1. Explain the following terminologies briefly. (15%, 每小題3分)
   (a) principle of transmissibility;
   (b) improper constraints;
   (c) theorems of Pappus and Guldinus;
   (d) coefficient of restitution;
   (e) Eulerian angles for the motion of a gyroscope.

2. The following assembly is used for exercise. It consists of four weightless pin-connected bars, AB, BC, CD, AD, each of length L, and a spring AC of stiffness k and unstretched length $\sqrt{2}L$. If the horizontal forces **P** are applied to the handles so that θ is slowly decreased, use the principle of virtual work to determine
   (a) the magnitude of P for equilibrium;
   (b) the angle θ at which the magnitude of **P** becomes a maximum. (15%)
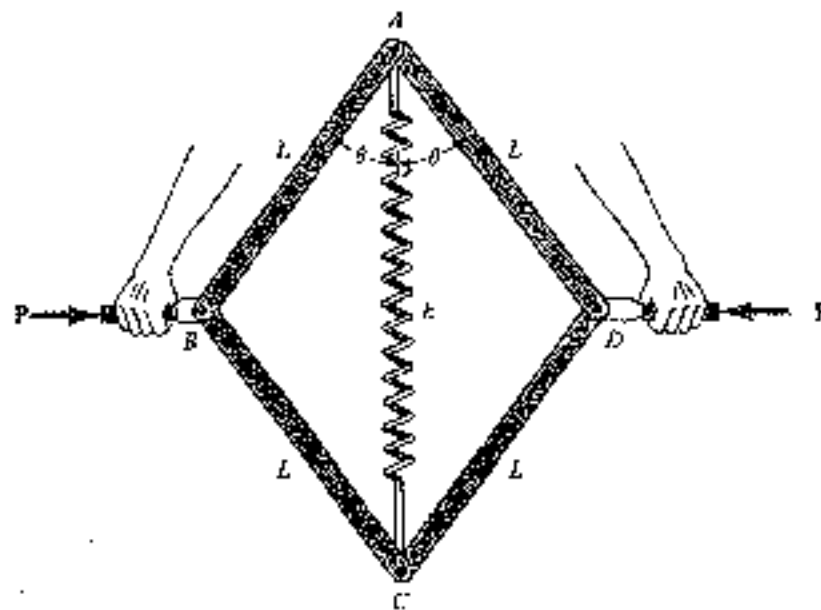
3. A uniform rectangular plate is suspended from a pin located at the midpoint of one edge as shown.

   (a) Derive the differential equation of motion of the plate for small oscillation θ.

   (b) Considering the dimension b constant, determine the ratio c/b for which the period of oscillation of the plate is minimum;

   (c) Considering the dimension b constant, determine a second value of c for which the period of oscillation is the same as the period of small oscillations for c=b. (20%)
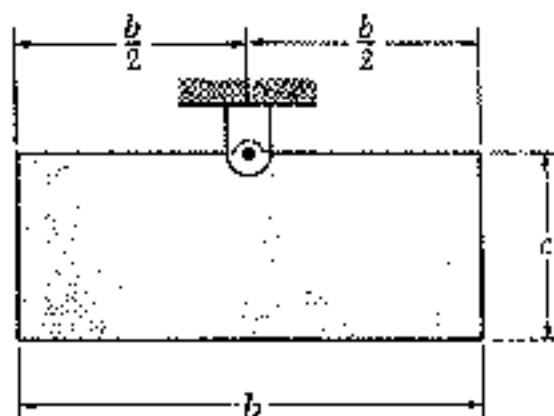

4. The telescoping arm ABC(which has uniform crossection and the weight is) is used to raise a worker to the elevation of overhead electric and telephone wires. For the extension shown, the worker, the bucket and equipment attached to the bucket together have a mass of 300 Kg and have a combined center of gravity at C. It is assume that all the arms except the arm ABC are weightless. Determine the force exerted at D by the hydraulic cylinder used. (15%)
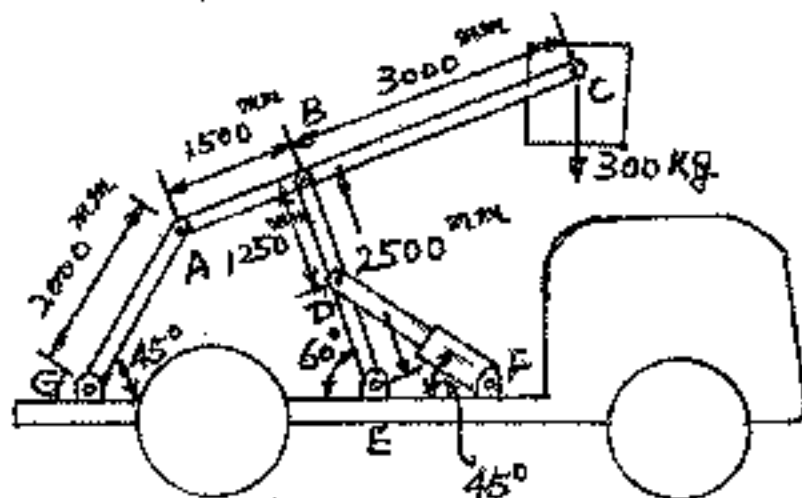
5. A flat belt connects pulleys A, B, C and D as shown in figure. The coefficient of the friction μ (Dry and slip)between all pulleys and the belt is 0.25. Determine the acceleration of the belt(assuming it is weightless) when a torque 0.1 kN m is applied on pulley D. The mass of the pulley A is 8 Kg. All the pulleys have the same thickness and are made in same material. (It is noted that the relation between the tension of the belt on one side and on the other side is $T_2/T_1 = e^{(\mu\beta)}$. (20%)
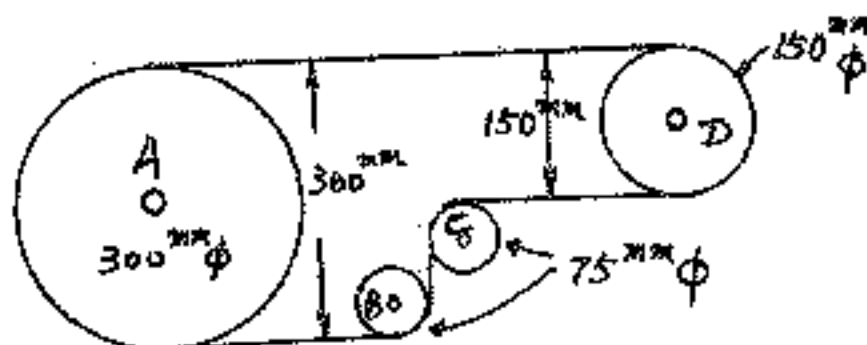
6. In the engine system shown, the piston P has a mass of m_1. The mass of the rod BD is M_1 and the crank AB is M_2. A sphere of mass M strikes point B of the system with a speed v and assuming perfectly elastic impact, determine immediately after the impact(a)the velocity of the sphere,(b)the velocity of the piston. (15%)