

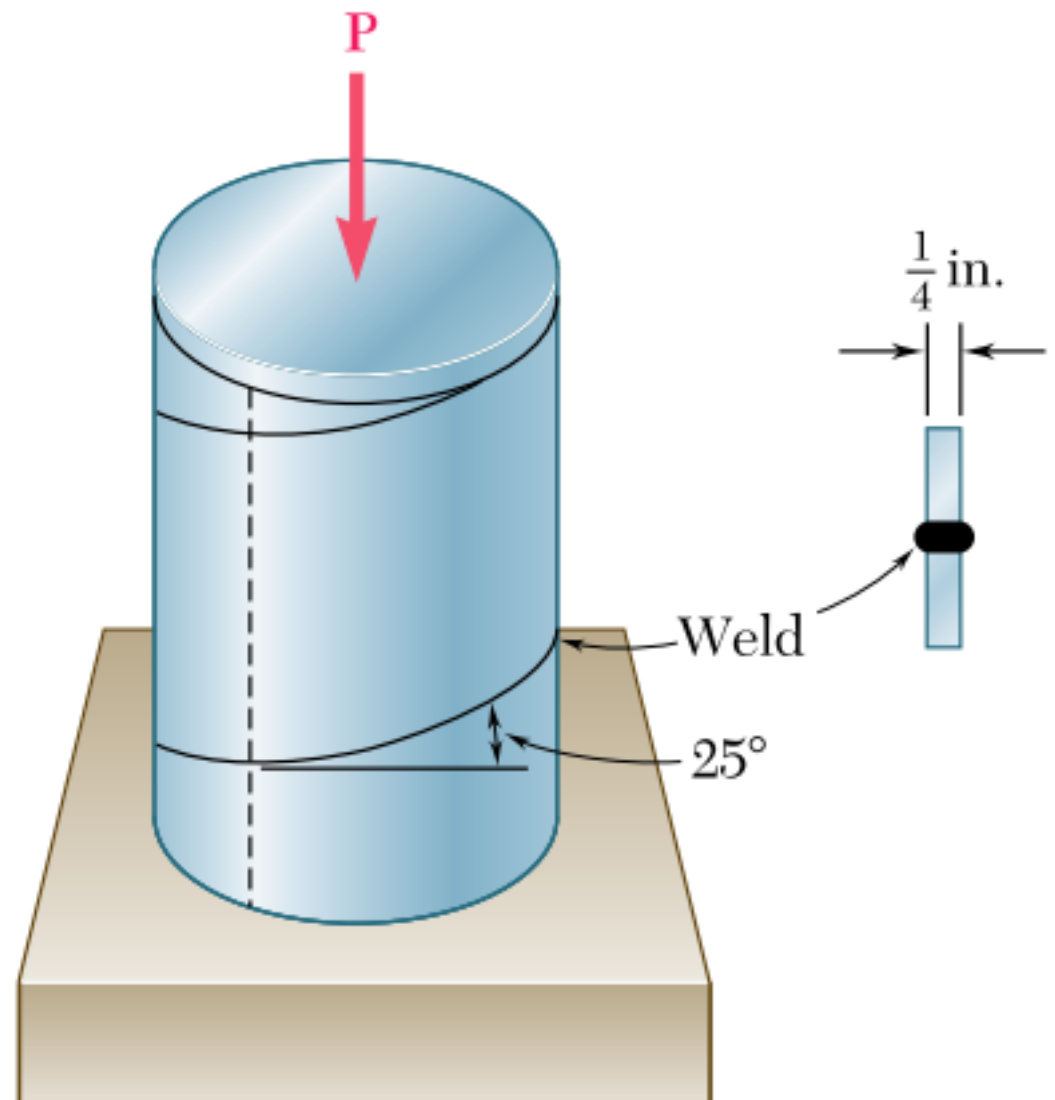
## Sec.4

# EGM 3520 Mechanics of Materials (MoM)

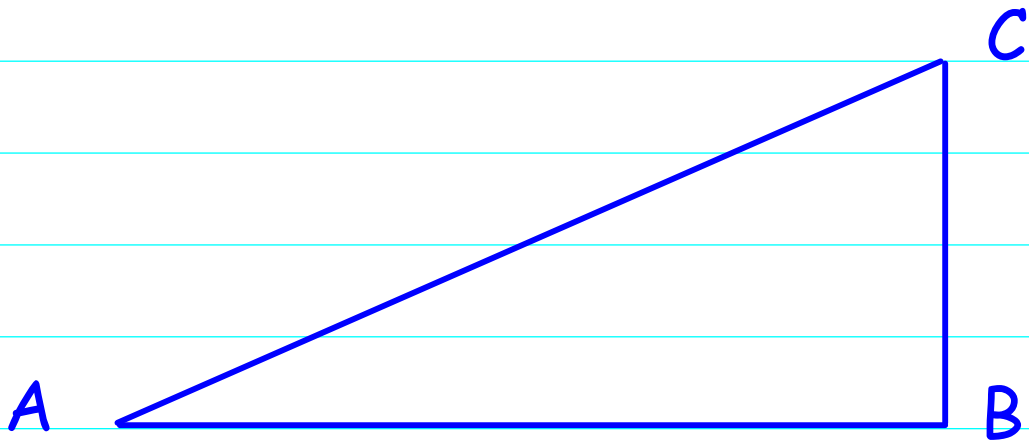
Beer et al. 2012, Mechanics of Materials, McGraw-Hill.

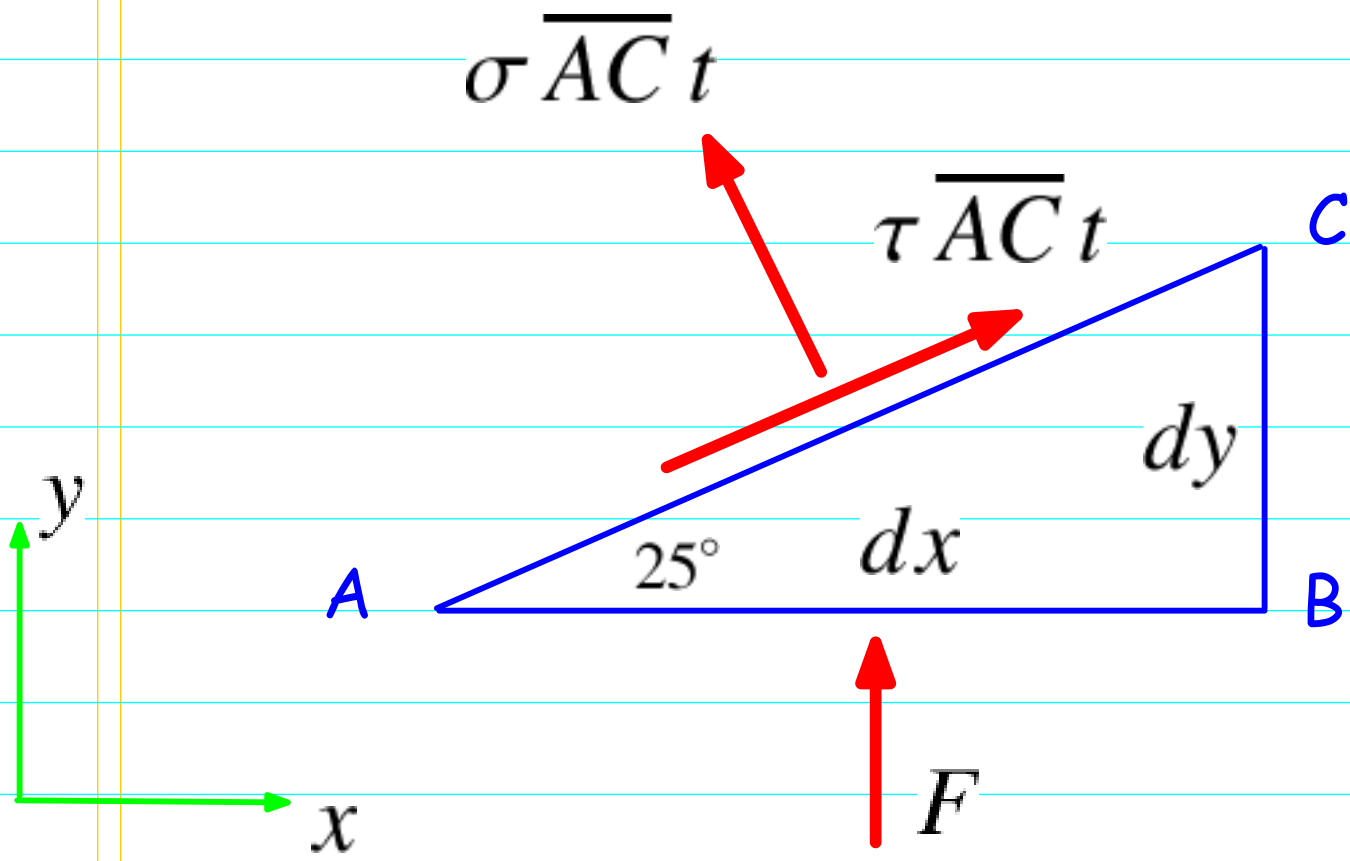
P1.34, p.36

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A steel pipe of 12-in. outer diameter is fabricated from  $\frac{1}{4}$ -in.-thick plate by welding along a helix that forms an angle of  $25^\circ$  with a plane perpendicular to the axis of the pipe. Knowing that a 66 kip axial force  $\mathbf{P}$  is applied to the pipe, determine the normal and shearing stresses in directions respectively normal and tangential to the weld.





$\sigma \overline{AC} t$   
 $\tau \overline{AC} t$

$25^\circ$

Pause video NOW !

Work out the next step

→ individually first

→ discuss with teammates  
if you get stuck

then continue to watch the video

## Method

$$F = \frac{P \cdot dx \cdot t}{A} \quad (1)$$

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$A$  area of cross section of pipe

$$\begin{aligned} A &= \pi[r_o^2 - (r_o - t)^2] \\ &= \pi[(r_o + (r_o - t))(r_o - (r_o - t))] \\ &= \pi t(2r_o - t) \end{aligned} \quad (2)$$

$A = \pi t(2r_o - t) = \pi t(d_o - t) = \pi(0.25 \text{ in})(12 \text{ in} - 0.25 \text{ in})$

Equilibrium of triangle ABC: 2 eqs for 2 unknowns

x components

$$\sum_i F_{i,x} = 0 \quad (3)$$

$\sum_i F_{i,x} = 0$

y components

$$\sum_i F_{i,y} = 0 \quad (4)$$

$\sum_i F_{i,y} = 0$

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## Computation

(2) p.4-3:

$$A = \pi t(2r_0 - t) = \pi t(d_0 - t)$$

$$= \pi(0.25 \text{ in})(12 \text{ in} - 0.25 \text{ in}) \quad (1)$$

$$A = \pi t(2r_0 - t) = \pi t(d_0 - t) = \pi(0.25 \text{ in})(12 \text{ in} - 0.25 \text{ in})$$

(1) p.4-3:

$$F = \frac{P \cdot dx \cdot t}{A} = \frac{66 \times 10^3 \text{ lbs} \cdot dx \cdot 0.25 \text{ in}}{A} \quad (2)$$

$$F = \frac{P \cdot dx \cdot t}{A} = \frac{66 \times 10^3 \text{ lbs} \cdot dx \cdot 0.25 \text{ in}}{A}$$

**Hold the computation !**

(3) p.4-3:

$$\sum_i F_{i,x} = 0 = \tau \overline{AC} t \cos 25^\circ - \sigma \overline{AC} t \sin 25^\circ \quad (3)$$

$$\sum_i F_{i,x} = 0 = \tau \overline{AC} t \cos 25^\circ - \sigma \overline{AC} t \sin 25^\circ$$

$$\tau \cos 25^\circ = \sigma \sin 25^\circ \quad (4)$$

$$\tau \cos 25^\circ = \sigma \sin 25^\circ$$

(4) p.4-3:

$$\sum_i F_{i,y} = 0 = F + \tau \overline{AC} t \sin 25^\circ + \sigma \overline{AC} t \cos 25^\circ$$

$$\sum_i F_{i,y} = 0 = F + \tau \overline{AC} t \sin 25^\circ + \sigma \overline{AC} t \cos 25^\circ \quad (5)$$

$$dx = \overline{AC} \cos 25^\circ \Rightarrow \overline{AC} = dx / \cos 25^\circ \quad (6)$$

$$dx = \overline{AC} \cos 25^\circ \Rightarrow \overline{AC} = dx / \cos 25^\circ$$



(5)-(6) p.4-4:

$$\frac{P \cdot dx \cdot t}{A} + \tau \frac{dx}{\cos 25^\circ} t \sin 25^\circ + \sigma \frac{dx}{\cos 25^\circ} t \cos 25^\circ = 0$$

$$\frac{P \cdot dx \cdot t}{A} + \tau \frac{dx}{\cos 25^\circ} t \sin 25^\circ + \sigma \frac{dx}{\cos 25^\circ} t \cos 25^\circ = 0$$

(1)

(1) p.4-4:  $A$

Data:  $P = 66 \times 10^3 \text{ lbs}$

$P = 66 \times 10^3 \text{ lbs}$

Use (1) and (4) p.4-4 to solve for the 2 unknowns.