Code No: 07A72101 **R07** **Set No. 2**

IV B.Tech I Semester Examinations,December 2011
VIBRATIONS AND STRUCTURAL DYNAMICS
Aeronautical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
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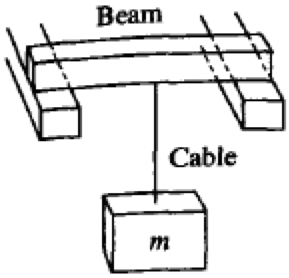
1. Explain the procedure of finding natural frequency of vibrations by Dunkerleys method with the help of simple supported beam acted by three point loads at equidistane along the span. [16]

2. Explain the equivalent stiffness concept. Determine the equivalent stiffness of the beam cable system, if the mass is 800 kg. Also determine the frequency of oscillations as shown in below figure 1. [16]



Beam: $E = 200 \times 10^9$ N/m^2
$I = 3.5 \times 10^{-4}$ m^4
Cable: $E = 200 \times 10^7$ N/m^2
$r = 10$ cm

Figure 1:

3. For the three nodded cantilever beam as shown in figure 2, determine global stiffness matrix and lumped mass matrix. [16]

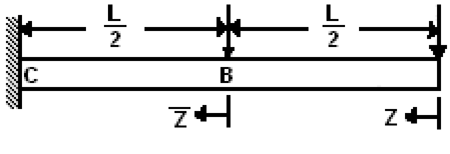


Figure 2:

4. Write the wave equation for longitudinal vibration of tapered bar and when subjected to external forces and give the displacement boundary conditions for all end conditions. [16]

5. A ramp-step forcing function shown in figure 3 acts on a spring-mass system. Obtain the shock of this forcing function. [16]

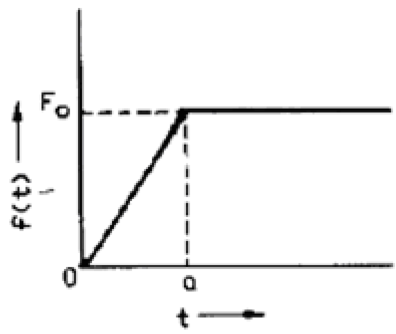


Figure 3:

6. A power shaft has a diameter of 25 mm and 850 mm long , and a simply supported. The shaft carries a rotor of 2.5 kg at its mid span. The rotor has an eccentricity of 0.5 mm. calculate the critical speed of shaft and deflection of the shaft at mid span at 1000 r/min. neglect mass of shaft take E = 2X 10^5 MPa. [16]

7. Two pendulums of different lengths are free to rotate y-y axis and coupled together by a rubber hose of torsional stiffness 7.35 X 10^3 Nm / rad as shown in figure 4. Determine the natural frequencies of the system if masses
   m1 = 3kg, m2 = 4kg, L1 = 0.30 m L2 = 0.35 m. [16]

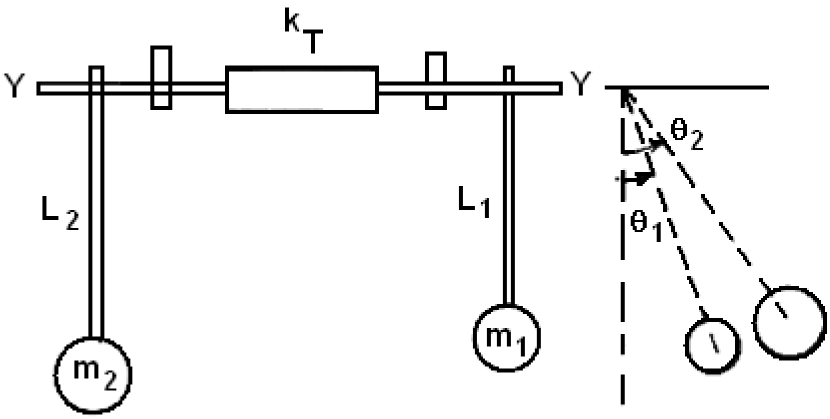


Figure 4:

8. For the system shown in figure 5, determine the damping ratio and frequency of damped oscillations. [16]

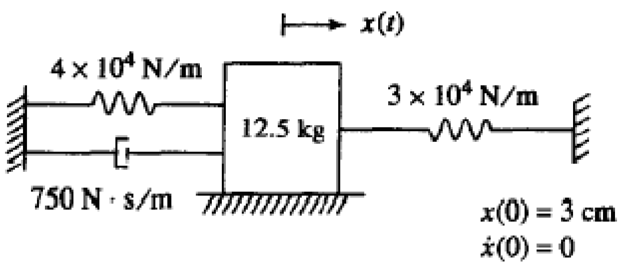


Figure 5

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VIBRATIONS AND STRUCTURAL DYNAMICS
Aeronautical Engineering

Time: 3 hours **Max Marks: 80**

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1. For the single element cantilever beam as shown in figure 6, determine the fundamental frequency of oscillation. [16]

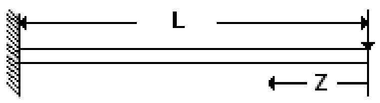

Figure 6:

2. Describe the concept of vibration absorber with the help of neat sketches. [16]

3. A vibrating body of mass 150 kg supported on springs of total stiffness 1050 kN/m has a rotating unbalance force of 525 N at a speed of 6000 rpm. If the damping factor is 0.3 determine:
   (a) The amplitude caused by the un balance.
   (b) The transmissibility.
   (c) The actual force transmitted to the foundation. [16]

4. A shaft of negligible weight 6 cm diameter and 5 meters long is simply supported at the ends and carries four weights 50 kg each at equal distance over the length of the shaft as shown in figure 7. Find the frequency of vibration by Dunkerley's method.
   Take E = 2 x 10^6 kg / cm^2 if the ends of the fixed. [16]

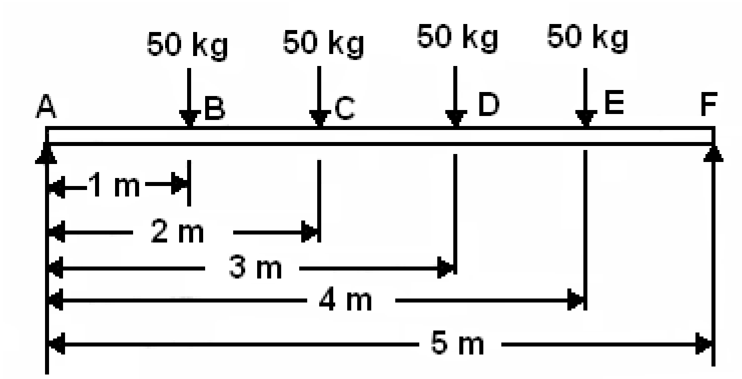

Figure 7:

5. (a) A shaft 1600 mm long and diameter 40 mm has a rotor of mass 5kg at its mid span. It is observed that the deflection of the shaft at mid span is 0.4 mm under the weight of the rotor. Find the critical speed of the shaft.

   (b) Describe the whirling speed of light vertical shaft with single disc of with damping with a supported diagram. [10+6]

6. (a) A circular cylinder of mass m and radius r is connected by a spring of stiffness K as shown in figure 8. If it is free to roll on the rough surface which is horizontal without slipping, find its natural frequency.

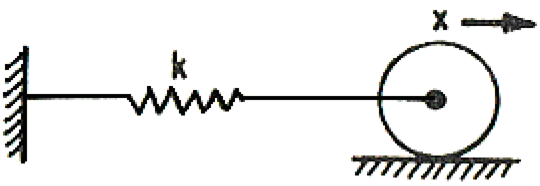

Figure 8:

   (b) An unknown mass m is hung on a spring of unknown stiffness k. When a mass $m_1 = 0.5$ kg is added to m, the system natural frequency is lowered from 50 Hz to 49 Hz.

      i. Determine the values of m and k. When second spring of stiffness k' is added in parallel with the first spring, the natural frequency is increased to 50 Hz.

      ii. Determine the value of k'. [8+8]

7. Prove that the free vibration equation of a string of density ρ, length l subjected to tensile force P at a distance x with vertical deflection w is given by
$P\frac{\partial^2\omega(x,t)}{\partial x^2} = \rho\frac{\partial^2\omega(x,t)}{\partial t^2}$. [16]

8. A spring-mass system is shown in figure 9. If the system is initially relaxed and a step-function excitation is applied to the mass, find the response of the system. [16]

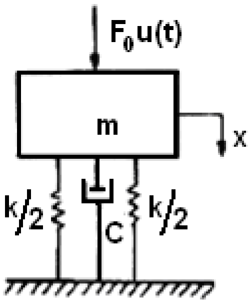

Figure 9:

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Code No: 07A72101 **R07** **Set No. 1**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. Determine the response of spring mass damper system to an step input and the plot the system response for different amounts of damping. [16]

2. What are the various cases of two degree freedom system vibrations. Explain them in detail with the help of neat sketches. [16]

3. Explain maxwell's reciprocal theorem with the help of simple supported beam with two concentrated loads. [16]

4. A spring-mass system with viscous damping is displaced a distance a_0=20 mm and released. After 8 cycles of vibration the amplitude decays to $a'_8 = 4$mm. A mass $m_1 = 2$ kg is attached to the initial mass producing a static displacement of 4 mm. If the new system is displaced a distance a_0=20 mm and released after 8 cycles of vibration the amplitude decays to $a''_8 = 5$ mm. Determine the mass m, the stiffness k and the damping coefficient c. [16]

5. Develop the equation of vibration and determine the natural frequency for the system shown in figure 10. [16]

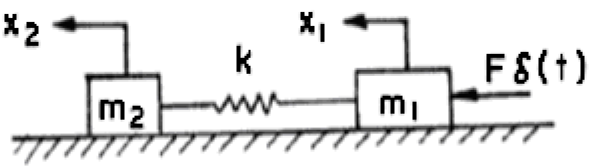

Figure 10:

6. The following data relate to a shaft held in long bearings. The length of the shaft is 1.2 m, diameter of shaft is 14 mm, mass of a rotor at midpoint is 16 kg, eccentricity of center of mass of rotor from the center of rotor is 0.4 mm, E = 200 GN/ m^2, permissible stress in shaft material is 70 MN/m^2. Determine the whipping speed of the shaft and the range of speed over which it is unsafe to run the shaft. Assume that the mass of the shaft is zero. [16]

7. For the system shown in below figure 11 the block slides on a rough surface (coefficient of friction μ) inclined at an angle of ϕ with respect to vertical. If the block is subjected to a periodic force of the form F(t) = F_0 sin (ωt).

   (a) Find the equations of motion. Do not neglect gravity;

(b) Find the amplitude of the steady-state response using M_c when

m = 1.25 kg,	k = 20 N/m,
$\phi = 30^0$,	$\mu = 0.125$,
$F_0 = 4$N,	$\omega = 2.00$ rad/s.

[8+8]

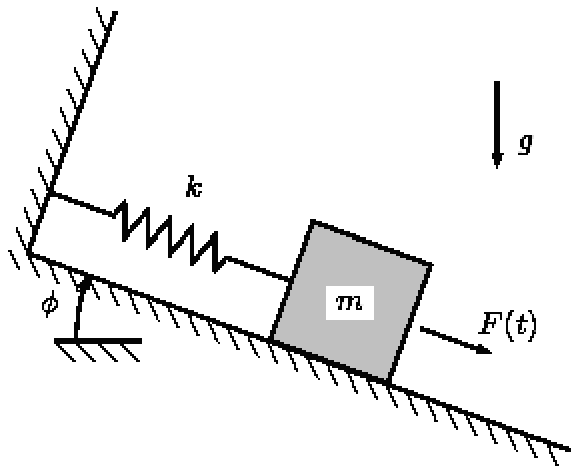

Figure 11:

8. Derive the orthogonality principle of normal modes for longitudinal vibrations of uniform bars. [16]

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. Solve the problem shown in figure 12 m_1=10kg, m_2=15kg and k = 320 N/m. [16]

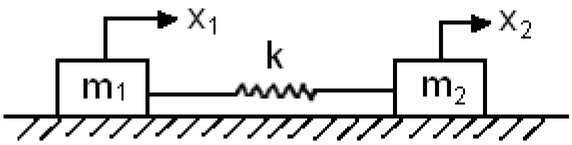

Figure 12:

2. Obtain the governing equation for the damped vibrations and determine the amplitude. [16]
3. Find the Laplace transform of the derivative of a function. [16]
4. Explain the concept of influence coefficients in several degrees of freedom vibrating systems with the help of an example. [16]
5. Determine the natural frequency of simple supported beam subjected to an axial compressive force. [16]
6. For the system shown in figure 13 write the global stiffness matrix using FEM approach and specify the displacement boundary conditions, for nodes 4 and 5 are fixed. [16]
7. Explain the Energy method of determining the frequency of vibrating system. Calculate the total K.E and P.E for the system as shown in figure 14 and obtain the frequency if k_1=k_2= 10 N/m Mass of the rotor is M = 8 kg, m = 4 kg, r_1 = 20 mm, r_2 = 80 mm. [16]
8. A piping system experiences resonance when the pump supplying power to the system operates at 500 r/min. when a 5 kg absorber tuned to 500 r/min is added to the pipe, the systems new natural frequencies are measured as 380 to 624 r/min. What is the natural frequency of the piping system and its equivalent mass?. Redesign the absorber such that the systems natural frequencies are less than 350 r/min and greater than 650 r/min. [16]

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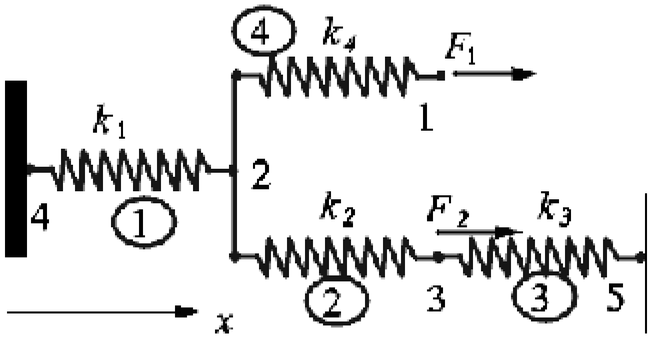

Figure 13:

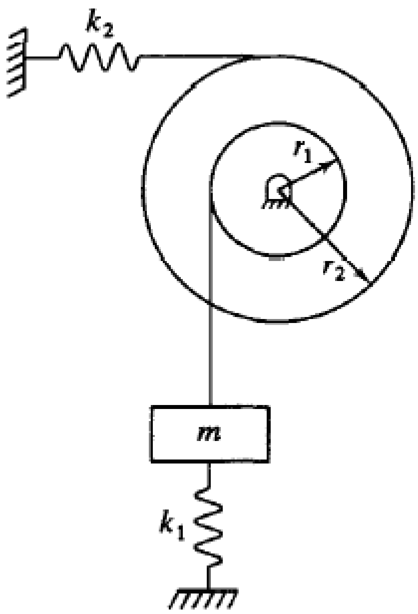

Figure 14: