Dept. of Medical Instrumentations Engineering

First Stage: **Academic Year: 2020-2021**

Subject: Mechanics **Instructor: Assist. Prof. Dr. Saad Alkhfaji**

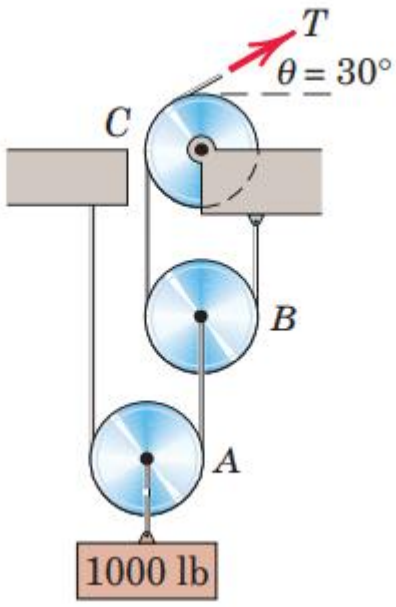
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LECTURE 6:

Equilibrium of Force System- Examples

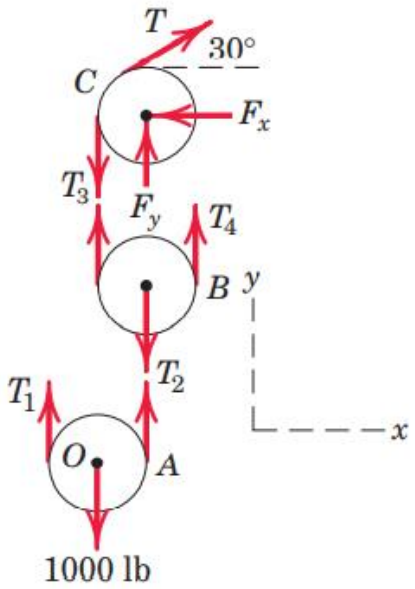
Example 1:

Calculate the tension T in the cable which supports the 1000-lb load with the pulley arrangement shown. Each pulley is free to rotate about its bearing, and the weights of all parts are small compared with the load. Find the magnitude of the total force on the bearing of pulley C.



Solution:

The free-body diagram of each pulley is drawn in its relative position to the others. We begin with pulley A, which includes the only known force. With the unspecified pulley radius designated by r, the equilibrium of moments about its center O and the equilibrium of forces in the vertical direction require:



$[\Sigma M_O = 0]$ $T_1 r - T_2 r = 0$ $T_1 = T_2$

$[\Sigma F_y = 0]$ $T_1 + T_2 - 1000 = 0$ $2T_1 = 1000$ $T_1 = T_2 = 500$ lb

From the example of pulley A we may write the equilibrium of forces on pulley B by inspection as

$$T_3 = T_4 = T_2/2 = 250 \text{ lb}$$

For pulley C the angle $\theta = 30°$ in no way affects the moment of T about the center of the pulley, so that moment equilibrium requires

$$T = T_3 \quad \text{or} \quad T = 250 \text{ lb} \qquad \textit{Ans.}$$

Equilibrium of the pulley in the x- and y-directions requires

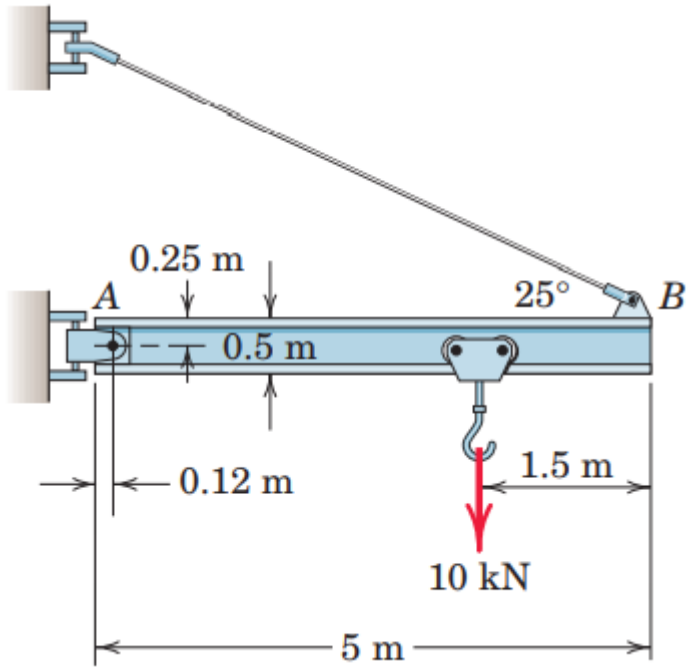
$[\Sigma F_x = 0]$ $250 \cos 30° - F_x = 0$ $F_x = 217$ lb

$[\Sigma F_y = 0]$ $F_y + 250 \sin 30° - 250 = 0$ $F_y = 125$ lb

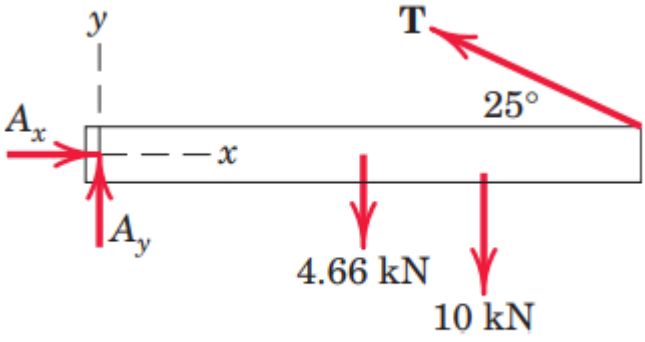
$[F = \sqrt{F_x^2 + F_y^2}]$ $F = \sqrt{(217)^2 + (125)^2} = 250$ lb *Ans.*

Example 2:

Determine the magnitude T of the tension in the supporting cable and the magnitude of the force on the pin at A for the jib crane shown. The beam AB is a standard 0.5-m I-beam with a mass of 95 kg per meter of length.



Solution:



Free-body diagram

$[\Sigma M_A = 0]$ $(T \cos 25°)0.25 + (T \sin 25°)(5 - 0.12) - 10(5 - 1.5 - 0.12) - 4.66(2.5 - 0.12) = 0$

from which $T = 19.61$ kN *Ans.*

Equating the sums of forces in the x- and y-directions to zero gives

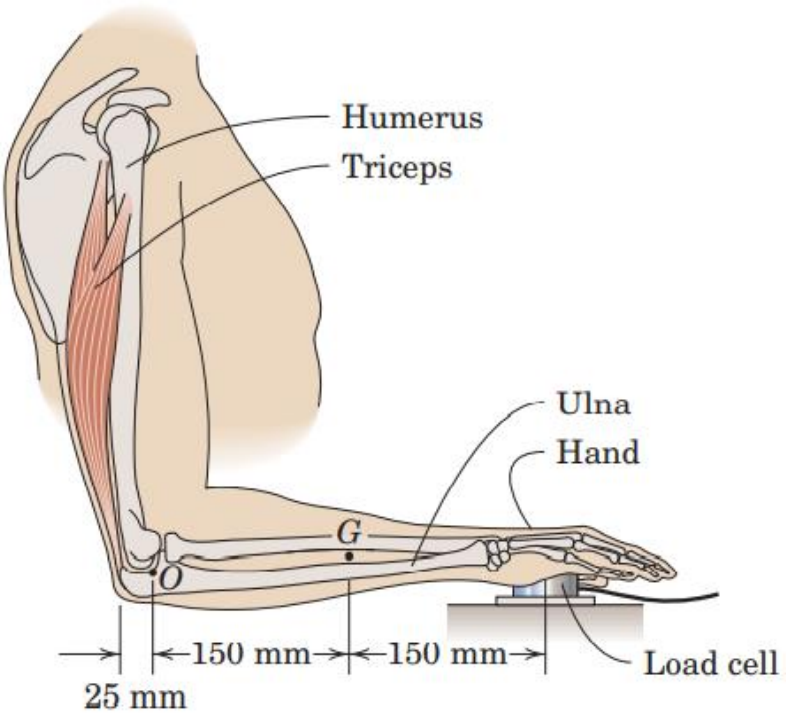
$[\Sigma F_x = 0]$ $A_x - 19.61 \cos 25° = 0$ $A_x = 17.77$ kN

$[\Sigma F_y = 0]$ $A_y + 19.61 \sin 25° - 4.66 - 10 = 0$ $A_y = 6.37$ kN

$[A = \sqrt{A_x^2 + A_y^2}]$ $A = \sqrt{(17.77)^2 + (6.37)^2} = 18.88$ kN *Ans.*

Example 3: To be solved on-line!

In a procedure to evaluate the strength of the triceps muscle, a person pushes down on a load cell with the palm of his hand as indicated in the figure. If the load-cell reading is 160 N, determine the vertical tensile force F generated by the triceps muscle. The mass of the lower arm is 1.5 kg with mass center at G. State any assumptions.



$F - 1832$ N **ans.**