1. (20%) The frame in Fig.1 is used to support a ***50-kg*** cylinder. Neglect the diameter of the pulleys at B and C, i.e. regard them as infinitesimal small pulleys and also neglect the friction of the pulleys. Determine the horizontal and vertical components of reaction at ***A*** and ***D***.

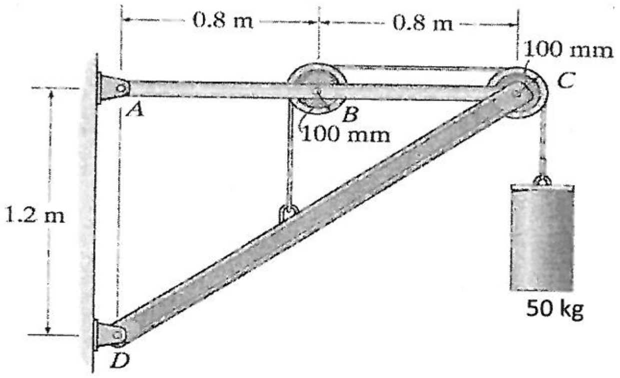

Figure 1

2. (20%) Two pulleys are connected to the ends of a rod of length ***l=0.5m*** and the rod is connected to a spring of spring constant ***k=240N/m*** as shown in Fig.2. The mass of the rod-pulley assembly is ***10 kg***. If the rod-pulley assembly stands vertically, i.e. when $\theta = 0^\circ$, the spring is unstretched. Determine

   (a) the angle θ for equilibrium, and (10%)

   (b) show the stability of the assembly at $\theta = 0^\circ$ and θ at equilibrium. (10%)

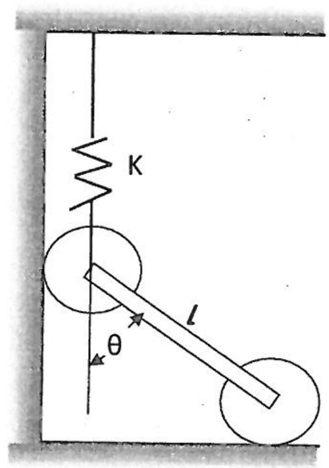

Figure 2

3. (25%) The smooth bar is Fig. 3 rotates in the horizontal plane with constant angular velocity ω_0 = **6 rad/s**. The linear spring k = **6N/m** connects collar A and rotation joint, and the collar A has mass m = **0.2kg** and is released at r_0 = **0.1m** with no radial velocity. Please determine

(a) the radial velocity of the collar as a function of r. (15%)

(b) the horizontal force exerted on the collar as a function of r. (10%)

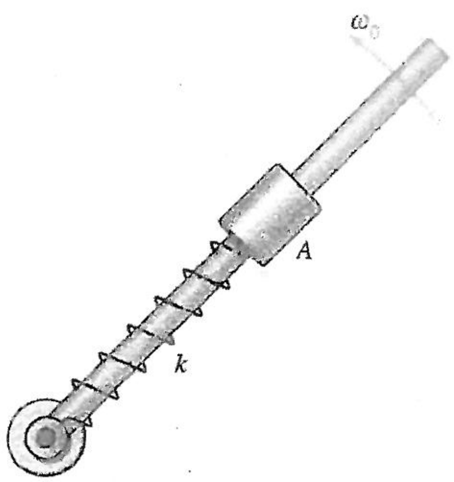

Figure 3

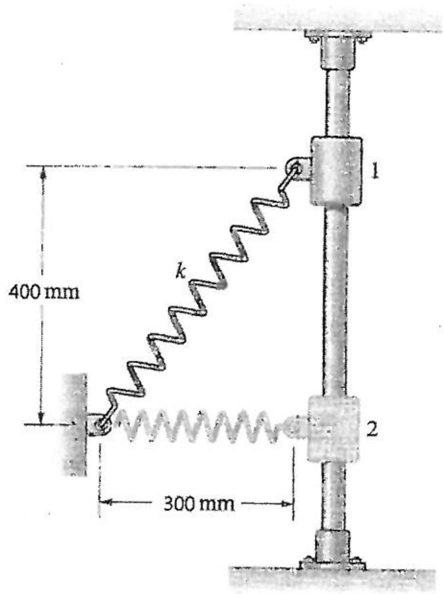

Figure 4

4. (20%)In the forging device shown in Fig. 4, the **40-kg** harmer is lifted to position 1 and released form rest. It falls and strikes a workpiece when it is in position 2. The spring constant k = **6000N/m**, and the tension in each spring is **600N** when the hammer is in position 2. Neglect friction.

(a) What is the velocity of the hammer just before it strikes the workpiece? (15%)

(b) Assuming that all of the hammer's kinetic energy is transferred to the workpiece, what average power is transferred if the duration of the impact is 0.02s (5%)

5. (15%) Two bars are shown in Fig. 5. The velocity v_A and acceleration a_A of point A can be formulated as

$$v_A = v_B + v_{Arel} + \omega \times r_{A/B} \quad \cdots (1)$$

$$a_A = a_B + a_{Arel} + 2\omega \times v_{Arel} + \alpha \times r_{A/B} - \omega^2 r_{A/B} \quad \cdots (2)$$

where v_B and a_B are the velocity and acceleration of point B; v_{Arel} and a_{Arel} are the velocity and acceleration of point A relative to the link 1; ω is the angular velocity of link 1; $r_{A/B}$ is the position vector of point A relative to the point B.

(a) Which term in Eq.(1) is the tangent velocity of point A? What direction of this term? (Please copy and draw Fig. 5 on the answer paper and define the direction on the figure.) (5%)

(b) Which term in Eq.(2) is the Coriolis acceleration of point A? What direction of this term? (5%)

(c) Which term in Eq.(2) is the central acceleration of point A? What direction of this term? (5%)

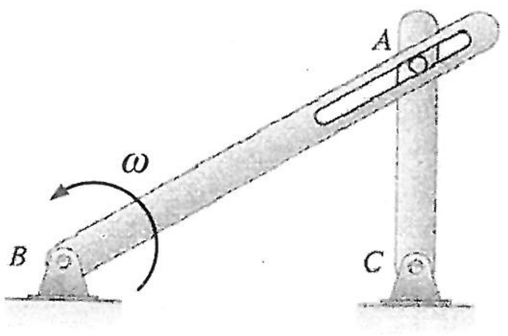

Figure 5