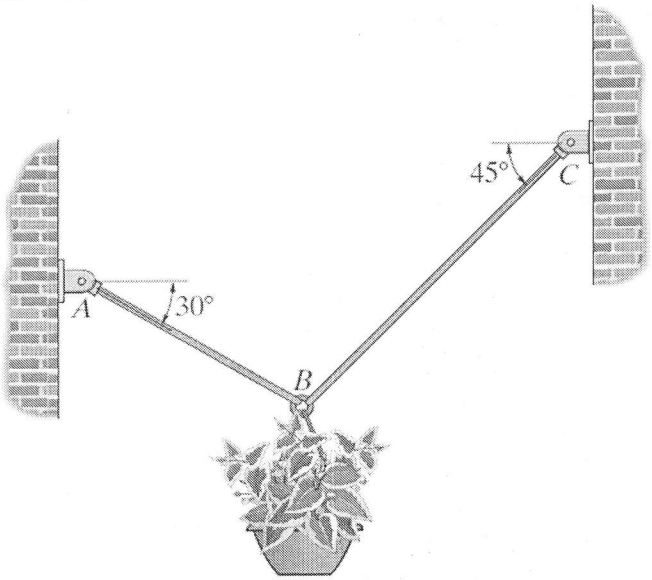
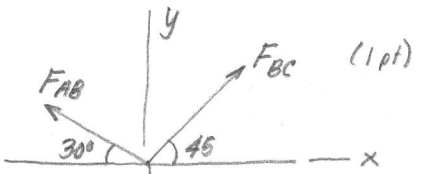
CME 260 – Mechanics of Materials
Exam #1 (01/26/2022)

Warrior ID # Grading

Do one of the two problems shown below (the second problem is on the back).
Show your work (you will not receive any credit if all you have is a final answer, right or wrong).

1. A 50 kg flowerpot is suspended from wires AB and BC. The wires have a normal failure stress of σ_{fail} = 350 MPa. Determine the minimum diameter of each wire. Use a factor of safety (F.S.) of 2.5.





(1 pt)

$(50\,kg)(9.81\,\frac{m}{s^2}) = 490.5\,N$ (0.5 pt)

$\Sigma F_x = 0, \quad -F_{AB}\cos 30° + F_{BC}\cos 45° = 0$

$F_{AB} = \frac{\cos 45°}{\cos 30°} F_{BC}$

$F_{AB} = 0.8165\,F_{BC}$ (1 pt)

$\Sigma F_y = 0, \quad F_{AB}\sin 30° + F_{BC}\sin 45° - 490.5\,N = 0$

$(0.8165\,F_{BC})\sin 30° + F_{BC}\sin 45° = 490.5\,N$

$1.115\,F_{BC} = 490.5\,N$

$F_{BC} = 439.8\,N$ (1 pt)

$F_{AB} = 0.8165(439.8N) = 359.1\,N$ (1 pt)

$F.S. = \frac{\sigma_{fail}}{\sigma_{allow}}$

$\sigma_{allow} = \frac{\sigma_{fail}}{F.S.} = \frac{350\,MPa}{2.5}$

$\sigma_{allow} = 140\,MPa$ (1.5 pt)

wire AB:

$\sigma = \frac{P}{A} \rightarrow A = \frac{P}{\sigma}$ (1 pt)

$\frac{\pi}{4} d^2 = \frac{359.1\,N}{140 \times 10^6\,\frac{N}{m^2}}$

$d^2 = 3.2659 \times 10^{-6}\,m^2$

$d = 1.807 \times 10^{-3}\,m$

or $\boxed{1.81\,mm}$ (1.5 pt)

wire BC:

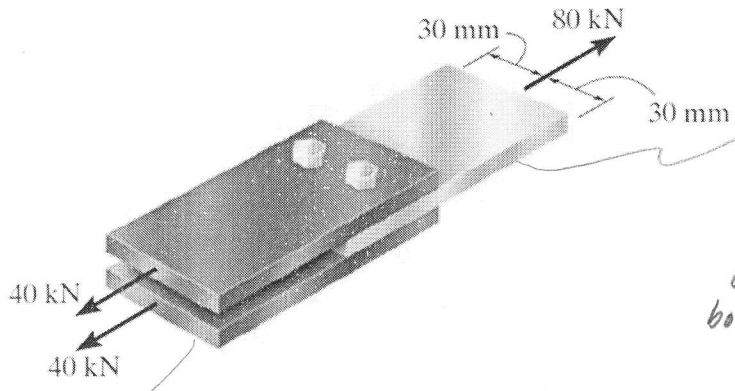
$\frac{\pi}{4} d^2 = \frac{439.8\,N}{140 \times 10^6\,\frac{N}{m^2}}$

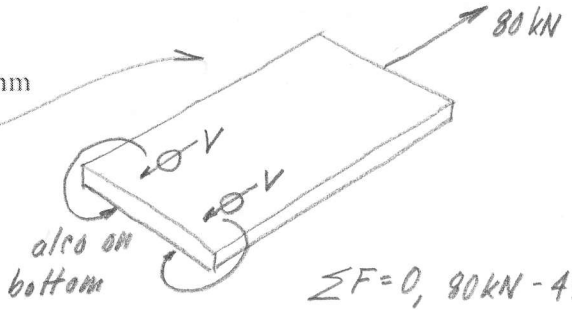
$d^2 = 3.9998 \times 10^{-6}\,m^2$

$d = 2.000 \times 10^{-3}\,m$

or $\boxed{2.00\,mm}$ (1.5 pt)

2. The double lap joint is assembled using two identical bolts. Determine the minimum diameter of the bolts if the shear failure stress is τ_{fail} = 350 MPa. Use a factor of safety (F.S.) of 2.5.

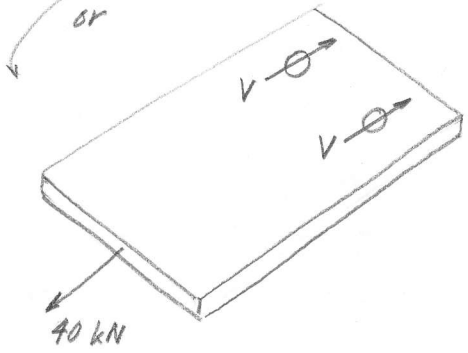




$\Sigma F = 0, \quad 80\,kN - 4V = 0$

$V = 20\,kN$ (3 pts)

or



$$F.S. = \frac{\tau_{fail}}{\tau_{allow}}$$

$$\tau_{allow} = \frac{\tau_{fail}}{F.S.} = \frac{350\,MPa}{2.5}$$

$$\tau_{allow} = 140\,MPa \quad (3\,pts)$$

$$\tau = \frac{V}{A} \rightarrow A = \frac{V}{\tau} \quad (1\,pt)$$

$$\frac{\pi}{4} d^2 = \frac{20 \times 10^3 N}{140 \times 10^6 \frac{N}{m^2}}$$

$$d^2 = 1.8189 \times 10^{-4}\,m^2$$

$$d = 1.349 \times 10^{-2}\,m$$

or $\boxed{13.5\,mm}$ (3 pts)