Statics - TAM 211

Lecture 19

November 7, 2018

Announcements

- Upcoming deadlines:

- Friday (11/9)
  - Written Assignment 7
- Tuesday (11/12)
  - Prairie Learn HW 8

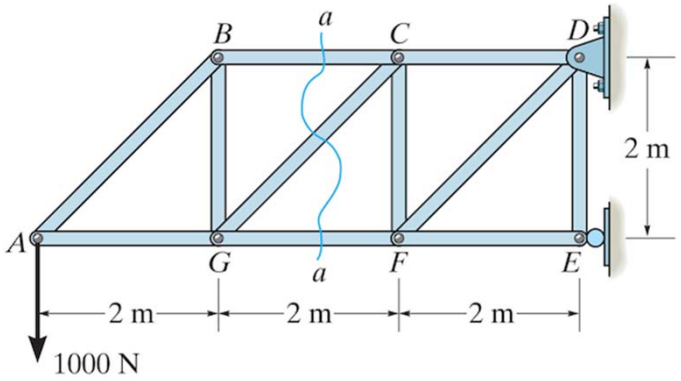
Chapter 6: Structural Analysis

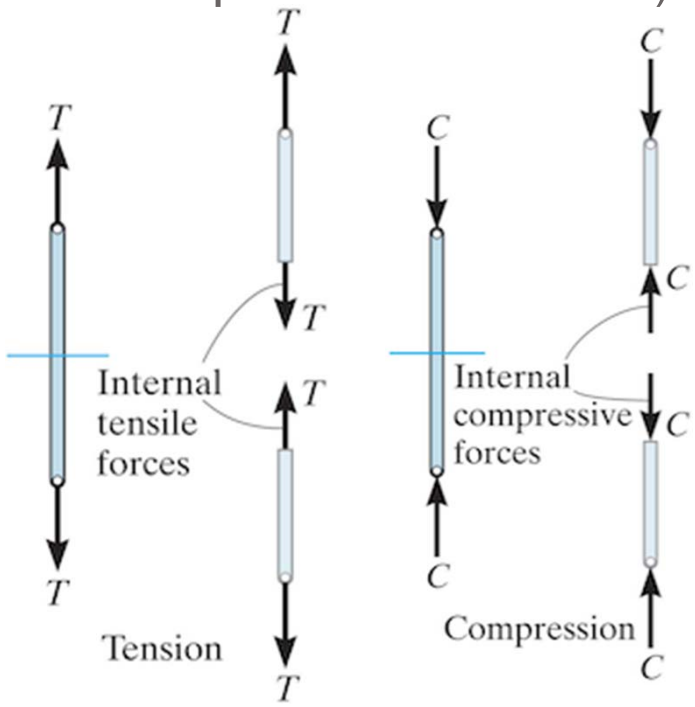
Goals and Objectives

- Determine the forces in members of a truss using the method of joints
- Determine zero-force members
- Determine the forces in members of a truss using the method of sections
- Determine the forces and moments in members of a frame or machine

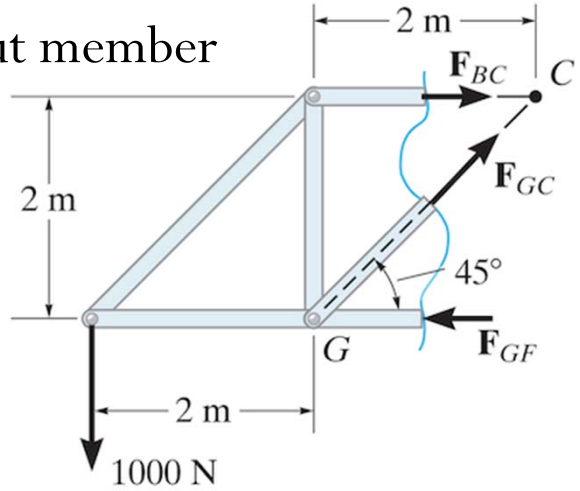
Recap: Method of sections (Solve for specific link force)

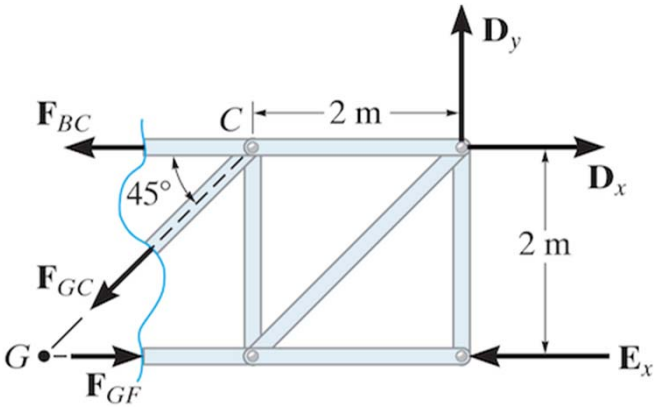
- Determine external support reactions (if necessary)
- "Cut" the structure at a section of interest into two separate pieces and set either part into force and moment equilibrium (your cut should be such that you have **no more than** three unknowns)





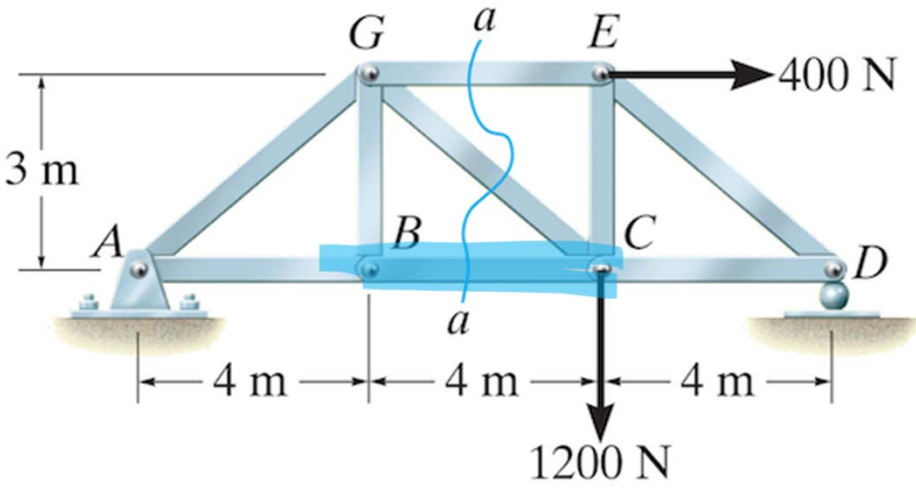
- Extend lines at cut to find point of intersection
- Draw unknown truss forces in cut member



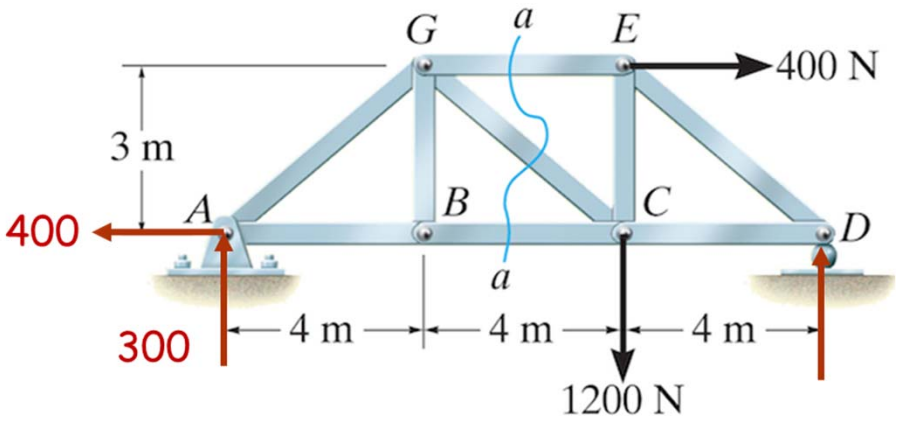


- Determine equilibrium equations (e.g., moment around point of intersection of two lines)
- Assume all internal loads are tensile.

Determine the force in member BC of the truss and state if the member is in tension or compression.

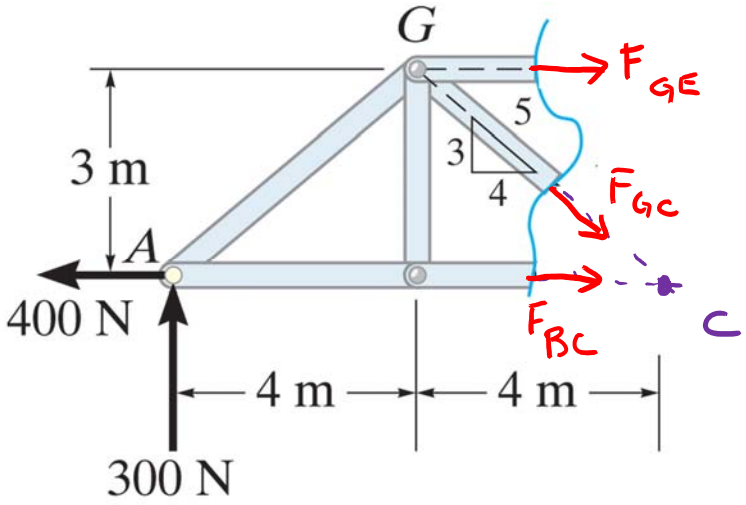


① Solve for support rxn forces at A & D. (Chap 5)



② After solving for A_x, A_y, D_y, use Method of Sections to solve for F_{BC}.

Solve problem on your own. Show that $F_{BC} = 800N$ ∴ link BC is in tension



Frames and machines

Frames and machines are two common types of structures that have at least **one multi-force member.** (Recall that trusses have **only** two-force members.) Therefore, it is not appropriate to use Method of Joints or Method of Sections for frames and machines.

Frames are generally **stationary** and used to support various external loads.

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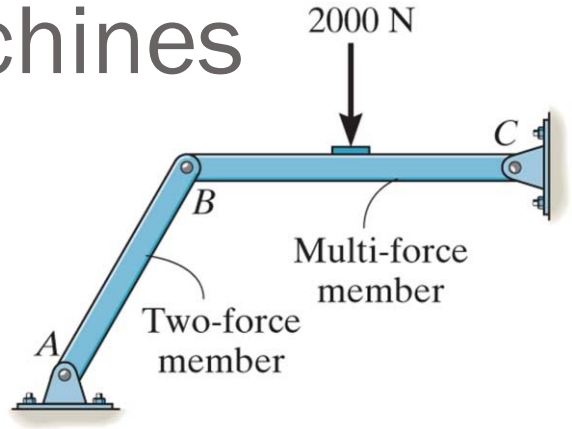
Machines contain **moving parts** and are designed to alter the effect of forces.

Forces/Moment in frames and machines



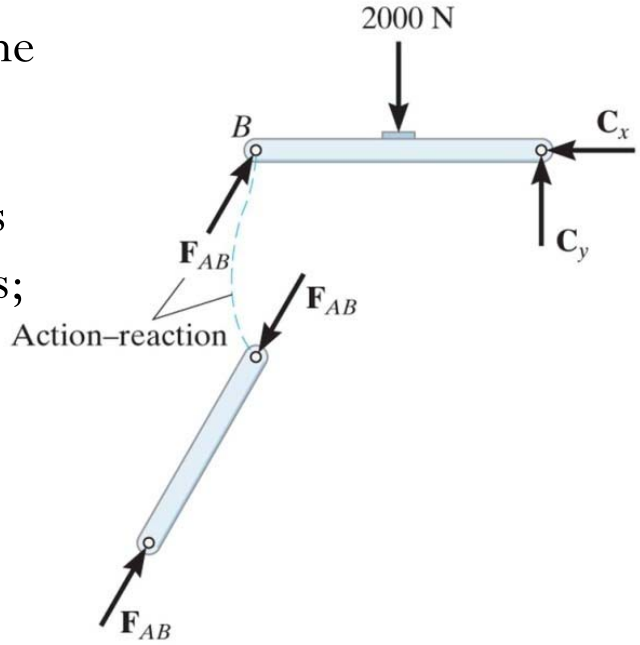
The members can be truss elements, beams, pulleys, cables, and other components. The general solution method is the same:

1. Identify two-force member(s) to simplify direction of unknown force(s).

2. Identify external support reactions on entire frame or machine. (Draw FDB of entire structure. Set the structure into external equilibrium: $\sum F_x = 0, \sum F_y = 0, \sum M_{most\ efficient\ pt} = 0$. This step will generally produce more unknowns than there are relevant equations of equilibrium.)

3. Draw FDBs of individual subsystems (members). (Isolate part(s) of the structure, setting each part into equilibrium $\sum F_x = 0, \sum F_y = 0,$ $\sum M_{most\ efficient\ pt} = 0$. The sought forces or couples must appear in one or more free-body diagrams.)

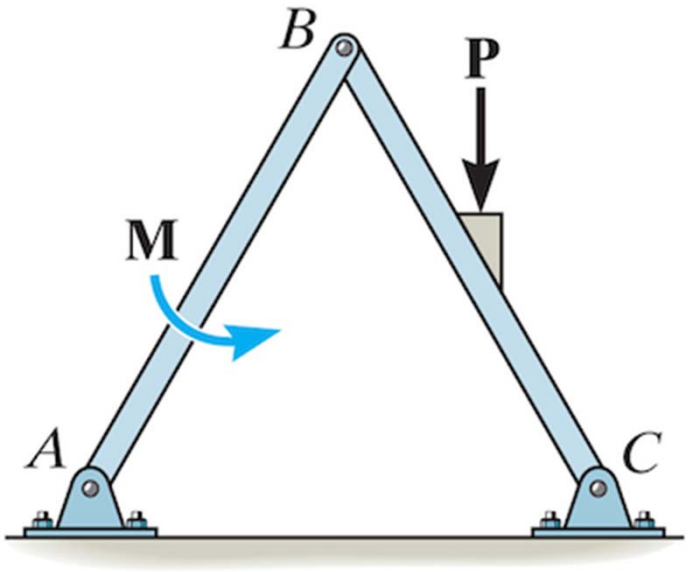
4. Solve for the requested unknown forces or moments. (Look for ways to solve efficiently and quickly: single equations and single unknowns; equations with least # unknowns.)

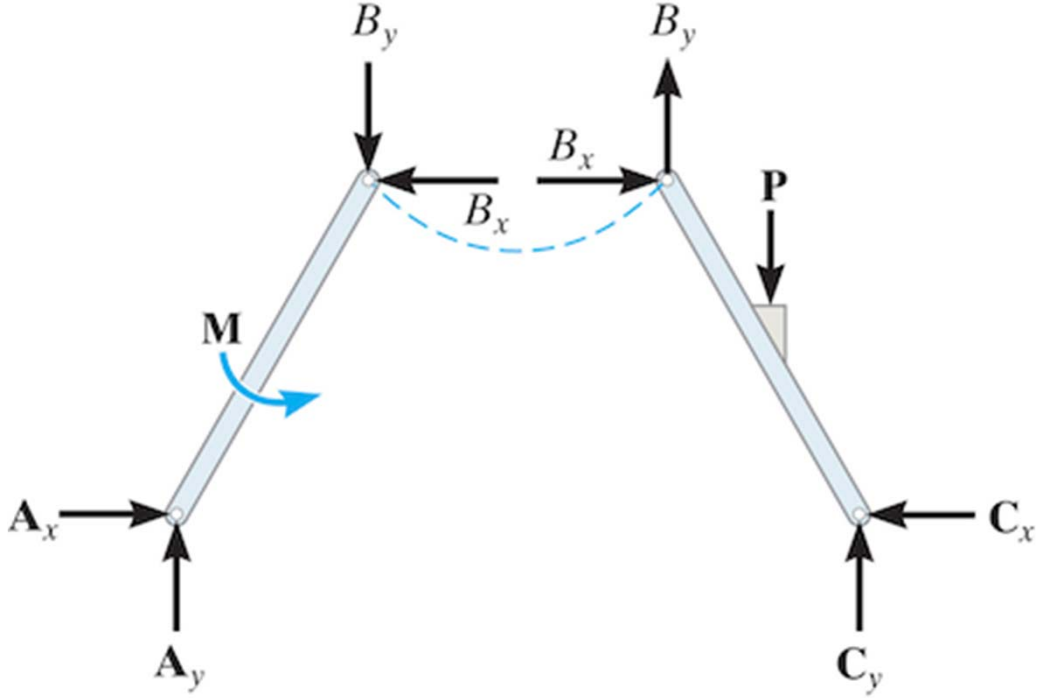


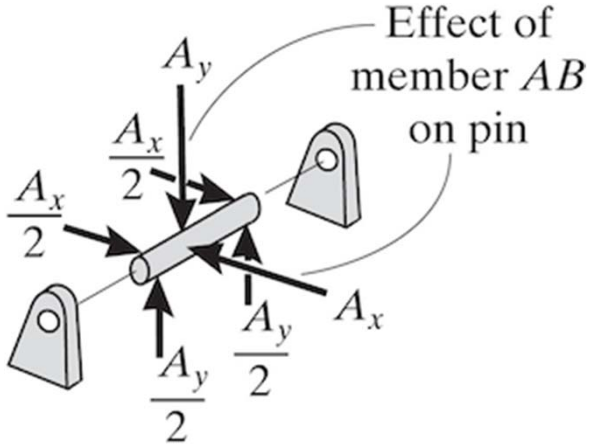
Problems are going to be **challenging** since there are usually several unknowns (and several solution steps). A lot of practice is needed to develop good strategies and ease of solving these problems.

A note about why skip drawing FBD of the pin joint between members:

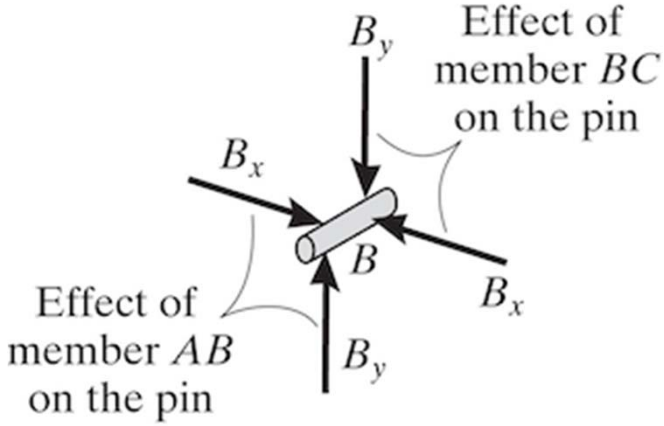
For the frames, we are interested in forces and/or moments on the rigid body members. Because this method examines individual members, we can ignore the pin that connects the members and directly consider that adjacent members experience equal and opposite forces at the joints.





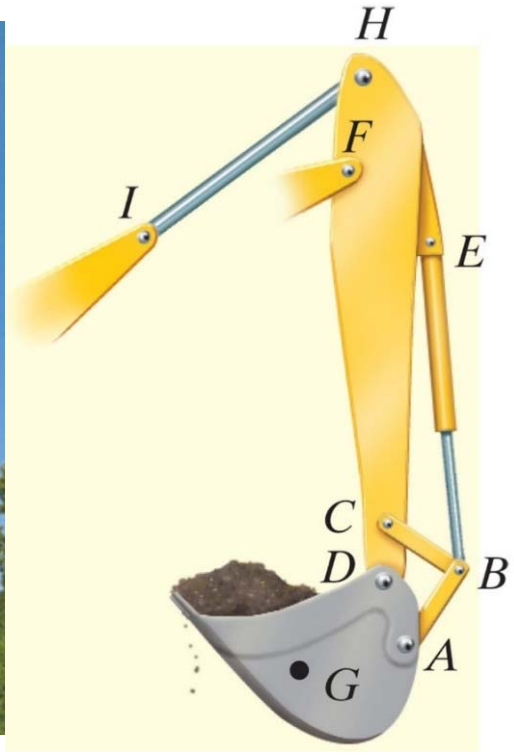


Pin A

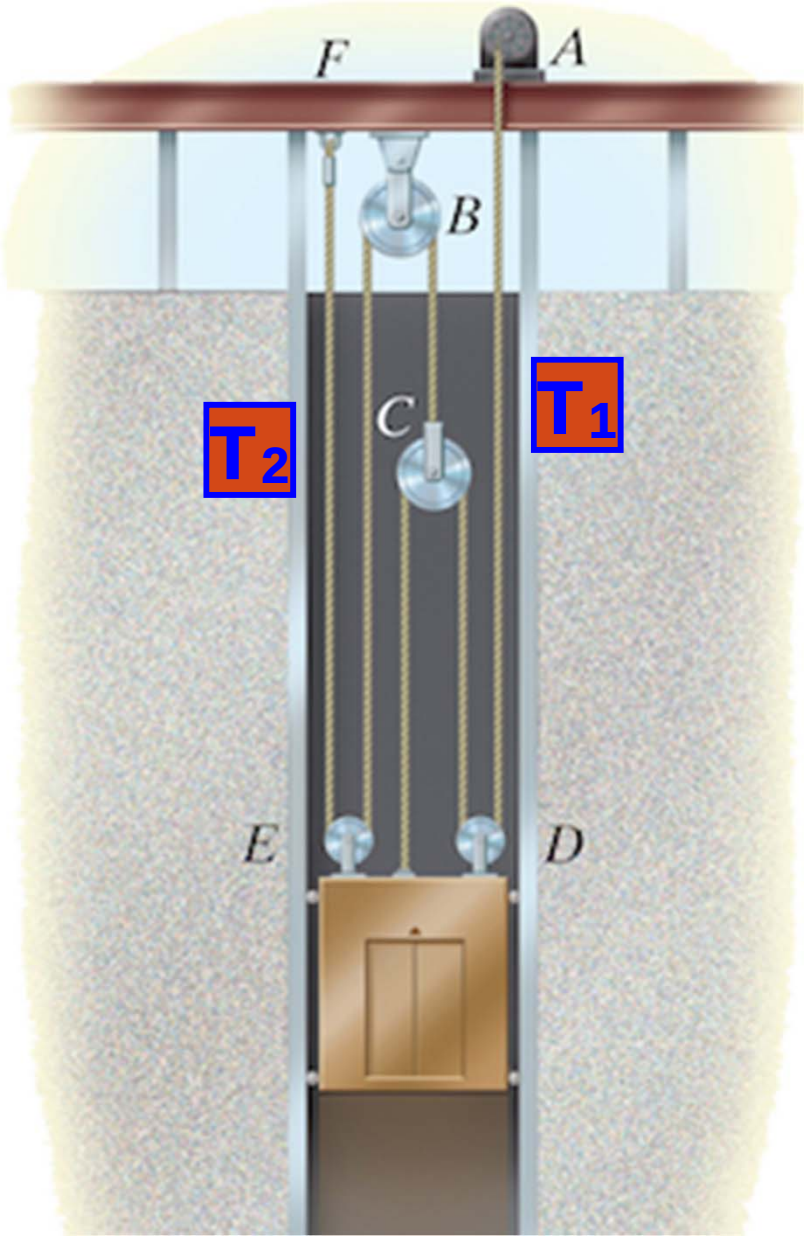


Pin B

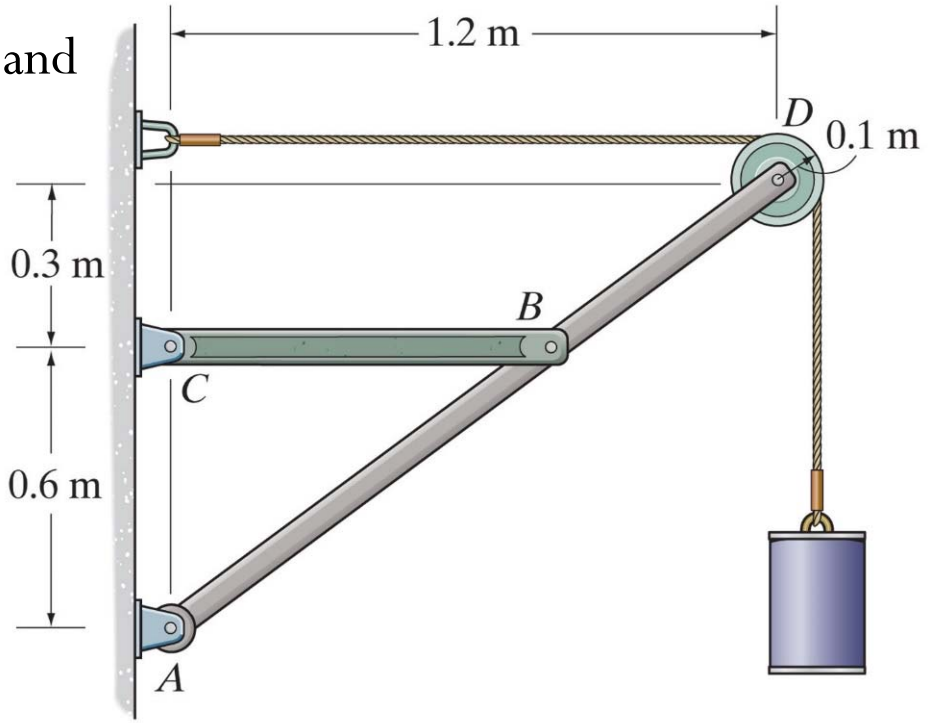
Draw the FBD of the members of the backhoe. The bucket and its contents have a weight W.



A 500 kg elevator car is being hoisted by a motor using a pulley system. If the car travels at a constant speed, determine the force developed in the cables. Neglect the cable and pulley masses.

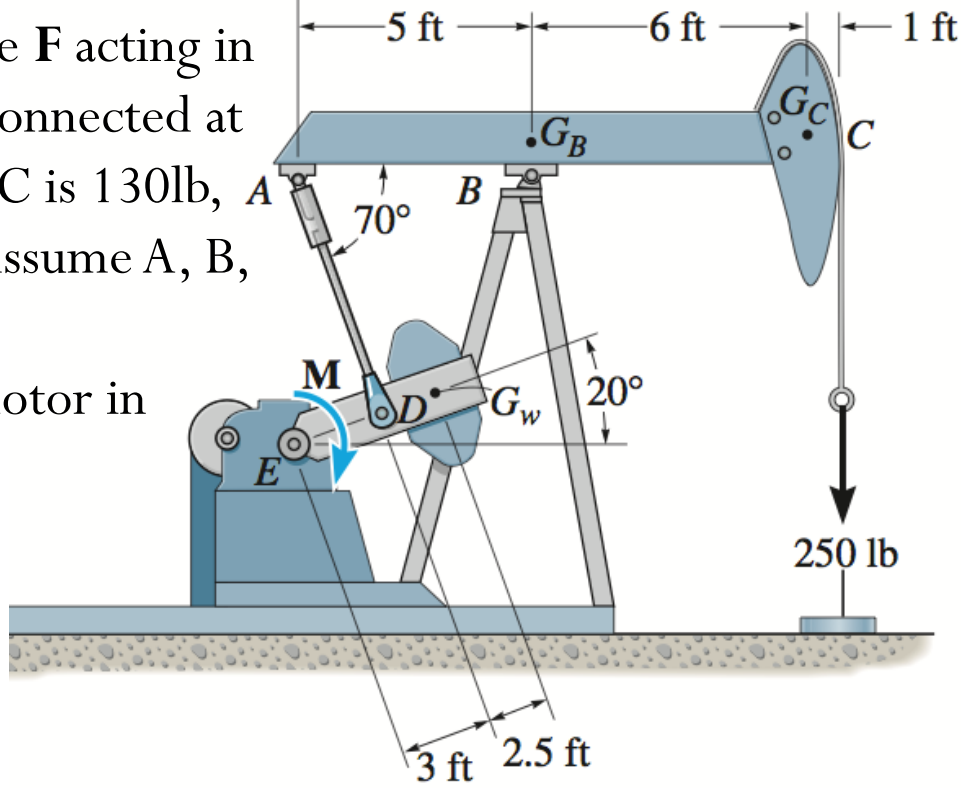


The frame supports a 50kg cylinder. Determine the horizontal and vertical components of reaction at A and the force at C



Given: The pumping unit used to recover oil has force **F** acting in the wireline at the well head. The pitman, *AD*, is pin connected at its ends and has negligible weight. Weight of beam ABC is 130lb, horsehead at C is 60lb, counterweight at D is 200lb. Assume A, B, C, G_B and G_C are collinear.

Find: The torque **M** which must be exerted by the motor in order to overcome this load.



The compound beam shown is pin-connected at I
Determine the components of reaction at its
supports. Neglect its weight and thickness.