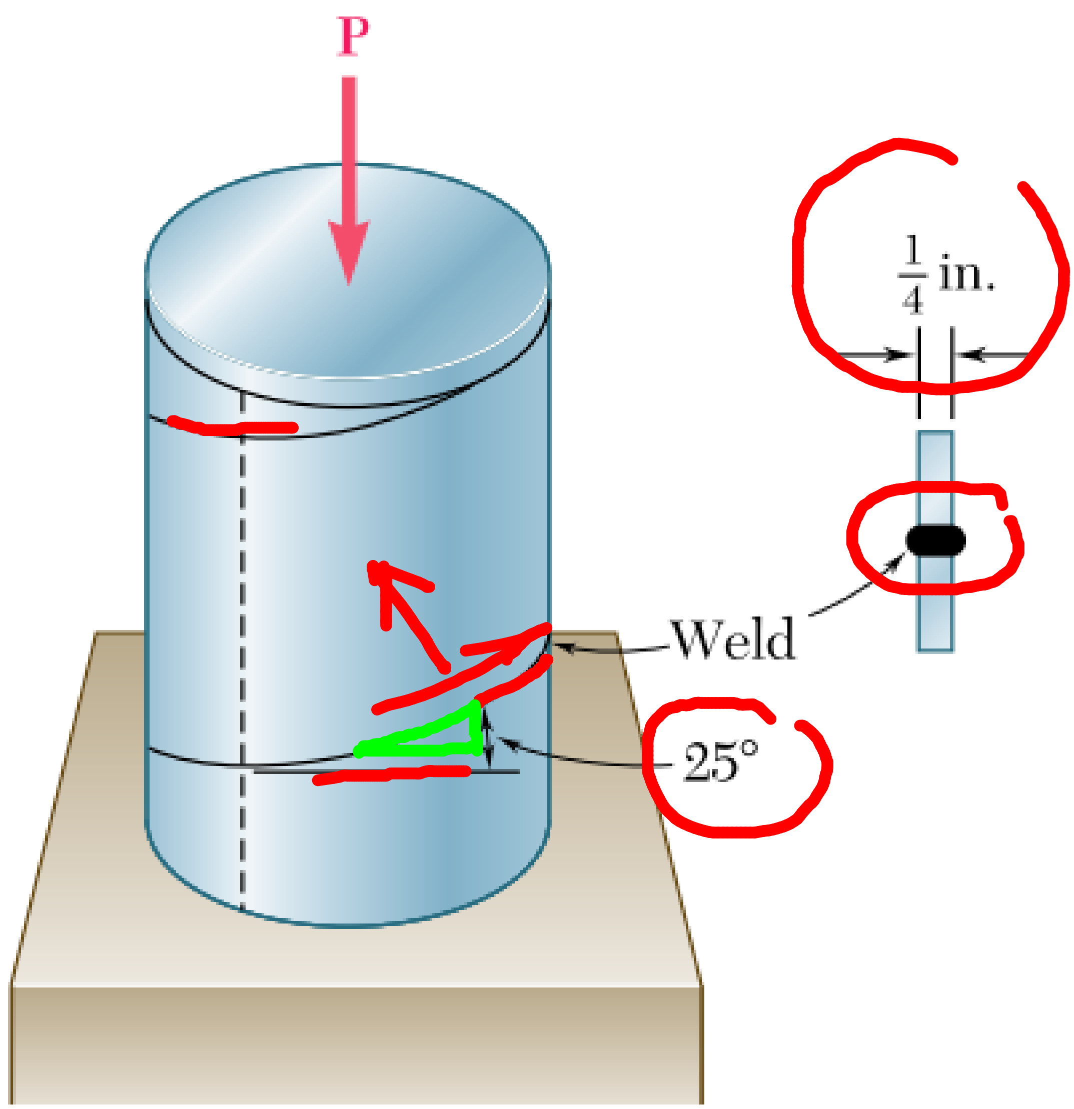
Sec.4

EGM 3520 Mechanics of Materials (MoM)

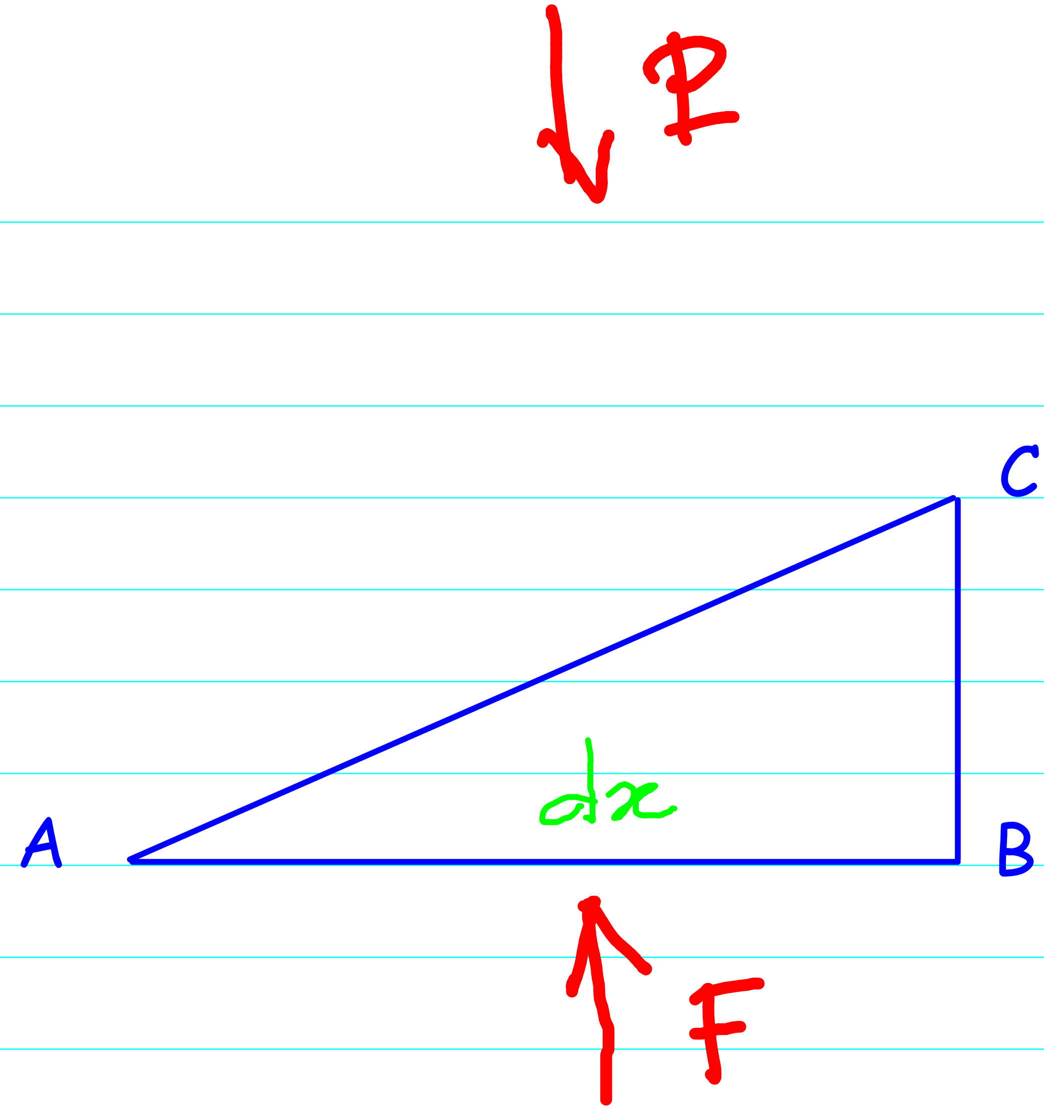
Beer et al. 2012, Mechanics of Materials, McGraw-Hill.

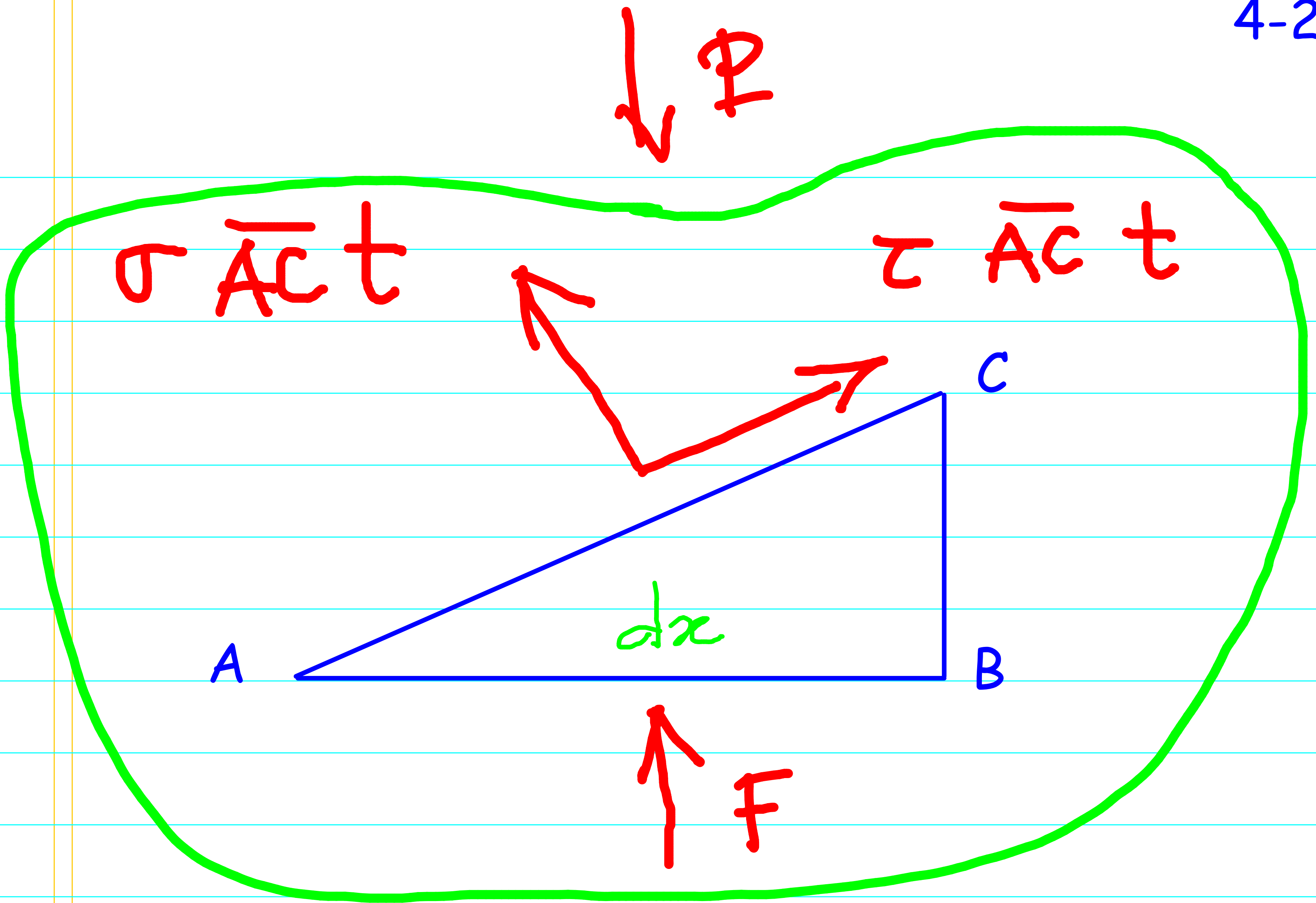
P1.34, p.36

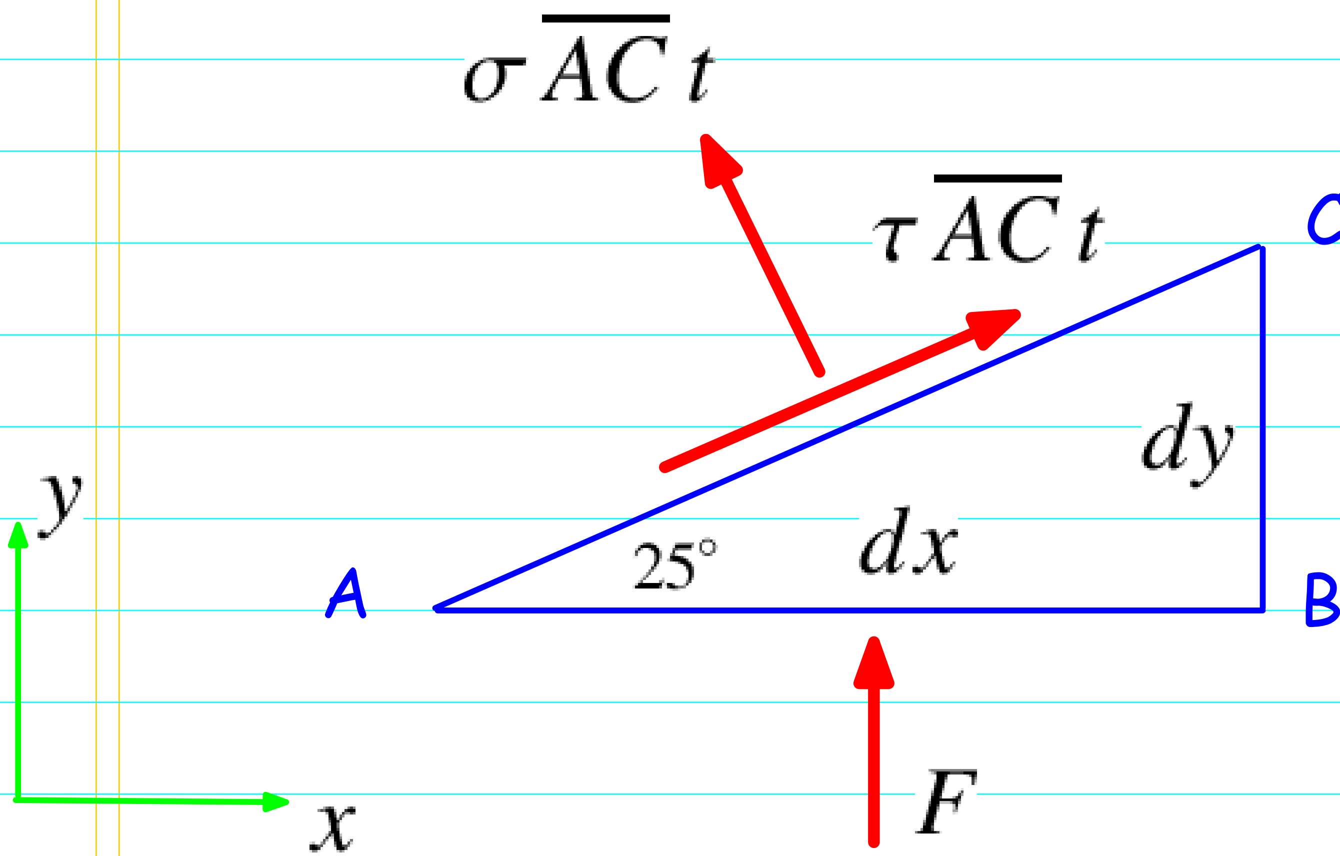
P1.34, p.36



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° with a plane perpendicular to the axis of the pipe. Knowing that a 66 kip axial force **P** is applied to the pipe, determine the normal and shearing stresses in directions respectively normal and tangential to the weld.


P
C
dx
A
B
F


P
σ Āc t
τ Āc t
C
dx
A
B
F



\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

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

F = \frac{P \cdot dx \cdot t}{A}

A area of cross section of pipe

$$A = \pi[r_o^2 - (r_0 - t)^2]$$
$$= \pi[(r_0 + (r_0 - t))(r_0 - (r_0 - t))]$$
$$= \pi t(2r_0 - t) \qquad (2)$$

A = \pi t (2 r_0 - t) = \pi t (d_0 - t) = \pi (0.25 \, in)(12 \, in - 0.25 \, in)

Equilibrium of triangle ABC: 2 eqs for 2 unknowns

x components

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

\sum_i F_{i,x} = 0

y components

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

\sum_i F_{i,y} = 0

Pause video NOW !

Work out the next step

→ individually first

→ discuss with teammates

if you get stuck

then continue to watch the video

Computation

(2) p.4-3:

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

$$= \pi (0.25 \, in)(12 \, in - 0.25 \, in) \quad (1)$$

A = \pi t (2 r_0 - t) = \pi t (d_0 - t) = \pi (0.25 \, in)(12 \, in - 0.25 \, in)

(1) p.4-3:

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

F = \frac{P \cdot dx \cdot t}{A} = \frac{66 \times 10^3 \, lbs \cdot dx \cdot 0.25 \, 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:

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

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

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

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: $P = 66 \times 10^3 \, lbs$

P = 66 \times 10^3 \, lbs

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