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B TECH
(SEM VI) THEORY EXAMINATION 2017-18
MECHANICAL VIBRATIONS

Time: 3 Hours ***Total Marks: 100***

Note: 1. Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt *all* questions in brief. 2 x 10 = 20

a. What do you understand by Transmissibility ratio?

b. A spring-mass system has a natural period of 0.21 sec. What will be the new period if the spring constant is (a) increased by 50 percent and (b) decreased by 50 percent?

c. Define logarithmic decrement and its importance.

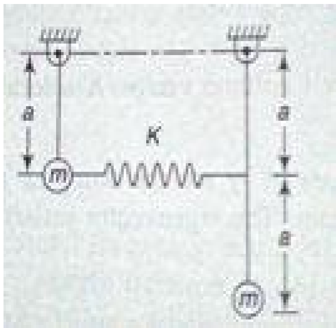
d. A child's swing consists of a seat hanging from four chains. A child is sitting quietly in a swing when a parent gently pulls and releases the seat. If the parent observes that it takes approximately 2 seconds for the child and swing to return, what is the length of the swing's hoist?

e. What do you mean by magnification factor? Also discuss its importance in brief.

f. Explain Maxwell's Reciprocal theorem.

g. What is superposition and beat phenomenon?

h. Find the equation of motion for small oscillation of the pendulum shown in figure. Assume rods are rigid & mass of rod is neglected.



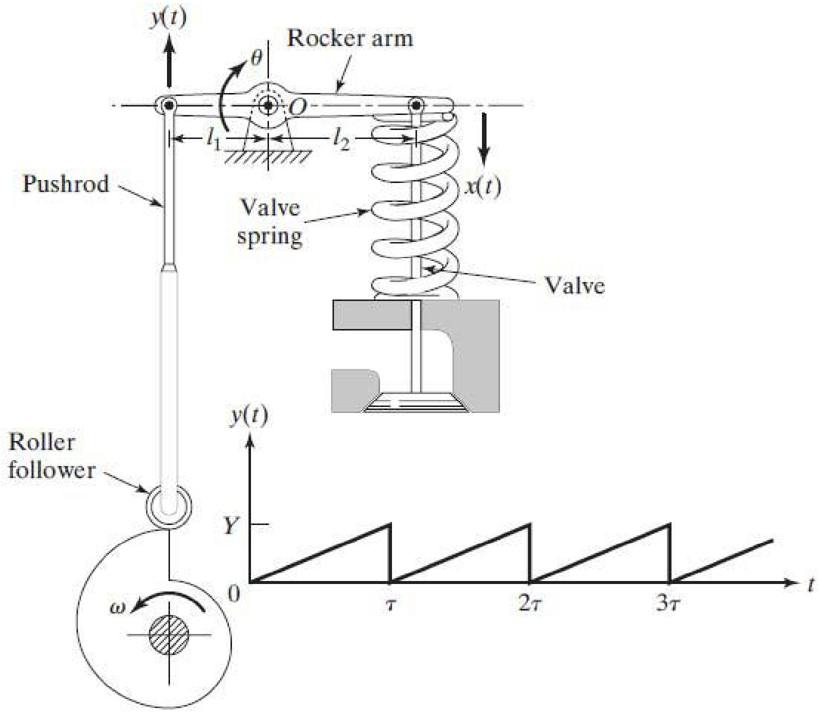
i. What is flexibility & stiffness influence coefficient?

j. Define degree of freedom of a system. Give one example of one, two and multi degree freedom system.

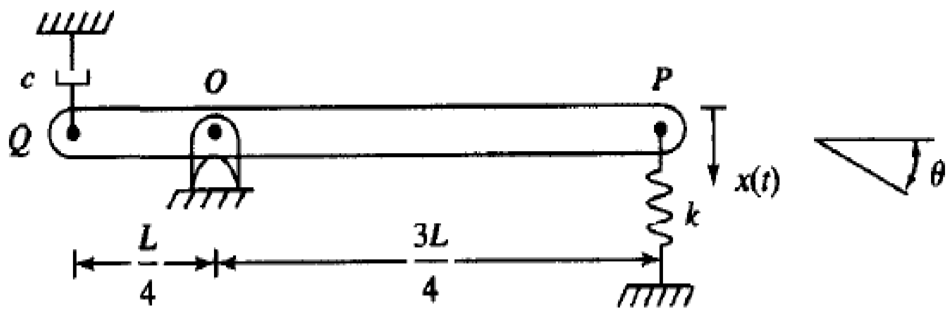
SECTION B

2. Attempt any *three* of the following: 10 x 3 = 30

a. Determine the Fourier series expansion of the motion of the valve in the cam-follower system shown in Figure:



b. A slender rod of length Land mass m is pinned at O as shown in figure. A spring of stiffness k is connected to the rod at point P while a dashpot of damping coefficient c is connected at point Q. Assuming small displacement, derive a linear differential equation governing the free vibrations of this system and calculate frequency of vibrations. Use x, the displacement of particle P, measured from the system's equilibrium position, as the generalized coordinates.



c. A disc of a torsional pendulum has mass moment of inertia of 600 kg-cm2 and is immersed in a viscous fluid. The brass shaft attached to it is of 10cm diameter and 40 cm long. When the pendulum is vibrating, the observed amplitudes on the same side of the rest position for successive cycles are 9o, 6o and 4o. Determine: (a) Logarithmic decrement (b) Damping torque at unit velocity (c) Periodic time of vibration. Assume for the brass shaft, G = 4.4 x 10^{10} N/m^2

d. Derive governing equation of motion of damped free vibration and discuss response of a general system subjected to varying damping conditions like critical and under damped condition.

e. A rotor of mass 10 kg is mounted in the middle of 30 mm diameter shaft supported at the two bearings. The bearing span is 500 mm. Because of certain manufacturing inaccuracies, the C.G of the disc is 0.03mm away from the geometric Centre of rotor. If the system rotates at 2500 rpm, find the amplitude of steady state vibrations and the dynamic force transmitted to the bearings. Neglect damping. Take E = 2 x 105 N/mm

SECTION C

3. Attempt any *one* part of the following: 10 x 1 = 10

(a) Attempt both parts:

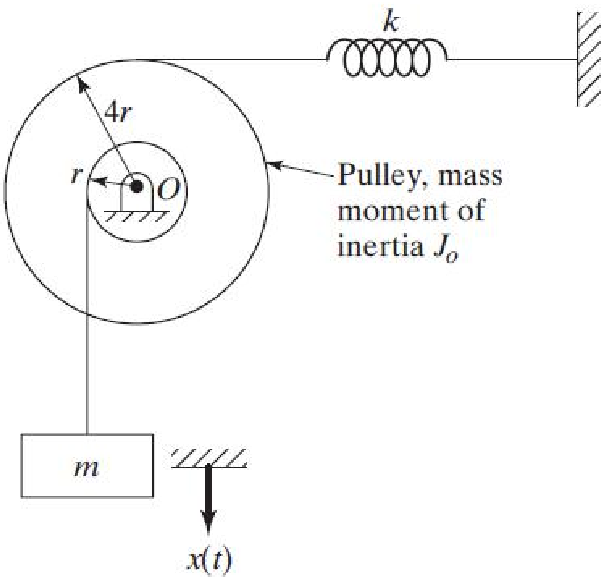
I. Add two vectors $x_1 = 4 \cos(wt + 10^o)$ and $x_2 = 5 \cos(wt + 60^o)$ analytically and check the results graphically.

II. Compare the effects of viscous damping and Coulomb damping.

(b) Attempt both parts: **[4 + 6 = 10]**

i. A stepped shaft has three segments of diameters and lengths as follows: d_1= 50mm, l_1=0.4m, d_2=60mm. l_2=0.5m, d_3=90mm, and l_3=0.6m. The shaft is fixed at one end and connected to a disc with moment of inertia of 15 kg m^2. G=83GPa. Find the natural frequency of the system.

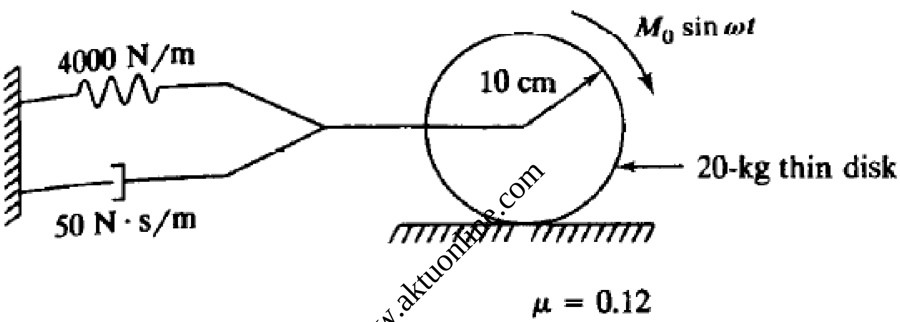
ii. Obtained the equation of motion for small movement of the system shown in figure. Also find its frequency equation.



4. Attempt any *one* part of the following: 10 x 1 = 10

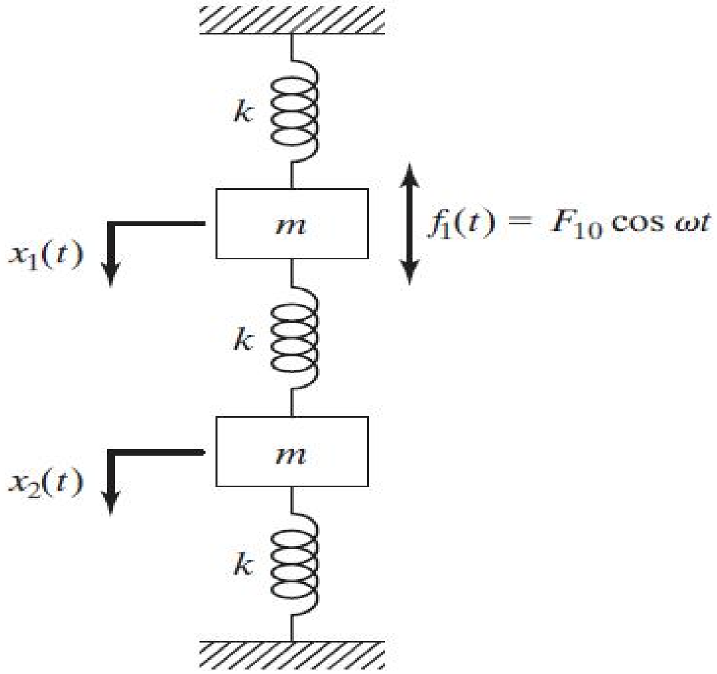
(a) A sensor and actuator are attached to a mechanical system in an effort to control any vibrations that may occur. The total mass of the system is 6 kg, its effective stiffness is 2 N/m and its coefficient of viscous damping is 3.7 N-sec/m.If the sensor detects a sustained harmonic vibration of amplitude 60 cm and frequency 2 rad/sec, what force must be applied by the actuator to counter the observed motion?

(b) If ω = 16.5 rad/s, what is the maximum value of M_0 such that the disk of figure rolls without slip?

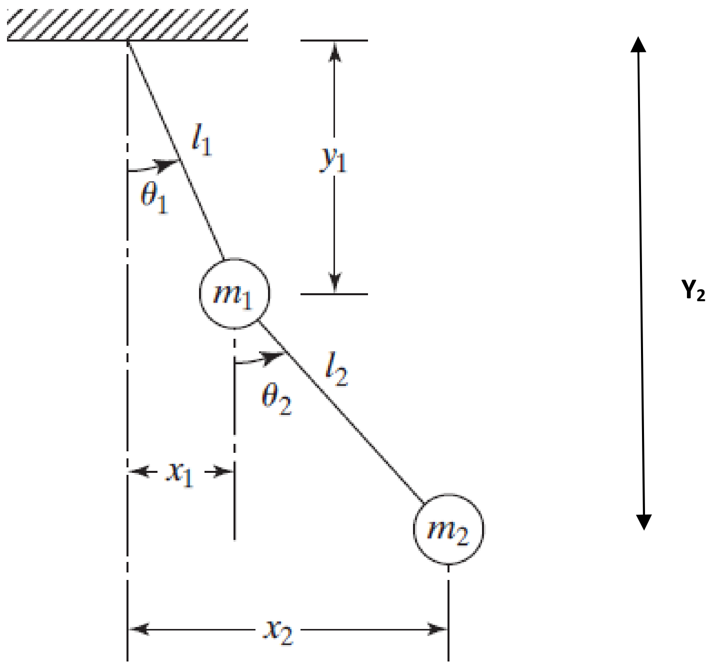


5. **Attempt any *one* part of the following:** **10 x 1 = 10**

(a) Find the steady-state response of the system shown in Figure when the mass m_1 excited by the force $F_1(t) = F_{10} \cos \omega t$. Also, plot its frequency-response curve.

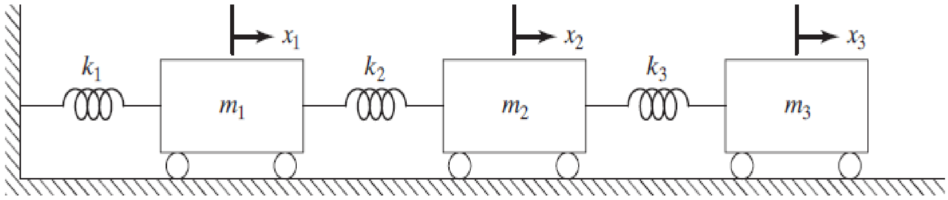


(b) Set up the differential equations of motion for the double pendulum shown in figure, using the coordinates x_1 and x_2 and assuming small amplitudes. Find the natural frequencies, the ratios of amplitudes, and the locations of nodes for the two modes of vibration when $m_1 = m_2 = m$ and $l_1 = l_2 = l$

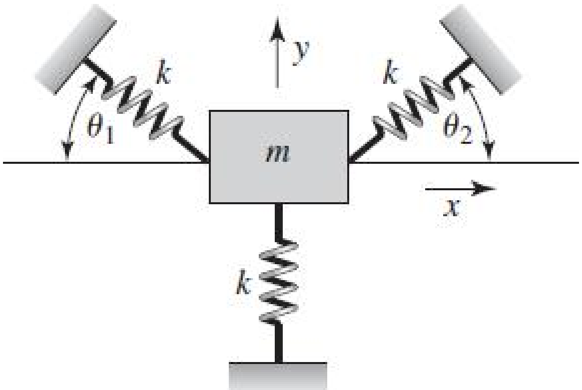


6. **Attempt any *one* part of the following:** **10 x 1 = 10**

(a) Find the natural frequencies and mode shapes of the system shown in Figure for $k_1 = k_2 = k_3 = k$ and $m_1 = m_2 = m_3 = m$



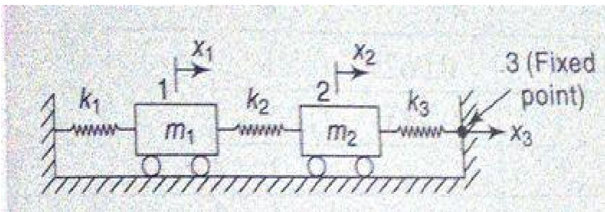
(b) Determine the natural frequencies and mode shapes for the system shown in figure, when $\theta_1 = 30°$and $\theta_2 = 45°$ at the equilibrium position. Let L be the length of each spring at the equilibrium position and assume that the deflections in the springs at an angle are small.



7. Attempt any *one* part of the following: 10 x 1 = 10

(a) For a system shown in figure obtain the natural frequencies by Holzer's method.

Take $m_1 = m_2 = 1$ unit, $k_1 = k_2 = 1$ unit, $k_3 = 2$unit.



(b) The circular shaft as shown in figure is fixed at x = 0 and has a thin disk of mass moment of inertia I attached at x = L. Determine the natural frequencies for this system. Identify the orthogonality condition satisfied by the mode shapes, and determine the normalized mode shapes.