DEPARTMENT OF APPLIED MECHANICS, I.I.T., MADRAS
Mechanics of Solids

Tutorial – 4: Virtual work

1. Bar AB rests on the 300 mm radius semi-cylinder and its lower end A rests on the floor, as shown in Figure1. Determine the virtual work done by the force *F* at end B in a virtual movement in which the bar remains tangent to the semi-cylinder as end A moves horizontally.

2. The frame shown in Figure 2 supports the applied load *F*. Determine the tension in cable BD using the principle of virtual work.

3. The parallelogram frame is loaded by a horizontal 100-N force. The unstretched length of the spring is 350 mm. Determine the required stiffness *k* of the spring if *s* = 400 mm in the static equilibrium position in Figure 3.

4. A linkage is formed by pinning collar *C* to bar *BD*. This collar may ride on the smooth horizontal guide *EG*. Determine the couple M_A that should be applied to bar *AB* to hold the linkage in position as in Figure 4 when a vertical 8-kN force is applied at end *D*.

5. The elevation of the load of mass *m* is controlled by the adjusting screw which connects joints *A* and *B* as in Figure 5. The change in the distance between *A* and *B* for one revolution of the screw equals the lead *L* of the screw. If a moment M_f is required to overcome friction in the threads and thrust bearing of the screw, determine the expression for the total moment *M*, applied to the adjusting screw, necessary to raise the load.

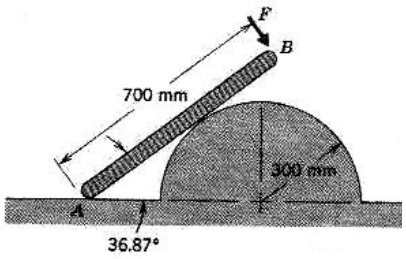

Figure 1

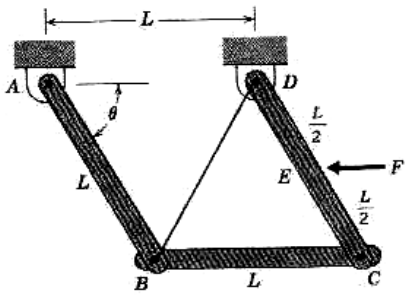

Figure 2

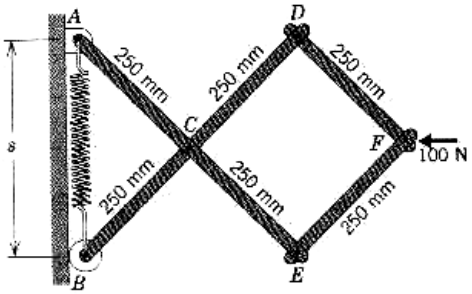

Figure 3

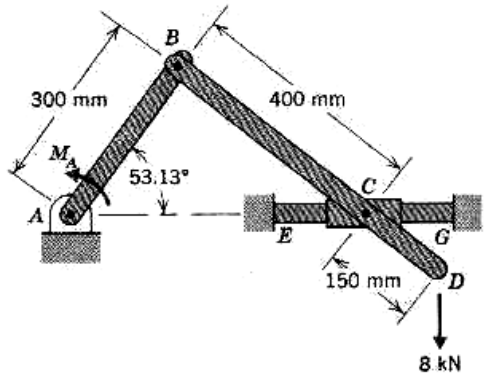

Figure 4

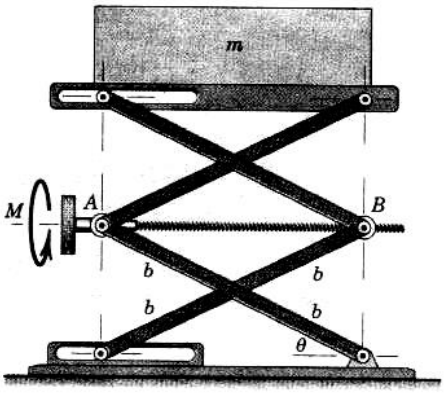

Figure 5

6. Determine the force *Q* at the jaw of the shear in Figure 6 for the 400-N force applied with $\theta = 30^{o}$.

7. Determine the force P developed at the jaws of the rivet squeezer in Figure7.

8. Two bars are attached to single spring of constant k that is unstretched when the bars are vertical. Determine the range of values for which the equilibrium of the system is stable in the position shown in Figure 8.

9. Determine the vertical moment of the joint D if the length of member BF is increased by 7.5 mm in the truss shown in Figure 9. (*Hint:* apply a vertical load at joint D, and, using the method of sections, compute the force exerted by member BF on joints B and F. Then apply the method of virtual work for a virtual displacement resulting in the specified increase in length of member BF. This method should be used for only small changes in the length of the member.)

10. Using the principle of virtual work find the force P required keeping the system in equilibrium in Figure 10.

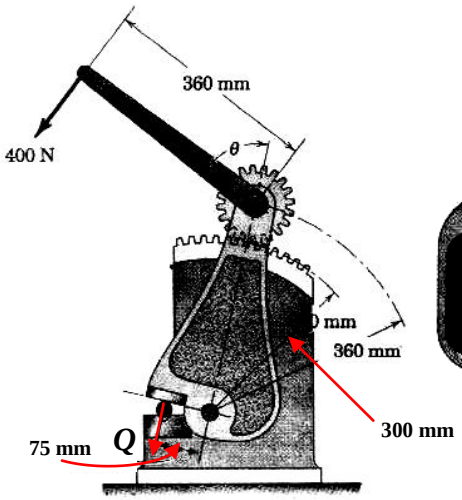

Figure 6

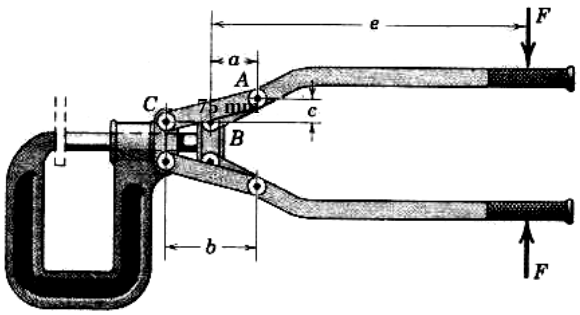

Figure 7

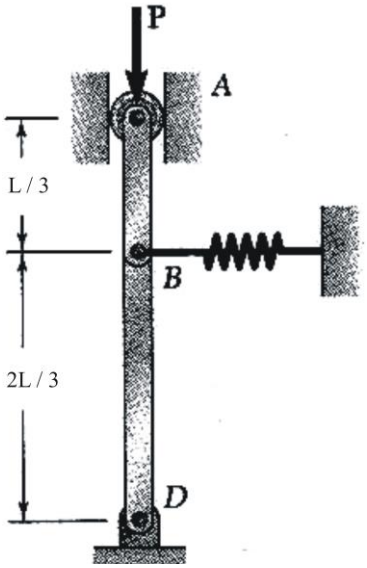

Figure 8

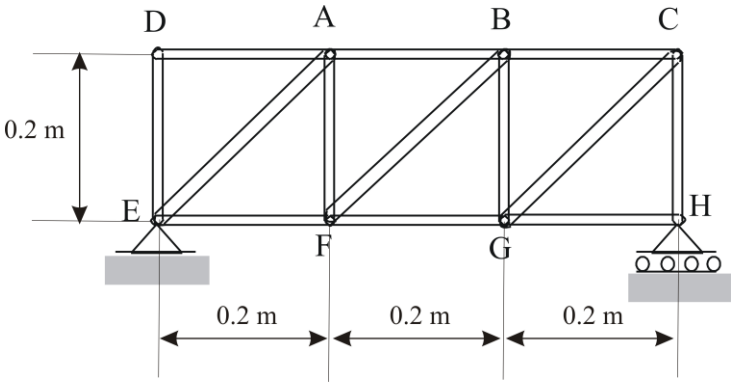

Figure 9

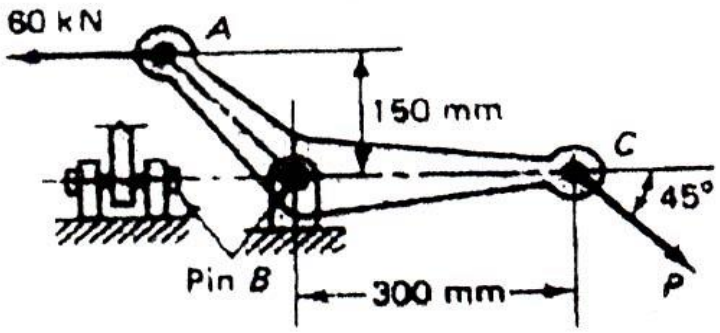

Figure 10