Printed Pages: 5 **Sub Code: EME-024**

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

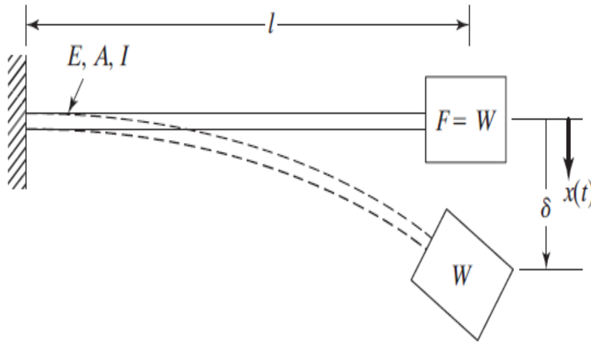
Time: 3 Hours ***Total Marks: 100***

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

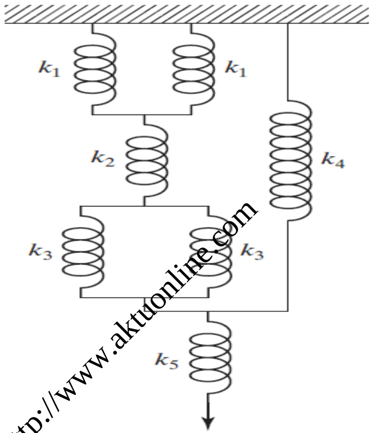
SECTION A

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

a. What do you mean by transmissibility ratio?
b. Define critical or whirling speed. Of a shaft.
c. Define damped vibration and enlists different types of damping system.
d. What do you mean by degree of freedom and generalized coordinates?
e. Represent the system shown in figure by equivalent spring-mass system.



f. The response of a system is given by ($x(t) = 0.003 \cos(30t) + 0.004 \sin(30t)$ ma) Determine (a) the amplitude of motion, (b) the frequency in Hz, (c) the frequency in rpm, (d) the phase angle
g. A spring-mass system has a natural frequency of 10 Hz. When the spring constant is reduced by 800 N/m, the frequency is altered by 45 percent. Find the mass and spring constant of the original system.
h. What is flexibility & stiffness influence coefficient?
i. Explain Maxwell's Reciprocal theorem.
j. Determine the equivalent spring constant of the system shown in diagram below:



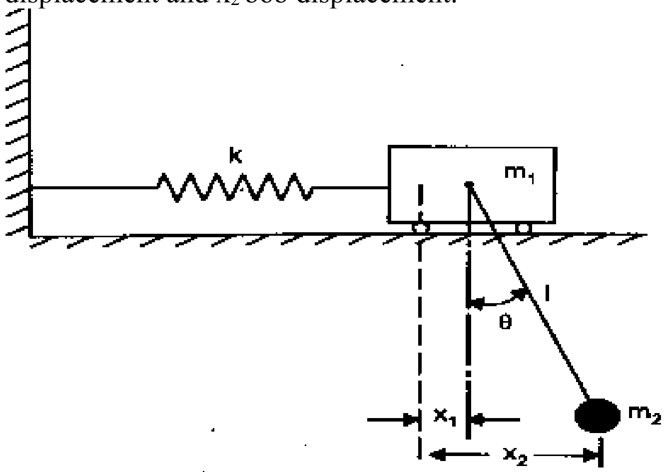
SECTION B

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

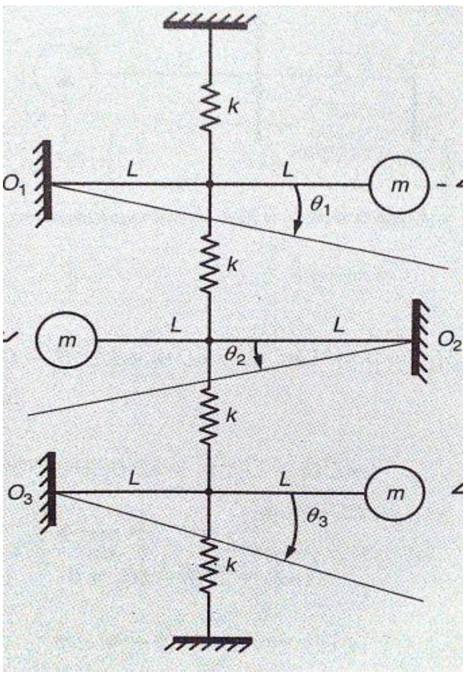
a. Prove that for finding the natural frequency of a spring -mass system, the mass of the spring can be taken into account by adding one third of its mass to the main mass.

b. 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.

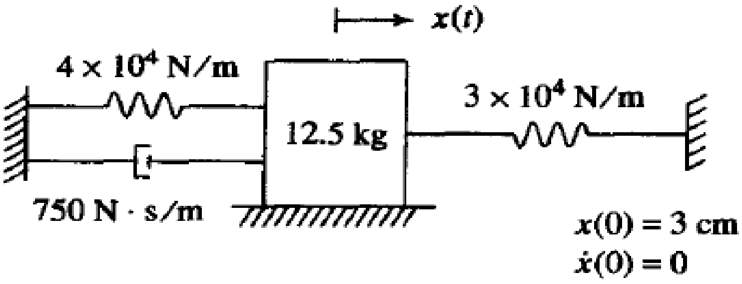
c. Determine the frequency equation for the system shown in figure, where x_1 is block displacement and x_2 bob displacement.



d. Find the equation of motion and also find the natural frequencies of the system shown in fig-7.



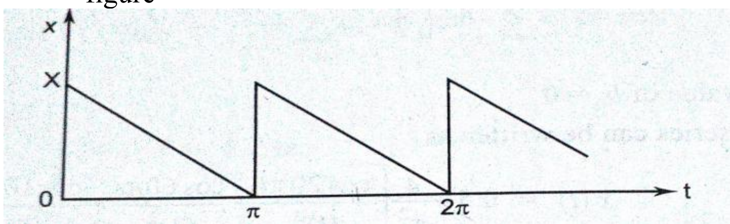
e. For the system shown in figure
   I. Determine damping ratio
   II. State whether the system is underdamped, critically damped or overdamped
   III. Determine x(t) or θ(t) for the given initial conditions



SECTION C

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

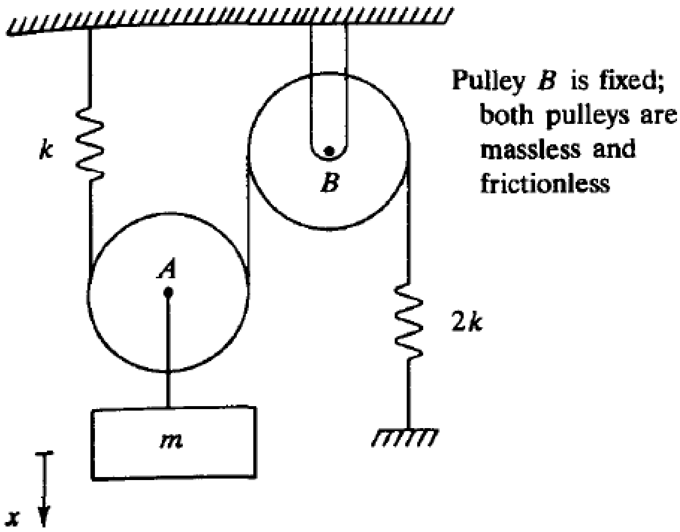
(a) I. Determine the Fourier series expansion of the periodic function shown in figure



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

(b) Attempt both parts:

I. Derive the differential equation governing the motion and determine the natural frequency of the system shown in figure

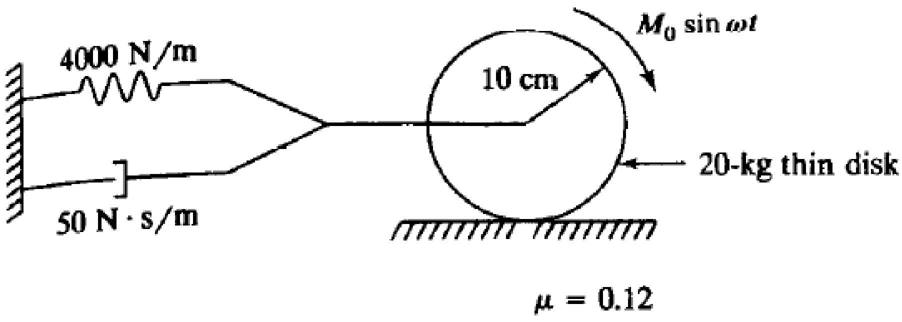


II. The natural frequency of a spring-mass system is found to be 2 Hz. When an additional mass of 1 kg is added to the original mass *m*, the natural frequency is reduced to 1 Hz. Find the spring constant *k* and the mass *m*

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

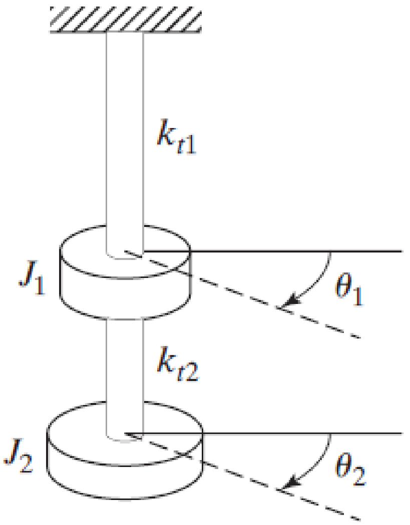
(a) Find the total response of a single degree of freedom system with m = 10 kg, c = 50 N-s/m, k = 2000 N/m under the action of harmonic force F = F_o sin wt with F_o = 200N and w = 31.416 rad/s. the initial conditions may be assumed as x = 0.01m and x = 5m/s at t = 0.

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

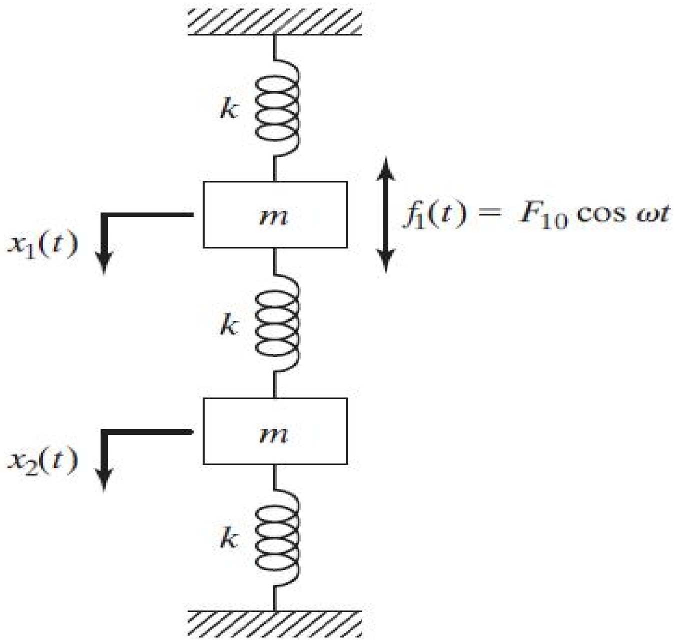


5. **Attempt any *one* part of the following:** **10 x 1 = 10**

(a) Find the natural frequencies and mode shapes for the torsional system shown in figure for $J_1 = J_0$, $J_2 = 2J_0$ and $k_{t1} = k_{t2} = k_t$.

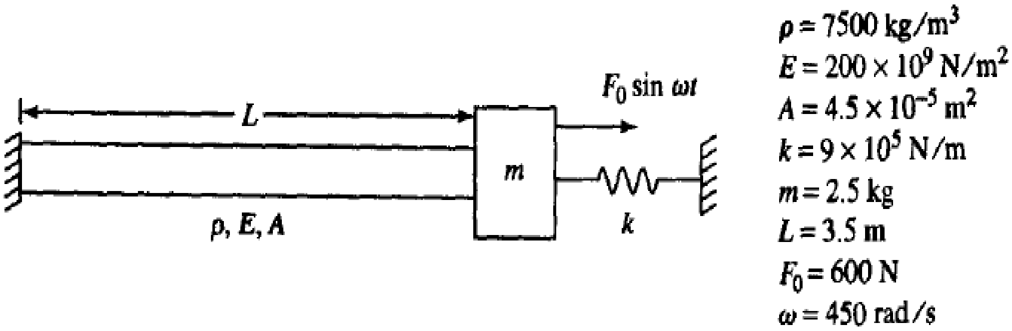


(b) Find the steady-state response of the system shown in Figure when the mass m_1 excited by the force $F_1(t) = F_{10} \cos \omega t$. Also, plot its frequency-response curve.

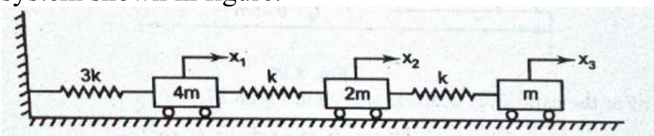


6. **Attempt any *one* part of the following:** **10 x 1 = 10**

(a) Determine the steady state response of the system shown below:



(b) Determine the fundamental natural frequency and corresponding mode shape of the system shown in figure.



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

(a) A shaft, carrying a rotor of weight 100 Kg and eccentricity 0.1 cm., rotates at 1200 rpm. Determine (a) the steady-state whirl amplitude and (b) the maximum whirl amplitude during start-up conditions of the system. Assume the stiffness of the shaft as $2 \text{ X } 10^5$ kg/cm^2 and the external damping ratio as 0.1

(b) Determine the fundamental natural frequency of the system shown in figure, using Stodola's method. Take $E = 196\text{x } 10^9$ N/m^2. $I = 4 \text{ x } 10^{-7}$ m^4.