

ENSC 2113

Engineering Mechanics: Statics

Lecture 17
Sections 5.1-5.2



College of Engineering, Architecture & Technology

5.1: Equilibrium

For a body to be in equilibrium, all forces acting on the body must equal **ZERO**. These forces include:

Weight of body

Externally Applied Forces

Reaction (or Support) Forces

For 2-D problems,

$$\sum F = 0$$

$$\sum M = 0 \quad (\text{About any point})$$

5.2: Free-Body Diagrams (*FBD*)

A ***FBD*** is a sketch of a rigid body showing:

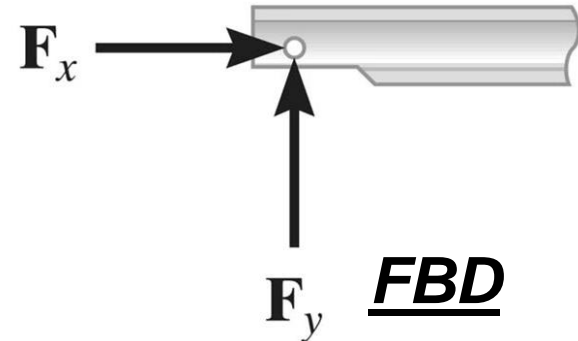
- 1) Outline of the body.
- 2) All forces (applied or reactive) affecting the body.
- 3) Labels for known and unknown forces, and dimensions indicating locations of forces, and size of body.

NOTE: The ***FBD*** is the most important part of the solution to a Statics problem ... and is ***required!***



pin

Actual condition


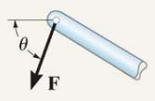

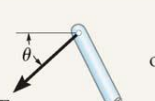








Supports constrain either movement or rotation of a rigid body, and are required for static equilibrium:

If the support constrains movement, a **force** exists.


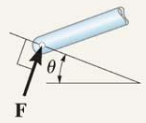

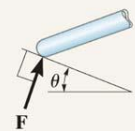

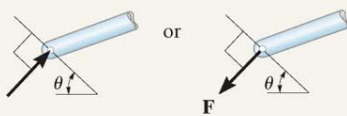
If the support constrains rotation, a **moment** exists.

Table 5-1 gives 2-D connection types and support reactions:

TABLE 5-1 Supports for Rigid Bodies Subjected to Two-Dimensional Force Systems		
Types of Connection	Reaction	Number of Unknowns
(1)  cable		One unknown. The reaction is a tension force which acts away from the member in the direction of the cable.
(2)  weightless link	 or 	One unknown. The reaction is a force which acts along the axis of the link.
(3)  roller		One unknown. The reaction is a force which acts perpendicular to the surface at the point of contact.
(4)  roller or pin in confined smooth slot	 or 	One unknown. The reaction is a force which acts perpendicular to the slot.

continued

Table 5-1 gives 2-D connection types and support reactions:

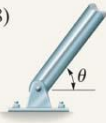
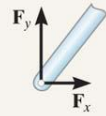


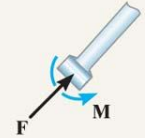

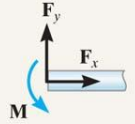
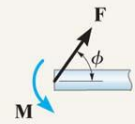
TABLE 5-1 Continued		
Types of Connection	Reaction	Number of Unknowns
(5)  rocker		One unknown. The reaction is a force which acts perpendicular to the surface at the point of contact.
(6)  smooth contacting surface		One unknown. The reaction is a force which acts perpendicular to the surface at the point of contact.
(7)  member pin connected to collar on smooth rod		One unknown. The reaction is a force which acts perpendicular to the rod.

continued

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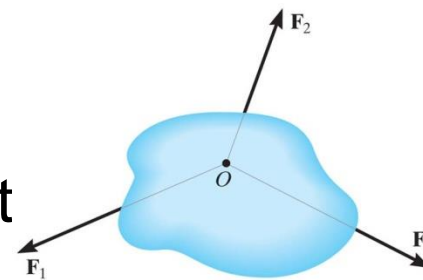
Support reactions act in the opposite direction of the forces they are supporting

Table 5-1 gives 2-D connection types and support reactions:

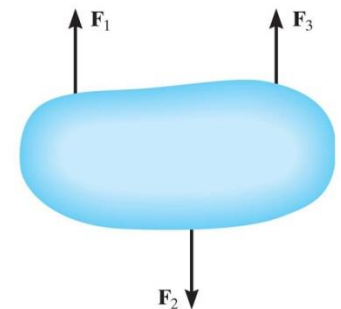
TABLE 5-1 Continued		
Types of Connection	Reaction	Number of Unknowns
(8)  smooth pin or hinge	 or 	Two unknowns. The reactions are two components of force, or the magnitude and direction ϕ of the resultant force. Note that ϕ and θ are not necessarily equal [usually not, unless the rod shown is a link as in (2)].
(9)  member fixed connected to collar on smooth rod		Two unknowns. The reactions are the couple moment and the force which acts perpendicular to the rod.
(10)  fixed support	 or 	Three unknowns. The reactions are the couple moment and the two force components, or the couple moment and the magnitude and direction ϕ of the resultant force.

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For a rigid body to be **stable**, it must have a min. of 3 support reactions that are not concurrent nor parallel



Concurrent forces



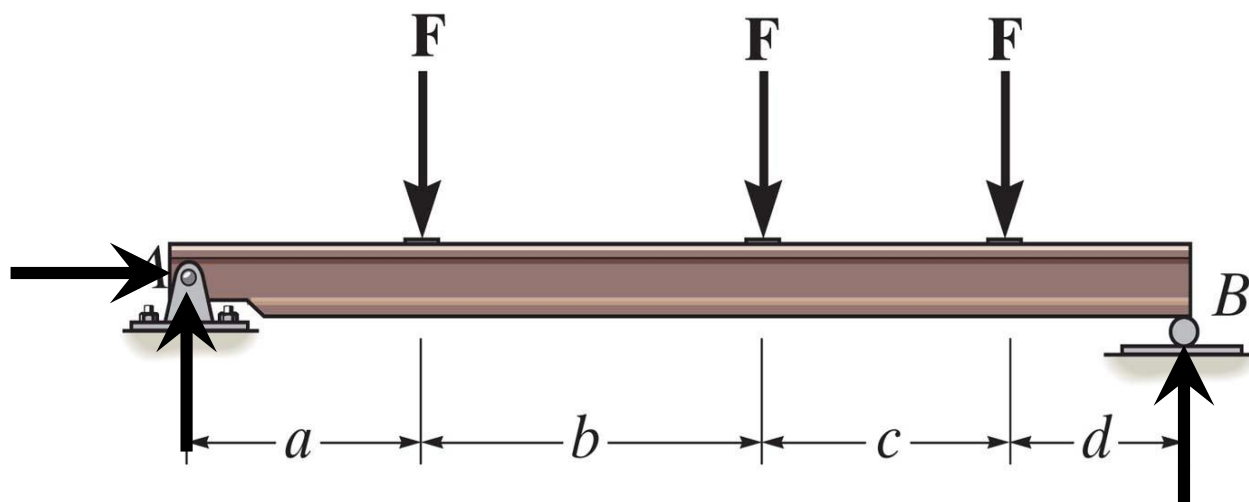
Parallel forces

Practical application of the Free Body Diagram:

Roof Structure:



Free Body Diagram (**FBD**):



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