Problem Set 6

Problem 6.1 Minimizing Tension in a Cable

The 200 lb. uniform tank is suspended by a 6 ft. cable which passes over the pulley at $O$. The cable can be attached at either points $A$ and $B$, or at points $C$ and $D$. Which attachment produces the smallest tension on the cable, and what is the tension?

Figure P6.1: Problem 6.1
Problem 6.2 Tension in a Network of Cords
The 30 kg pipe is supported by a series of five cords. Determine the force in each cord for equilibrium.
Problem 6.3 Tension in Three Cables
Determine the tension in cables $AB$, $AC$, and $AD$ required to hold the 60 lb. crate in equilibrium.

Figure P6.3: Problem 6.3
Problem 6.4

If cables $BD$ and $BC$ can withstand a maximum tensile force of 20 kN, determine the maximum mass of the girder that can be suspended from cable $AB$ so that neither cable will fail. The center of mass of the girder is located at point $G$.

Result: $m = 2\,787$ kg.
Problem 6.5

Determine the unstretched length of spring AC if a force $P = 80$ lb causes the angle $\theta = 60^\circ$ for equilibrium. Cord AB is 2 ft long. Take $k = 50$ lb/ft and $b = 2$ ft.

![Figure P6.5: Problem 6.5](image)

Solution

1. Mechanical System: spring AC and cord AB.
2. Free-Body Diagram (FBD): node A (see figure).
3. Equations: $\sum F_x = 0$ & $\sum F_y = 0$.

```matlab
P = 80; % lb
k = 50; % lb/ft
a = 2; % ft
b = 2; % ft
theta = 60*pi/180;
AB = a; BC = a + b;
% AC = l
l = sqrt(AB^2+BC^2-2*AB*BC*cos(theta));
% AC = l = 3.4641 ft
% 1/sin(theta) = a/sin(phi) =>
phi = asin(a*sin(theta)/l);
% phi = 0.5236 rad = 30 deg
% FBD of A
```
\[ F_x = -T\cos(\theta) + F\cos(\phi); \]
\[ F_y = T\sin(\theta) + F\sin(\phi) - P; \]
% solve \( F_x = 0 \) and \( F_y = 0 \);
sol = solve(Fx,Fy);
Fs = sol.F; Ts = sol.T;
% \( F = F_s = 40.000 \) (lb)
% \( F_s = k (l - l_o) \Rightarrow l_o = l - F_s/k \)
\[ l_o = l - F_s/k; \]
% \( l_o = 2.664 \) (ft)

Result: unstretched length of the spring is 2.664 ft.
Problem 6.6

Two spheres $A$ and $B$ have an equal mass and are electrostatically charged such that the repulsive force acting between them has a magnitude of 20 mN and is directed along line $AB$. Determine the angle $\theta$, the tension in cords $AC$ and $BC$, and the mass $m$ of each sphere.

Figure P6.6: Problem 6.6

Results: $\theta = 19.1066^\circ$, $T_A = 0.0529$ N, $T_B = 0.03464$ N, and $m = 0.004077$ kg.
Problem 6.7

Determine the mass of each of the two cylinders if they cause a sag of $s = 0.5 \text{ m}$ when suspended from the rings at $A$ and $B$. Note that $s = 0$ when the cylinders are removed.

Result: $m = 2.3673 \text{ kg}$.
Problem 6.8
Determine the force acting along the axis of each of the three struts needed to support the 500-kg block.