M. E. First Semester Examination 2011

Subject: Theory of Mechanical Vibration (ME-913)

Duration: 3 hours F. M. 70

Answer ***question No. 1 and any three*** from the rest

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1. Consider the system illustrated in Fig. 1. The slender bar may be assumed rigid.
   (a) Write the equations of motion of the system using the Euler-Lagrange formulation.
   (b) Determine the natural frequencies and mode shapes of the system.
   (c) Graphically illustrate the mode shapes showing the locations of the nodes.

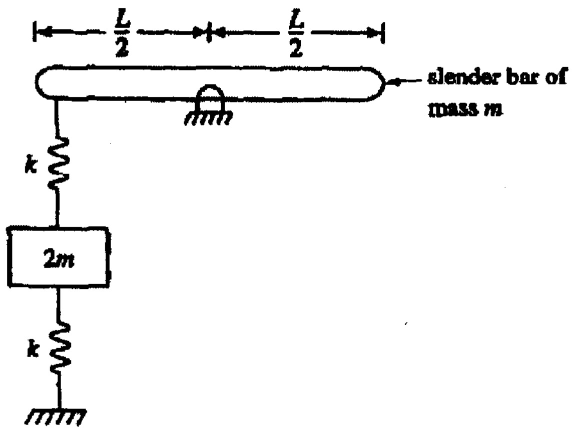

Figure 1

(5+8+3=16)

2. Determine the steady state amplitude of vibration of the mass centre of the rigid bar shown in Fig. 2 when its right end is subject to a dynamic moment $M = 4000\sin(150t)$ N-m.

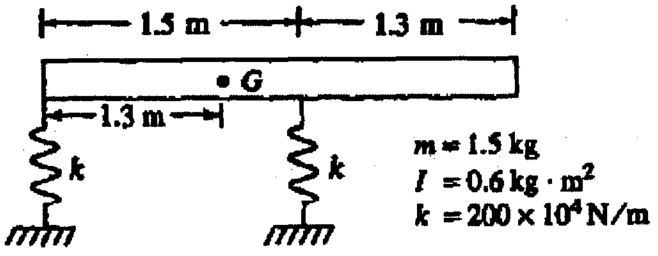

Figure 2

(18)

3. Write the appropriate boundary conditions and hence obtain the frequency equation for the transverse vibration of a cantilever beam with the free end supported on a linear spring.

(18)

4. (a) Obtain a two degrees-of-freedom lumped parameter model for the axial vibration of the tapered bar with circular cross-section shown in Fig. 3 using Assumed Mode Method (AMM). Consider the following trial functions:

$$\phi_n(x) = \sin\left[\frac{(2n-1)\pi x}{2L}\right], \quad n = 1, 2$$

(b) Estimate the natural frequencies and the corresponding mode shapes for the numerical values supplied in the figure.

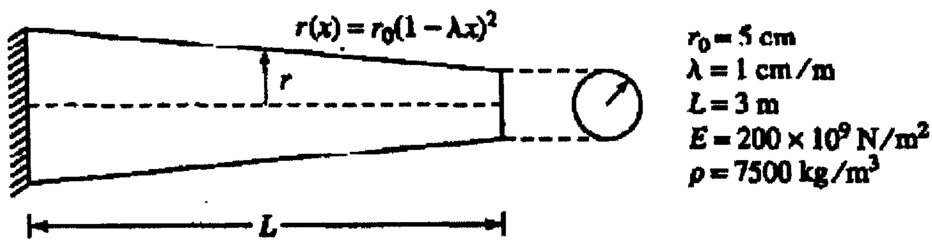

Figure 3

(10+8=18)

5. A simply supported beam of length L and flexural rigidity EI is subject to a purely harmonic load $F(t) = F_0 \sin(\omega t)$ at the quarter span.
   (a) Write the partial differential equation describing the transverse vibration of the beam.
   (b) Obtain the modal equations.
   (c) State with physical reasoning whether all modes of vibration will be excited or not.

(5+10+3=18)