Nonlinear System Analysis Final Examination
(Graduate School)

Take-Home Exam's deadline: 2022/1/16 24:00

1. The undamped single degree of freedom system consists of a 10 kg mass suspended by a linear spring which has a stiffness coefficient of 6000 N/m. is subjected to the initial conditions Xo = 0.02 m and Vo = 3 m/s. Determine the system response as a function of time. Also determine the maximum velocity and the total energy of the system. (15%)

2. For the system shown in Fig. 1, let m = 0.5 kg, a = 0.2 m, 1= 0.4 m, k = 1000 N/m. Determine the damping coefficient c if the system is to be critically damped. If the system has an initial angular velocity of 5 rad/s counterclockwise, determine the angular displacement and angular velocity after 0.3 s. Assume small oscillations. (15%)

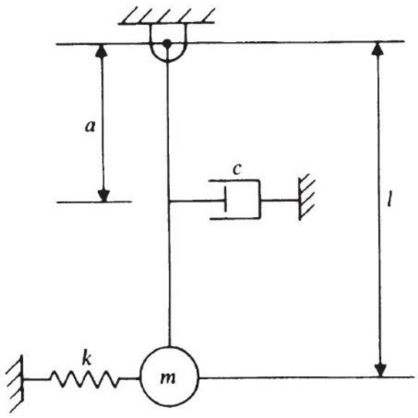

Fig. 1

3. Derive the differential equation of motion ofthe system shown in Fig. 2 by using Newton's second law, and also by using Lagrange's equation. (15%)

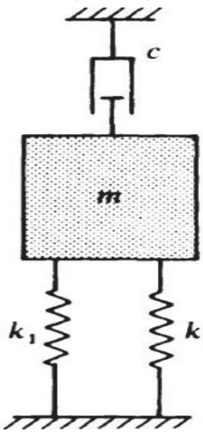

Fig. 2

4. In the system shown in Fig. 3, AB is a rigid bar which pivots freely about a pin connection at A. At equilibrium the bar AB is in a horizontal position. Derive the differential equation of motion of this system using Lagrange's equation. (15%)

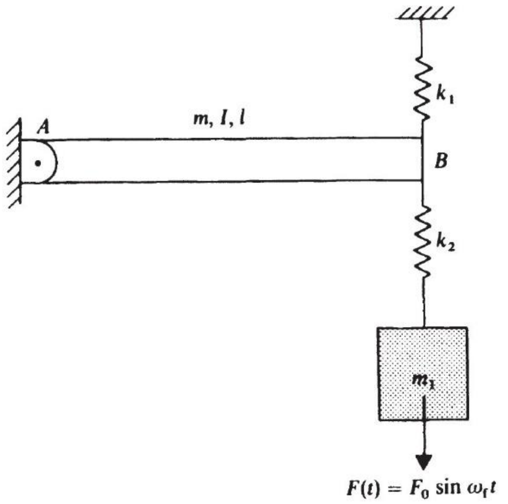

Fig. 3

5. Obtain the differential equations of free vibration of the three degree of freedom system shown in Fig. 4 by using Newton's second law. Assume small oscillations. (15%)

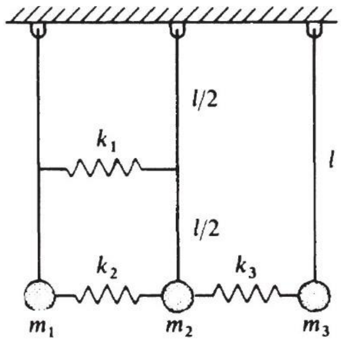

Fig. 4

6. Use Lagrange's equation to derive the differential equations of free vibration of the system of Problem 5. Obtain also the natural frequencies and the mode shapes of vibration, assuming that $m_1 = m_2 = m_3 = 1$ kg, $l = 0.5$ m, and $k_1 = 0$, $k_2 = k_3 = 2000$ N/m. (15%)

7. Determine the equation of motion, boundary conditions, and freq uency equation of longitudinal vibration of a uniform rod with a mass m attached to each end. Check the fundamental frequency by reducing the uniform rod to a spring with end masses. (15%)

8. Determine the equation of transverse vibration, boundary conditions, and frequency equation of a uniform beam of length *l* clamped at one end and pinned at the other end. (15%)

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