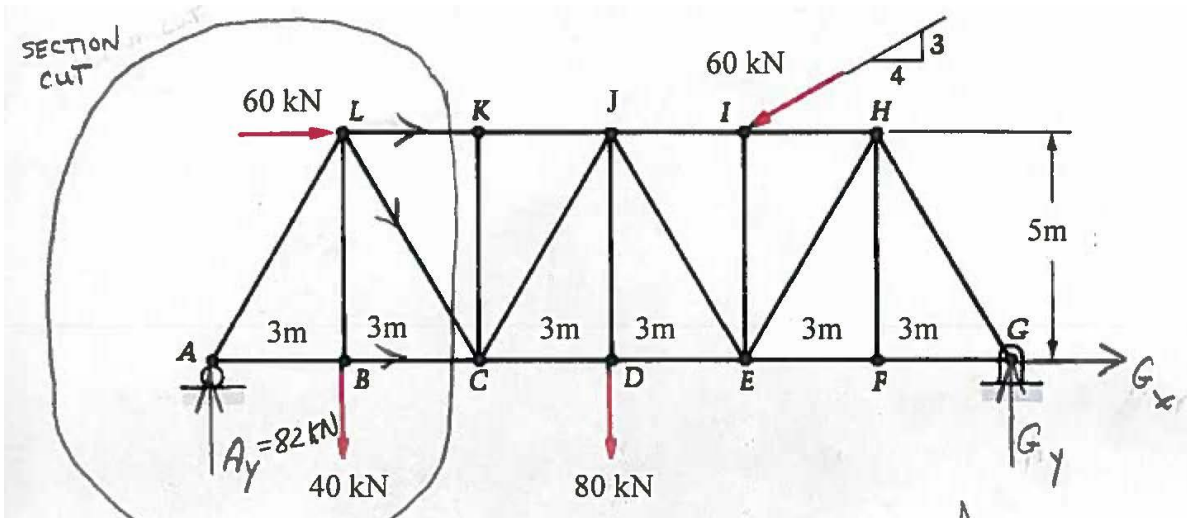
MOOC – "Mechanics of Materials I"

Week One Quiz

Problem 1) For the truss shown below, member BC is a circular solid bar with a 25 mm diameter. Find:

- the normal and shear stress in member BC on a non-transverse plane 35° from the vertical as shown
- the maximum normal stress and maximum shear stress in member BC



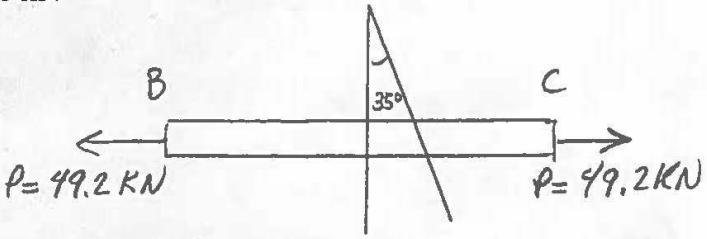
FBD - ENTIRE STRUCTURE

$\circlearrowleft + \Sigma M_G = 0$

$-A_y(18) + 40(15) - 60(5) + 80(9) + \left(\frac{3}{5}\right)60(6) + \left(\frac{4}{5}\right)60(5) = 0$

$A_y = 82\ \text{KN}$

FBD – SECTION CUT



$\circlearrowleft + \Sigma M_L = 0$

$-A_y(3) + BC(5) = 0$ ($A_y = 82$)

$BC = 49.2\ \text{KN (T)}$

$A_t = \pi r^2 = \pi(12.5\ \text{mm})^2 = 491\ \text{mm}^2$

$\sigma = \frac{P}{A_t}\cos^2\theta = \frac{49.2\ \text{kN}}{491\ \text{mm}^2}\cos^2 35^\circ$

$\sigma = 0.0673\ \frac{\text{kN}}{\text{mm}^2} = 0.0673\ \text{GPa (T)}$

$= 67.3\ \text{MPa (T)}$ ANS

$\tau = \frac{P}{2A_t}\sin 2\theta = \frac{49.2\ \text{kN}}{2(491\ \text{mm}^2)}\sin[2(35^\circ)]$

$\tau = 0.0471\ \frac{\text{kN}}{\text{mm}^2} = 0.0471\ \text{GPa} = 47.1\ \text{MPa}$ ANS.

σ_{MAX} OCCURS WHEN $\cos^2\theta = 1$

$\sigma_{MAX} = \frac{P}{A_t} = \frac{49.2\ \text{kN}}{491\ \text{mm}^2} = 0.100\ \text{GPa (T)}$

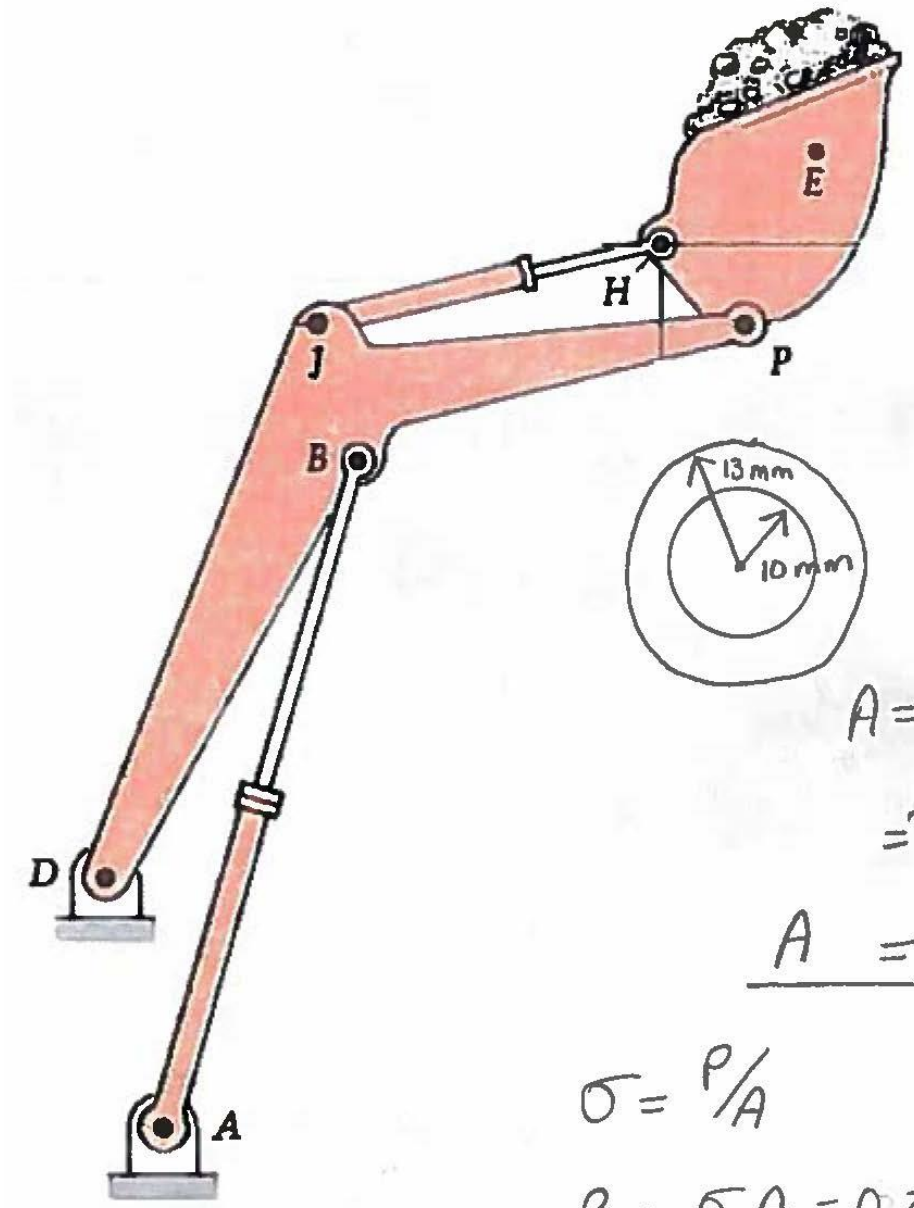
$= 100\ \text{MPa (T)}$ ANS

τ_{MAX} OCCURS WHEN $\sin 2\theta = 1$

$\tau_{MAX} = \frac{P}{2A_t} = \frac{49.2\ \text{kN}}{2(491\ \text{mm}^2)} = 0.0501\ \text{GPa}$

$= 50.1\ \text{MPa}$ ANS.

Problem 2) For the engineering structure below you may assume the weight of the members to be negligible when compared to the loads they are supporting. All pin connections may be considered frictionless. A portion of member JH is a hollow steel tube with an inner radius of 10mm and an outer radius of 13 mm. The normal stress for a transverse cut through this member is 200 MPa in compression. Find the axial force in member JH.



$$A = \pi r_o^2 - \pi r_i^2$$

$$= \pi (13)^2 - \pi (10)^2$$

$$A = 217 \text{ mm}^2$$

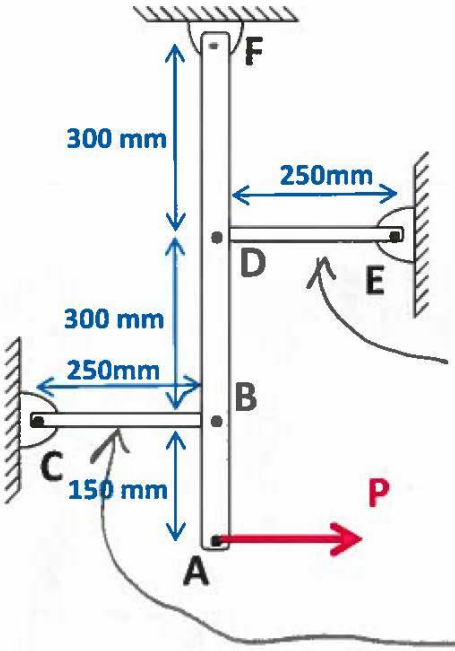
$$\sigma = P/A$$

$$P = \sigma A = 0.2 \text{ GPa} \left(217 \text{ mm}^2\right)$$

$$P = 43.4 \text{ KN (C)}$$

ANS.

Problem 3) For the engineering structure below you may assume the weight of the members to be negligible when compared to the loads they are supporting. All pin connections may be considered frictionless.
Bar DE is aluminum and has a cross sectional area of 5000 mm^2 and has a normal stress of 200 MPa in compression.
Bar BC is steel and has a cross sectional area of 1300 mm^2 and has a normal stress of 150 MPa in tension.
Find the force P.

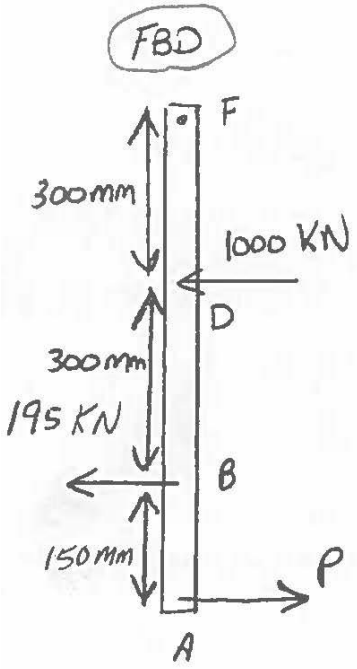


$P_{ALUMINUM} = (0.2\ GPa)\,5000\ mm^2$

$= 1000\ KN\ (C)$

$P_{STEEL} = (0.15\ GPa)(1300\ mm^2)$

$= 195\ KN\ (T)$



$\circlearrowleft + \sum M_F = 0$

$P(750) - 1000(300) - 195(600) = 0$

$P = 556\ KN \rightarrow$

ANS