Auto

TE|SemVI|CBSGS|MECH|MV|M-J-18

AUTO

24|05|18

Q.P.Code:38429

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.

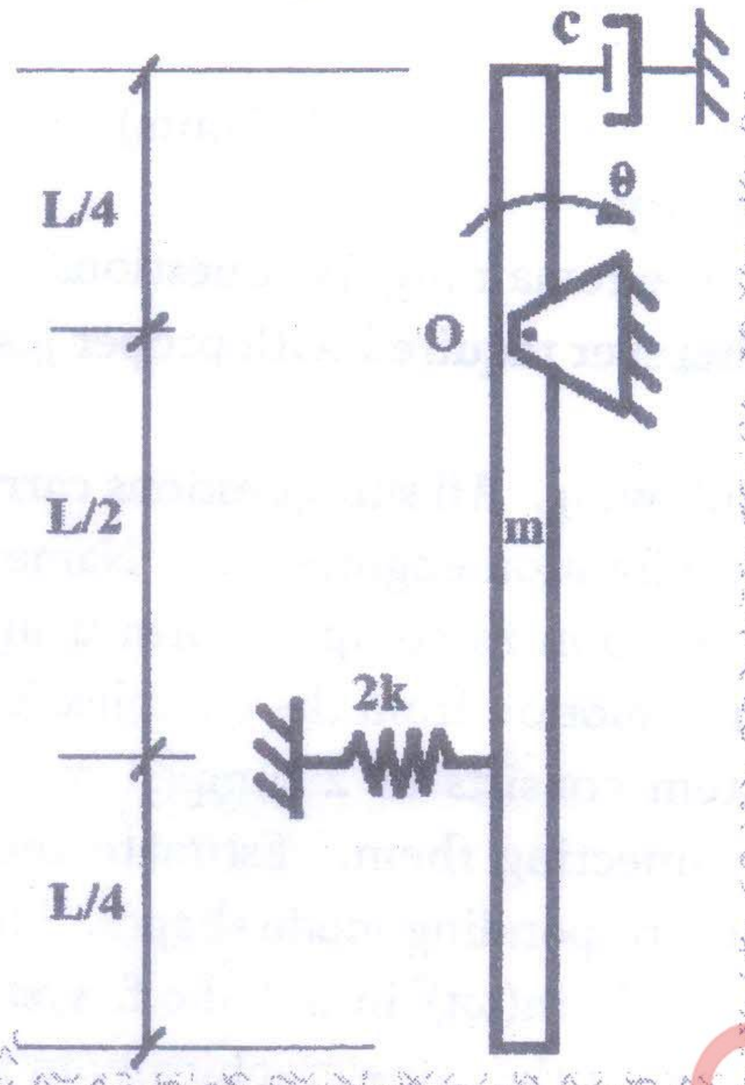
1. Attempt **any four** of the following. **All sub-questions carry equal marks.** 20
   (a) What are the goals of vibration engineering? Name any three causes of vibrations.
   (b) Represent harmonic motion in complex form using Euler's formula. Hence, derive the differential equation of motion from the complex form of the displacement equation.
   (c) A semi-definite system consists of 2 lumped masses 2 kg each and a helical spring of stiffness 100 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) For the case of $F(t) = F_0.\sin(\omega t)$ in a 1 d.o.f. system, write the force balance equation analytically, and represent the same graphically in terms of vector polygon of forces.
   (e) A vibration measuring device is used to find the displacement and acceleration of a machine running at 150 r.p.m. If the natural frequency of the instrument is 10 Hz and it shows 0.005 cm, what are the two readings? Assume no damping.
   (f) Three holes are drilled in a uniform circular disc at a radius of 100 mm and angles of 0°, 120° and 220°. The mass removed at hole 1 is 100 gm, and at holes 2 and 3 is 120 gm each. If the disc is to be balanced statically by drilling a fourth hole at a radius of 130 mm, find the mass to be removed and the angular location of the fourth hole.

2. (a) A connecting rod has a mass of 4 kg. The distance of centre of gravity (C.G.) from the smaller end (about which it is suspended) is 20 cm, and the natural frequency is found to be 50 cycles/minute. Estimate the moment of inertia of the connecting rod about its C.G. 10
   (b) Overshoot for an underdamped system is defined as the maximum displacement of the system at the end of its first half cycle. Find minimum damping ratio for the system such that it is subjected to no more than 10% overshoot. 10

3. (a) A 25 kg block is connected to a spring of stiffness 1.5×10^5 N/m. The coefficient of friction between the block and the surface on which it slides is 0.1. The block is displaced 15 mm from equilibrium and released. What is the amplitude of motion at the end of the first cycle? How many cycles of motion occur? 10
   (b) A spring-mass-damper system, having an undamped natural frequency of 20 Hz and a damping constant of 20 N-s/m, is used as a vibrometer to measure the vibration of a machine operating at a speed of 2500 rpm. If the actual velocity is 30 m/s and the recorded velocity is 29 m/s, find the mass and the spring constant of the vibrometer. 10

4. (a) A, B, C and D are four masses carried by a rotating shaft at radii 120 mm, 140 mm, 220 mm and 180 mm respectively. The planes in which the masses revolve are spaced 700 mm apart and the mass of B, C and D are 12 kg, 7 kg, and 5 kg respectively. Find the required mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance. 8

(b) Figure below shows a pendulum connected to a spring and viscous damper. Derive the equivalent system parameters for small angular oscillation Θ. 8



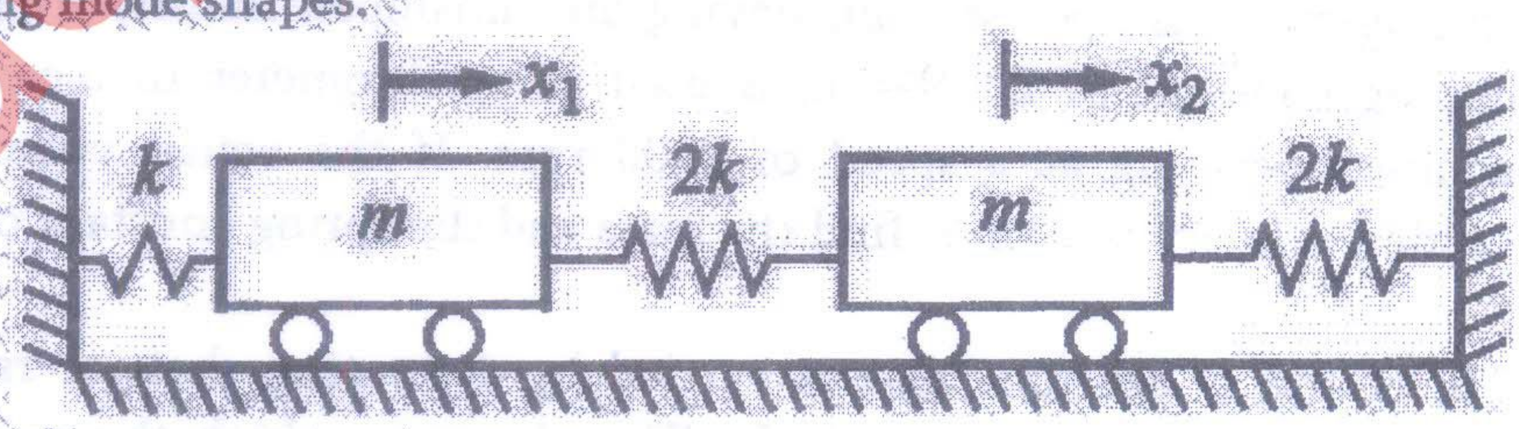
(c) Explain Influence Coefficients and Maxwell's Reciprocity Theorem for analyzing beam vibrations. 4

5. (a) A three cylinder internal combustion engine works on 2-stroke cycle. Investigate the unbalance effect graphically (for primary and secondary forces and couples) with respect to mid-axis of engine. Given—Mass of each piston is 3 kg, crank radius is 200 mm, angular frequency is 10 rad/s, linear pitch between cylinders is 200 mm, and ratio of crank length to radius is 4. 10

(b) An automobile is modeled as a single degree of freedom system vibrating in the vertical direction while travelling over a rough road. The vehicle has a mass of 1000 kg. The suspension system has a spring constant of 350 kN/m and a damping ratio of 0.4. If the vehicle speed is 25 km/hr, determine the displacement amplitude of the vehicle. The road surface varies sinusoidally with an amplitude of Y = 0.04 m and a wavelength of 5 m. 10

6. (a) Using simple pendulum as an example, explain the phenomenon causing oscillations once it is disturbed. 5

(b) Derive the differential equations of motion for the following two degree of freedom system using Newton's method. Also calculate the natural frequencies and draw the corresponding mode shapes. 10



(c) Write short note on Holzer's method. 5