(Pages : 3) **9117**

Reg. No. : ....

Name : ....

First Semester M.Tech. Degree Examination, February 2015
(2013 Scheme)
Branch : Mechanical Engineering
Stream : Machine Design
MDC 1001 : ADVANCED THEORY OF VIBRATION

Time : 3 Hours Max. Marks : 60

***Instruction :** 2 questions are to be answered from **each** Module.*

Module – 1

1. The recoil mechanisms of large firearms are designed with critical damping to take advantage of the quickest return to the firing position without oscillation. A 52 kg cannon is to return to within 50 mm of its firing position 0.1 s after maximum recoil. The initial recoil velocity of the cannon is 2.5 m/s. Determine (a) the stiffness of the recoil mechanism, (b) the damping coefficient of the recoil mechanism, and (c) the maximum recoil. **10**

2. A disk of mass m and with moment of inertia J0 is set on a hub of radius r (Fig. 1). The disk hub is supported by a curvilinear circular guide of radius R. Assuming the disk motion to occur without slipping between the hub and the guide, set up the differential equation for small free vibrations of the disk and write the frequency of oscillation of the disk. **10**

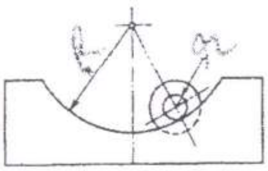

Fig. 1

3. A machine of 100 kg mass is supported on springs of total stiffness 700 kN/m and has an unbalanced rotating element, which results in a disturbing force of 350 N at a speed of 3000 rpm. Assuming a damping factor of $\xi = 0.20$, determine (a) its amplitude of motion due to the unbalance, (b) the transmissibility, and (c) the transmitted force. **10**

P.T.O.

Module – 2

4. Use the quadratic forms of kinetic and potential energy to derive the differential equations governing free vibration of the system of Fig. 2 and discuss the coupling using (a) x and θ as generalized coordinates and (b) xA, the vertical displacement of particle A, and xB, the vertical displacement of particle B, as generalized coordinates. **10**

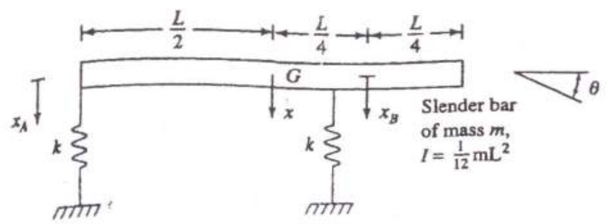

Fig. 2

5. A railroad car of mass 1500 kg is to be coupled to an assembly of two precoupled identical railroad cars. The couplers are elastic connections of stiffness 4.2 × 107 N/m. The single car is rolled toward the other cars with a velocity of 7 m/s. Describe the motion of the three railroad cars after coupling is achieved. Hint – After coupling, the motion of the three railroad cars is modeled by using three degrees of freedom, as shown in Fig. 3. **10**

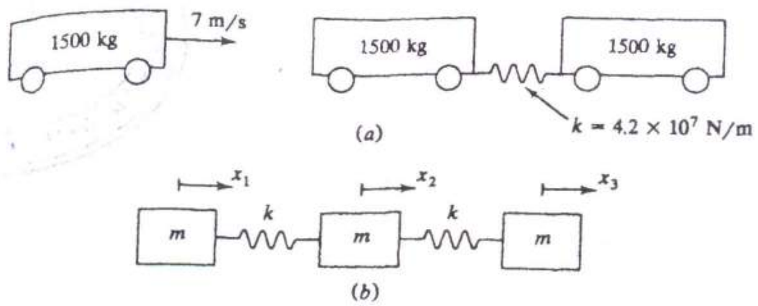

Fig. 3

6. For the system shown in Fig. 4, write the matrix equation based on the flexibility and determine the lowest natural frequency by iteration. **10**

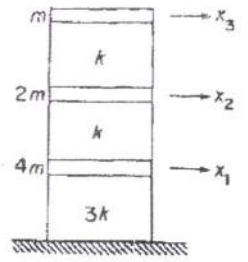

Fig. 4

Module – 3

7. Determine the natural frequencies and normalized mode shapes for a simply supported beam. **10**

8. Derive the differential equation of small vibrations and calculate the first frequency of vibrations for a heavy filament with a weight at its end (Fig. 5). The weight. mass is m, and the mass of a unit length of the filament is m_0 so that $m = m_0 l$ **10**

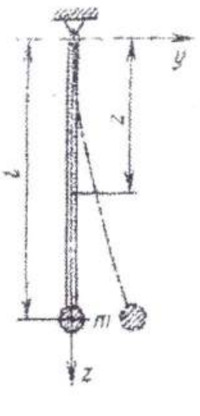

Fig. 5

9. Using the Rayleigh-Ritz method, determine the first two natural frequencies and mode shapes for the longitudinal vibration of a uniform rod with a spring of stiffness k_0 attached to the free end, as shown in Fig. 6. Use the first two normal modes of the fixed-free rod in longitudinal motion. **10**

Fig. 6