Housekeeping

- Practice quiz available on PL website
- Thursday
  - Mastering engineering HW3
- Friday (5pm)
  - Last quiz time
- Sunday
  - WA2

The Best Female Rock Climber In the World is 14 Years Old

You tube: crane accidents caught on tape Chandeliers swaying on 38th floor of Denver hotel as storm passes
Recap

• Position and unit vectors

• Dot (scalar) product
i>clicker time
Given points A and B, determine the position vector.
Example

Which cartesian components of force exist in strut AO?

(A)  i and j

(B)  j and k

(C)  i and k

(D)  i, j, and k
Example

Determine the projected component of the force vector $\mathbf{F}_{AC}$ along the axis of strut AO. Express your result as a Cartesian vector.
Cross (or vector) product

The cross product of vectors \( A \) and \( B \) yields the vector \( C \), which is written

\[
C = A \times B
\]

The magnitude of vector \( C \) is given by:

The vector \( C \) is perpendicular to the plane containing \( A \) and \( B \) (specified by the right-hand rule). Hence,
Cross (or vector) product

The right-hand rule is a useful tool for determining the direction of the vector resulting from a cross product. Note that a vector crossed into itself is zero, e.g., $i \times i = 0$

Considering the cross product in Cartesian coordinates

$$A \times B = (A_x i + A_y j + A_z k) \times (B_x i + B_y j + B_z k)$$
Cross (or vector) product

Also, the cross product can be written as a determinant.

\[
\mathbf{A} \times \mathbf{B} = \begin{vmatrix}
\mathbf{i} & \mathbf{j} & \mathbf{k} \\
A_x & A_y & A_z \\
B_x & B_y & B_z
\end{vmatrix}
\]

Each component can be determined using 2 × 2 determinants.
Chap 2 - recap

- Scalars –
- Vectors –
- Dot product –
- Cross product –
Chapter 3: Equilibrium of a particle
For a spool of given weight, how would you find the forces in cables AB and AC? If designing a spreader bar (BC) like this one, you need to know the forces to make sure the rigging (A) doesn’t fail.
Equilibrium of a particle

According to Newton’s first law of motion, a particle will be in equilibrium (that is, it will remain at rest or continue to move with constant velocity) if and only if

\[ \sum F = 0 \]

where \( \sum F = 0 \) is the resultant force vector of all forces acting on a particle.

In three dimensions, equilibrium requires:
Equilibrium of a particle (cont.)

Contact force in smooth surface:
Free body diagram
I-clicker question
i>clicker question

\[\theta = 40^\circ\]
Idealizations

Pulleys are (usually) regarded as frictionless; then the tension in a rope or cord around the pulley is the same on either side. Springs are (usually) regarded as linearly elastic; then the tension is proportional to the change in length \( s \).

\[ F = ks = k(l-l_0) \]
Scrawny Arms Rob Lowe is ready to do his lat pull downs. His trainer told him to load the machine with a whopping 25 lbs, but he is afraid that all of that weight will break the cable and thusly he will smash his pretty boy face with the bar. Assuming equal sized cables, which machine should Scrawny Arms use to lessen his fears.

A) 

B)
Equilibrium of a system of particles

Some practical engineering problems involve the statics of interacting or interconnected particles. To solve them, we use Newton’s first law \( \sum \mathbf{F} = 0 \) on selected multiple free-body diagrams of particles or groups of particles.

The five ropes can each take 1500 N without breaking. How heavy can \( W \) be without breaking any?
Determine the maximum mass of the lamp that the cord system can support so that no single cord develops a tension exceeding 400N.
Determine the mass of each of the two identical cylinders if they cause a sag of \( s = 0.5 \text{ m} \) when suspended from the rings at A and B. Note that \( s \) is zero when the cylinders are removed.
A “scale” is constructed with a 4-ft-long cord and the 10-lb block D. The cord is fixed to a pin at A and passes over two small frictionless pulleys. Determine the weight of the suspended block B if the system is in equilibrium when $s = 1.5\text{ft}$. 

![Diagram of a scale with a cord and pulleys]
Determine the unstretched length of spring AC if a force $P = 80$ lb causes the angle $\theta = 60^\circ$ for equilibrium. Cord AB is 2 ft long. Use the spring stiffness $k = 50$ lb/ft.