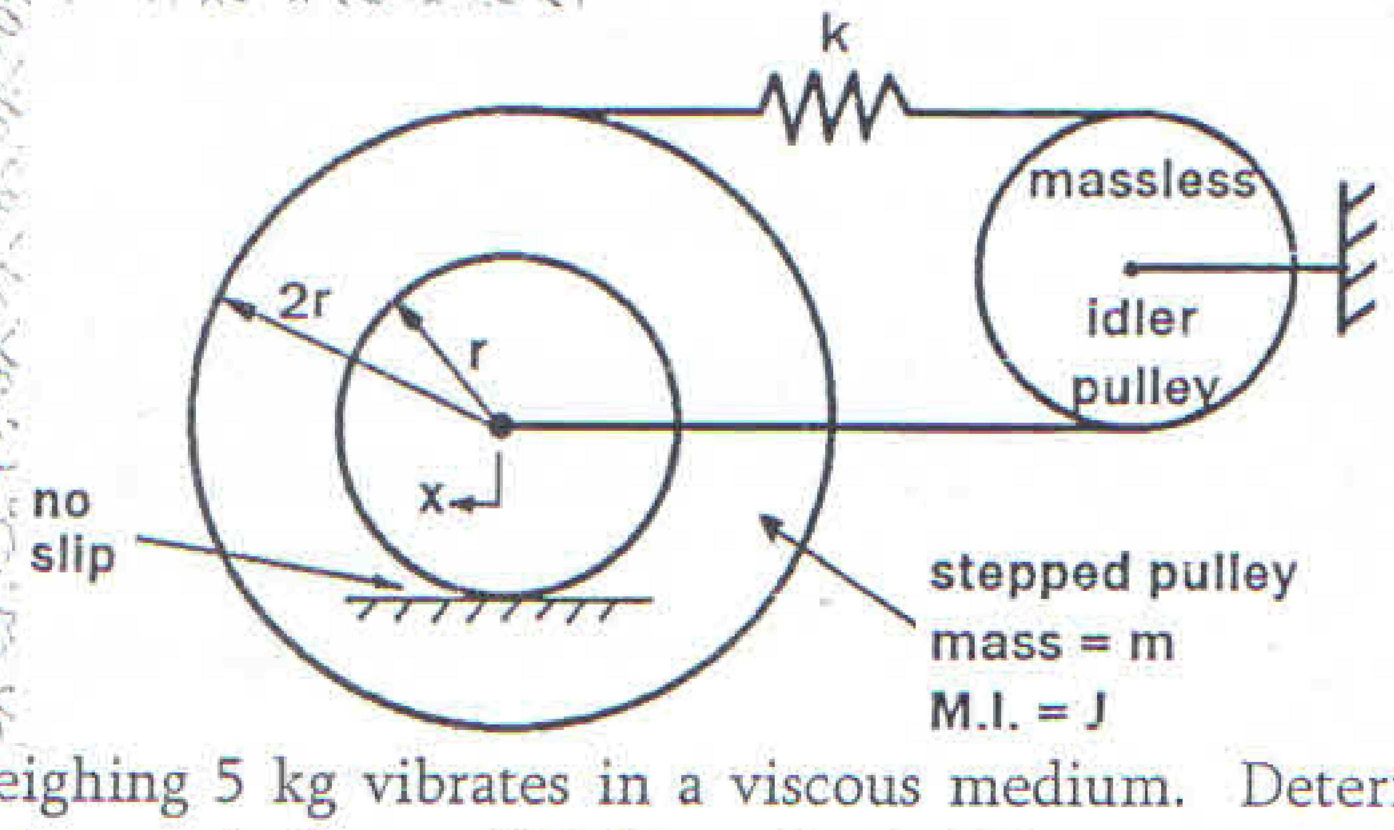
(c) A semi-definite system consists of 2 lumped masses 1 kg each and a helical spring of stiffness 50 N/m connecting them. Estimate the values of the natural frequencies in rad/s, and draw the corresponding mode shapes. Find the position of the nodes, if any.

(d) How does the force transmitted to the base change as the speed of the machine increases? Explain using an equation and the corresponding graph.

(e) Stating the formula, sketch the dimensionless amplitude versus frequency curves of a vibration measuring instrument. Explain in what regions it can be used as an accelerometer and as a vibrometer.

(f) Two identical discs are connected by four bolts of different sizes and mounted on a shaft. The masses and locations of three bolts are as follows—m_1 = 35 gm, r_1 = 110 mm, and Θ_1 = 40°; m_2 = 15 gm, r_2 = 90 mm, and Θ_2 = 220°; and m_3 = 25 gm, r_3 = 130 mm, and Θ_3 = 290°. Find the mass and location of the fourth bolt (m_4, r_4 and Θ_4) which results in the static balance of the discs.

2. (a) Considering generalized coordinate x, evaluate the time period of vibration for the system shown below. 10



(b) A machine part weighing 5 kg vibrates in a viscous medium. Determine the damping coefficient when a harmonic force of 36 N results in 15 mm resonant amplitude with a period of 0.32 s. 10

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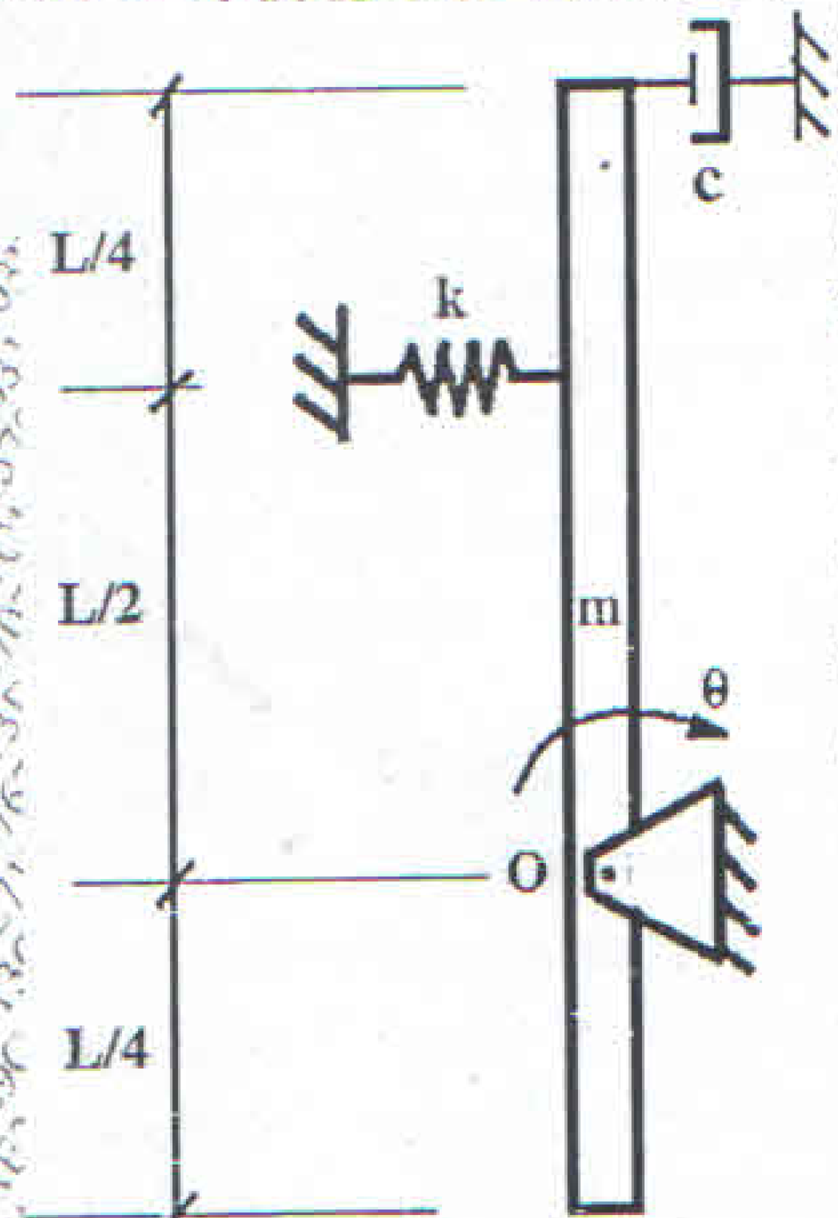
3. (a) In a simple spring-mass-damper system, the mass is 20 kg, spring constant is 10 kg/cm, and the damping coefficient has a value of 0.15 kg-s/cm, and the system is initially at rest. When a velocity of 10 cm/s is given to it, determine the displacement and velocity of the mass after 1 second. 10

(b) A spring-mass system, having a static deflection of 10 mm and negligible damping, is used as a vibrometer. When mounted on a machine operating at 4000 rpm, the relative amplitude is recorded as 1 mm. Find the maximum values of displacement, velocity, and acceleration of the machine. 10

4. (a) Figure below shows an inverted pendulum connected to a spring and viscous damper. Assuming that the inverted pendulum is in stable equilibrium while in motion, derive the equivalent system parameters for small angular oscillation Θ. 8



(b) Four masses A, B, C and D are completely balanced. Masses C and D make angles of 90° and 195° respectively with that of mass B in the counter-clockwise direction. The rotating masses have following properties—m_B = 25 kg, m_C = 40 kg, m_D = 35 kg, r_A = 150 mm, r_B = 200 mm, r_C = 100 mm, r_D = 180 mm. Planes B and C are 250 mm apart. Determine—(i) the mass A and its angular position w.r.t. mass B (ii) the positions of all the planes relative to plane of mass A. 8

(c) Compare Dunkerley's and Rayleigh's methods for analyzing beam vibrations. 4

5. (a) A four-cylinder in-line engine has a reciprocating mass of 1.6 kg, a stroke of 15 cm, and a connecting rod length of 25 cm in each cylinder. The cranks are separated by 10 cm axially and 90° radially, as shown in the following figure. Find the unbalanced primary and secondary forces and couples with respect to the reference plane shown in figure, at an engine speed of 1500 r.p.m. 10

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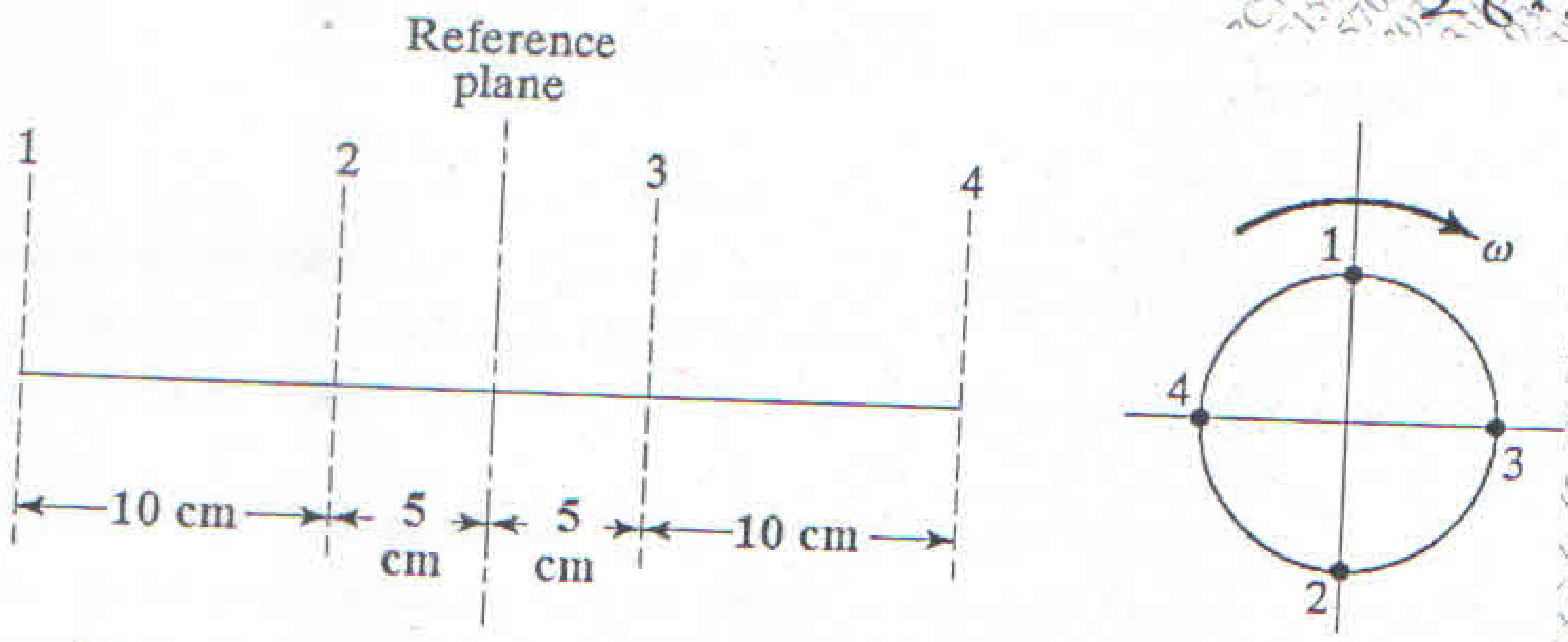
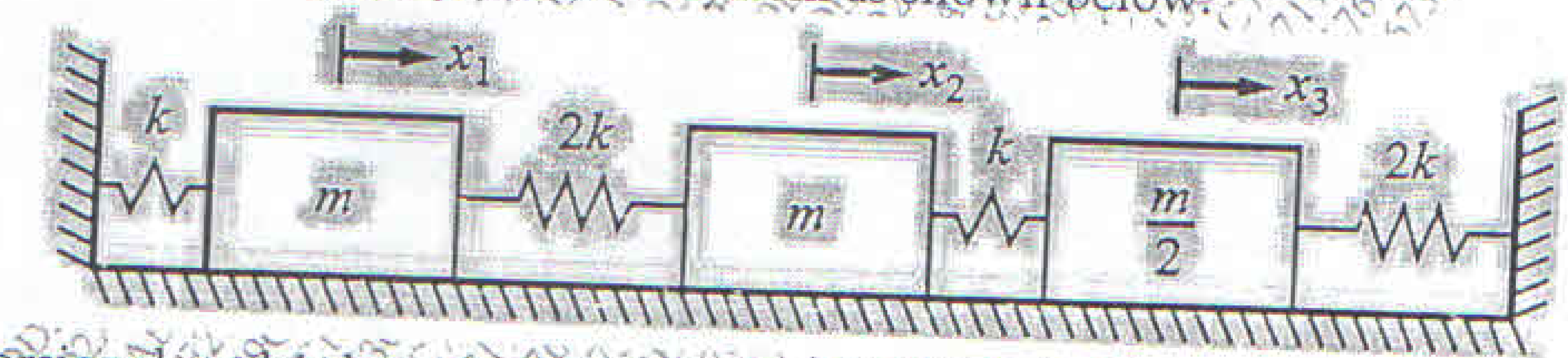


(b) When a washing machine, of mass 200 kg and an unbalance 0.02 kg-m, is mounted on an isolator, the isolator deflects by 5 mm under the static load. Find (i) the amplitude of the washing machine, and (ii) the force transmitted to the foundation at the operating speed of 1200 rpm. 10

6. (a) What are the steps followed in the vibration analysis? Briefly explain. 5

(b) Using exact analysis, calculate the natural frequencies and draw the corresponding mode shapes for the three degree of freedom system as shown below. 10



(c) For the torsional multi-degree of freedom semi-definite system shown below, investigate whether $\omega = 1.78$ rad/s (approximately) is one of the natural frequencies, or not. Also, state the value of the fundamental frequency. Use Holzer's method. Here, I is expressed in kg-m² and k_t is expressed in Nm/rad. 5