Problem Set 7

Problem 7.1 Cable Force to Lift a Ramp

The ramp of a ship has a weight of 200 lb and a center of gravity at G. Determine the cable force in CD needed to just start lifting the ramp (i.e., so that the reaction at B is zero). Also, determine the horizontal and vertical components of force at the hinge A.

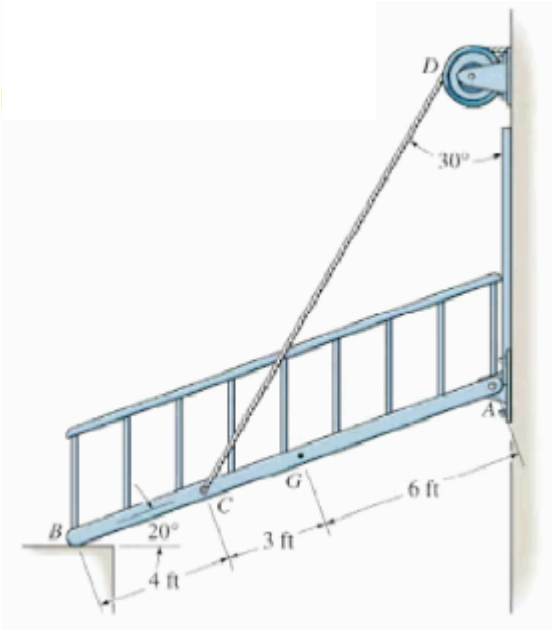

Figure P7.1: Problem 7.1

Problem 7.2 Force Reactions at Frictionless Connections

Determine the reactions on the bent rod which is supported by a smooth surface at B and a frictionless collar at A.

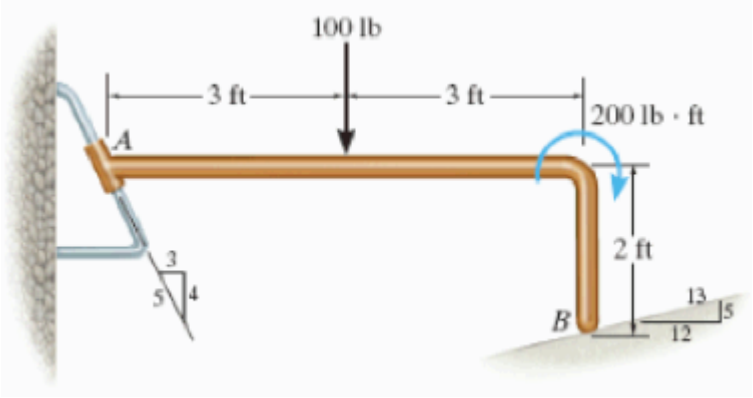

Figure P7.2: Problem 7.2

Problem 7.3

The links 1 and 2 shown in Fig. P7.3 are each connected to the ground at A and C, and to each other at B using frictionless pins. The length of link 1 is $AB = l$. The angle between the links is $\angle ABC = \theta$. A force of magnitude P is applied at the point D ($AD = 2l/3$) of the link 1. The force makes an angle θ with the horizontal. Find the force exerted by the lower link 2 on the upper link 1. Numerical application: a) $l = 1$ m, $\theta = 30°$, and $P = 1000$ N; b) $l = 2$ ft, $\theta = 45°$, and $P = 500$ lb.

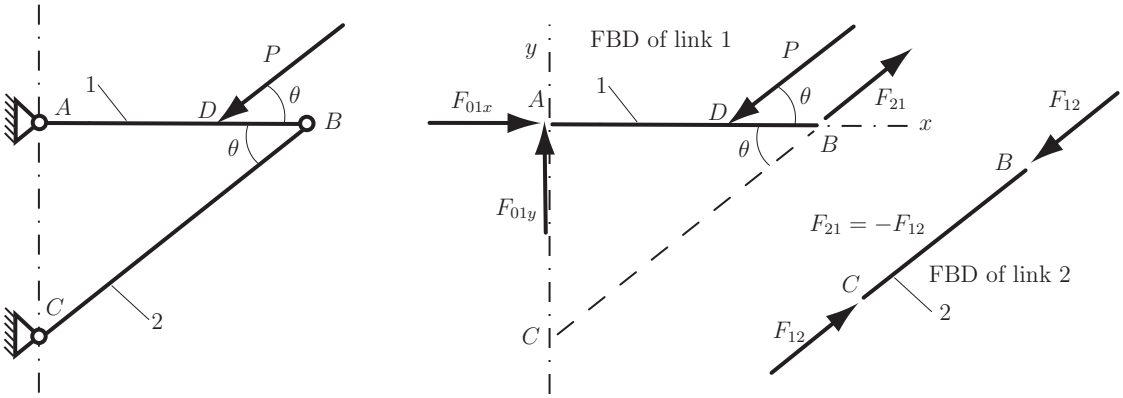

Figure P7.3: Problem 7.3

Problem 7.4

The dimensions of the shaft shown Fig. P7.4 are $a = 50$ mm and $l = 120$ mm. The force on the disk with the radius $r_1 = 50$ mm is $F_1 = 4000$ N and the force on the disk with the radius $r_2 = 100$ mm is $F_2 = 2000$ N. Determine the bearing loads at A and B.

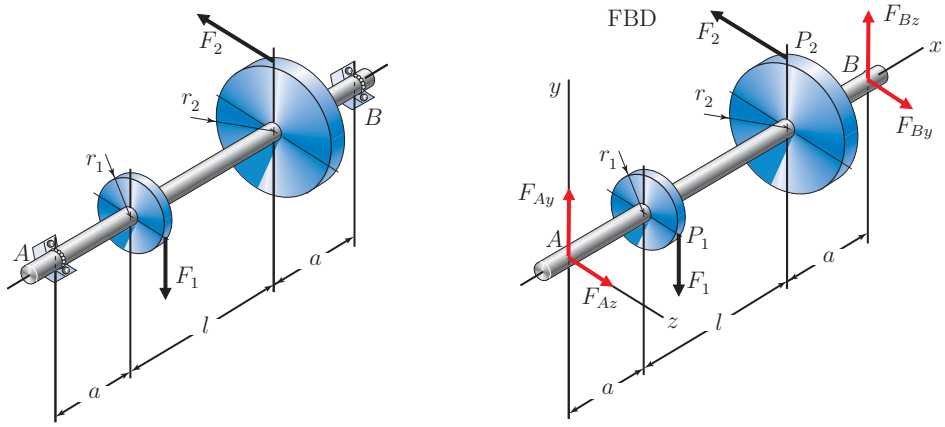

Figure P7.4: Problem 7.4

Solution

1. Mechanical System: shaft and disks
2. Free-Body Diagram: FBD of link 1 (see figure).
3. Equations: $\sum F_x = 0$ & $\sum F_y = 0$ & $\sum M_A = 0$.

```
% reaction force of the bearing on the shaft at A
FA = [0, FAy, FAz];
% reaction force of the bearing on the shaft at B
FB = [0, FBy, FBz];
% position vector of B
rB = [a+l+a, 0, 0];
% vector force F1
F1v = [0, -F1, 0];
% vector force F2
F2v = [0, 0, -F2];
% position vector of P1 application point of F1
rP1 = [a, 0, r1];
% position vector of P2 application point of F2
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```
rP2 = [a+l, r2, 0];
% sum of the moments about A
MA = cross(rP1, F1v)+cross(rP2, F2v)+cross(rB, FB);
% MAy = 340 - (11*FBz)/50 = 0;
% MAz = (11*FBy)/50 - 200 = 0;
% FBy =  909.0909 (N)
% FBz =  1545.5 (N)

% sum F = 0
FAn= -(F1v+F2v+FBn)
% FA = [0 3090.9 454.5] (N)
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Problem 7.5

Determine the horizontal and vertical components of reaction at the pin A and the tension developed in cable BC used to support the steel frame.

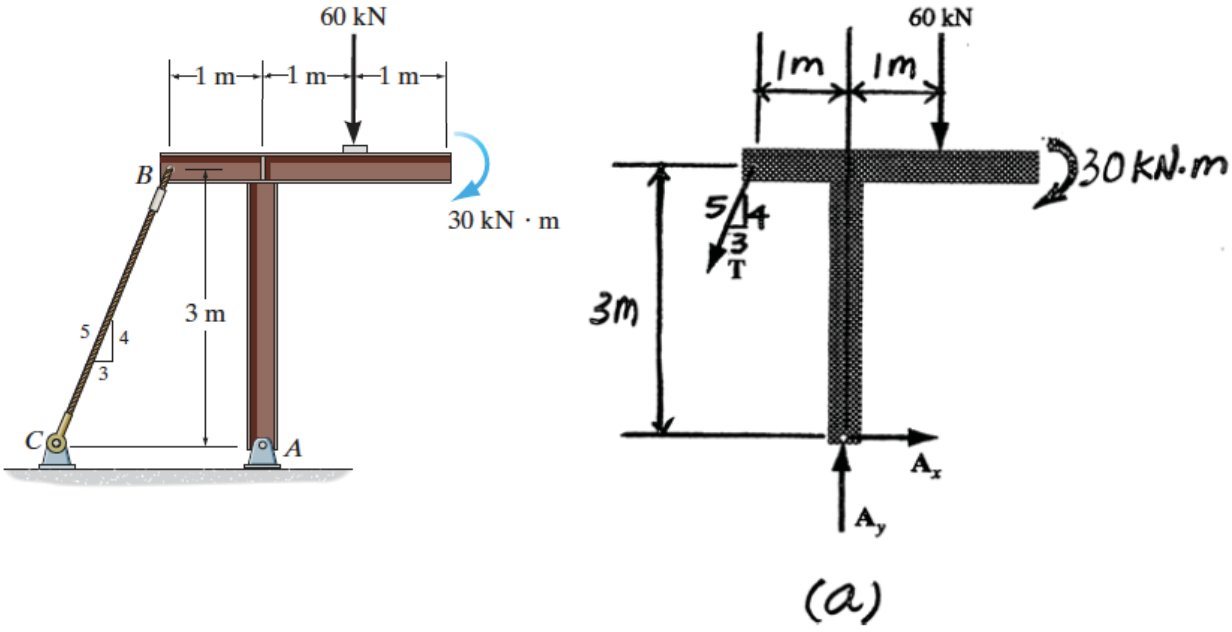

Figure P7.5: Problem 7.5

Results: $T_{BC} = 34.6154$ kN, $A_x = 20.7692$ kN, $A_y = 87.6923$ kN.

Problem 7.6

Determine the horizontal and vertical components of force at the pin A and the reaction at the rocker B of the curved beam.

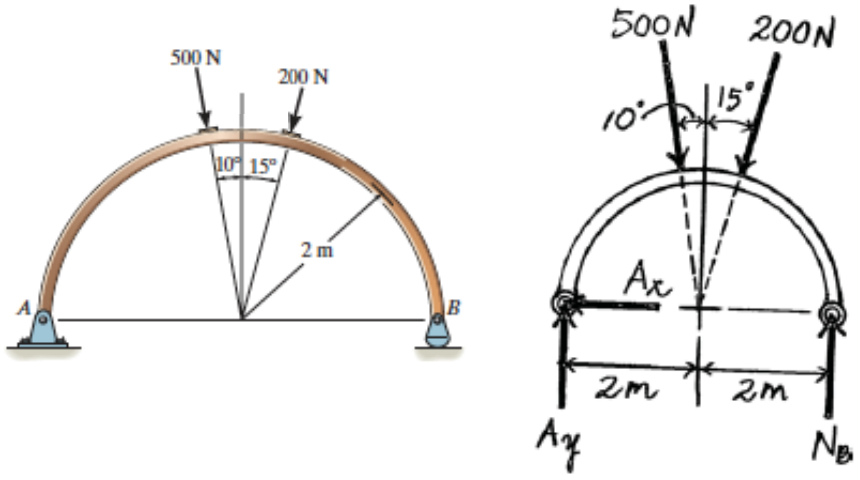

Figure P7.6: Problem 7.6

Results: $N_B = 342.7945$ N, $A_x = 35.0603$ N, and $A_y = 342.7945$ N.

Problem 7.7

If the load has a weight of 200 lb, determine the x, y, z components of reaction at the ball-and-socket joint A and the tension in each of the wires.

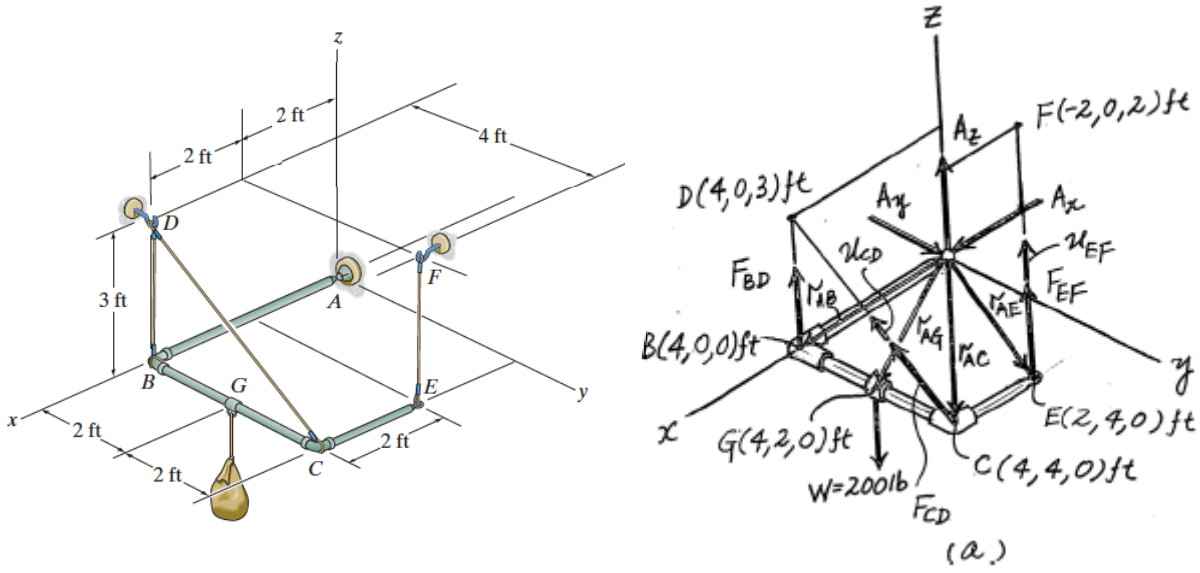

Figure P7.7: Problem 7.7

Results: $A_x = A_y = 0$, $A_z = -50$, $F_{CD} = 0$, $F_{EF} = 100$, $F_{BD} = 150$ (lb).

The negative sign indicates that A_z acts in the opposite sense to that on the FBD.