Period #1: Course Overview and Equilibrium

A. Course Overview:

This course addresses how mechanical systems respond when subjected to loads:

When loads are applied to a mechanical system what are the internal stresses?
- What is stress?
- How do we describe it?

When loads are applied, how much does the system deform?
- What is strain?
- How do we describe it?

Is the load too large for the system to handle safely?
- What happens if the load is too large?

How does the material of the structure behave?
- Relevant material parameters of stiffness and strength.

We will address these questions for different types of mechanical systems:
- Axially loaded members;
- Shafts under torsion;
- Beams under bending loads;
- Trusses and Frames;

B. Equilibrium of Deformable Body

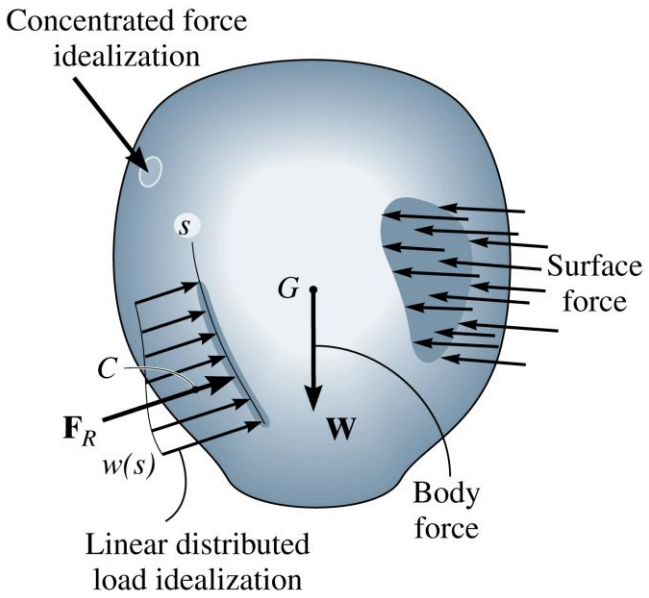
A body is in a state of equilibrium if no net forces and no net moments are applied to it. Stated mathematically:

No net forces: $\sum F_x = 0;\ \sum F_y = 0;\ \sum F_z = 0;$

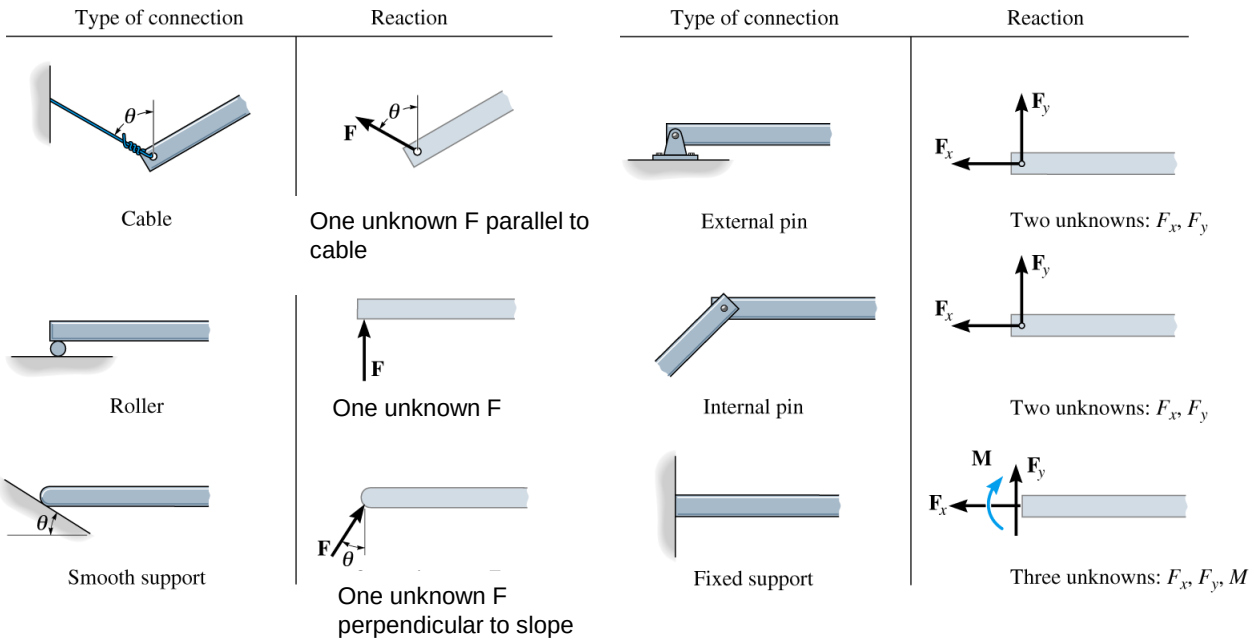
No net moments: $\sum M_x = 0;\ \sum M_y = 0;\ \sum M_z = 0;$

When considering the forces acting on a body, there are:

a. Surface forces;
b. Body forces; and
c. Reaction forces.

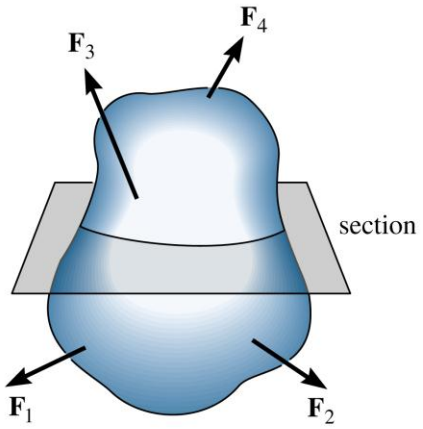


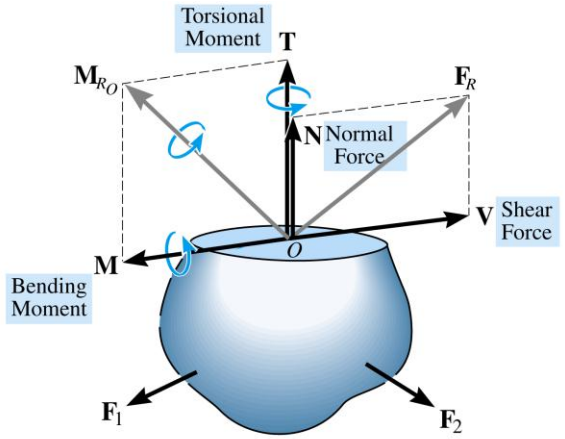
C. Reactions

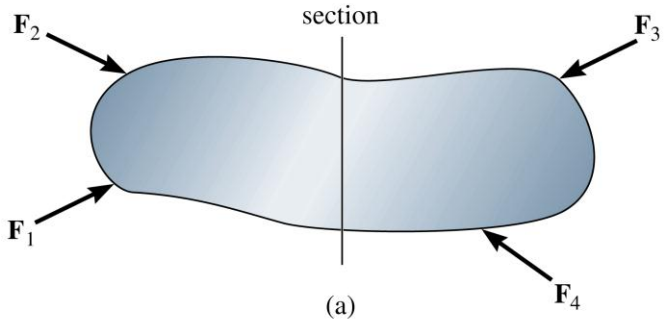

Type of connection
Reaction
Type of connection
Reaction
θ
F
θ
Cable
One unknown F parallel to cable
External pin
F_y
F_x
Two unknowns: F_x, F_y
Roller
F
One unknown F
Internal pin
F_y
F_x
Two unknowns: F_x, F_y
θ
F
θ
Smooth support
One unknown F perpendicular to slope
Fixed support
M
F_y
F_x
Three unknowns: F_x, F_y, M

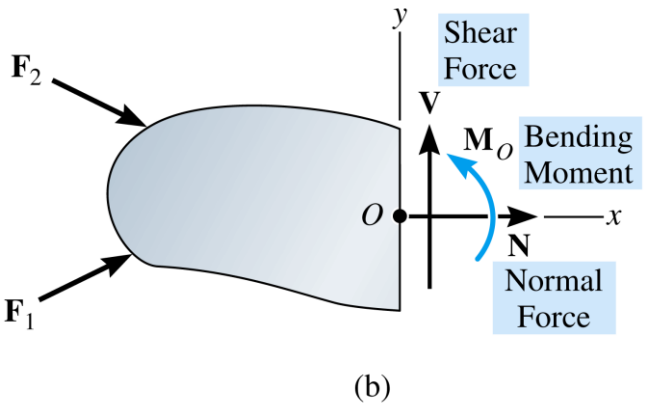
D. The Free-Body Diagram

External forces and reaction forces applied to a body result in internal forces/moments within the body. These are drawn/shown when the body is sectioned.



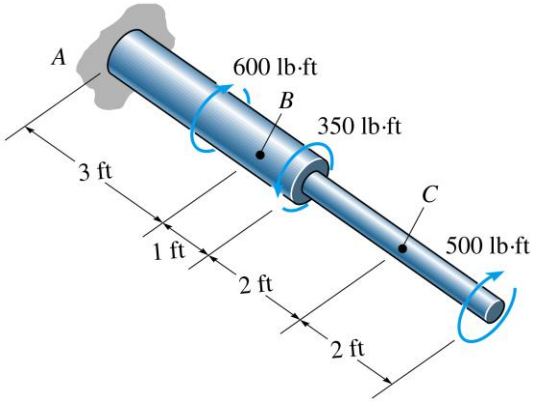






E. Example Problems:

Example 1.1 Determine the resultant internal torque acting on the cross sections through points B and C.



Example 1.2. Determine the resultant internal loadings acting on the cross section at point B.