Today:

- Mechanical Systems
- 3D

Book: Chapter 5.3, 5.4 & 5.7

Recap: Static equilibrium of a body

In general:

$$\sum \mathbf{F}_x = 0$$

$$\sum \mathbf{F}_y = 0$$

$$\sum \mathbf{M}_A = 0$$

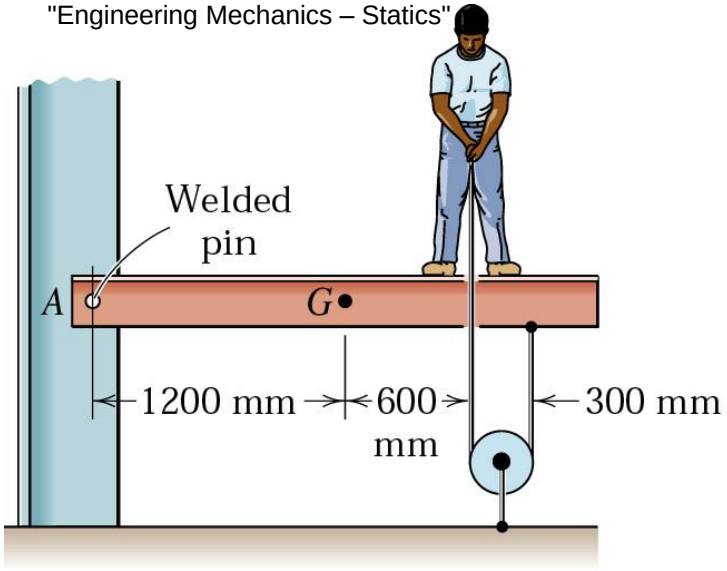
Free-body diagram

A diagrammatic representation of the isolated system treated as a single body.

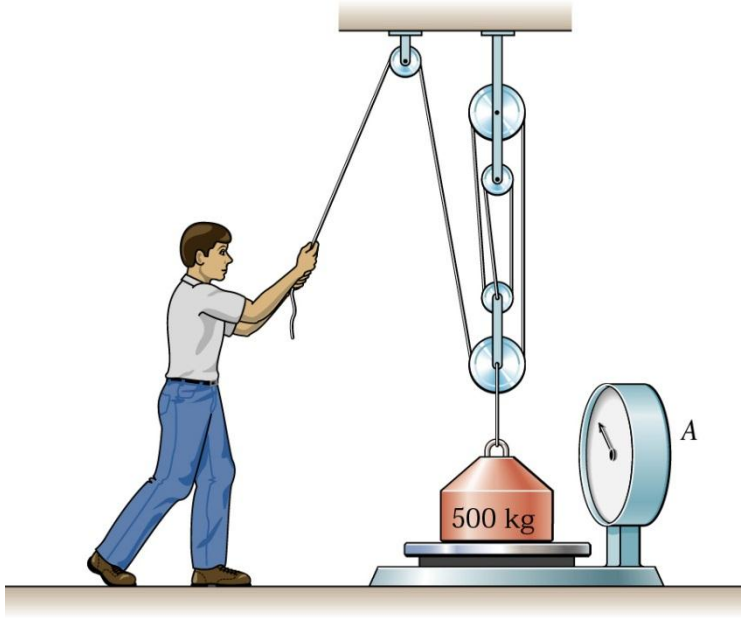
Support reactions

1. If a support allows motion in a certain direction (degree-of-freedom) then it provides no reaction force in that direction
2. Conversely, if a support constrains motion in a certain direction, a reaction could be present in that direction

Source: R.C. Hibbeler,
"Engineering Mechanics – Statics"



The pin A, which connects the 200 kg steel beam with center of gravity G to the column, is welded both to the beam and the column. To test the weld, the 80 kg man loads the beam by exerting a 300 N force on the rope which passes through a hole in the beam as shown. **Calculate the force F and torque (couple) M supported by the pin.**



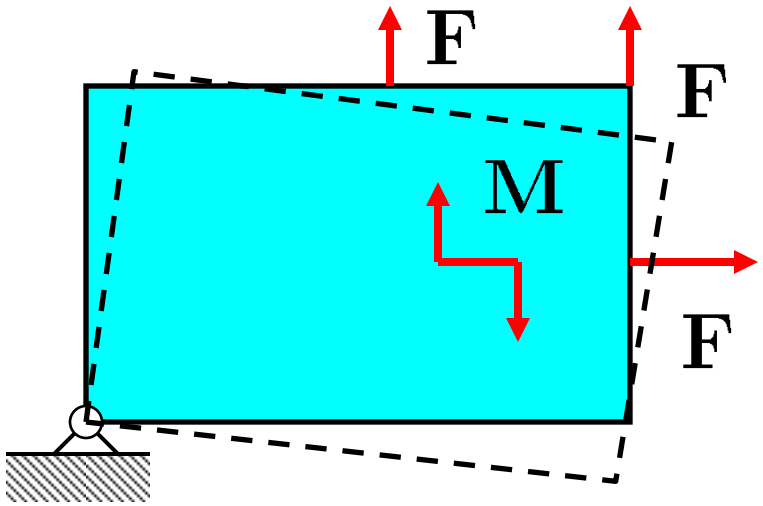
With what force with magnitude T must the person pull on the cable in order to cause the scale *A* to read 2000 N? The weights of the pulleys and cables are negligible. State any assumptions.

Source: R.C. Hibbeler,
"Engineering Mechanics – Statics"

Kinematical determinacy

• When a structure is supported in such a way that (irrespective of the applied forces and moments) all free movements are prohibited, it is **kinematically determinate.**

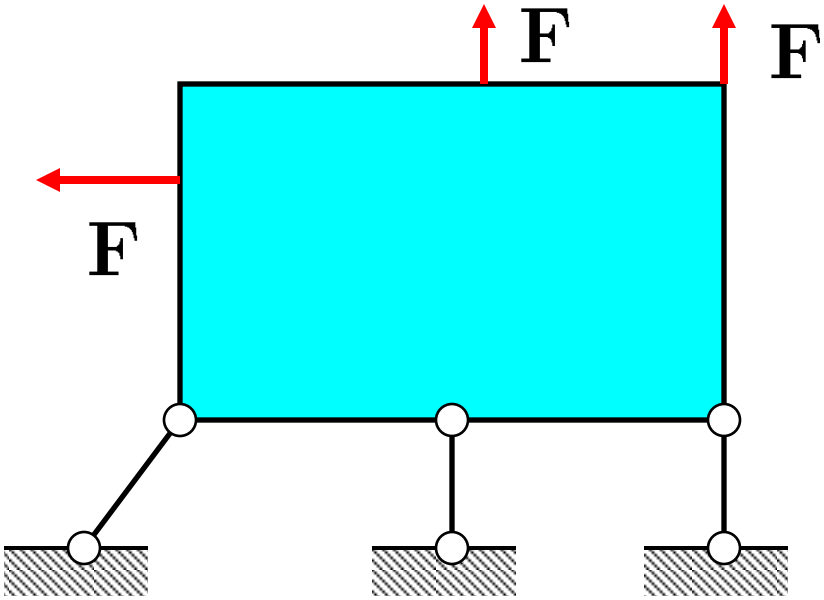
• Otherwise, the structure is called **kinematically indeterminate** or a **mechanism.**



Kinematically determinate?

A) Yes

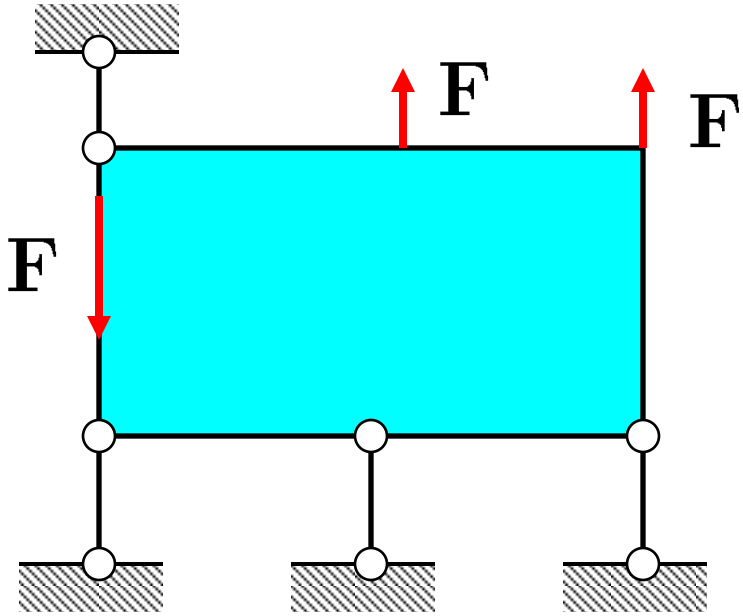
B) No



Kinematically determinate?

A) Yes

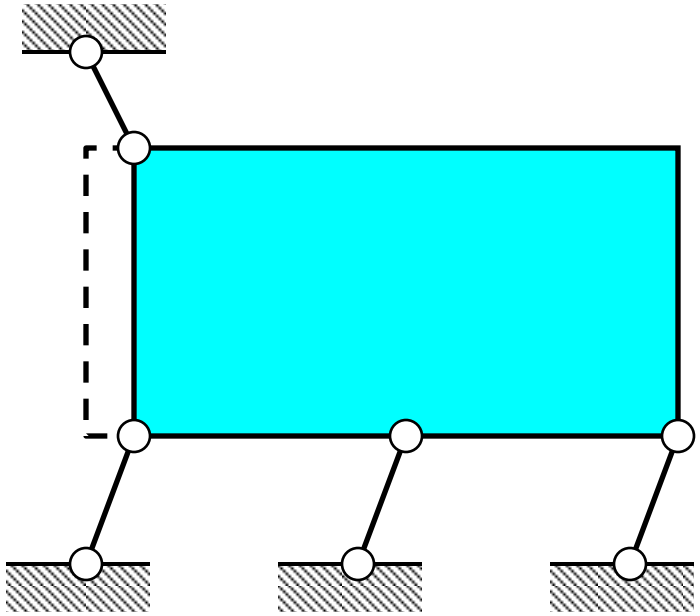
B) No



Kinematically determinate?

A) Yes

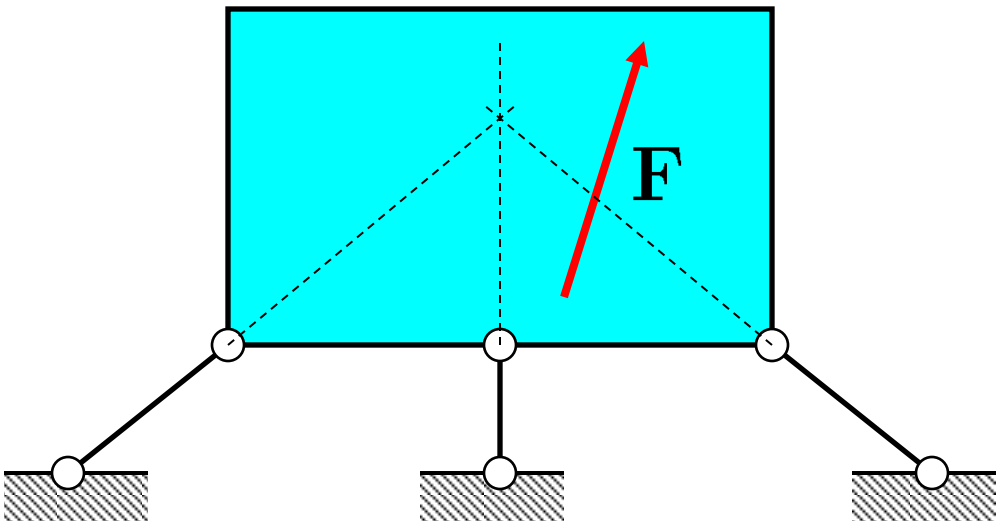
B) No



Kinematically determinate?

A) Yes

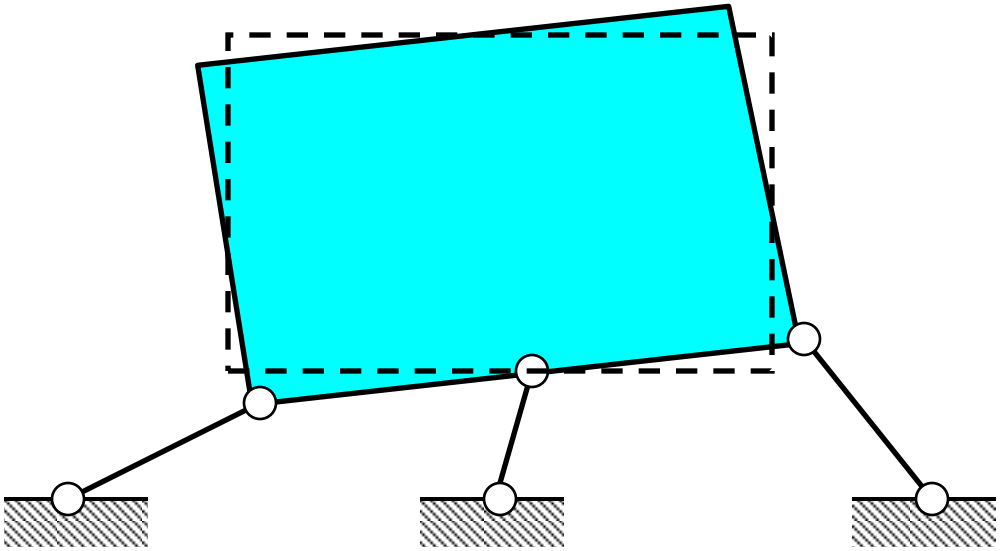
B) No



Kinematically determinate?

A) Yes

B) No



Kinematically determinate?

A) Yes

B) No

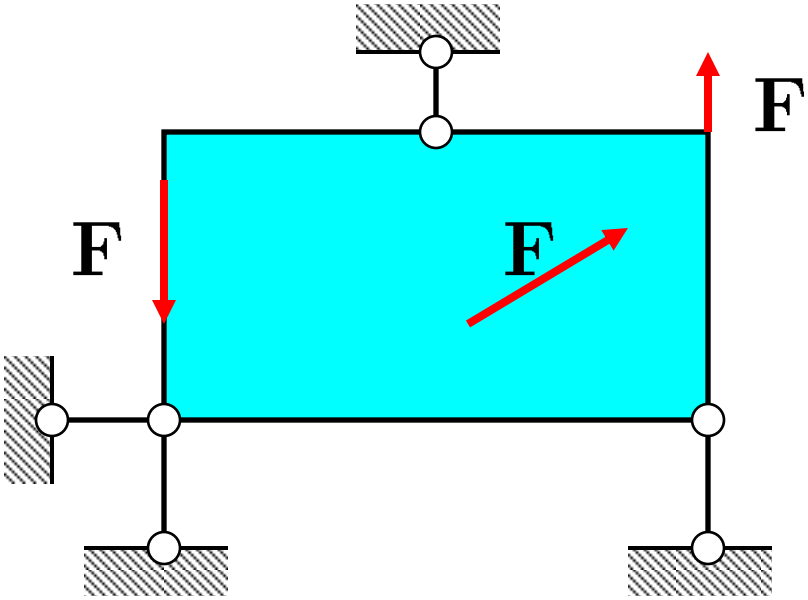
2-Dimensional structures with r constraint forces:

- r < 3 The structure is **kinematically indeterminate**
- r >=3 The structure is **kinematically determinate**, unless the lines of action of all reaction forces
  - cross the same point
  - are parallel

Statical determinacy

• When the number of reaction forces is just enough to guarantee kinematical determinacy, the structure is called **statically determinate.**

• Otherwise, when reaction forces can be removed without destroying the equilibrium of the body, it is called **statically indeterminate**.



Statically determinate?

A) Yes

B) No

If a 2-dimensional structure is kinematically determinate,

- r = 3 The structure is **statically determinate**
- r >3 The structure is **statically indeterminate**,

(r = number of constraint forces)

In this course (statics) we will deal with **kinematically** and **statically** determinate structures only.