Class 3: Resolving Force Vectors
Material covered on January 27th, 2012

Learning Objectives:
1. Draw force vector components and resultants using the Parallelogram Law
2. Determine the magnitude and direction of a resultant force vector by adding its two component vectors (parallelogram/triangle)
3. Resolve a force vector into two components given their directions (line of action) (parallelogram/triangle)
4. Determine the magnitude and direction of a component vector when the resultant vector and the other component vector are known graphically

Problems Discussed in Class:

Example 3-1: Graphical Solution to Problem 3 from the last homework
Given: The 140 lb force is applied vertically and the 800 lb force is applied at an angle, \( \theta \), from the vertical.
Find: The angle, \( \theta \), required so the resultant force of the 1400 lb and 800 lb forces has a magnitude of 2000 lb.

Problem 2(a)
Given: Magnitude and direction of resultant force and directions (lines of action) of ropes A and B.
Find: The magnitude of forces \( F_A \) and \( F_B \) in each rope in order to develop a resultant force having a magnitude of 950 N directed along the positive x-axis. Set \( \theta = 50^\circ \).

Problem 2(b)
Given: Magnitude and direction of resultant force and direction of rope A (and line of action of \( F_A \)).
Find: The magnitude of forces \( F_A \) and \( F_B \) and angle \( \theta \) of \( F_B \) so that the magnitude of force \( F_B \) is a minimum.
Take \( \|F_R\| = 950 \) N and \( F_A \) at \( 20^\circ \) as in Problem 2(a).

Homework: Due on Monday, January 30th
Three problems shown on attached handout
Sections to Read in Textbook for next class:
Sections 3.1, 3.2, 3.3
Useful Geometry:

“Adding” two vectors can be performed graphically by joining the tails of the two vectors to be added. The diagonal of the resulting parallelogram constructed is the resultant vector.

The same resultant vector can be identified by joining the two vectors tip to tail. The hypotenuse of the triangle constructed is the resultant vector.

“Resolution” of a vector is breaking up a vector into two components. It is like using the parallelogram law in reverse.

\[ \alpha + b + c = 180^\circ \] (sum of the three angles)

Also have two alternative Cosine laws:

\[
B = \sqrt{A^2 + C^2 - 2AC \cos b} \\
A = \sqrt{B^2 + C^2 - 2BC \cos a}
\]

If the angle \( c = 90^\circ \), then \( \cos(c) = 0 \) and the Law of Cosines simplifies to

\[
C = \sqrt{A^2 + B^2}
\]
Class 3 Homework Assignment – Due Monday, January 30th

Problem 1

Note – Solve by setting up the parallelogram and applying the Law of Sines and/or the Law of Cosines (No x-y components for this solution)

It is desired to remove the spike from the timber by applying a force along its horizontal axis. An obstruction A prevents direct access, so that two forces, one 400 lb and the other \( P \), are applied by cables in the directions shown. Calculate the magnitude of \( P \) necessary to ensure a resultant force \( T \) directed along the spike. Also find the magnitude of the resultant force \( T \).

Problem 2

Note – Solve by setting up the parallelogram and applying the Law of Sines and/or the Law of Cosines (No x-y components for this solution)

Resolve the 50-lb force into its components acting along
(a) the x and y axes as defined in the figure
(b) the x and y' axes as defined in the figure
(c) Your buddy at work is baffled over the fact that the x-components of the 50-lb force calculated in part (a) and in part (b) do not have the same magnitude even though the x-axis remains defined in the same direction. Provide a nice, clear explanation of why the two x-components have different magnitudes.

Problem 3

Note – Solve by setting up the parallelogram and applying the Law of Sines and/or the Law of Cosines (No x-y components for this solution)

The beam is to be hoisted using two chains. If the resultant force of the two chain forces is to be 600 N, directed along the positive y axis, determine the magnitudes of the forces \( F_A \) and \( F_B \) acting on each chain and the direction \( \theta \) of \( F_B \) so that the magnitude of \( F_B \) is a minimum. \( F_A \) acts at 30° from the y-axis as shown.