(20%) 1.

(a) Determine the equations of motion of the systems, shown in Figures (1a) and (1b), in terms of the variable x.

(b) Under what conditions that the natural frequency of the system (1a) is equal to that of the system (1b)?

(c) Determine the critical driving frequency ω_c for which the oscillations of the mass m_2 in system (1b) tend to become excessively large.

Note that the homogeneous solid cylindrical pulley has mass m_1 and radius r. The cord which connects mass m_2 to the upper spring does not slip on the pulley. In system (1b), the attachment at B undergoes the indicated harmonic displacement.

(20%) 2. In Figure 2, a system is used to arrest the motion of an airplane landing on a field of restricted length. The plane of mass m rolling freely with a velocity v_n engages a hook which pulls the ends of two heavy chains each of length L and mass ρ per unit length in the manner shown in the figure. A conservative calculation of the effectiveness of the device neglects the retardation of chain friction on the ground and any other resistance to the motion of the airplane.

(a) With these assumptions, compute the velocity v of the airplane at the instant that the last link of each chain is put in motion.

(b) Also determine the relation between displacement x and the time t after contact with the chain.

(Assume each link of the chain acquires its velocity v suddenly upon contact with the moving links)

(20%) 3. A bar (m_B = 20 kg) with a uniform cross section is attached to a solid circular disk (m_D = 5 kg) at end A and to a slider block of negligible mass in a smooth vertical slot at end B, as shown in Figure 3. The 200-mm diameter disk rolls without slipping on the horizontal surface and at the instant shown has an angular velocity of 15 rad/s counterclockwise and an angular acceleration of 25 rad/s^2 clockwise. Determine the force F being applied to pin A and the forces exerted on the bar by the pins at A and B.

(20%) 4. A rigid rod, hinged at one end and attached to a linear spring (spring constant k) at the other end, is subjected to a load P as shown in Figure 4. The rod has a length L and massless. Determine equilibrium positions in terms of the rotation angle θ of this system and discuss the characteristic of these equilibrium positions.

(20%) 5. The crane truss shown in Figure 5 is secured to the fixed supports at A and K, and its winch W is locked in position while supporting the 1.5-Mg tank. Identify any statically indeterminate members and calculate the force in member HG, GI, and IJ.

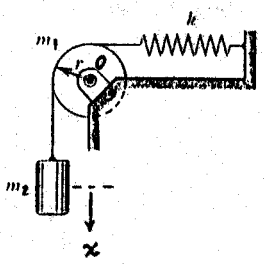

Figure (1a)

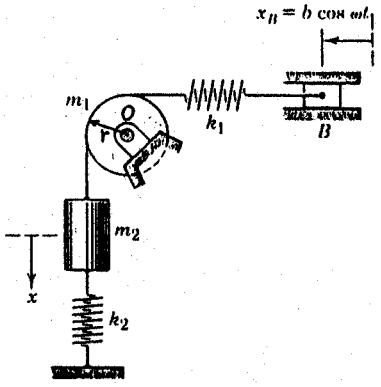

Figure (1b)

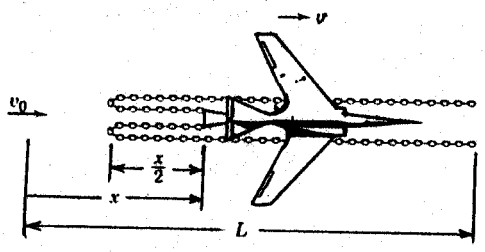

Figure 2

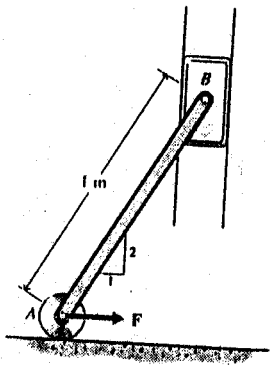

Figure 3

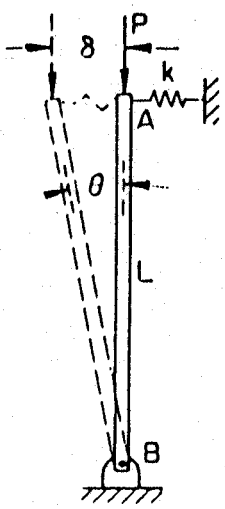

Figure 4

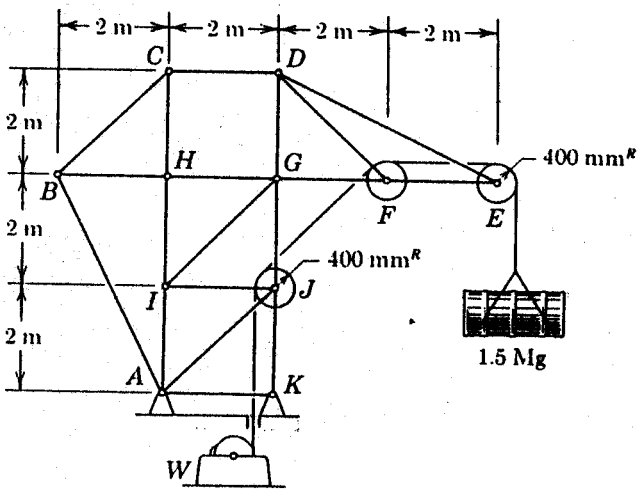

Figure 5