Welcome to C30/ME85 Spring 2024

(Introduction to Solid Mechanics)

• *Shaofan Li*

• University of California at Berkeley

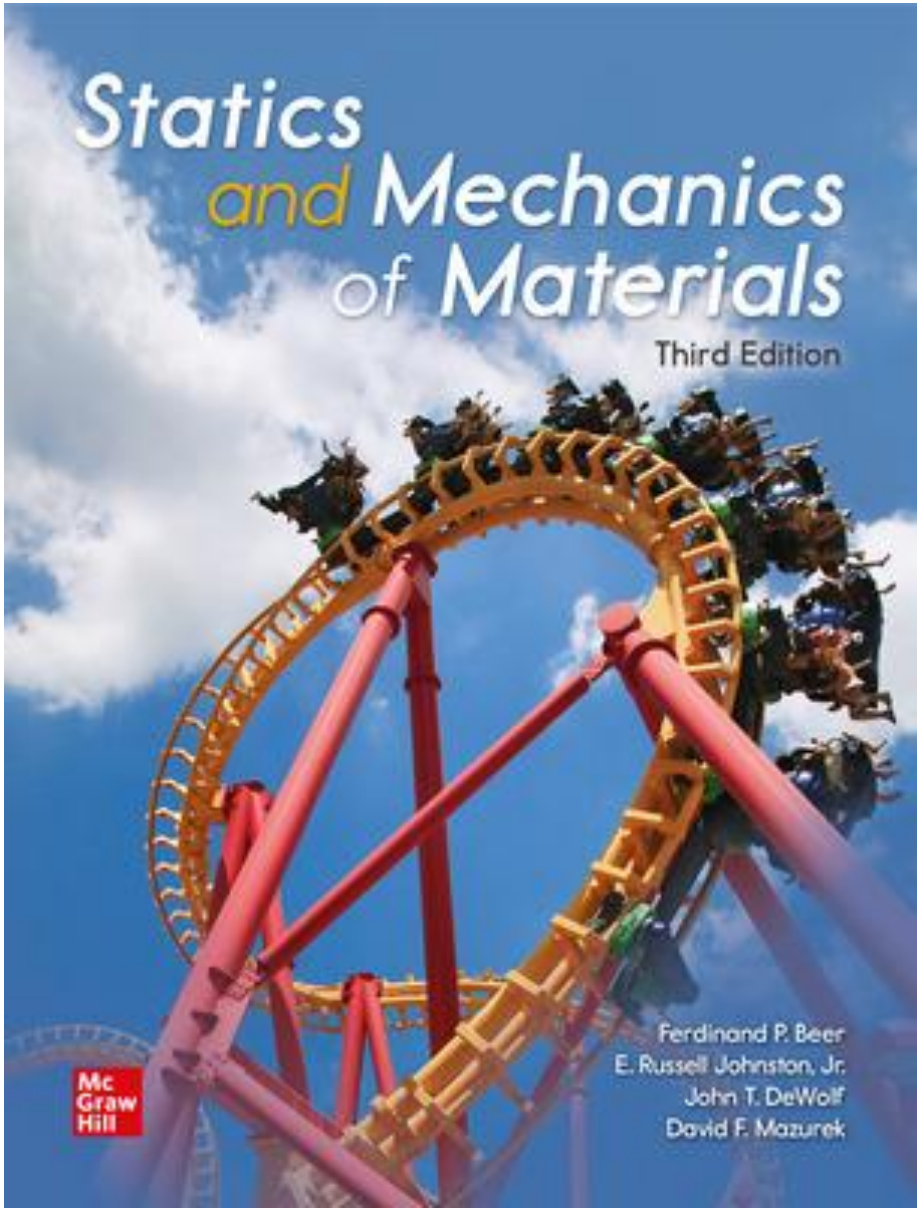
Class Logistic Information

1. Textbook: Statics and Mechanics of Materials (2021)
   Third Edition, Beer et al McGraw-Hill;
2. Class schedule: MWF: 1:00 pm – 2:00 pm,
3. Class location: 50 Birge Hall;
3. My office: 783 Davis Hall;
4. My office hours: Tu/Thu: 9:30am-11:30am;
5. Email: shaofan@berkeley.edu, Tel: 510-642-5362;
6. Class website: Bcourses

This class is in-person !
Please DO NOT send any email through the Bcourses/Canvas!

Textbook

It is available in Cal bookstore.



CE30/ME85 – Introduction to Solid Mechanics
Section II

Date	Class #	Topic	Readings	Homework	Notes
1/17	1	Introduction and Review of vector algebra	Chapter 1		
1/19	2	Force and monents (1)	Chapert 2	HW1 (S)	
1/22	3	Force and moments (2)	Chapter 2 & 3	HW2 (S)	
1/24	4	Forces and moments (3)	Chapter 2 & 3	HW2 (S)	
1/26	5	Statics: Equilibrium (1)	Chapter 3 & 4		HW1 (In)
1/29	6	Equivalent force-moment systems	Chapter 3 & 4	HW3(S)	
1/31	7	Equilibrium of Rigid Bodies	Chapter 4		
2/2	8	Friction force	Chapter 4	HW4 (S)	HW2 (In)
2/5	9	2D Trusses (method of joints)	Chapter 6	HW4 (S)	
2/7	10	2D Trusses (method of sections)	Chapter 6		
2/9	11	Frames and machines	Chapter 6	HW5 (S)	HW3 (IN)
2/12	12	Distributed force: Centroids	Chapter 5	HW5 (S)	
2/14	13	Distributed force: Moment of Inertia	Chapter 7		
2/16	14	Internal forces and stress	Chapter 8	HW6(S)	HW4 (In)
2/19	15	Academic Holiday	Chapter 8		
2/21	16	Stresses (1)	Chapter 8	HW6 (S)	
2/23	17	Stresses (2)	Chapter 9		HW5 (In)
2/26	18	Deformation and strain	Chapter 9	HW7 (S)	
2/28	19	Stress-strain relation	Chapter 9	HW7 (S)	
3/1	20	Deflection of bars	Chapter 9		HW6 (In)
3/4	21	Static indeterminacy	Chapter 9	TBA	
3/6	22	Torsion of circular shafts (1)	Chapter 10	TBA	
3/8	23	Torsion of circular shafts (2)	Chapter 10	HW8 (S)	HW7 (In)
3/11	24	Midterm exam (through lecture 21)			
3/13	25	Torsion of circular shafts	Chapter 10	HW8 (S)	
3/15	26	Beam statics	Chapter 11		HW8 (In)
3/18	27	Bending of beams (I)	Chapter 11	HW9 (S)	
3/20	28	Bending of beams (II)	Chapter 12	HW9 (S)	

UNIVERSITY OF CALIFORNIA AT BERKELEY
Department of Civil Engineering
Spring 2024

Structural Engineering,
Mechanics and Materials
Professor: S. Li

Date	Class #	Topic	Readings	Homework	Notes
3/22	29	Beam bending (III)	Chapter 11		HW9 (In)
3/25	30	Spring Break	Chapter 11		
3/27	31	Spring Break	Chapter 11		
3/29	32	Spring Break	Chapter 11	HW9 (S)	
4/1	33	Shear stress in beam (1)	Chapter 13	HW10 (S)	
4/3	34	Shear stress in beam (2)	Chapter 13	HW10 (S)	HW10 (In)
4/5	35	Shear stress in beam (3)	Chapter 13		
4/8	36	Deflection of beam (1)	Chapter 15	HW11 (S)	
4/10	37	Deflection of beam (2)	Chapter 15	HW11 (S)	HW11(In)
4/12	38	Transformation of stress	Chapter 14		
4/15	39	Mohr's cirlce (1)	Chapter 14	HW12 (S)	
4/17	40	Mohr's cirlce (2)	Chapter 14	HW12 (S)	HW12(In)
4/19	41	Mohr's cirlce (3)	Chapter 14		
4/22	42	Stability and Column Buckling (1)	Chapter 16	HW13 (S)	
4/24	43	Column Buckling (2)	Chapter 16	HW13 (S)	HW13(In)
4/26	44	Column Buckling (3)	Chpater 16	HW13 (S)	
4/29	45	Final Review	End of Instruction	HW13 (S)	
5/1	46	RRR Week Office Hour		HW14	HW14(In)
5/7	47	Final Exam	Tuesday	8am-11am	

Required Textbook: Statics and Mechanics of Materials, by Beer et. al. Third Edition, McGraw-Hill, 2021.

FAQs:

Q1. If I have conflicts in final exam schedule, what should I do ?

A1. No worry about final exam conflicts, and it always works out in the end.

Q2. I do not have a textbook yet, what should I do ?

A2. Buy it online or buy it at Bookstore.

Q3. What is the chance I get A in this class?

A3. 35% to 45 % ---that is so NOT bad, but you have to work hard.

Q4. Is this class online or in person ?

A4. This class is in-person.

FAQs:

Q5. I am still in the waitlist what is the chance that I ca get in ?

A5. 90% chance.

Q6. Does this class require attendance?

A6. Yes. You must attend 33 out of 38 lectures to get Two-point attendance points..

Q7. What is the chance I can pass this class?

A7. 95 % to 99%.

Q8. Can I change (Switch) my discussion session?

A8. Yes, you can without additional enrollment procedure.

Q9. Any More Questions?

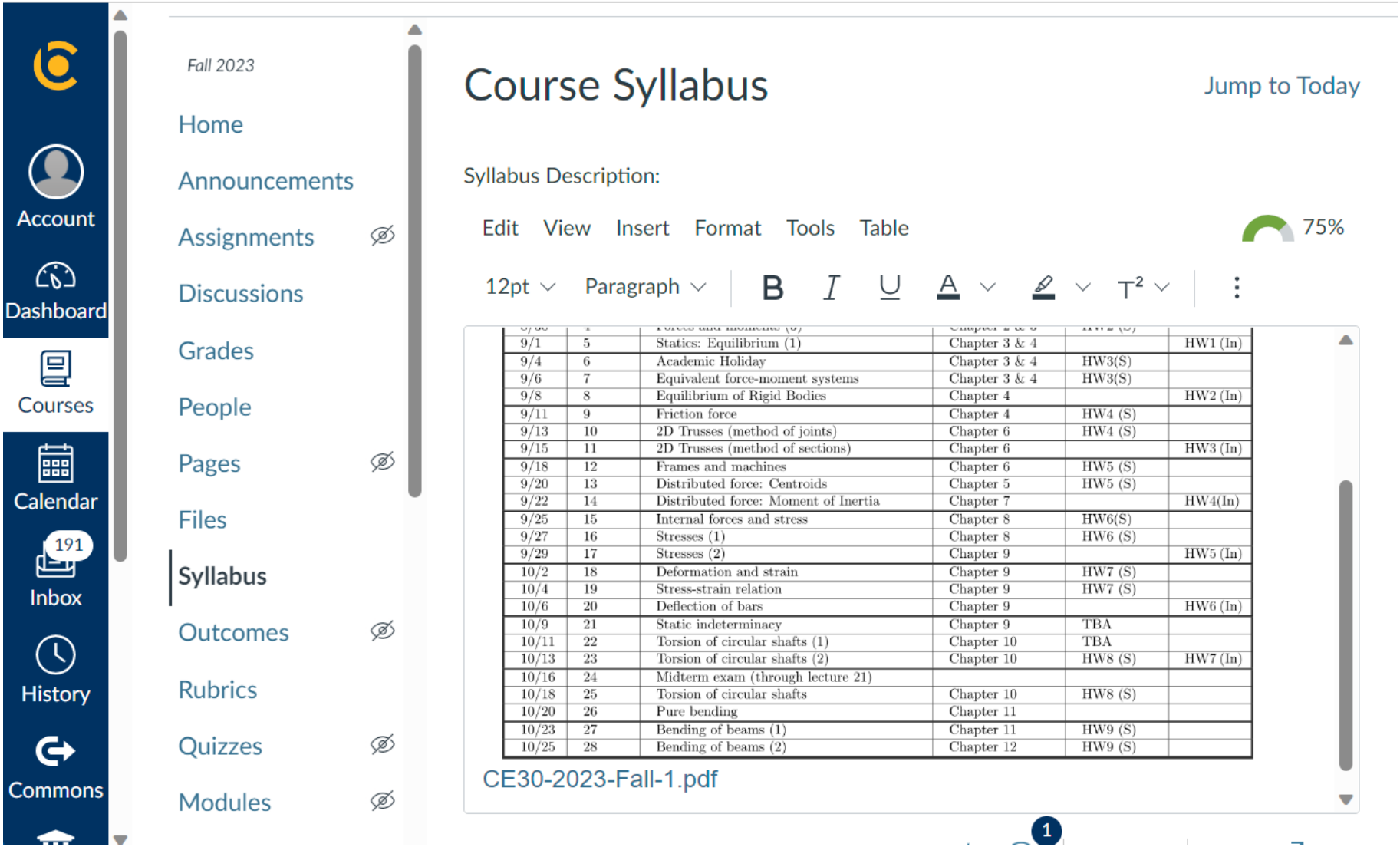
Discussion Session and GSIs:
TA 1: Mr. Qijun Chen Email: cdec76@berkeley.edu;
Office Hours (305 Davis Hall):
M: 11:00 am –1:00 pm and 2:00pm – 4:00pm;
W: 11:00 am –1:00 pm

Mr. Qijun Chen also serves as a reader.

TA 2: Mr. Caglar Tamur; Email: caglar.tamur@berkeley.edu;
Discussion Session: Monday: 5:00-6:00 pm, 534 Davis Hall;
Discussion Session: Tuesday: 5:00-6:00 pm, 534 Davis Hall;
Discussion Session: Wednesday: 5:00-6:00 pm, 534 Davis Hall;

Office Hours (504 Davis Hall):
Tu/Wed 3:00 pm - 4:30 pm.

Class web-page is in Bcourses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191
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Fall 2023
Home
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Assignments
Discussions
Grades
People
Pages
Files
Syllabus
Outcomes
Rubrics
Quizzes
Modules
Course Syllabus
Jump to Today
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9/1 5 Statics: Equilibrium (1) Chapter 3 & 4 HW1 (In)
9/4 6 Academic Holiday Chapter 3 & 4 HW3(S)
9/6 7 Equivalent force-moment systems Chapter 3 & 4 HW3(S)
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9/22 14 Distributed force: Moment of Inertia Chapter 7 HW4(In)
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9/27 16 Stresses (1) Chapter 8 HW6 (S)
9/29 17 Stresses (2) Chapter 9 HW5 (In)
10/2 18 Deformation and strain Chapter 9 HW7 (S)
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10/6 20 Deflection of bars Chapter 9 HW6 (In)
10/9 21 Static indeterminacy Chapter 9 TBA
10/11 22 Torsion of circular shafts (1) Chapter 10 TBA
10/13 23 Torsion of circular shafts (2) Chapter 10 HW8 (S) HW7 (In)
10/16 24 Midterm exam (through lecture 21)
10/18 25 Torsion of circular shafts Chapter 10 HW8 (S)
10/20 26 Pure bending Chapter 11
10/23 27 Bending of beams (1) Chapter 11 HW9 (S)
10/25 28 Bending of beams (2) Chapter 12 HW9 (S)
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Homework and Grade

- Detailed HW assignments will be announced online every Friday (including this Friday);
- One mid-term exam and one final exam;
- Course grade system:
- HW 40%, Mid-terms 30 % , and Final 30 % ;
- Two points of Bonus point for attendance.
- You must attend 33 out of 38 lectures to gain the two attendance bonus points.
- Total 102 points.
- We have additional Million-Dollar Question Points.

Homework and Grade

A+ : 98 above
A : 92 above
A- : 87 above
B+: 82 above
B : 77 above
B- : 72 above
C+: 67 above
C : 60 above
……..
Straight scale grading system, Everyone only competes with him- or herself.

How to be a smart student?

- Attending class ---

  it will save you time and help you get better grades;

  Cherish your college life!

- Read the textbook before attending class;

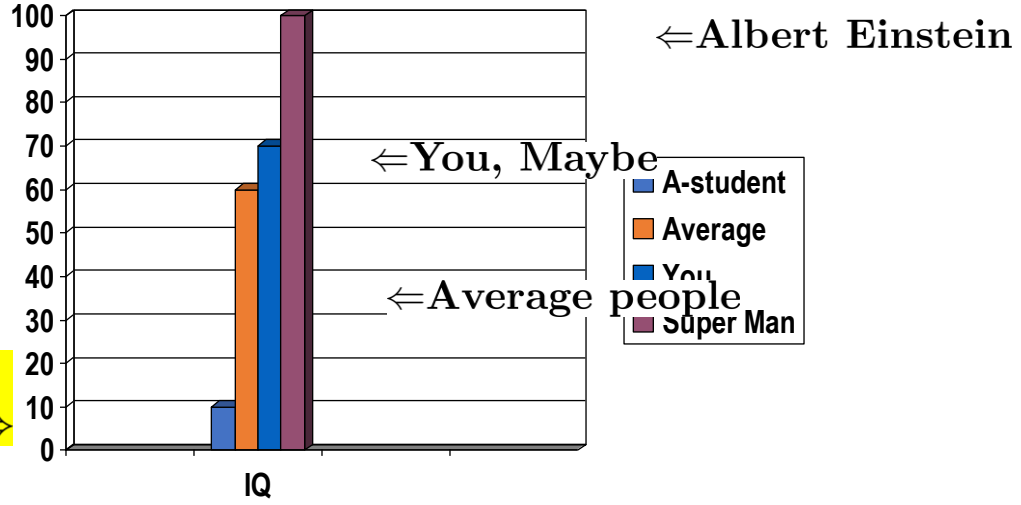
- Do Homework ---

It is an essential part of your engineering traning

- Renew your AMBITION ---Be the best you can be

The Truth about human intelligence vs. achievement

Required intelligence to get A in this class ⇒



⇐Albert Einstein

Human Intelligence

Why ?

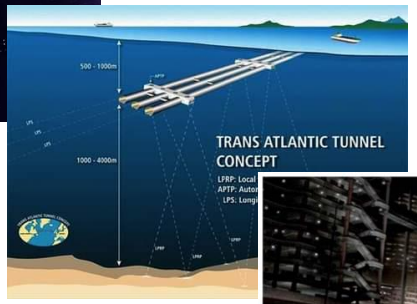
Why ? two people who have the same intelligence, one succeeds and one fails ?

1. Discipline and 2. Mind Set

Why Introduction to Solid Mechanics?

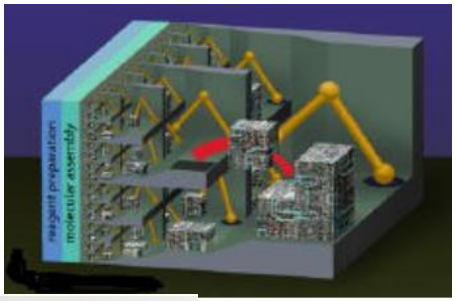
We aim to train and cultivate the next-generation first-class engineers to design, innovate, and create future engineering machines, structures, and wonders.

Space elevator



Trans-Atlanta tunnel

Nanofactory



Mar Base

Underground megacity

Mechanics of Materials is a key knowledge component and fundamental skill set that will help you succeed in your future careers.

Leonardo da Vinci

Augustin Cauchy

Leonhard Euler

Jacob Bernoulli

James C. Maxwell

Stephen Timoshenko

The contents of the class is the ``intellectual crystallization'' contributed by many giants and geniuses in science.

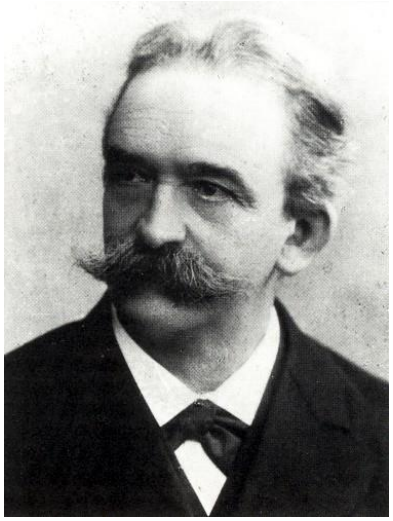
However, we aim at train the next generation of engineers and inventors

George Stephenson

Alberto Castigliano

Zhuravskii

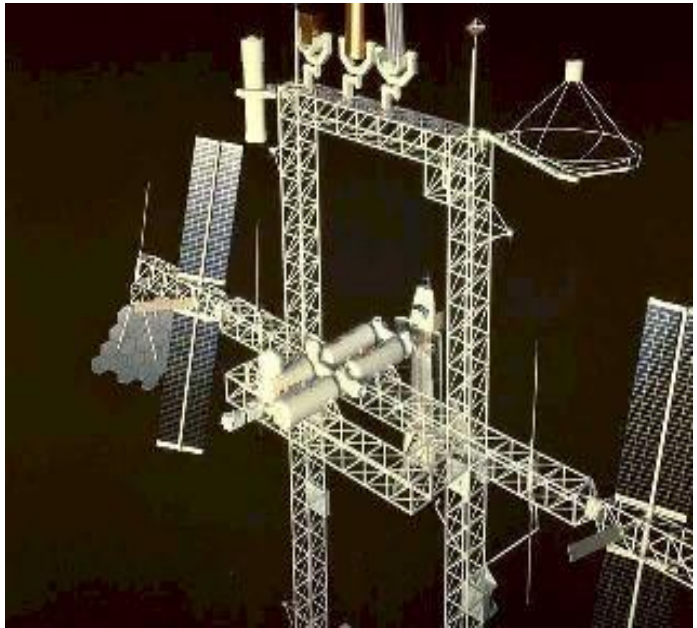
Arthur Ruge



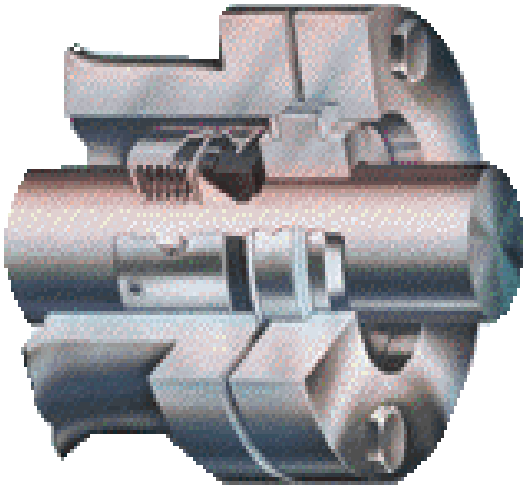
Christian Otto Mohr

Elon Musk

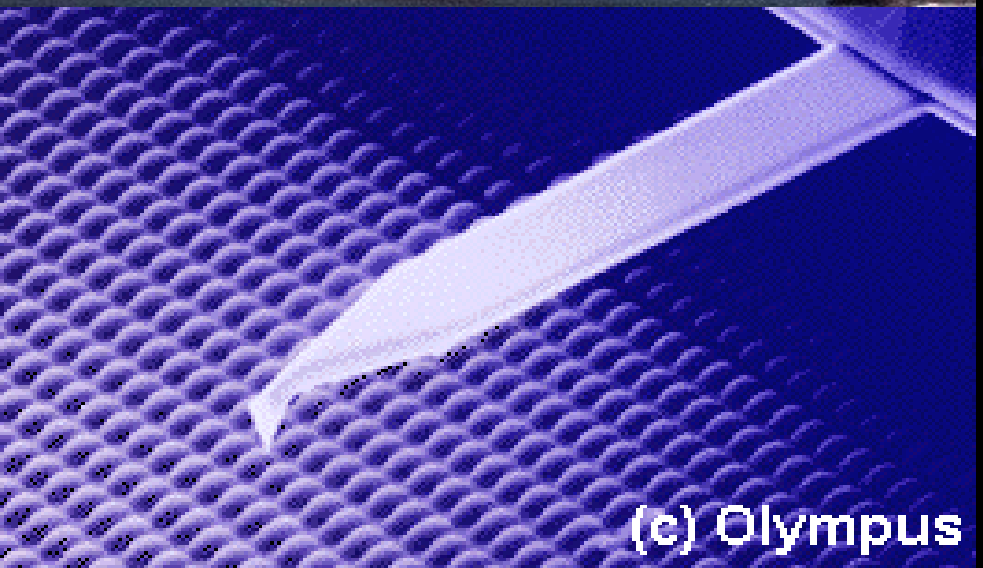
Truss Structure: Fundamental to design structures from buildings, bridge, to space structures.

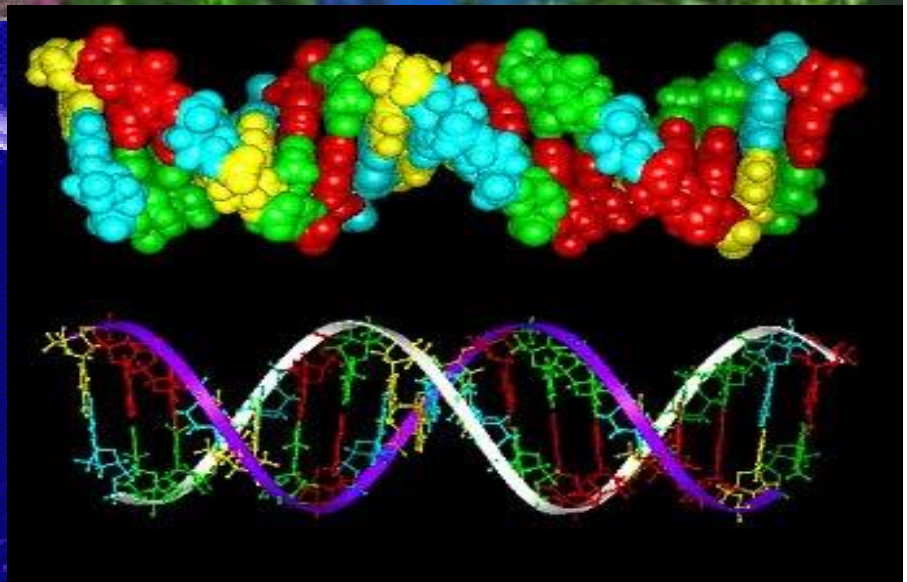


Torsion and Shaft
Fundamental to Design devices for mechanical power transfer

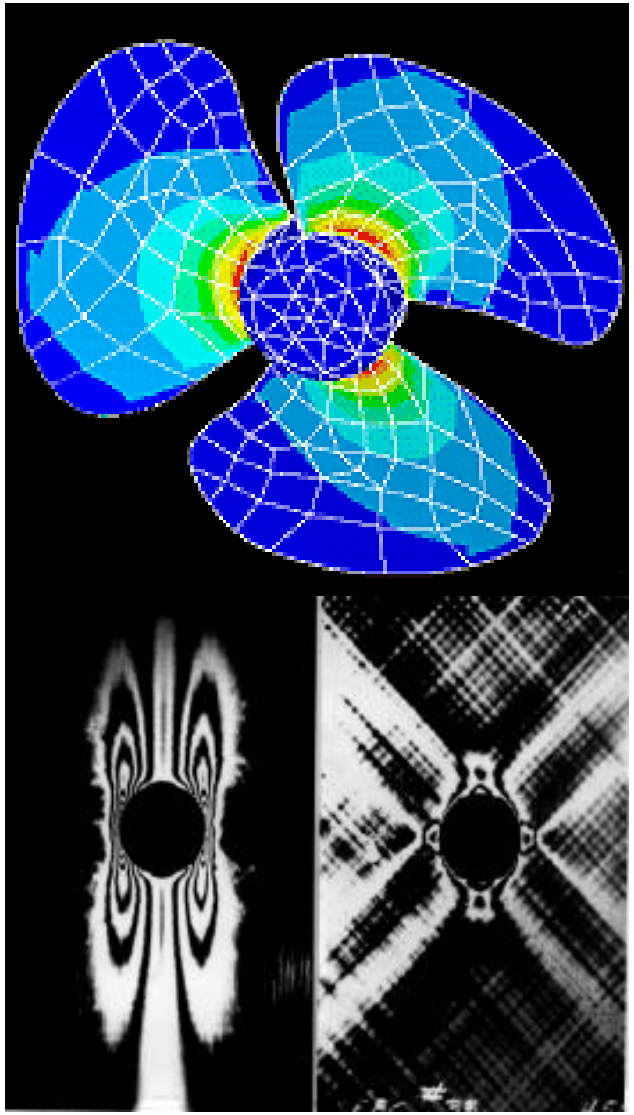


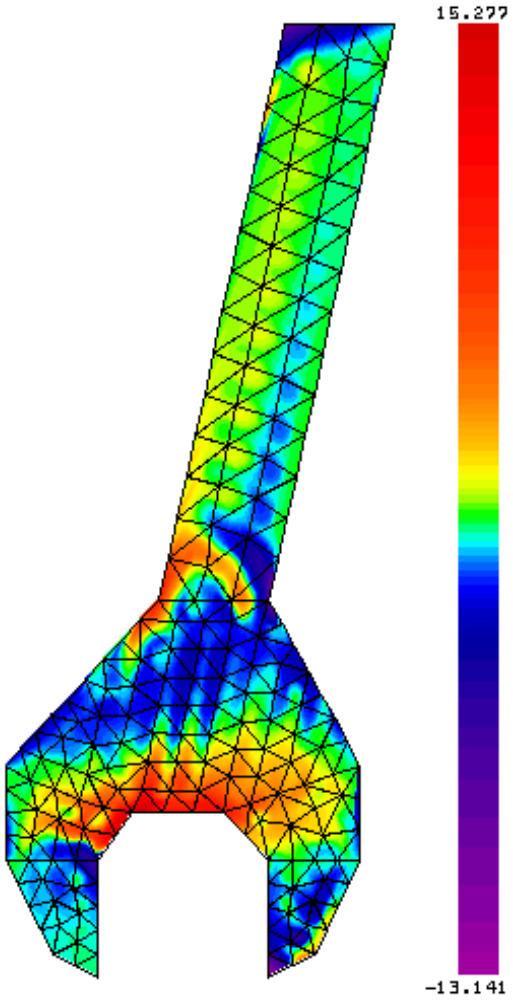
Beam Theory: Fundamental to designing structures from nano-devices to bridges

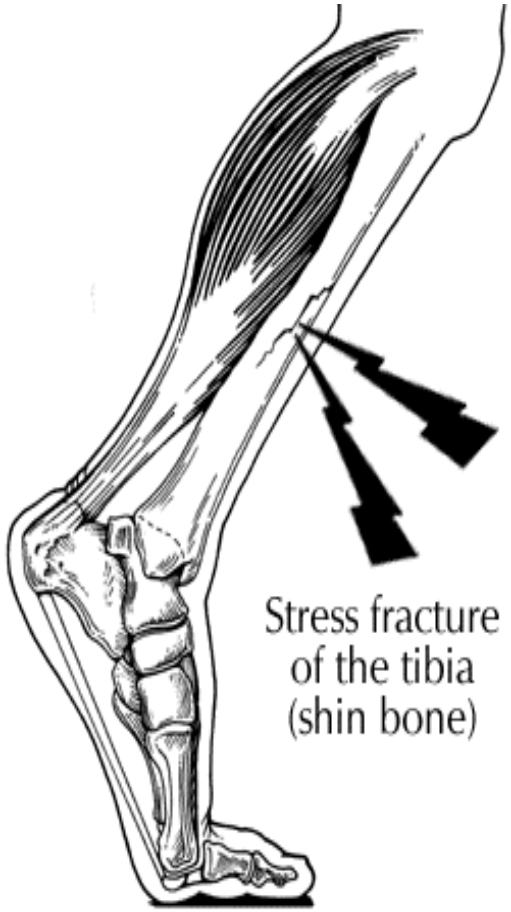




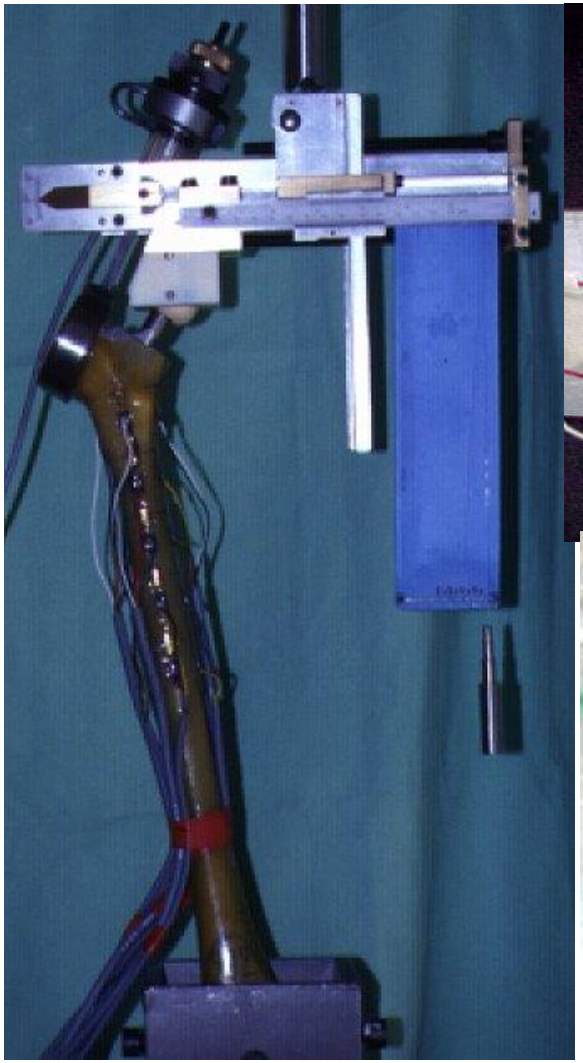
Stresses: Fundamental to structural failure analysis

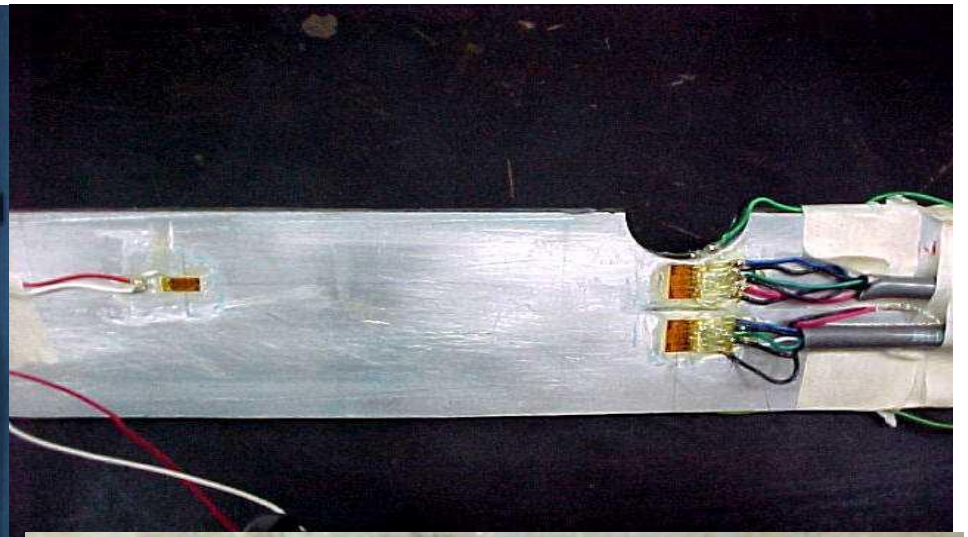




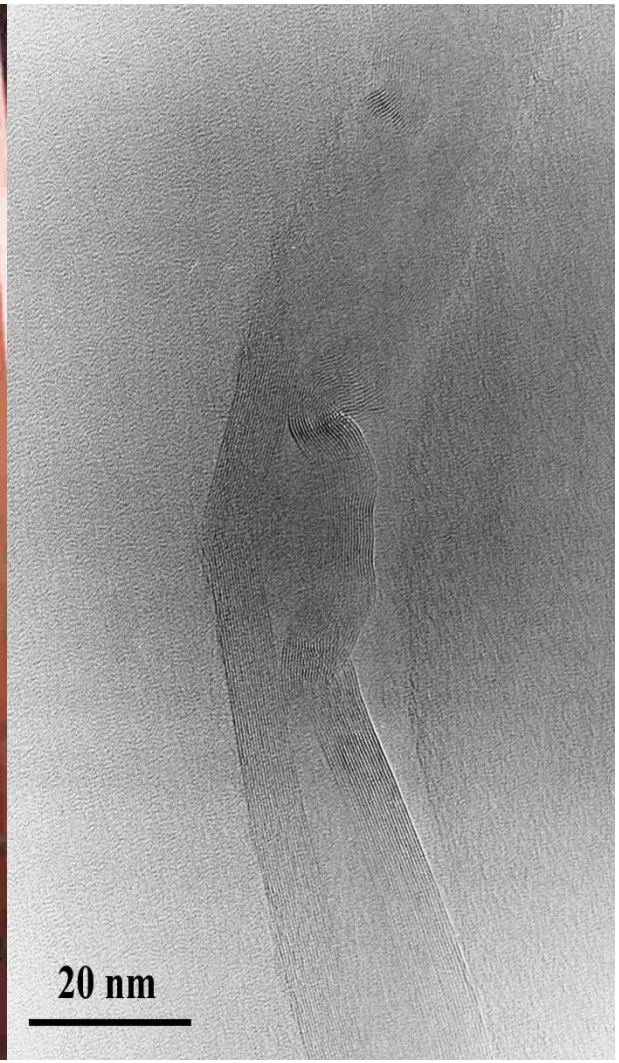


Strains: Fundamental to all mechanical sensors





Buckling of Columns (Stability):
Fundamental to design: large-scale engineering structures



The Road Map of Statics and Mechanics of Materials
Basic Technical Ingredients of MM

- ***Balance of Force: Equilibrium***
- ***Compatibility of deformation: Kinematics***
- ***Stress-strain relations: Materials properties***
- ***How to build a mechanics model for engineering applications (design)***
- ***How to apply mathematical analysis to solve engineering problems;***

Lecture 1 Review Vector Algebra

I. A vector is a mathematical quantity with two characteristics:
  - 1) magnitude: “how much”, size of vector, or, the “length” of vector
  - 2) Direction: orientation in space.

II. Can you think of science quantities which are vectors in nature?

Name some scalars & Vectors

- Scalar Quantities
  - Scalar quantities can be completely described by their magnitudes.
  - Examples
    - Mass
    - Density
    - Length
    - Speed
    - Time

- Vector Quantities
  - A vector quantity has both magnitude and direction (line of action).
  - A vector quantity obeys the parallelogram of addition
  - Examples:
    - Force
    - Displacement
    - Velocity
    - Acceleration

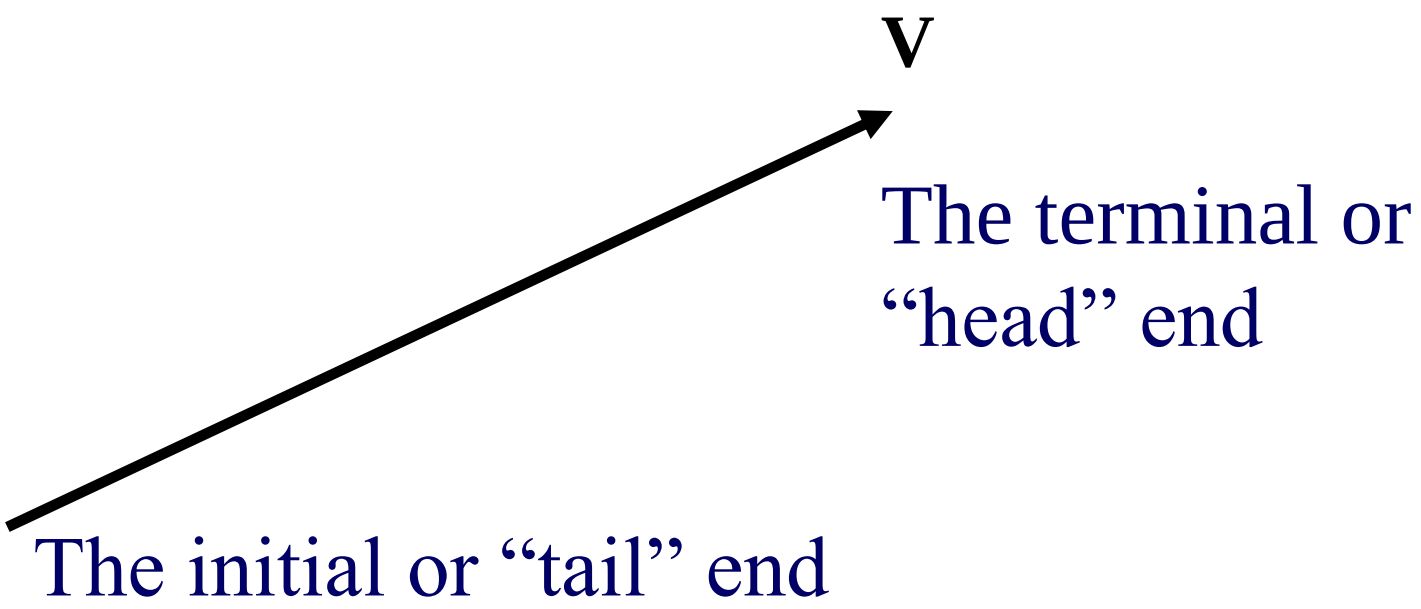
How to express scalar and vector ?

1.1 Scalars and Vectors

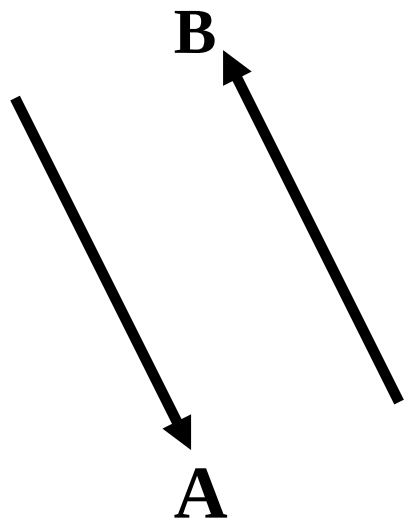
	Data Types	Examples	Physical Quantities
Scalar	constants variables functions	$\sqrt{2}, 3, \pi$ x, y, t, T e^{-x^2}	time, Temperature
Vector	constants variables functions	$\sqrt{2}\mathbf{u_x} + 3\mathbf{u_y}$ $x\mathbf{u_x} + y\mathbf{u_y}$ $cos(\omega t)\mathbf{u_x} + sin(\omega t)\mathbf{u_y}$	velocity, Force

Later in this class, we shall introduce a quantity called **Tensor**

Geometrically, a vector can be represented as an arrow



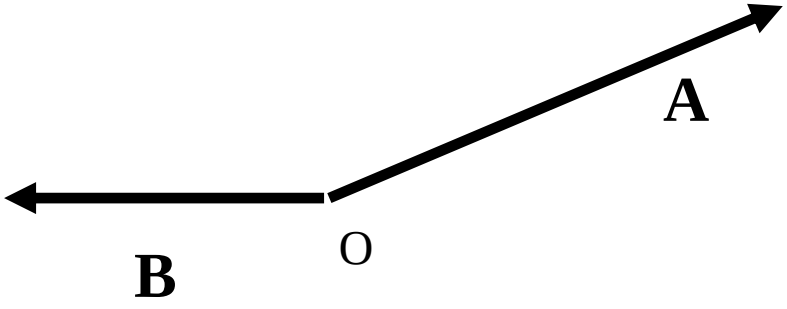
A = **-B** says that vectors **A** and **B** are anti-parallel. They have same size but the opposite direction.

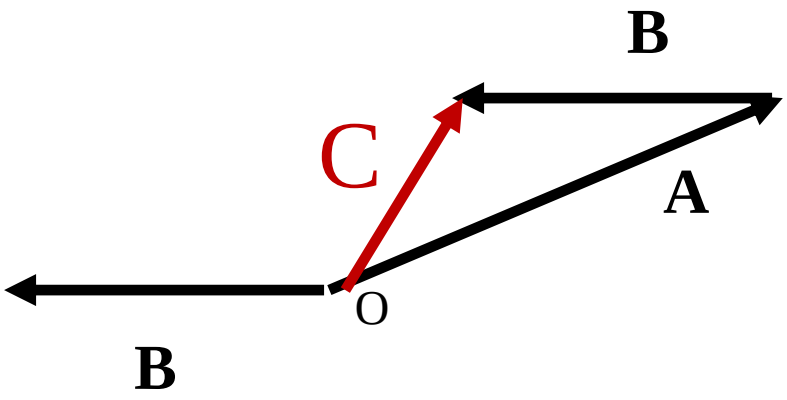


A = **-B** also implies
B = **-A**

Vectors can be added geometrically (Triangle rule)

Find **A + B**





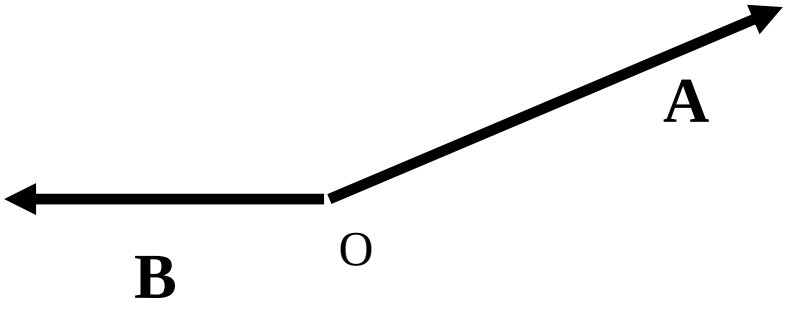
Vector C is the sum of **A + B**

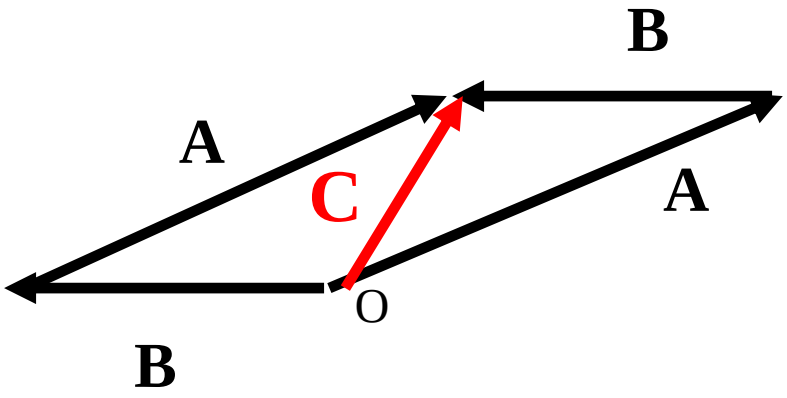
C = A + B

Vector Addition is Commutative

A + B = B + A

Find **A + B**



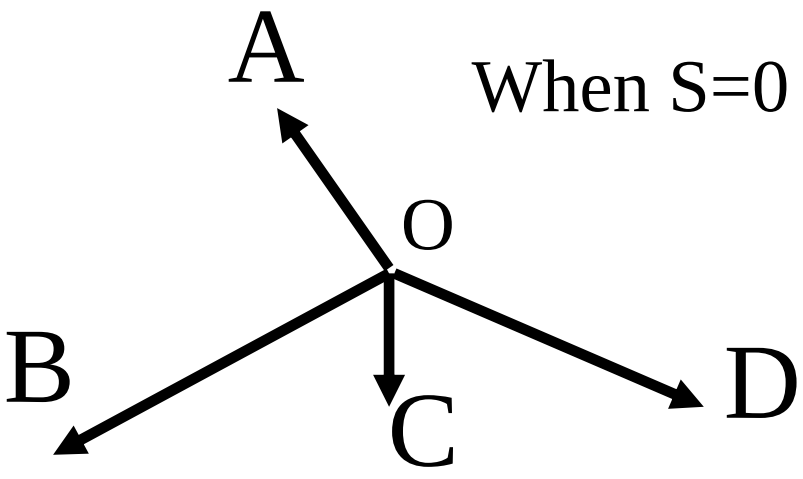


Vector C is the sum of **A + B**

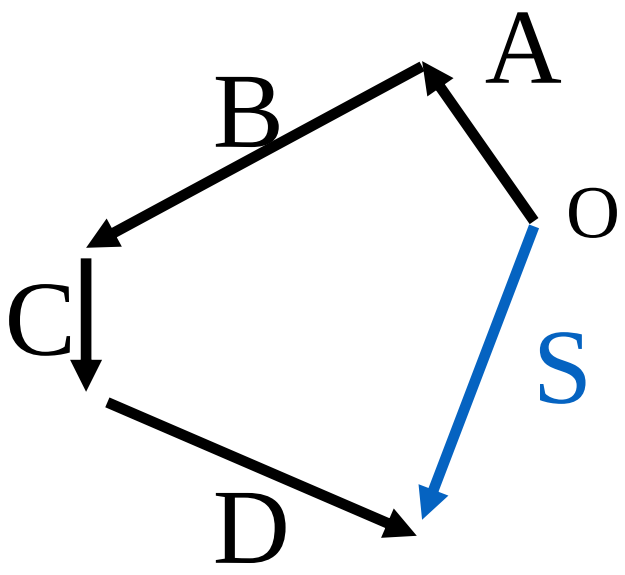
C = A + B = B + A

This is the "parallelogram method" taught in trigonometry.

Add multiple vectors “head to head”

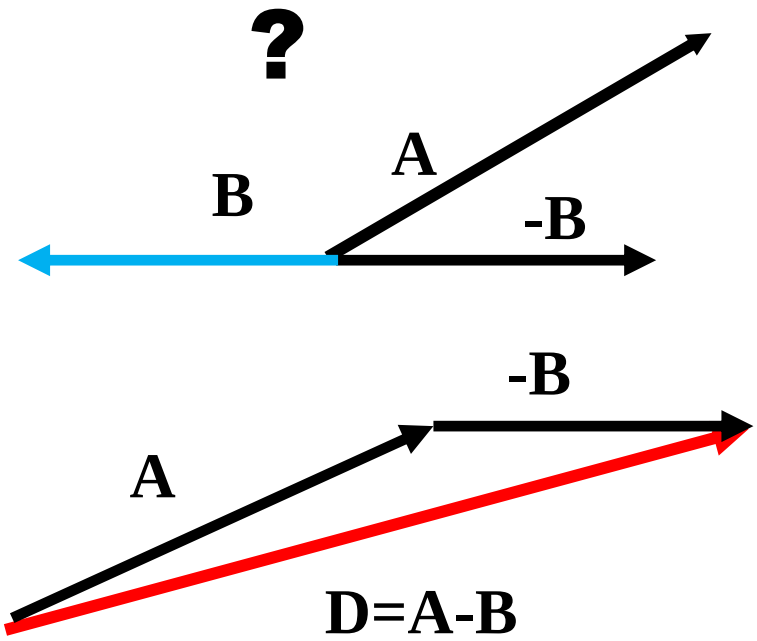


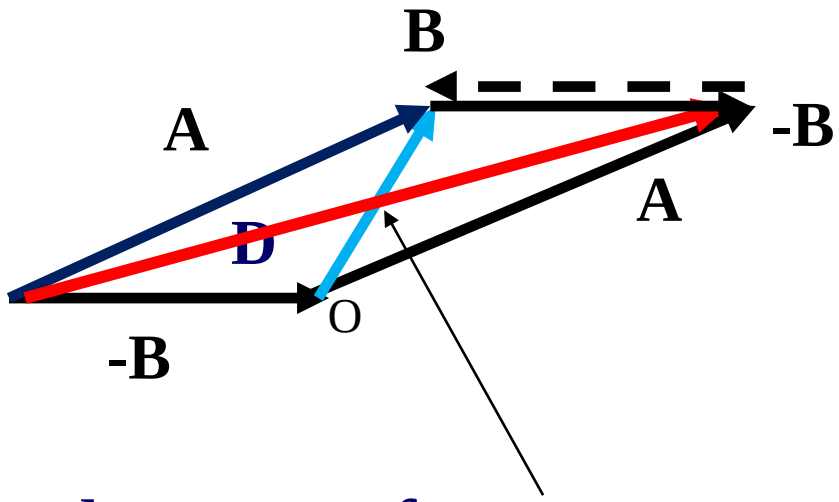
could represent
four forces
acting upon
point O -tug-of-war



$S = A + B + C + D$

How to find **D = A – B ?**





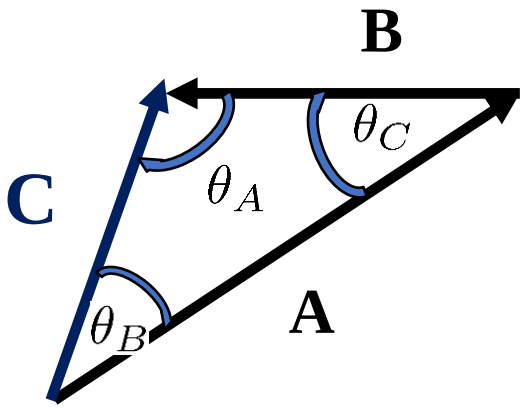
Vector C is the sum of **A + B**

D = A - B = -B + A

This is the “parallelogram method”

Vectors can be added geometrically as well as analytically (coordinate-freeTriangle rule)

$$\mathbf{C = A + B}$$



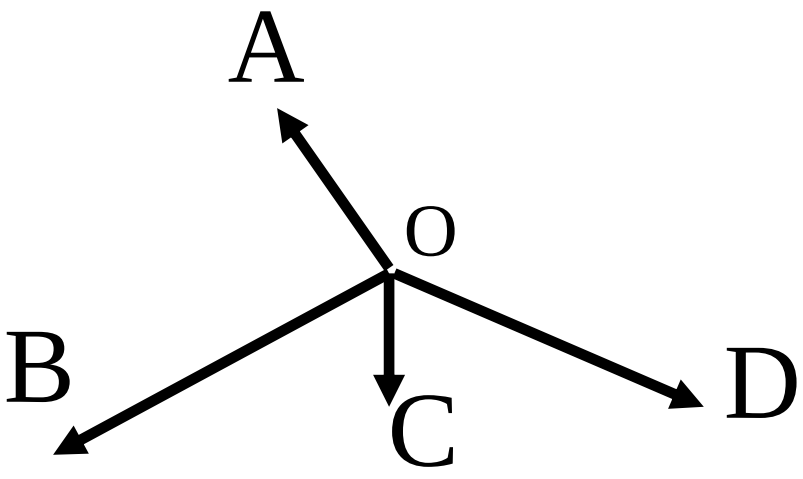
Law of Sine

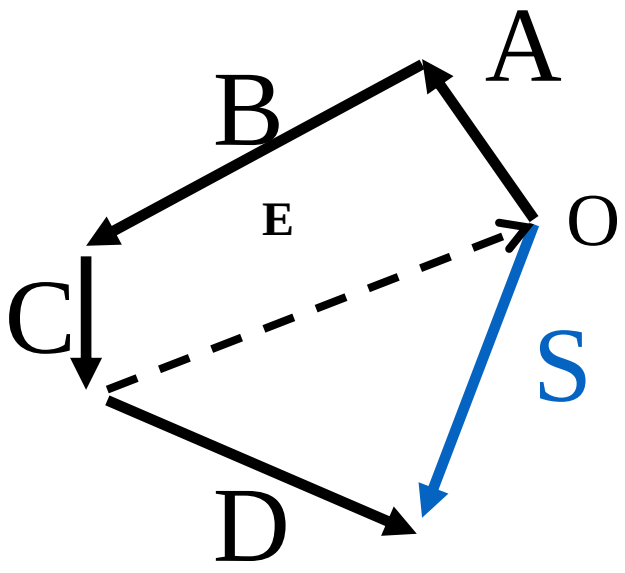
$$\frac{A}{\sin\theta_A} = \frac{B}{\sin\theta_B} = \frac{C}{\sin\theta_C} \quad \rightarrow \quad \frac{\sin\theta_A}{A} = \frac{\sin\theta_B}{B} = \frac{\sin\theta_C}{C}$$

Law of Cosine

$$C^2 = A^2 + B^2 - 2AB\cos\theta_C$$

When: A+B+C+E = 0?

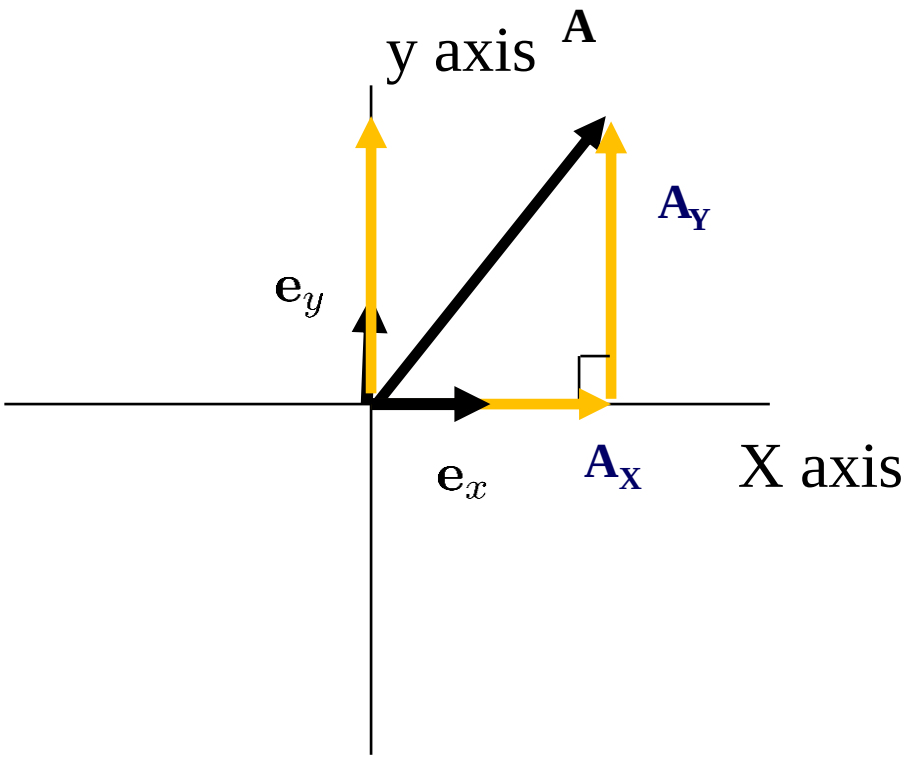




could represent
four forces
acting upon
point O tug-of-war

$$S = A + B + C + D$$

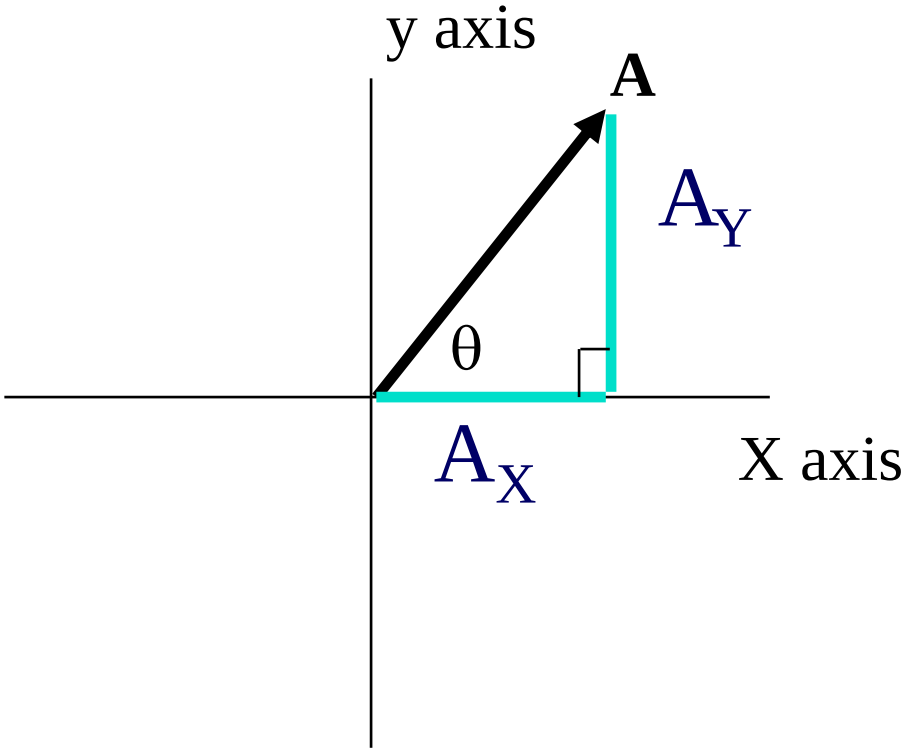
A vector **A** in the x-y plane can be represented by its perpendicular components in a coordinate system.



Components A_X and A_Y can be positive, negative, or zero. The quadrant that vector A lies in dictates the sign of the components.

Components are scalars.

When the magnitude of vector A is given and its direction specified then its components can be computed easily



$$A_X = A\cos\theta$$

$$A_Y = A\sin\theta$$

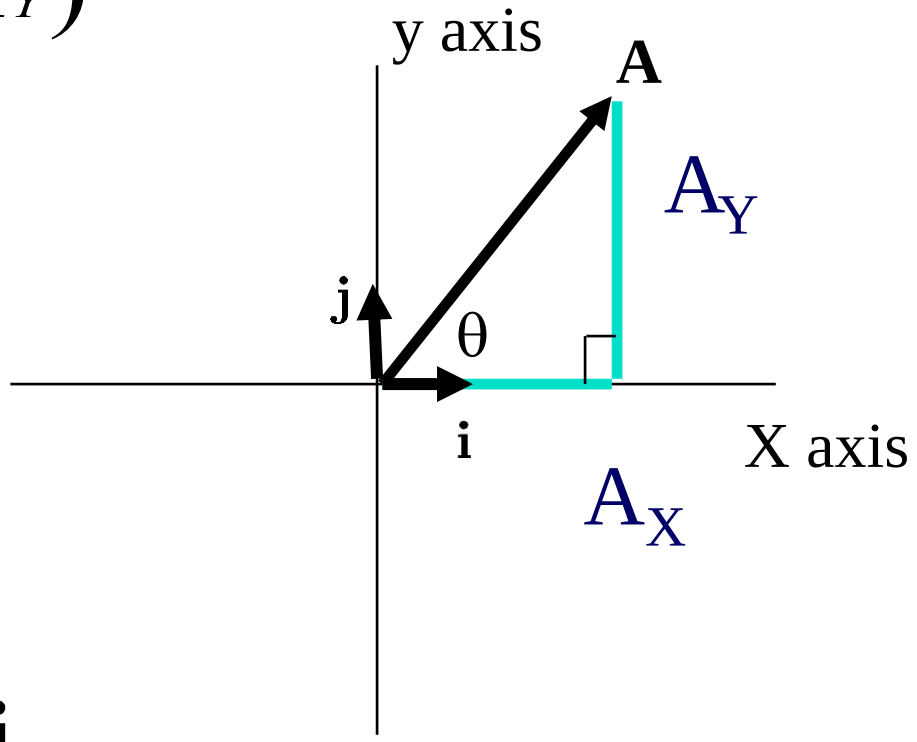
Magnitude and direction of a vector can be found by knowing its components

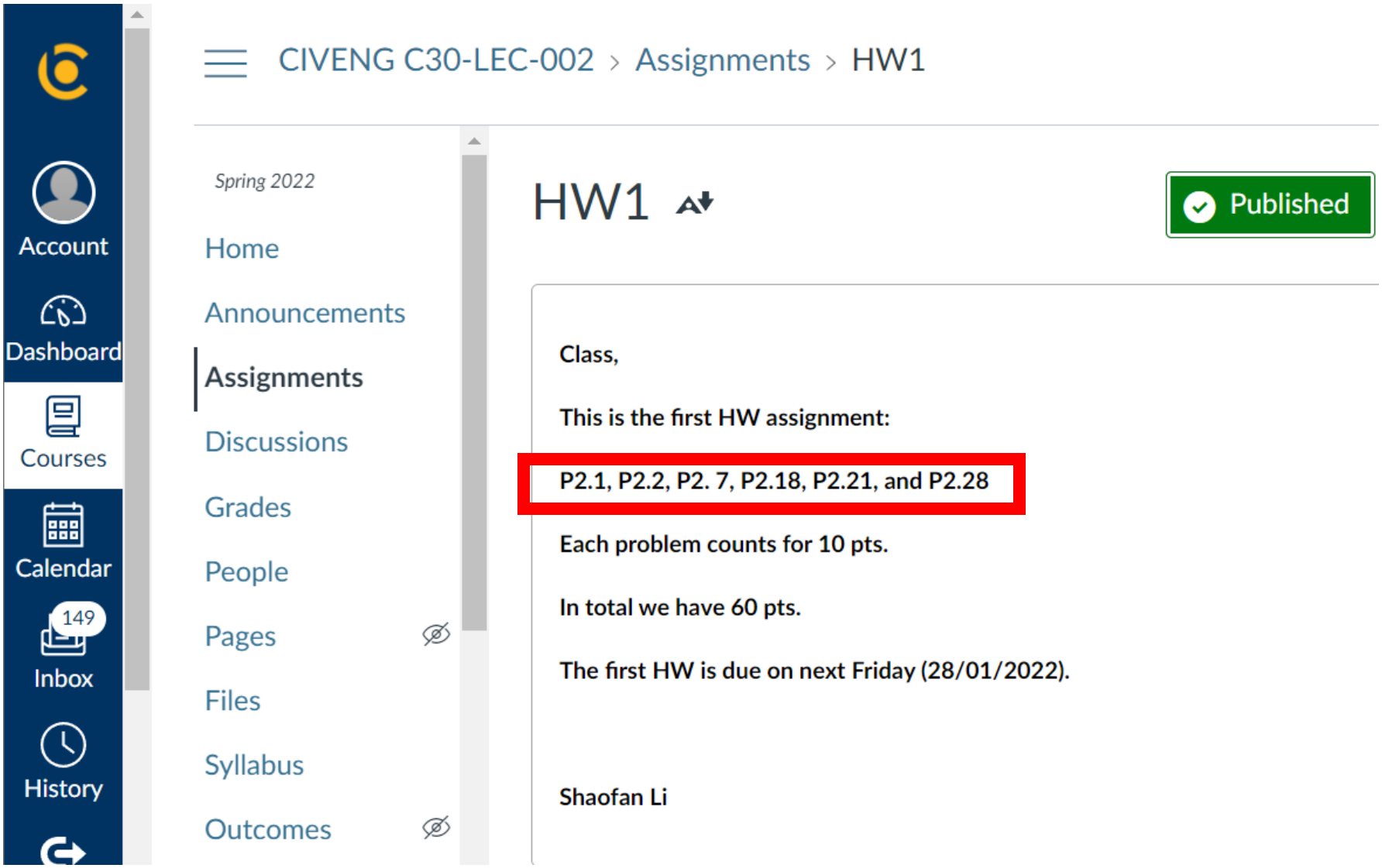
$$A = \sqrt{(A_X)^2 + (A_Y)^2}$$

$$\tan\theta = A_Y/A_X$$

$$\theta = \tan^{-1}(A_Y/A_X)$$

$$\mathbf{A} = A_x\mathbf{i} + A_y\mathbf{j}$$

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Pages
Files
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Outcomes
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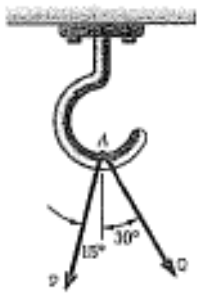
Class,
This is the first HW assignment:
P2.1, P2.2, P2. 7, P2.18, P2.21, and P2.28
Each problem counts for 10 pts.
In total we have 60 pts.
The first HW is due on next Friday (28/01/2022).
Shaofan Li

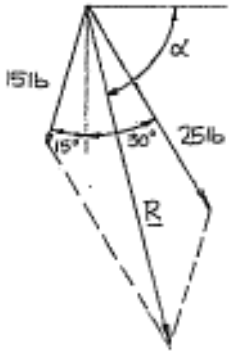
PROBLEM 2.1



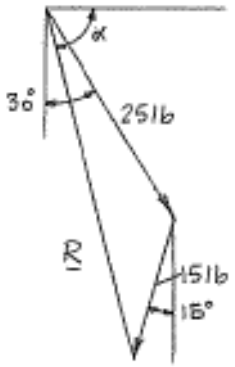
Two forces **P** and **Q** are applied as shown at point A of a hook support. Knowing that $P = 15$ lb and $Q = 25$ lb, determine graphically the magnitude and direction of their resultant using (a) the parallelogram law, (b) the triangle rule.

SOLUTION

(a)

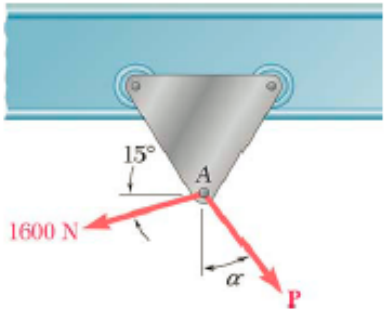


(b)



Using ruler
and protractor

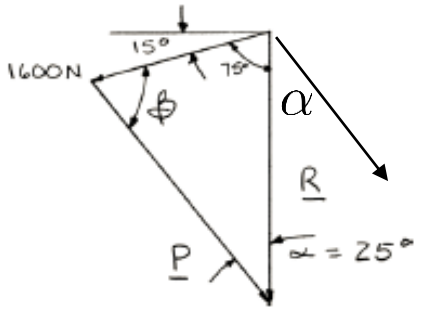
We measure: $R = 37$ lb, $\alpha = 76°$



PROBLEM 2.7

A trolley that moves along a horizontal beam is acted upon by two forces as shown. (*a*) Knowing that $\alpha = 25°$, determine by trigonometry the magnitude of the force **P** so that the resultant force exerted on the trolley is vertical. (*b*) What is the corresponding magnitude of the resultant?

SOLUTION



Using the triangle rule and the law of sines:

(*a*)
$$\frac{1600\text{ N}}{\sin 25°} = \frac{P}{\sin 75°}$$
$$P = 3660\text{ N} \blacktriangleleft$$

(*b*)
$$25° + \beta + 75° = 180°$$
$$\beta = 180° - 25° - 75°$$
$$= 80°$$
$$\frac{1600\text{ N}}{\sin 25°} = \frac{R}{\sin 80°}$$
$$R = 3730\text{ N} \blacktriangleleft$$

Law of Sine

$$\frac{A}{\sin\theta_A} = \frac{B}{\sin\theta_B} = \frac{C}{\sin\theta_C} \quad \rightarrow \quad \frac{1600}{\sin 25^o} = \frac{P}{\sin 75^o} = \frac{R}{\sin\theta_C}$$

2.18 and 2.19 Determine the x and y components of each of the forces shown.

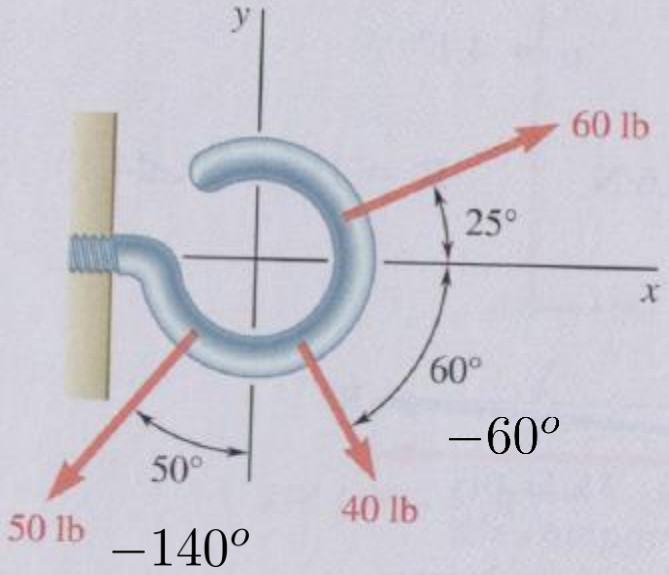


Fig. P2.18

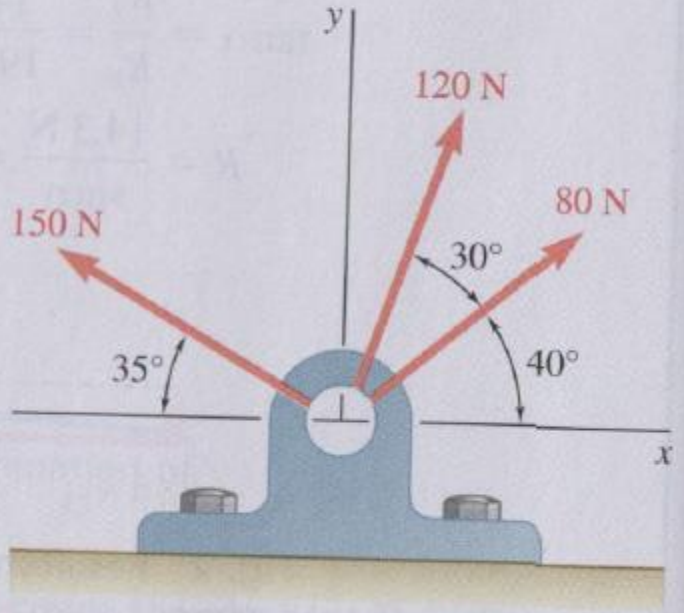


Fig. P2.19

$$F_x = \sum_{i=1}^{3} F_{ix} = \sum_{i=1}^{3} F_i \cos\theta_i \qquad F_y = \sum_{i=1}^{3} F_{iy} = \sum_{i=1}^{3} F_i \sin\theta_i$$

2.18 and 2.19 Determine the x and y components of each of the forces shown.

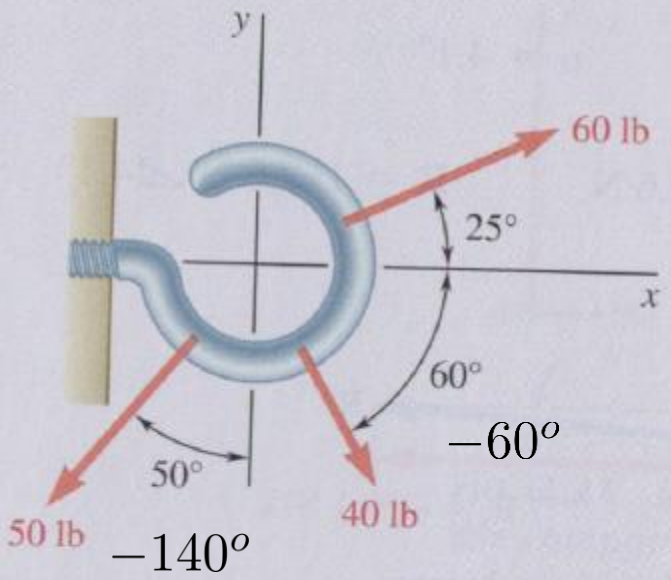


Fig. P2.18

$$F_x = \sum_{i=1}^{3} F_{ix} = \sum_{i=1}^{3} F_i \cos\theta_i$$

$$F_y = \sum_{i=1}^{3} F_{iy} = \sum_{i=1}^{3} F_i \sin\theta_i$$

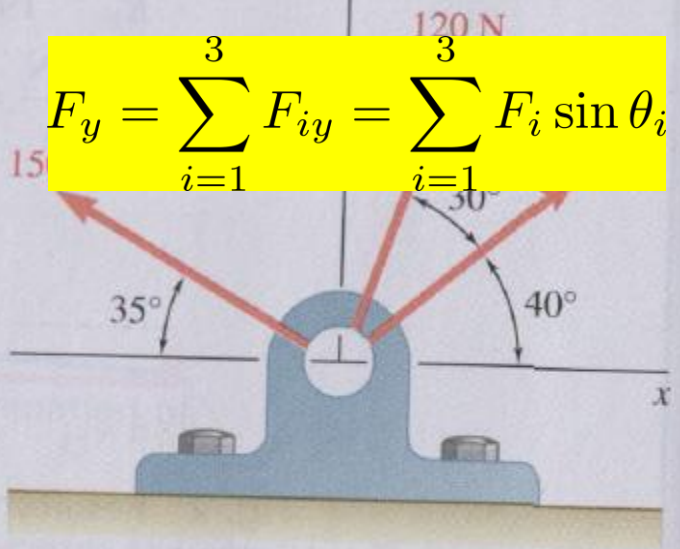
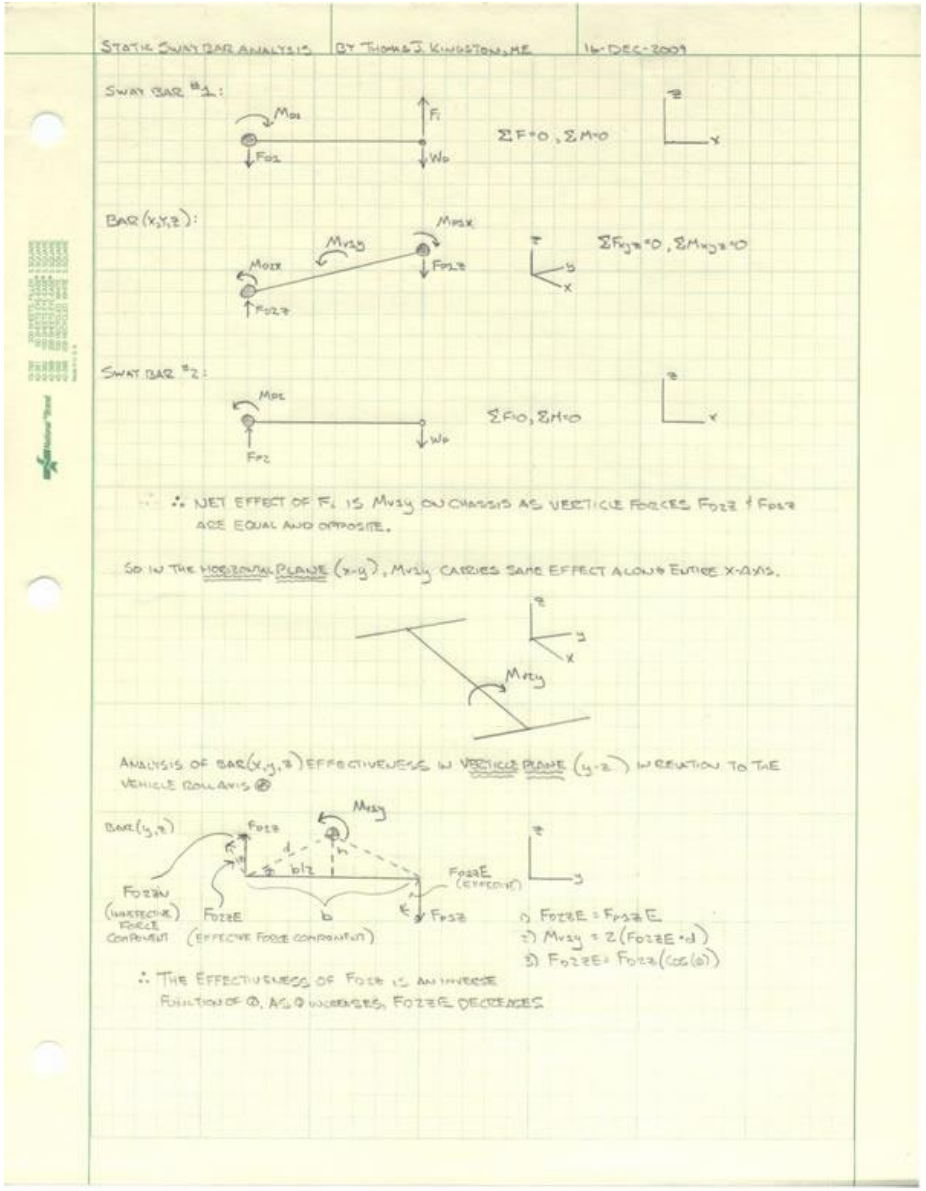


Fig. P2.19

$$F_x = 60\cos 25^o + 40\cos(-60^o) + 50\cos(-140^o) = ?$$

$$F_y = 60\sin 25^o + 40\sin(-60^o) + 50\sin(-140^o) = ?$$

Use Engineering Paper for HWs



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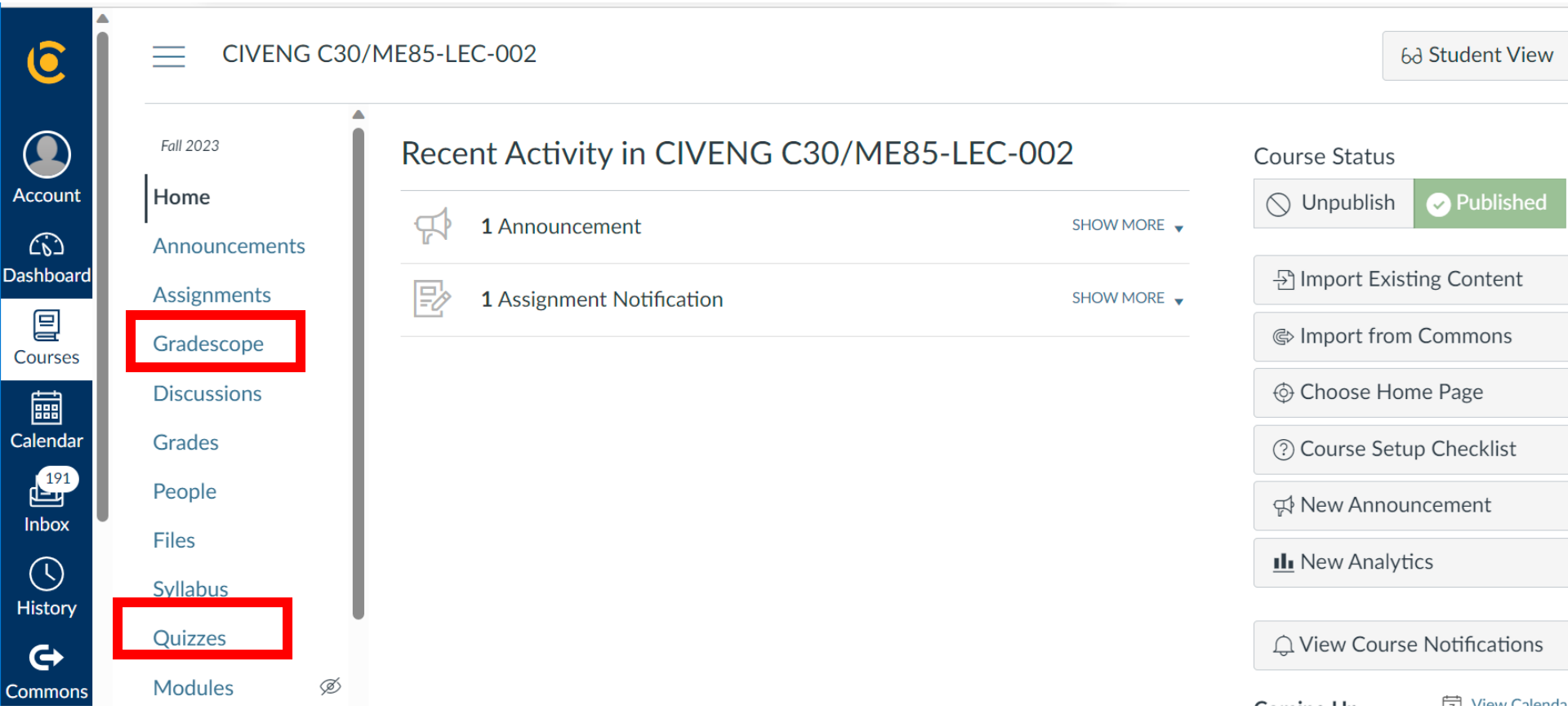

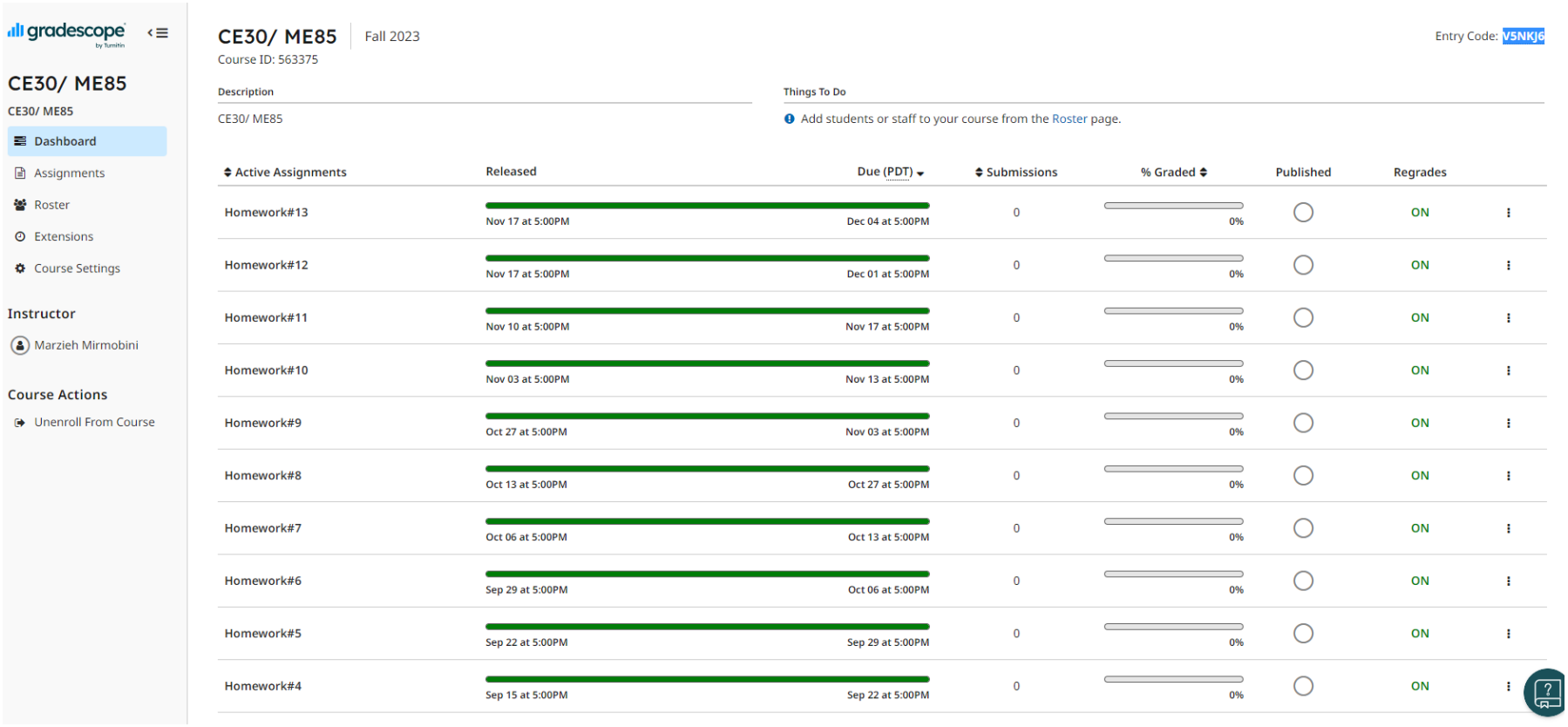
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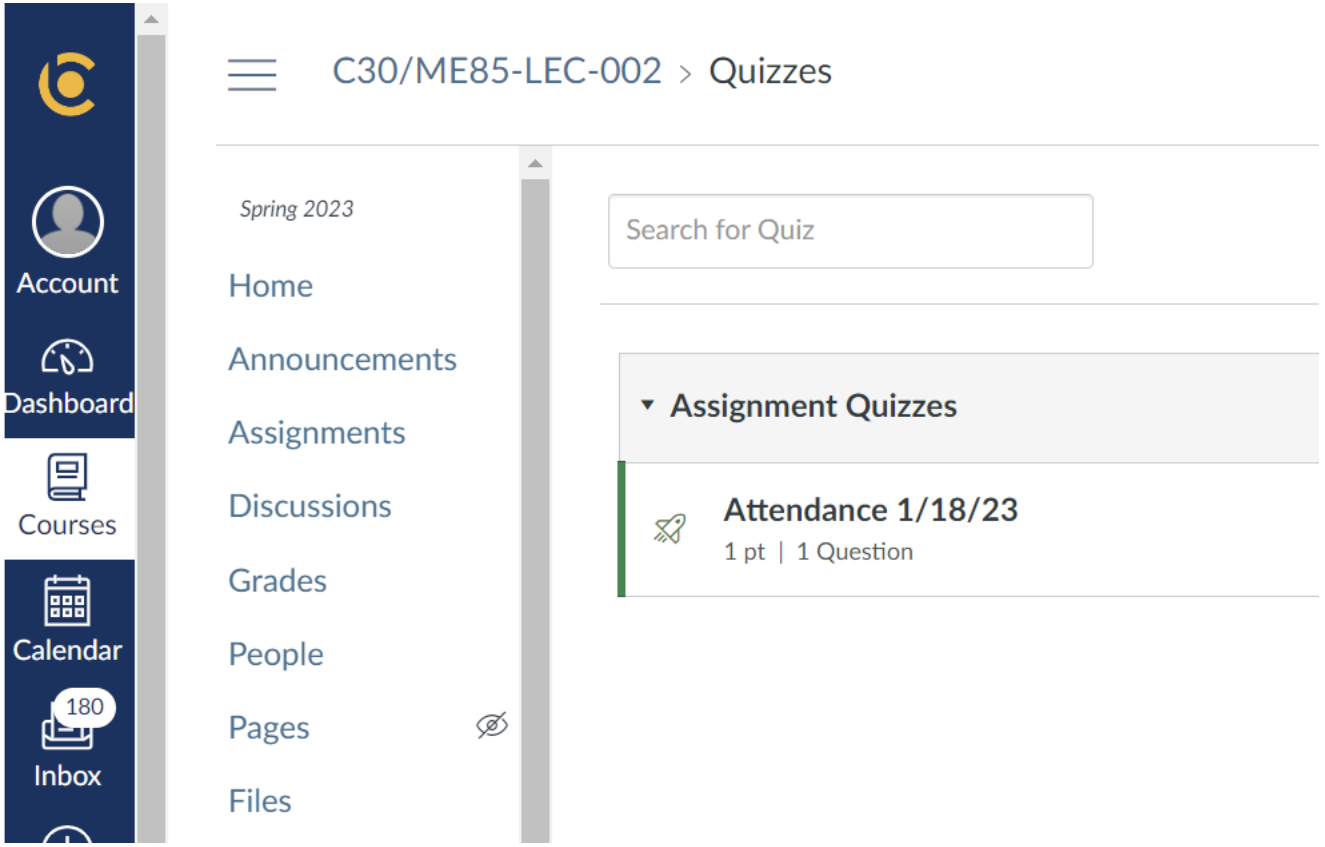

Today's Lecture Attendance Password

Happy New Year!