1. Derive the principle of work and energy of a particle

$$T_1 + V_1 + U_{1\to 2} = T_2 + V_2$$

from Newton's Second Law where T and V represent the kinetic energy and potential energy respectively and $U_{1\to 2}$ represents the work done by nonconservative forces. (25%)

2. The 2-kg block shown in Fig. 1 rests on a smooth horizontal surface and is attached to an elastic cord that has a stiffness of $k_c = 20$ N/m and is initially unstretched. If the block is given a velocity of $(v_B)_1 = 1.5$ m/s, perpendicular to the cord, determine the rate at which the cord is being stretched and the speed of the block at the instant the cord is stretched 0.2 m. What is (are) the conservation law(s) employed to solve this problem? (conservation of energy, momentum, angular momentum, mass) explain it. (25%)

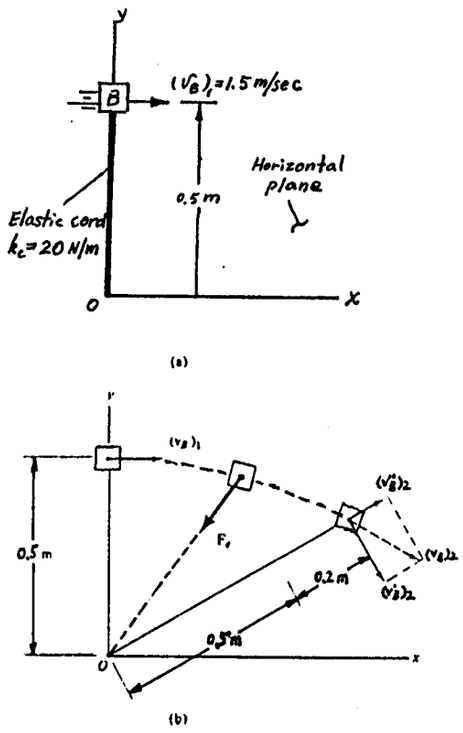

Fig. 1

3.Explain the following terms: (10%)
(a) magnification factor and resonance
(b) eccentric impact

4.A slender prismatic bar AB of length l and weight W is allowed to fall vertically in an inclined position but without rotation as shown in Fig.4.If the center of gravity C of the bar has velocity v_c at the instant when the end A strikes a smooth horizontal plane, find that the new velocity v_c' and angular velocity ω' just after the impact assuming no rebound at A. (20%)

5.The system shown in Fig.5 consisting of an unknown mass m and a spring with unknown spring constant k ,has been observed to oscillate naturally with the frequency ω_n=100 rad/sec.Determing the mass m and spring constant k knowing that when a mass M=0.9 kg is added the modified natural frequency is Ω_n=80 rad/sec. (20%)

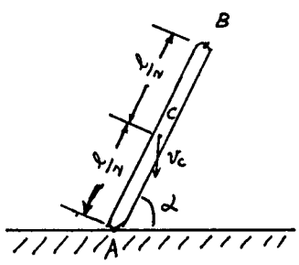

Fig. 4

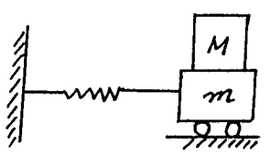

Fig. 5