Sec.3

EGM 3520 Mechanics of Materials (MoM)

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

P1.25, p.25

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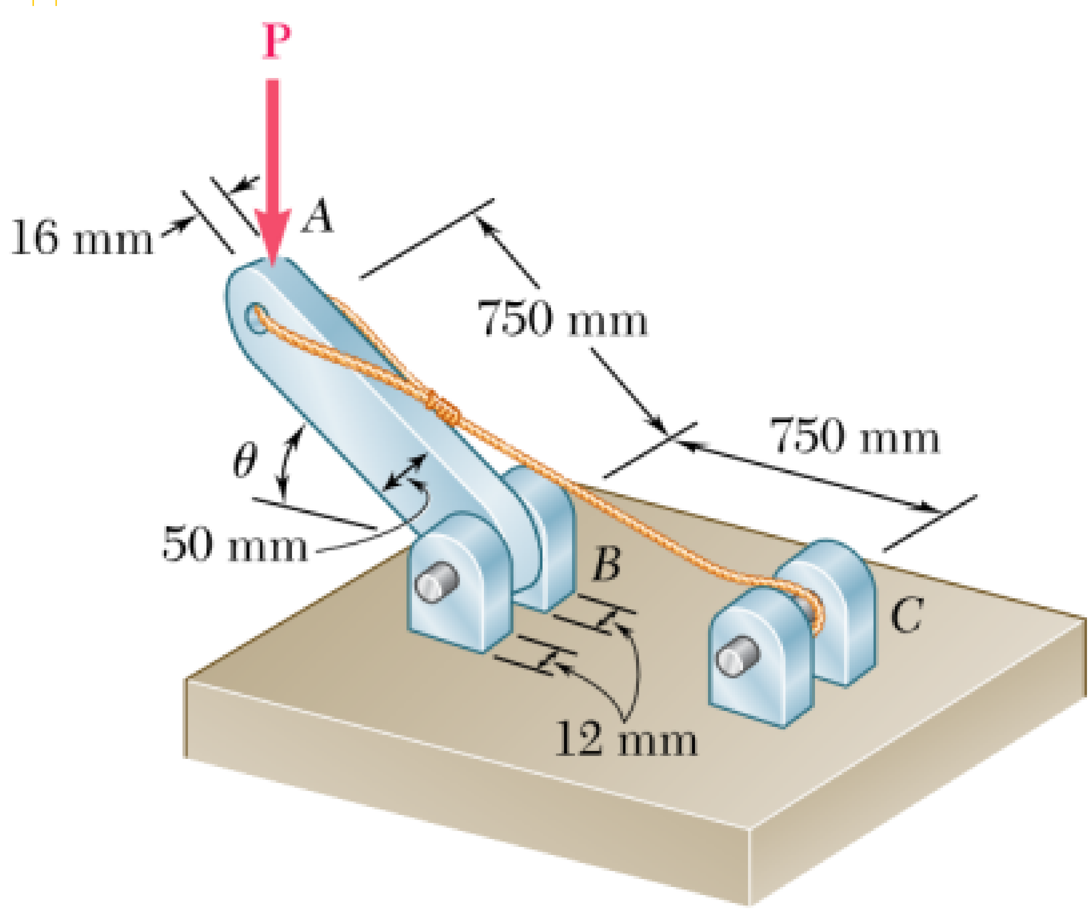
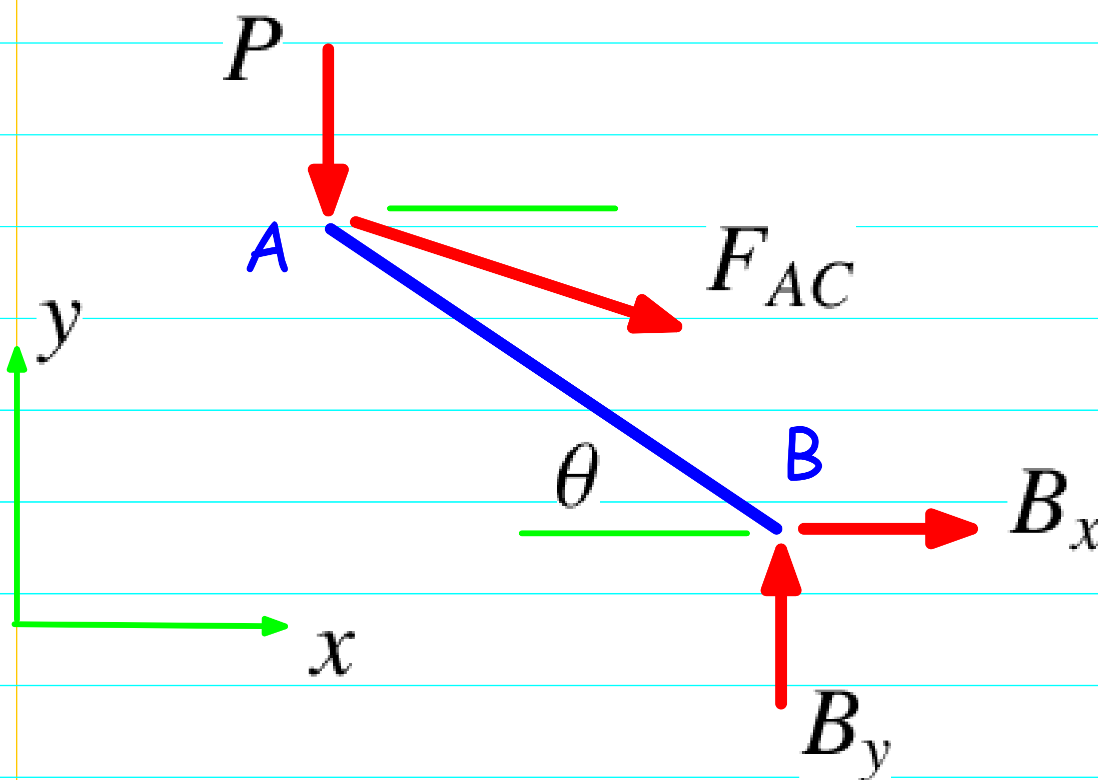
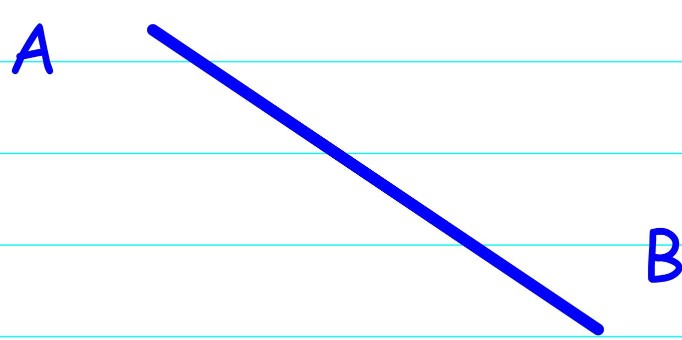


Determine the largest load **P** that can be applied at A when $\theta = 60°$, knowing that the average shearing stress in the 10-mm-diameter pin at B must not exceed 120 MPa and that the average bearing stress in member AB and in the bracket at B must not exceed 90 MPa.

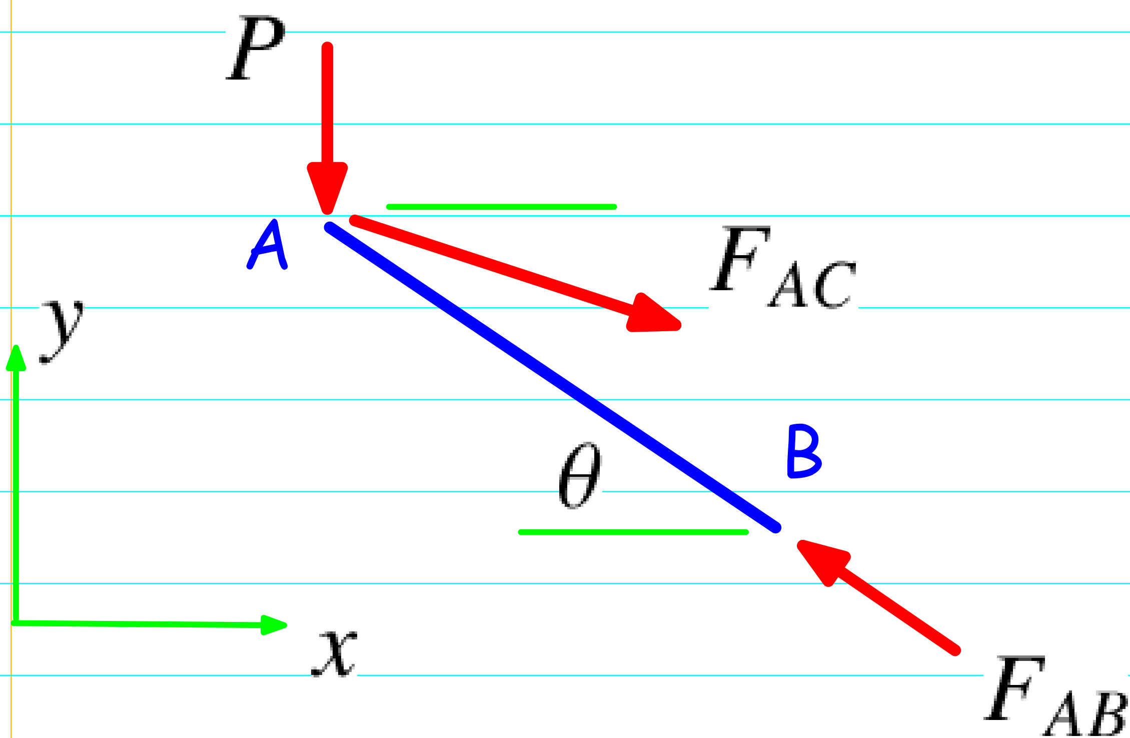


F_{AC}

B_y

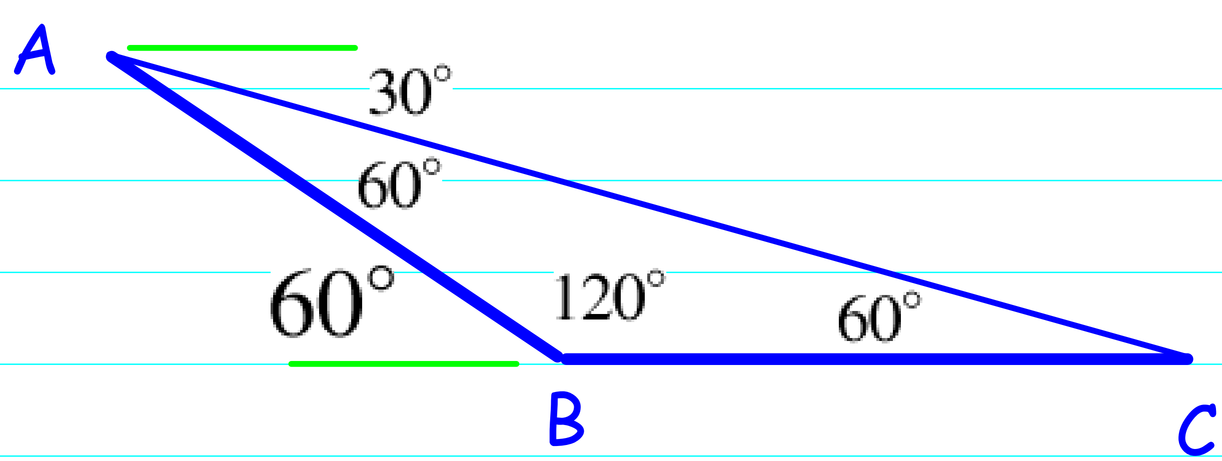


3-2b



F_{AC}

B_y



60^\circ

At point A:

$$\sum_i \mathbf{F}_i = \mathbf{0} \quad (1)$$

\sum_i \mathbf{F}_i = \mathbf{0}

x components

$$\sum_i F_{i,x} = 0 \quad (2)$$

\sum_i F_{i,x} = 0

y components

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

\sum_i F_{i,y} = 0

(2): $F_{AC} \cos 30^\circ - F_{AB} \cos 60^\circ = 0$ (4)

F_{AC} \cos 30^\circ - F_{AB} \cos 60^\circ = 0

(3): $-P - F_{AC} \sin 30^\circ + F_{AB} \cos 60^\circ = 0$ (5)

- P - F_{AC} \sin 30^\circ + F_{AB} \cos 60^\circ = 0

Use (4)-(5) to find P in terms of F_{AC} , and then in terms of F_{AB} .

Check the critcal conditions

1. If shearing stress at pin at B is critical:

$$A = \frac{\pi}{4} d^2 = \frac{\pi}{4} (0.010)^2 = 78.54 \times 10^6 m^2 \quad (1)$$

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$$F_{AB,1} = 2A\tau_{max} = 2(78.54 \times 10^6 m^2)(120\, MPa)$$
$$= 18.85 \times 10^3 N \quad (2)$$

F_{AB, 1} = 2 A \tau_{max} = 2 (78.54 \times 10^6 m^2) (120 \, MPa) = 18.85 \times 10^3 N

2. If bearing stress in member AB is critical:

Bearing area $A_{b,AB} = h_{AB}\, b_{AB}$ (3)

A_{b,AB} = h_{AB} \, b_{AB}

h_{AB} height of bar AB

b_{AB} width of bar AB

$$F_{AB,2} = A_{b,AB}\, \sigma_b \quad (4)$$

F_{AB, 2} = A_{b,AB} \, \sigma_b

σ_b bearing stress

3. If bearing stress at bracket at B is critical:

Bearing area $A_{b,B} = 2\, t_B\, d_B$ (1)

A_{b,B} = 2 \, t_{B} \, d_{B}

t_B thickness of bracket at B

d_B pin diameter at B

$$F_{AB,3} = A_{b,AB}\, \sigma_b \quad (2)$$

F_{AB, 3} = A_{b,B} \, \sigma_b

Maximum allowable force in bar AB

$$F_{AB,max} = \min\{F_{AB,1}, F_{AB,2}, F_{AB,3}\} \quad (3)$$

F_{AB, max} = \min \{ F_{AB,1} , F_{AB,2} , F_{AB,3} \}

Maximum allowable applied force P: (4)-(5) p.3-3