ENGR19000
Elementary Engineering Design

Mechanical and Civil Engineering (MCE)

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Purdue University Northwest

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Mechanical and Civil Engineering (MCE)

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  - Office hours: by appointment(When you email me, please allow up to 24 hours to receive the response, on weekends, 48 hours)

- Lab TA: Mervyn Earl John Medidi
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- **Lecture: CLO 132,** Tuesday 9:30am – 10:20am

- **All Labs: Potter 308,**

ENGR 19000-013 Th 14 pm – 16:50 pm, Potter 308
ENGR 19000-014 F 8 am – 10:50 am, Potter 308
ENGR 19000-016 F 15 pm – 17:50 pm, Potter 308

Brightspace

1. **Course Materials - slides, manuals etc.**
   - ENGR19000-012 LEC

2. **Homework Submission from your lab session**

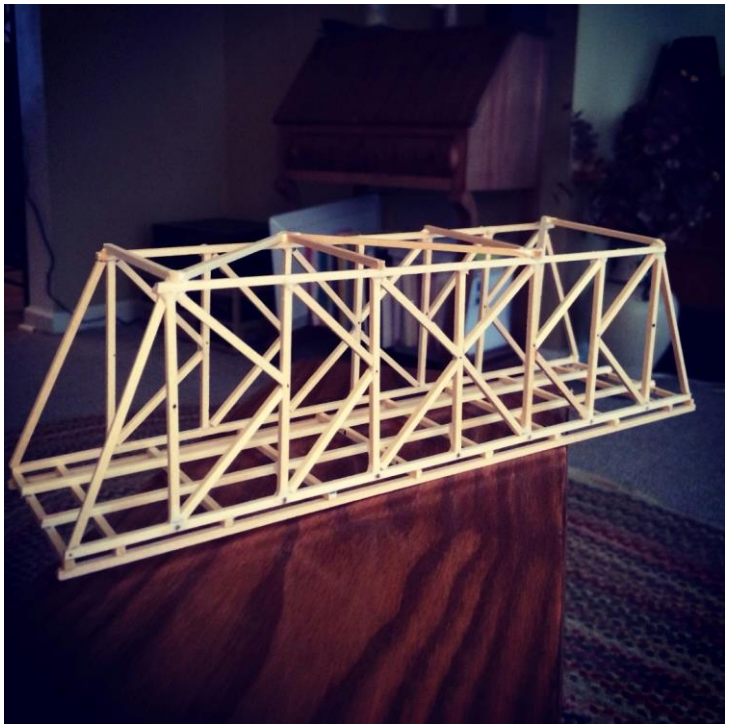
ENGR 19000-013

ENGR 19000-014

ENGR 19000-016

Course Topics

- Solve simple statics problems.
- Analyze forces on trusses.
- Design a basswood bridge, using statics analysis and material properties
- Understand the concept of 3D modeling
- Understand the concept of stress-strain relation through tensile experimentation.



Class Schedule

Week	Lecture Date	Lecture Topic	Lab Topic
1	08/22	Lect. 1: Trigonometry and Vector	HW1
2	08/29	Lect. 2: Static Analysis	HW2
3	09/06	Lect. 3: Truss Force Calculation	HW3
4	09/13	Lect. 4: Bridge Design I	Bridge Design HW
5	09/20	Lect. 5: - Bridge Construction - Engineering tools	- Bridge Design + Construction - 3D Printing
6	09/27	Lect. 6: Tensile Experiment	- Tensile Experiment - Bridge Construction
7	10/04	No class/Q&A	Bridge Testing

Introduction: What is Engineering?

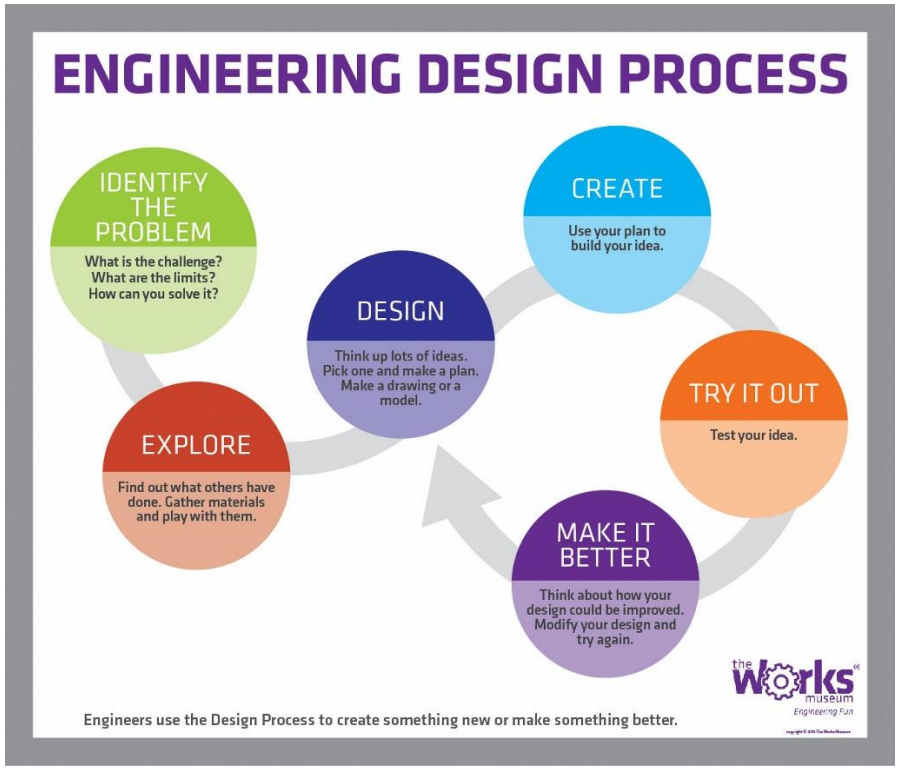
Engineering according to Wikipedia is defined as the use of scientific principles to design and build machines, structures, and other items, including bridges, tunnels, roads, vehicles, and buildings.

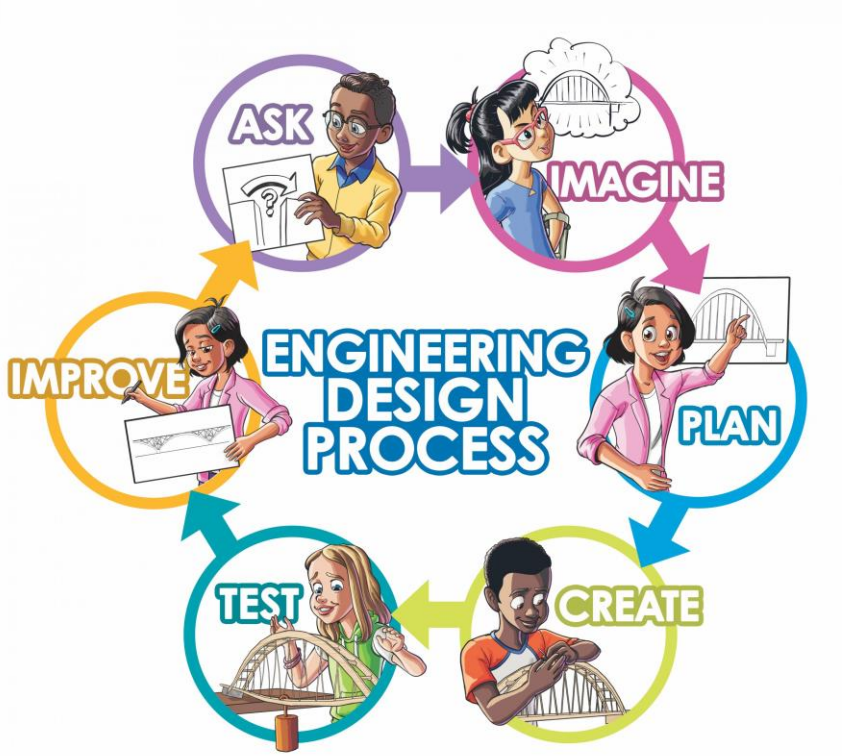
The purpose of every engineer is to solve problems related with human activities in the most efficient, economical and environmentally friendly way possible.

Introduction: What is Engineering?

The term engineering is derived from the Latin **ingenium, meaning "<u>cleverness</u>" and ingeniare, meaning "<u>to contrive, devise</u>"**.

What do engineers do?





https://www.youtube.com/watch?v=owHF9iLyxic

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Truss Bridge

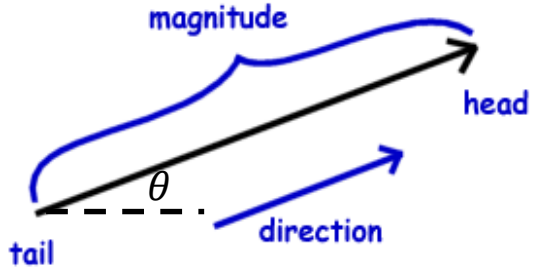
- A **truss bridge** is a **bridge** whose load-bearing superstructure is composed of a **truss**, a structure of connected elements usually forming triangular units. The connected elements (typically straight) may be stressed from tension, compression, or sometimes both in response to dynamic loads.

Scalar and Vector

- Scalar
  - positive or negative physical quantity
  - completely specified by magnitude
  - e.g. length. mass

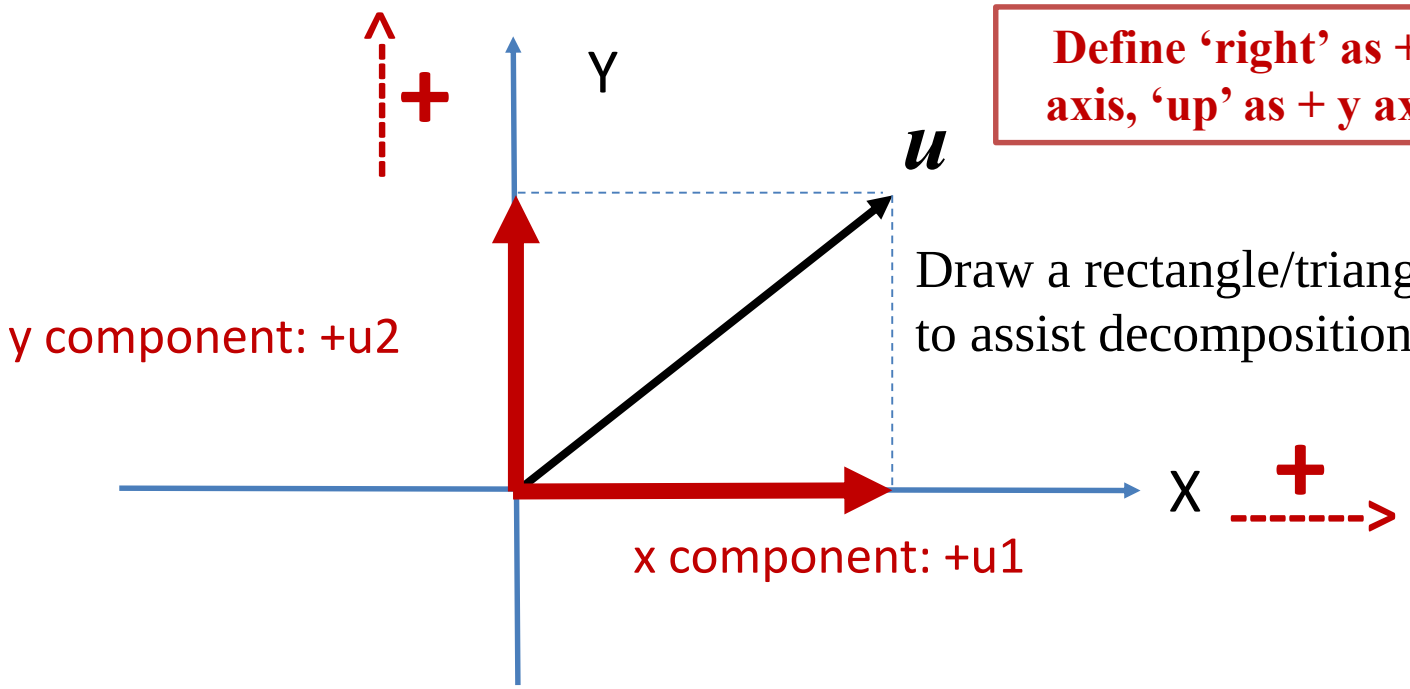
Scalar and Vector

- Vector
  - Physical quantity that requires both a magnitude and a direction for its complete description
  - E.g. force



  - Length of arrow: magnitude of vector
  - Angle theta: direction of its line of action
  - Head of arrow: points to the direction of the vector

Decomposing a vector into two perpendicular vector components

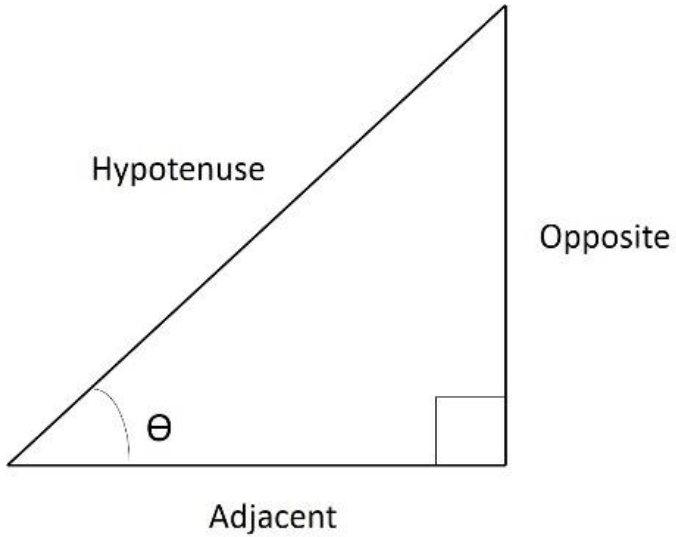


Vector ***u*** can now be decomposed into two perpendicular vector components

- x component: +u1 (direction and magnitude)
- y component: +u2 (direction and magnitude)
- u1 is perpendicular to u2

Trigonometry

$$sin\theta = \frac{Opposite}{Hypotenuse} \qquad cos\theta = \frac{Adjacent}{Hypotenuse} \qquad tan\theta = \frac{Opposite}{Adjacent}$$



Pythagoras Theorem

$$Hypotenuse^2 = Adjacent^2 + Opposite^2$$

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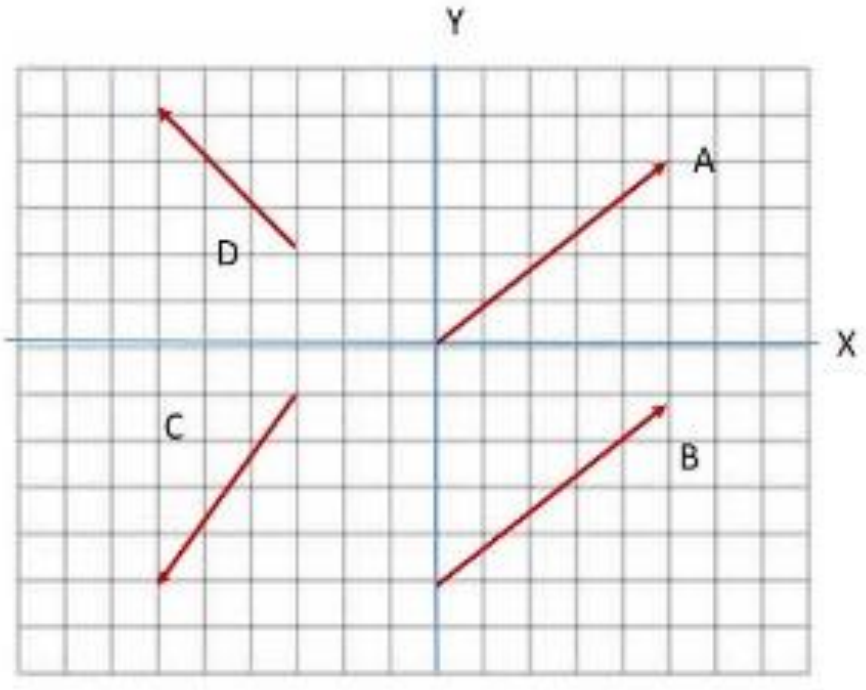
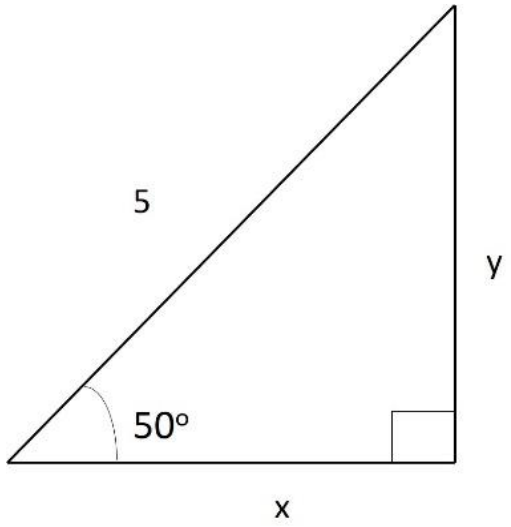
e.g., Find the magnitude , x-component, and y-component of each vector



e.g. Find the values for x and y.

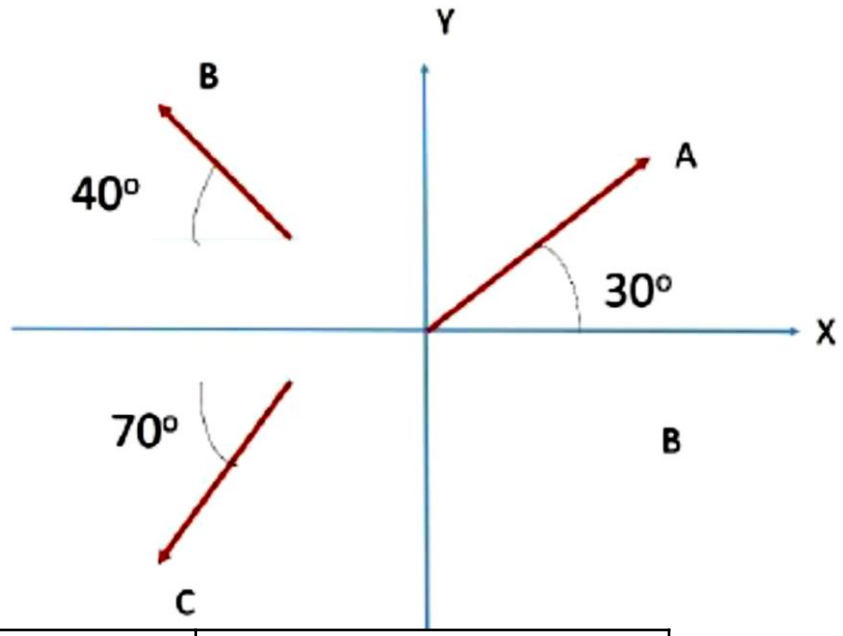
$$sin\theta = \frac{Opposite}{Hypotenuse}$$

$$\cos\theta = \frac{Adjacent}{Hypotenuse}$$



$$sin50° = \frac{y}{5} \Rightarrow 5\ x\ sin50° = y \Rightarrow y = 3.83$$

e.g. Find the x-component and y-component of each vector from the table and the figure.



Tip: if Θ is along +x axis

- x component: (+/-) *magnitude* × cosΘ
- y component: (+/-) *magnitude* × sinΘ

Vector	Magnitude	x-component	y-component
A	5		
B	3		
C	4		

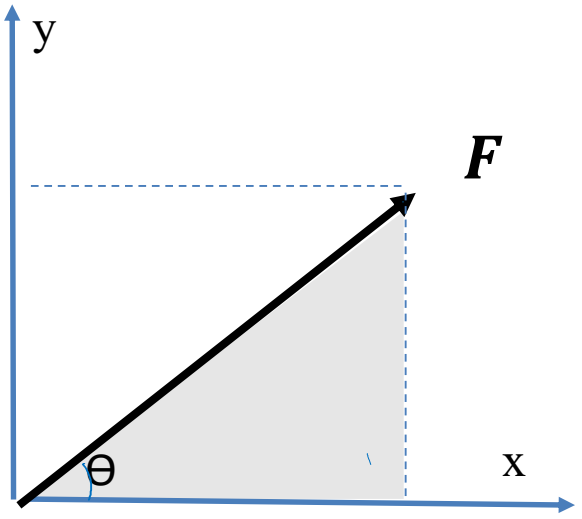
Finding the components of a force

- When a force is resolved into two components along the x and y axes. The components are then called rectangular components.

Direction Magnitude

x component: $(+/-)F\cos\theta$

y component: $(+/-)F\sin\theta$



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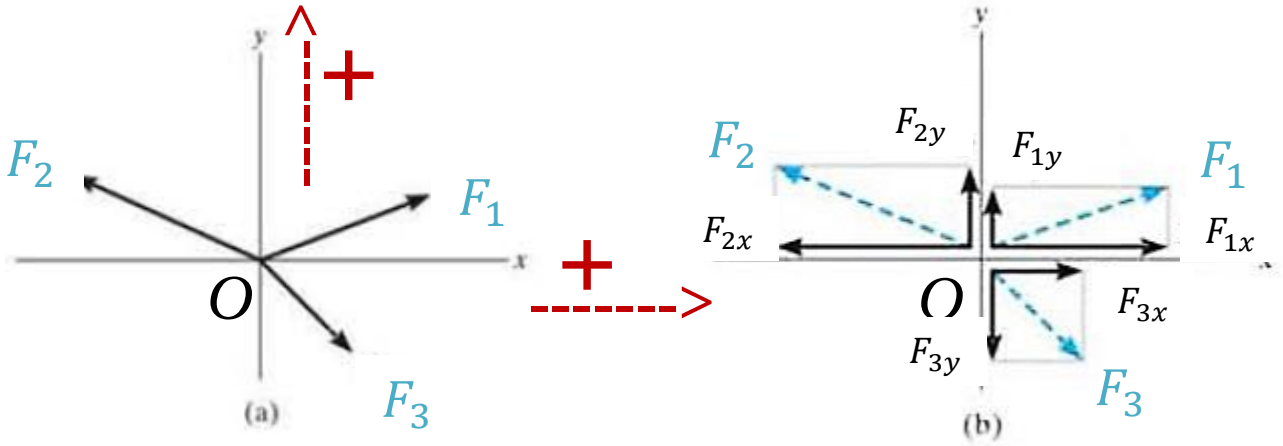
Static Equilibrium of a point

- When all the forces that act upon an object/point are balanced, then the object is said to be in a state of equilibrium.
- The forces are considered to be balanced if the rightward forces are balanced by the leftward forces and the upward forces are balanced by the downward forces.
- If an object/point is at rest and is in a state of equilibrium, then we would say that the object is at "static equilibrium". "Static" means stationary or at rest.
- For an object/point in static equilibrium, ***the sum of forces in x direction is zero, and the sum of forces in y direction is also zero.***

Solve problem: Static Equilibrium of a point



Steps

1. Each force is resolved into its x and y components
2. Respective components are added
   - Usually define 'right' as positive x axis, 'up' as positive y axis.
   - Plus or minus sign depends on whether they are pointing along the + or -, x or y axis

$$\Sigma F_x = +F_{1x} - F_{2x} + F_{3x}$$
$$\Sigma F_y = +F_{1y} + F_{2y} - F_{3y}$$

3. Sum of forces in x and y directions is zero, respectively.

$$\sum F_x = 0,\ \sum F_y = 0$$

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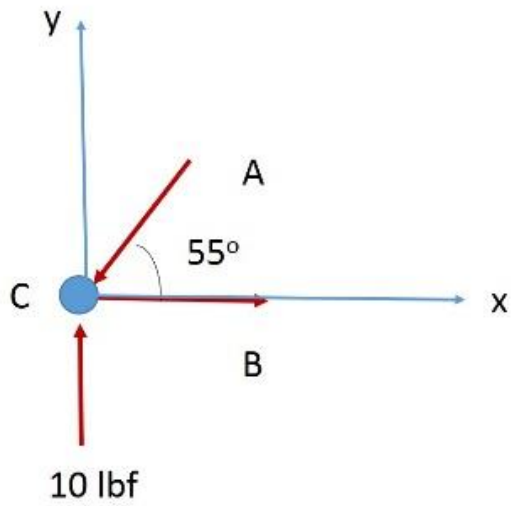
e.g., The particle C is in static equilibrium. Three forces are applied to a particle C. Find the magnitude, x-component, and y-component of each force vector from the table and the figure below. Initial force directions are assumed as the figure below.

Force vector	Magnitude	x-component	y-component
A			
B			



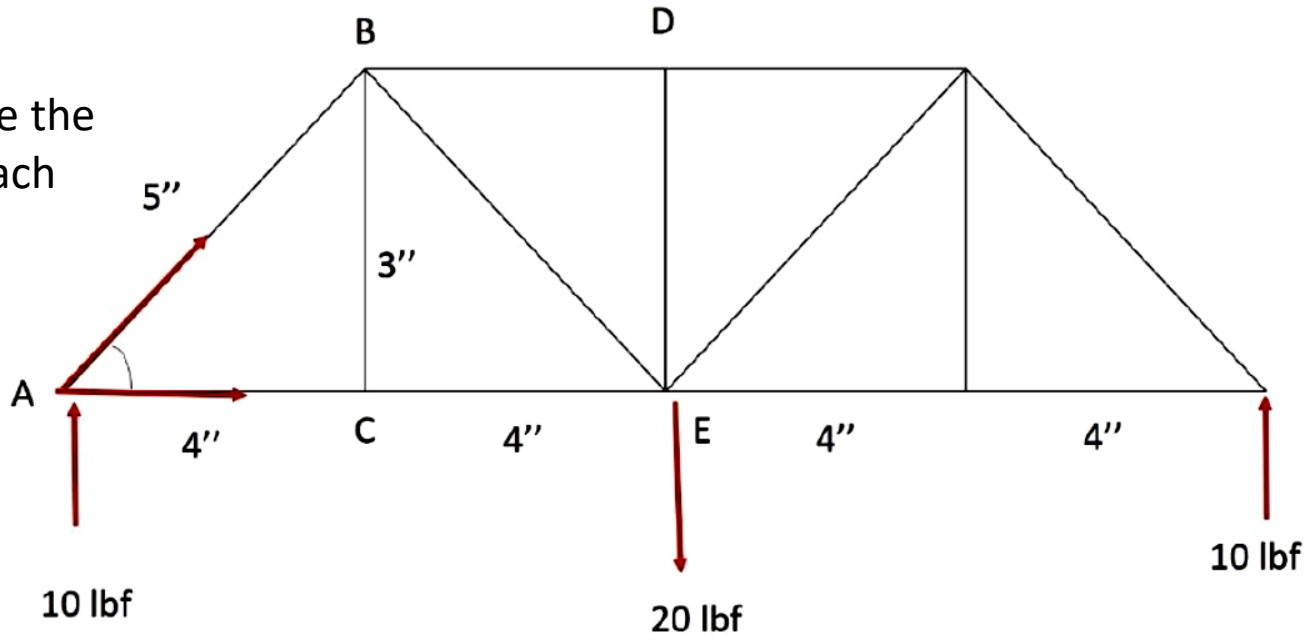
Assignment of the Week

1. Reading Lecture 1
2. HW#1 (Q&A during this week's lab)
3. Finish **HW#1 and submit in Brightspace (one single pdf or word file)** before the end of lab 2 (solution with steps)

e.g. Find the magnitude, x-component, and y-component of each force vector. The bridge is in static equilibrium. Initial force directions are assumed as the figure below.

Force vector	Magnitude	x-component	y-component
AB			
AC			

3'' 4'' 5'' are the length of each member



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