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Code No: **RT41211** **R13** **Set No. 1**

IV B.Tech I Semester Supplementary Examinations, February/March - 2018

VIBRATIONS AND STRUCTURAL DYNAMICS

(Aeronautical Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B
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PART–A *(22 Marks)*

1. a) What methods are available for solving the governing equations of a vibration problem? [4]
   b) When a tensile force of 300 N is applied to an elastic element, it has an elongation of 1 mm. What is the stiffness of the element? [4]
   c) Discuss the difference in the assumed solution for free vibrations of an undamped two degree-of-freedom system and one with viscous damping. [4]
   d) What is the dynamical matrix? [3]
   e) Using the matrix iteration method, how do you find the intermediate natural frequencies? [3]
   f) How do you find the response of a viscously damped system under rotating unbalance? [4]

PART–B *(3x16 = 48 Marks)*

2. a) A bar of length L and Young s modulus E is subjected to an axial force. Compare the spring constants of bars with cross sections in the form of a solid circle (of diameter d), square (of side d) and hollow circle (of mean diameter d and wall thickness $t = 0.1\ d$). Determine which of these cross sections leads to an economical design for a specified value of axial stiffness of the bar. [8]
   b) Find the equivalent spring constant of the system shown in figure 2 (b)

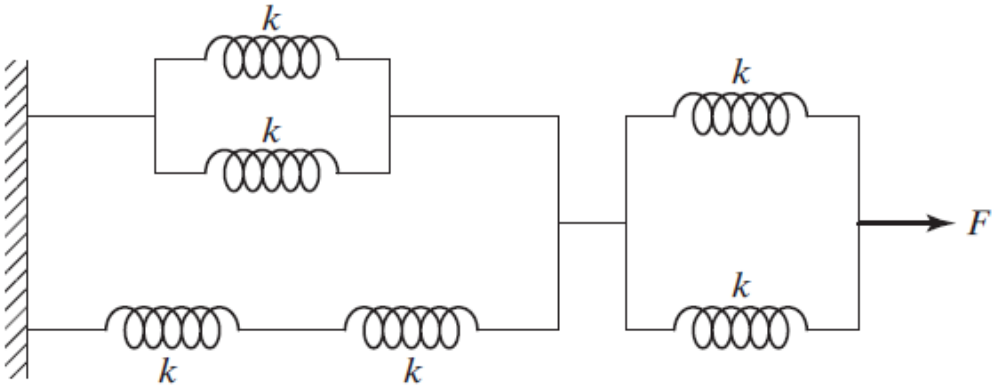

Figure 2 (b) [8]

3. a) A torsional pendulum has to have a natural frequency of 5 Hz. What length of steel wire of diameter 2 mm should be used for this pendulum. The inertia of the mass fixed at the free end is 0.0098 kg.m^2. Take G = 0.85 x 10^{11} N/m^2. [8]

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b) A helical spring, when fixed at one end and loaded at the other, requires a force of 100 N to produce an elongation of 10 mm. The ends of the spring are now rigidly fixed, one end vertically above the other, and a mass of 10 kg is attached at the middle point of its length. Determine the time taken to complete one vibration cycle when the mass is set vibrating in the vertical direction. [8]

4. a) Find the steady-state response for the system of figure 4 (a)

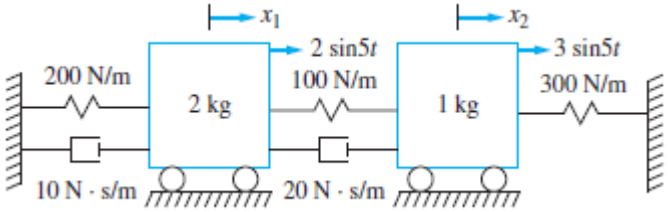

Figure 4 (a) [8]

b) Use Lagrange's equations to derive the differential equations governing the motion of the system of figure 4 (b) using x_1, x_2, and x_3 as generalized coordinates.

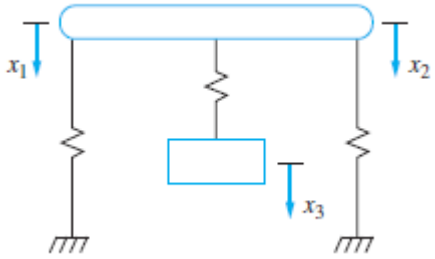

Figure 4 (b) [8]

5. a) Determine the natural frequencies for the three degree-of-freedom system shown in figure 5 (a).

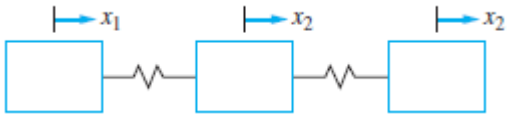

Figure 5 (a) [8]

b) Determine the eigenvalues and eigenvectors of the system shown in figure 5 (b), taking $k_1 = k_2 = k_3 = k_4 = k$, $m_1 = 2m$, $m_2 = 3m$ and $m_3 = 2m$.

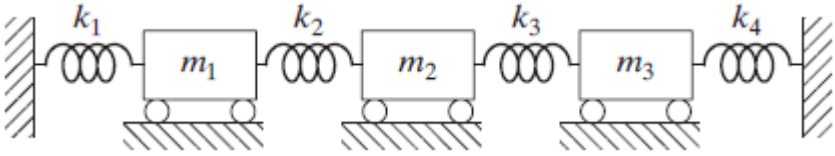

Figure 5 (b) [8]

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6. a) Two machines are placed on the massless fixed-pinned beam of figure 6 (a) Determine the natural frequencies for the system using matrix iteration method.

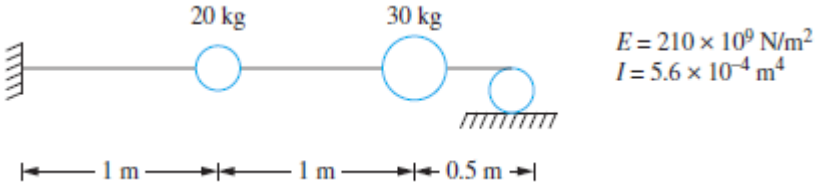

Figure 6 (a) [8]

b) A 500 kg machine is placed at the end of a 3.8 m. long, 190 kg fixed-free beam. The beam is made of a material of elastic modulus 200 X 10^9 N/m^2 and has a cross-sectional moment of inertia of 1.4 X 10^{-5} m^4. Use a three degree-of-freedom model to approximate the two lowest natural frequencies of the system. [8]

7. a) A mass m is suspended from a spring of stiffness 4000 N/m and is subjected to a harmonic force having an amplitude of 100 N and a frequency of 5 Hz. The amplitude of the forced motion of the mass is observed to be 20 mm. Find the value of m. [8]

b) Consider a spring-mass-damper system with k = 4000 N/m, m = 10 kg, and c = 40 N-s/m. Find the steady-state and total responses of the system under the harmonic force F(t) = 200 cos 10t N and the initial conditions $x_0 = 0$ and $\dot{x}_0 = 10$ m/s. [8]

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