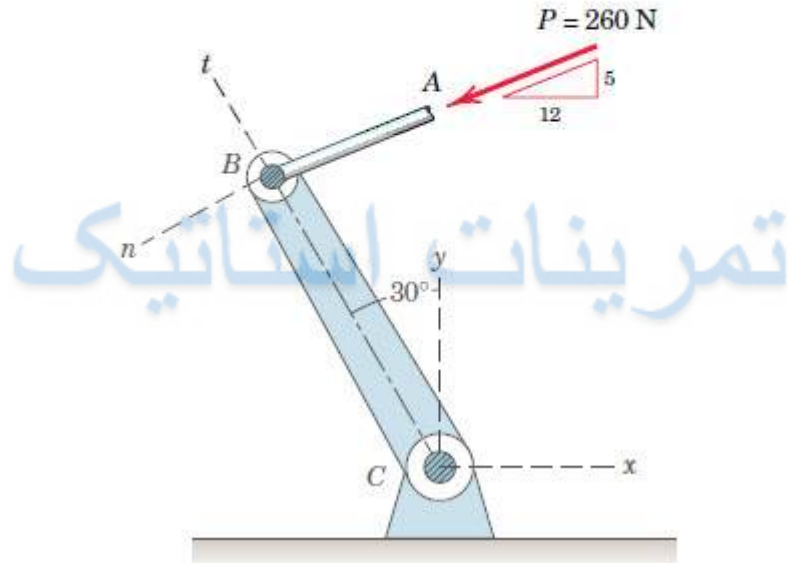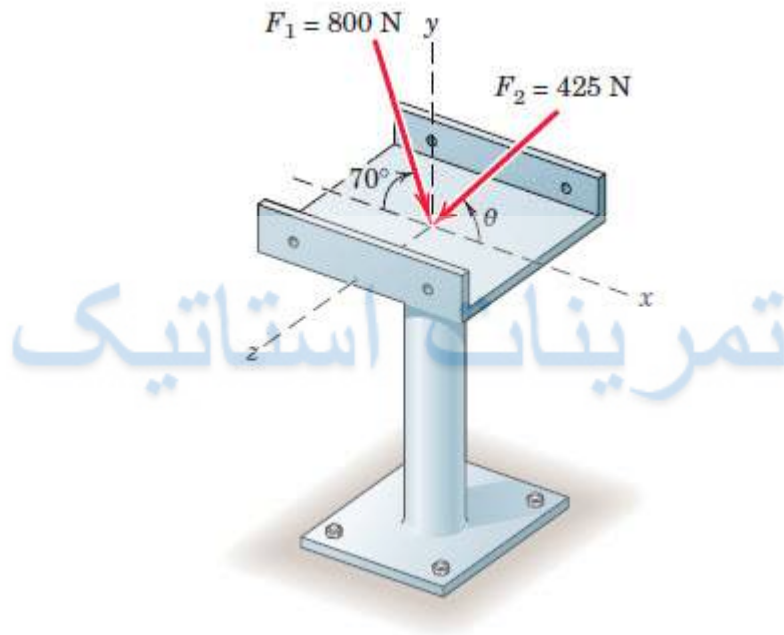**1**

In the design of a control mechanism, it is determined that rod *AB* transmits a 260-N force **P** to the crank *BC*. Determine the *x* and *y* scalar components of **P**.
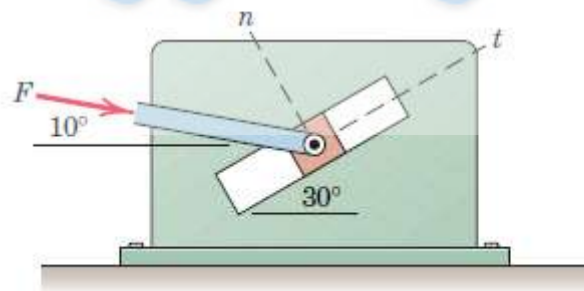
2

Two forces are applied to the construction bracket as shown. Determine the angle θ which makes the resultant of the two forces vertical. Determine the magnitude R of the resultant.
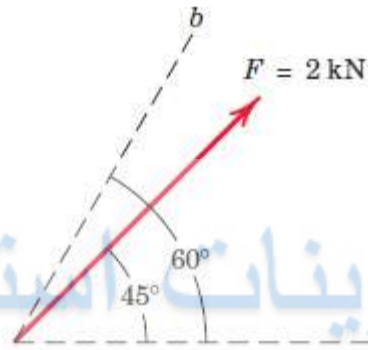
$F_1 = 800$ N y

$F_2 = 425$ N

$70°$

θ

x

z

3

The t-component of the force $\mathbf{F}$ is known to be 75 N. Determine the n-component and the magnitude of $\mathbf{F}$.
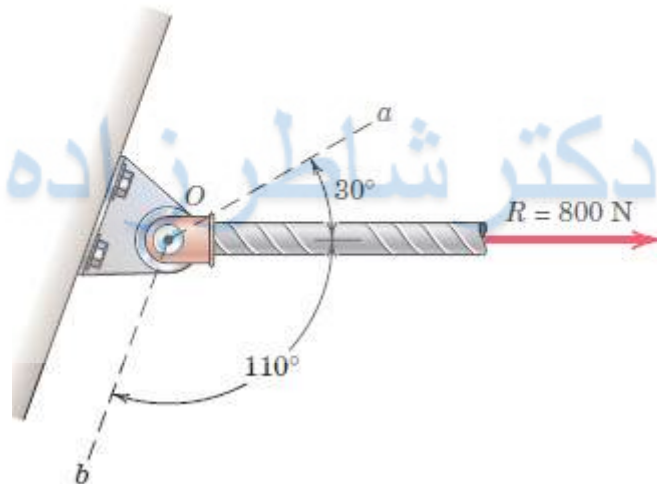
n

t

$\mathbf{F}$

$10°$

$30°$

4

Determine the components of the 2-kN force along the oblique axes a and b. Determine the projections of **F** onto the a- and b-axes.

b

$F = 2\,\text{kN}$

$60°$

$45°$

a

5

Determine the scalar components R_a and R_b of the force **R** along the nonrectangular axes a and b. Also determine the orthogonal projection P_a of **R** onto axis a.
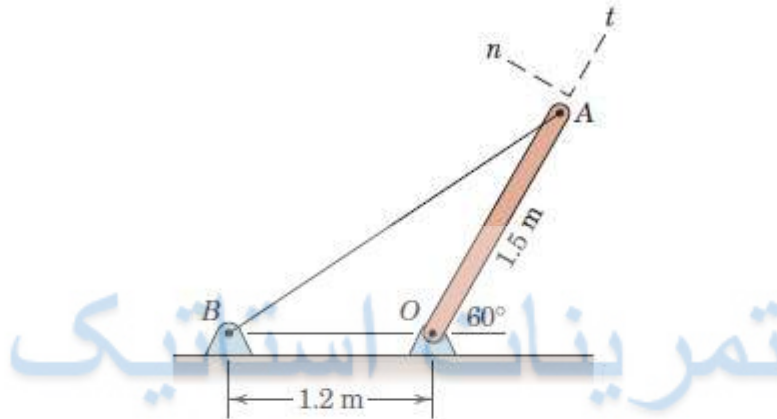
a

O

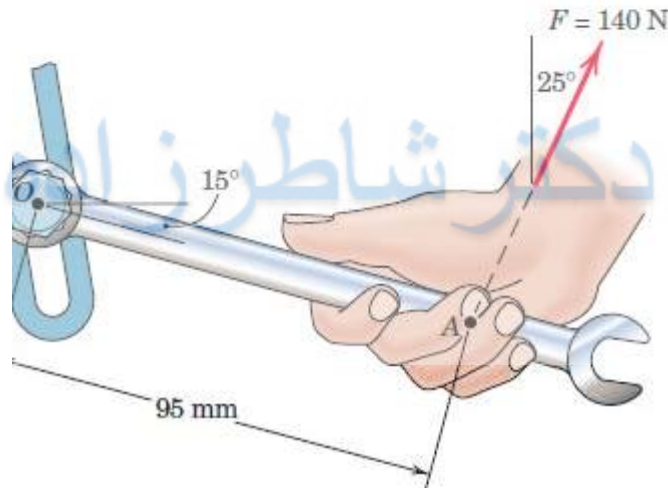$30°$

$R = 800\,\text{N}$

$110°$

b

6

The cable *AB* prevents bar *OA* from rotating clock-wise about the pivot *O*. If the cable tension is 750 N, determine the *n*- and *t*-components of this force acting on point *A* of the bar.

7

A mechanic pulls on the 13-mm combination wrench with the 140-N force shown. Determine the moment of this force about the bolt center *O*.

8

A 150-N pull T is applied to a cord, which is wound securely around the inner hub of the drum. Determine the moment of T about the drum center C. At what angle θ should T be applied so that the moment about the contact point P is zero?

$T = 150$ N

125 mm

C

200 mm

θ

P
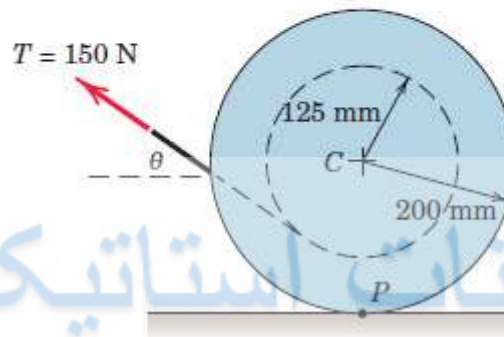
9

In order to raise the flagpole OC, a light frame OAB is attached to the pole and a tension of 3.2 kN is developed in the hoisting cable by the power winch D. Calculate the moment M_O of this tension about the hinge point O.

A

3 m   3 m
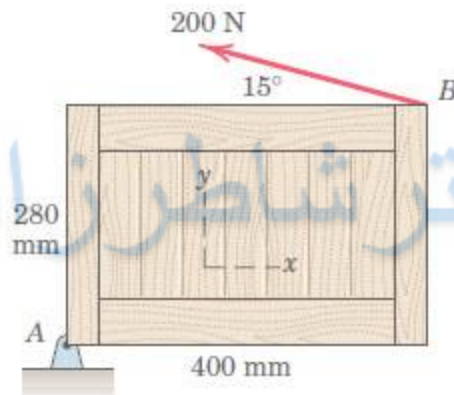
20°

3 m B C

D

O
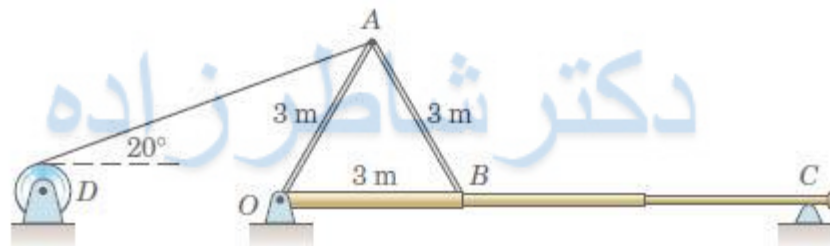
10

In raising the pole from the position shown, the tension T in the cable must supply a moment about O of $72 \text{ kN} \cdot \text{m}$. Determine T.
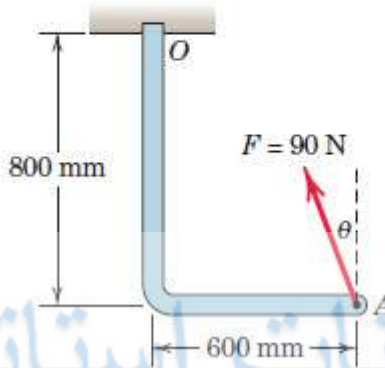
10 m

T

30 m

O 60°

←12 m→
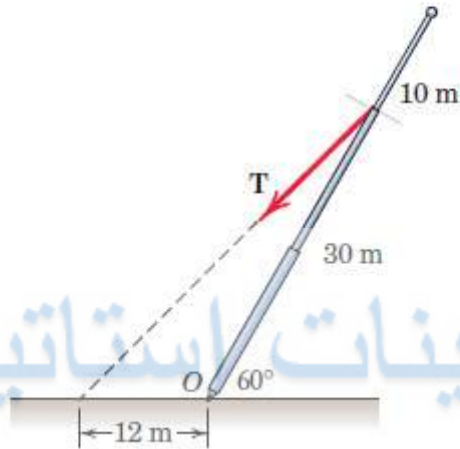
11

Calculate the moment M_A of the 200-N force about point A by using three scalar methods and one vector method.

200 N

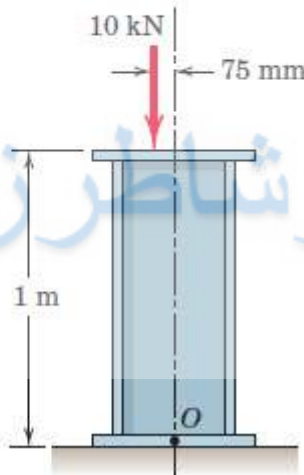15°   B

280 mm

y

x

A

400 mm

12

(a) Calculate the moment of the 90-N force about point O for the condition $\theta = 15°$. Also, determine the value of θ for which the moment about O is (b) zero and (c) a maximum.


13

Replace the 10-kN force acting on the steel column by an equivalent force–couple system at point O. This replacement is frequently done in the design of structures.

14

A lug wrench is used to tighten a square-head bolt. If 250-N forces are applied to the wrench as shown, determine the magnitude F of the equal forces exerted on the four contact points on the 25-mm bolt head so that their external effect on the bolt is equivalent to that of the two 250-N forces. Assume that the forces are perpendicular to the flats of the bolt head.
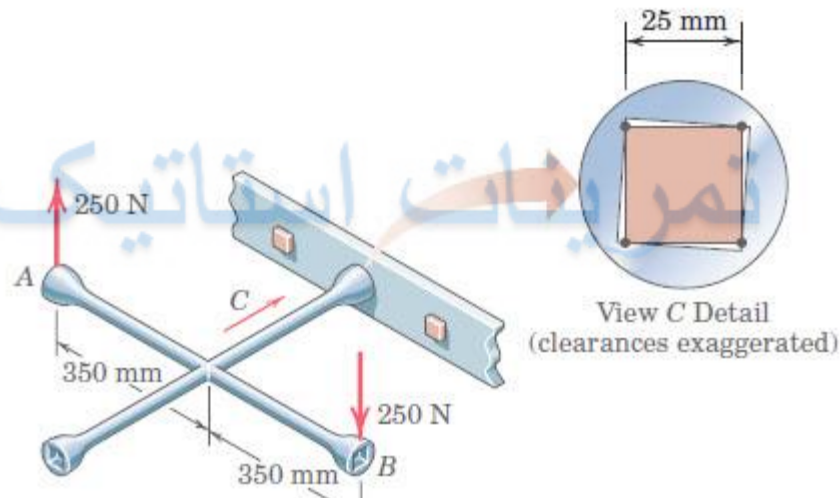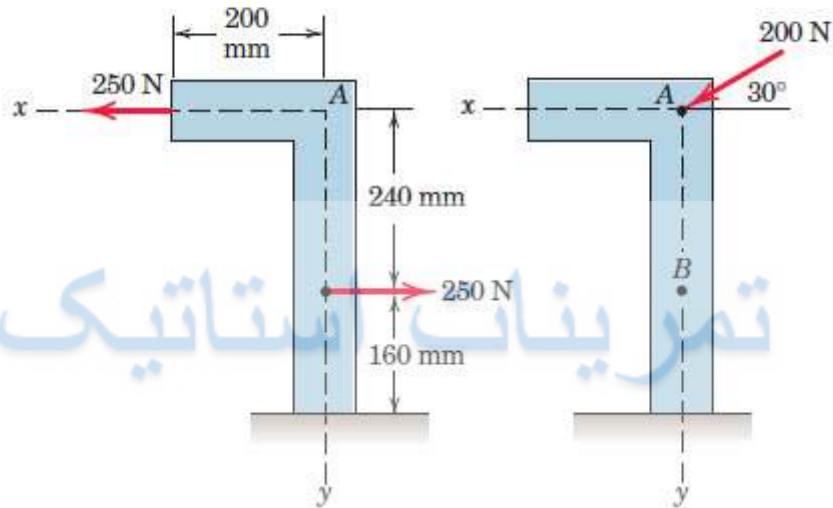
15

The 180-N force is applied to the end of body OAB. If $\theta = 50°$, determine the equivalent force–couple system at the shaft axis O.
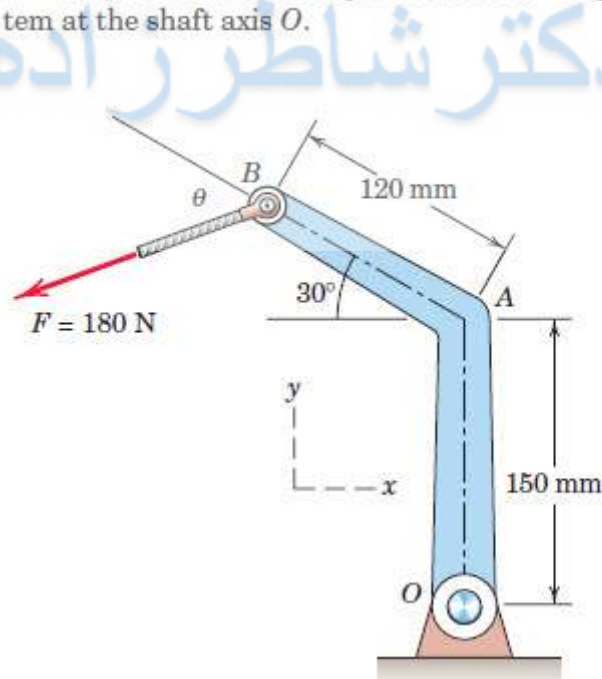
The angle plate is subjected to the two 250-N forces shown. It is desired to replace these forces by an equivalent set consisting of the 200-N force applied at A and a second force applied at B. Determine the y-coordinate of B.
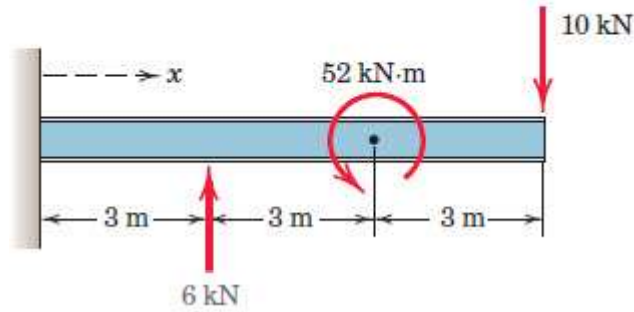
17

The weld at O can support a maximum of 2500 N of force along each of the n- and t-directions and a maximum of 1400 N·m of moment. Determine the allowable range for the direction θ of the 2700-N force applied at A. The angle θ is restricted to $0 \le \theta \le 90°$.
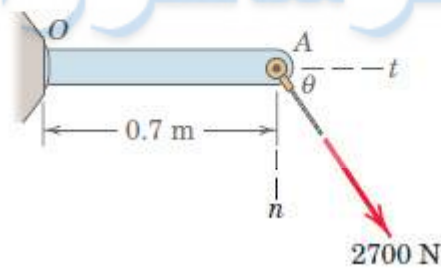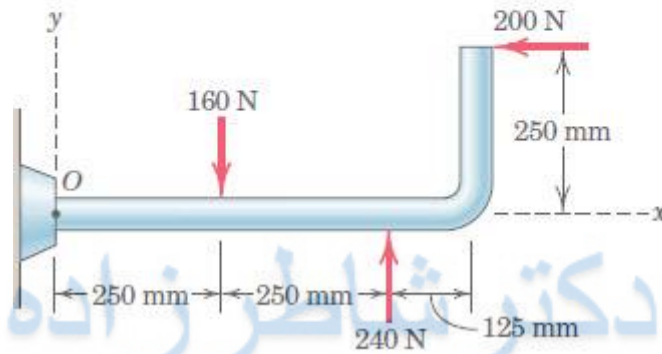
18

Determine and locate the resultant **R** of the two forces and one couple acting on the I-beam.


19

Replace the three forces acting on the bent pipe by a single equivalent force **R**. Specify the distance x from point O to the point on the x-axis through which the line of action of **R** passes.

20

An exhaust system for a pickup truck is shown in the figure. The weights W_h, W_m, and W_t of the head-pipe, muffler, and tailpipe are 10, 100, and 50 N, respectively, and act at the indicated points. If the exhaust-pipe hanger at point A is adjusted so that its tension F_A is 50 N, determine the required forces in the hangers at points B, C, and D so that the force–couple system at point O is zero. Why is a zero force–couple system at O desirable?

Dimensions in meters
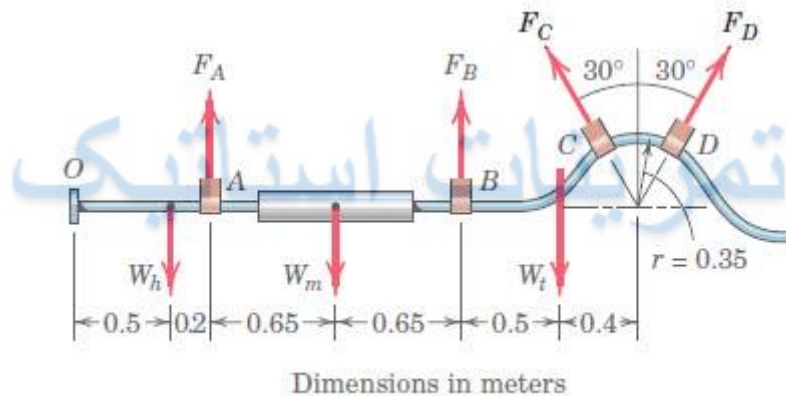
21

In the equilibrium position shown, the resultant of the three forces acting on the bell crank passes through the bearing O. Determine the vertical force P. Does the result depend on θ?