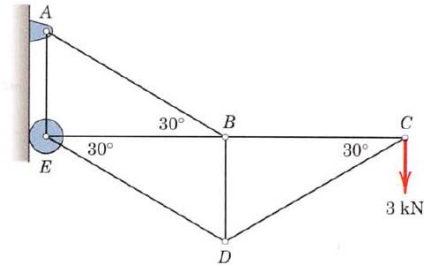
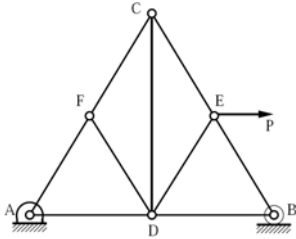


# MECHANICS (ME10001)

## Tutorial 4: Equilibrium - III

1. Determine the force in each member of the loaded truss.

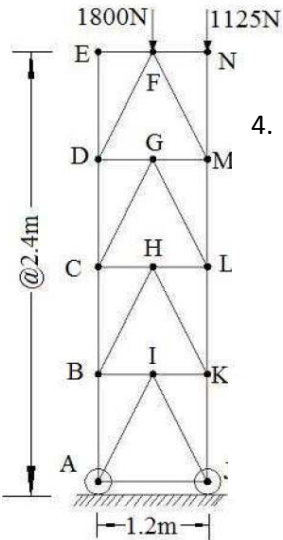
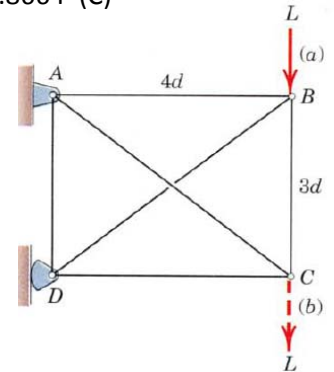
Ans.  $AB = 12 \text{ kN T}$ ,  $AE = 3 \text{ kN C}$   
 $BC = 5.20 \text{ kN T}$ ,  $BD = 6 \text{ kN T}$   
 $BE = 5.20 \text{ kN C}$ ,  $CD = DE = 6 \text{ kN C}$



2. Determine the force in the bar CD of the simple truss supported and loaded as shown using only two equations. The triangle ABC is an equilateral triangle, and D, E and F are mid-points of the respective sides. (Note: Try solving with one equation also.) Ans:  $CD = 0.866 P (C)$

3. The rectangular frame is composed of four perimeter two-force members and two cables AC and BD which are incapable of supporting compression. Determine the forces in all members due to the load L in position (a) and then in position (b).

Ans. (a)  $AB = AD = BD = 0$ ,  $BC = L (C)$  (b)  $AB = AD = BC = BD = 0$   
 $AC = \frac{5L}{3} (T)$ ,  $CD = \frac{4L}{3} (C)$   $AC = \frac{5L}{3} (T)$ ,  $CD = \frac{4L}{3} (C)$

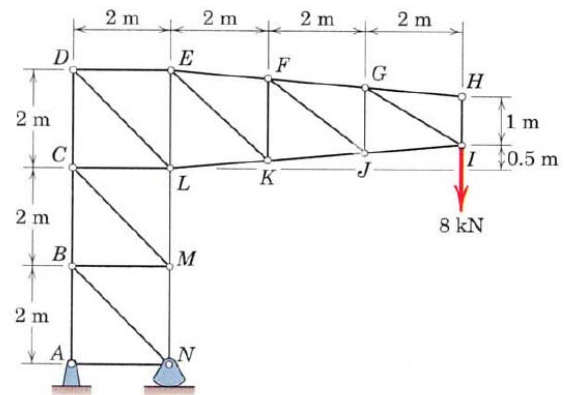


4. A K-truss used for scaffolding is loaded as shown. Determine the force in members DG and GM using the method of sections. All joints are pin connected.

Ans:  $DG = GM = 225 \text{ N (T)}$

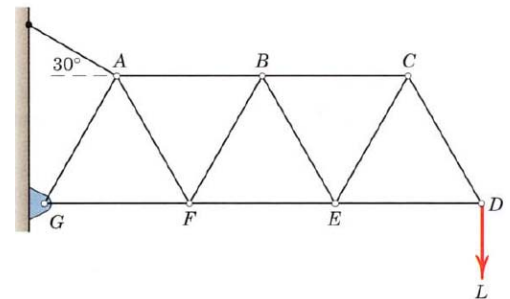
5. Determine the forces in members DE and DL.

Ans:  $DE = 24 \text{ kN (T)}$ ,  $DL = 33.94 \text{ kN (T)}$



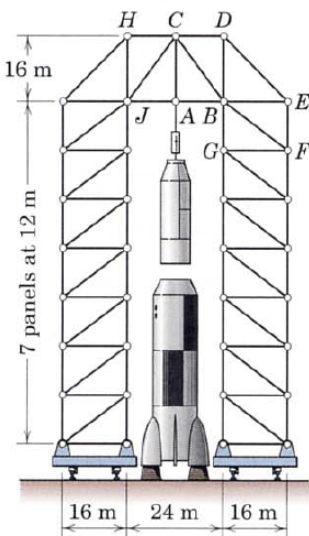
6. Determine the forces in members BC, BE and BF by method of sections. All triangles are equilateral.

Ans.  $BC = BE = \frac{2L}{\sqrt{3}} (T)$ ,  $BF = \frac{2L}{\sqrt{3}} (C)$



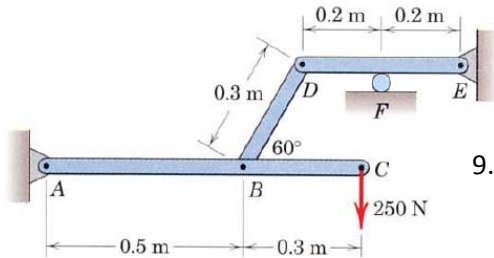
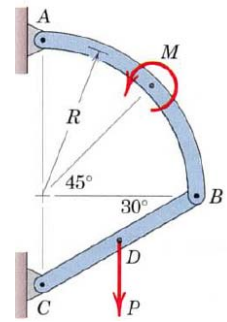
7. A 60 Mg section of a rocket is suspended from a movable gantry as shown. The strain gage measurements indicate a compressive force of 50 kN in member AB and a tensile force of 120 kN in member CD due to the 60 Mg load. Calculate the corresponding forces in members BF and EF.

Ans:  $BF = 188.4 \text{ kN (C)}$  and  $EF = 120 \text{ kN (T)}$



8. A force  $P$  is applied to the midpoint  $D$  of link  $BC$ . State the values of the couple  $M$  which would render (a) the horizontal force transmitted by pin  $B$  zero, and (b) the vertical force transmitted by pin  $B$  zero.

Ans: (a)  $M=0.5PR$  CW, (b)  $M=0.866 PR$  CCW

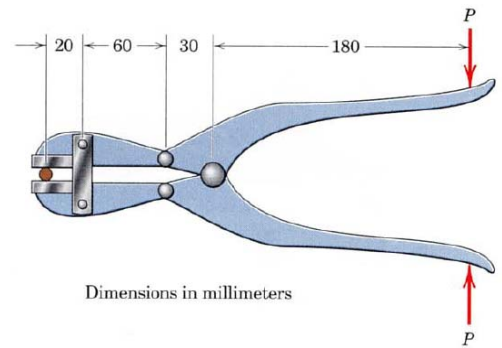


9. Determine the reaction at the roller  $F$  for the frame loaded as shown.

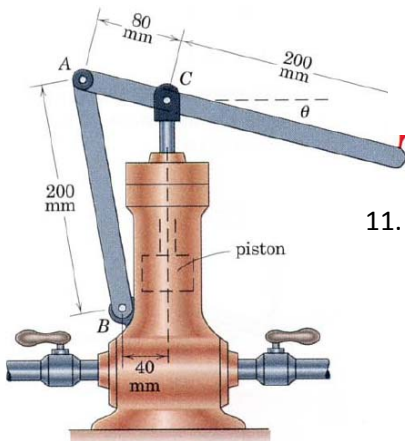
Ans:  $F=800$  N

10. For a gripping force of  $P=150$  N at the handles of a small bolt cutter as shown, determine the cutting force  $Q$  developed by each jaw on the rod to be cut.

Ans.  $Q = 2.7$  kN



Dimensions in millimeters

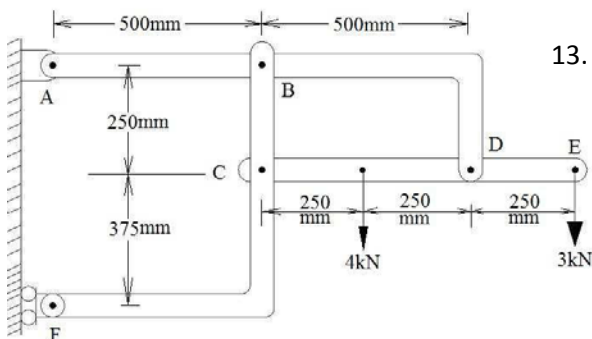
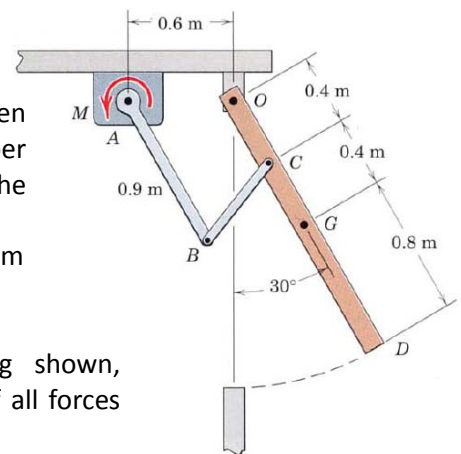


11. The figure shows a high-pressure hand pump used for boosting oil pressure in a hydraulic line. When the handle is in equilibrium at  $\theta=15^\circ$  under the action of a force  $P=120$  N, determine the oil pressure  $p$  which acts on the 46 mm diameter piston. (Pressure on the top of the piston is atmospheric).

Ans:  $P=0.27$  MPa

12. The 80 kg ventilation door  $OD$  with mass center at  $G$  is held in the open position by means of a moment  $M$  applied at  $A$ . Given that the member  $AB$  is parallel to the door in the configuration shown, determine the moment  $M$ .

Ans:  $M=706.32$  Nm



13. For the frame and loading shown, determine the components of all forces acting on member  $ABD$ .

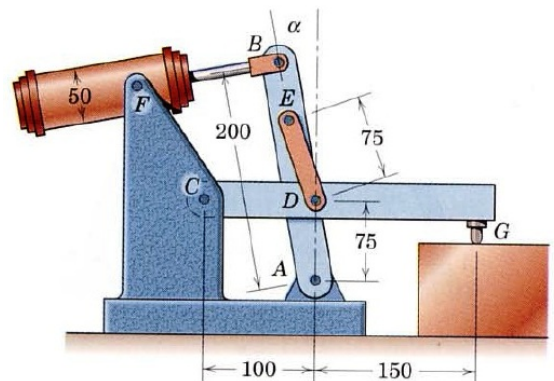
Ans:  $R_A = -10.8i + 7j$  kN

$R_B = -16.2i - 0.5j$  kN

$R_D = 27i - 6.5j$  kN

14. A pneumatic cylinder pivoted at  $F$  operates the lever  $AB$  of the toggle clamp, which clamps the work piece under the pin  $G$  in position. For an air pressure of 400 kPa above the atmospheric pressure in the cylinder against the 50 mm diameter piston, determine the clamping force at  $G$  for the position  $\alpha=10^\circ$  with  $FB$  perpendicular to  $AB$ .

Ans:  $F_G=2.3$  kN



Dimensions in millimeters