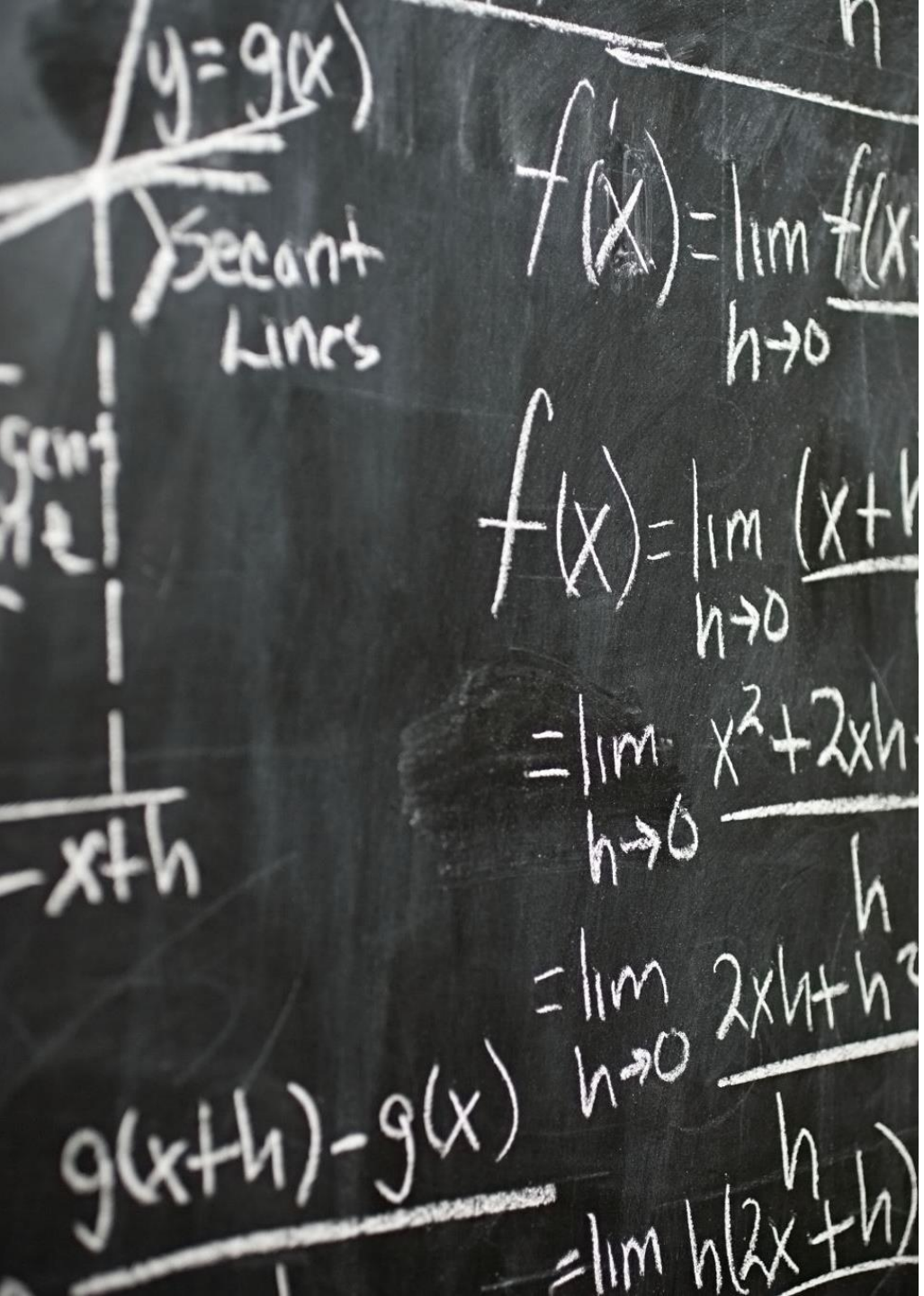


MA261: Multivariate Calculus Spring 2026!

- Welcome!
- Instructor: Prof. Mahesh Sunkula
- Office: Mathematical Sciences Building (MATH), Room 842
- Email: msunkula@purdue.edu
- Course Webpage: https://www.math.purdue.edu/MA261 & Bright Space
- Office Hours: Monday, Friday 9:45 AM – 11:00 AM Thursday 11AM – 12PM or By Appointment

What is MA261?

extending what you already know from Calculus 1 & 2 to more Variables

- Multivariable function
- partial derivatives
- Multiple integrals
- Vector fields

} Applications in Optimization, physics, Machine Learning

Today:

① Syllabus

② Review of Vectors (13.1 - 13.4)

- Defn. of Vector
- Addition, Subtraction
- Dot product
- Cross product

Textbook & Online Homework

Course Schedule

Accessing Lectures Notes & Recordings

Grading Scheme

Homework	**15%**
Quizzes	**15%**
Midterms	**40% (20% each)**
Final	**30%**

A+	97%
A	93%
A-	90%
B+	87%
B	83%
B-	80%
C+	77%
C	73%
C-	70%
D+	67%
D	63%
D-	60%

At the end of the semester, if the distribution of the letter grades is way off the traditional one, we MAY LOWER the above-mentioned cut-off points. We will NEVER RAISE the cut-off points.

Homework and Quizzes

- 37 online assignments using My Lab Math
  - Due on almost every Tuesday and Thursday (11:59pm)
  - No late homework is accepted.
  - 3 lowest homework scores dropped.

- A quiz administered in almost every recitation session
  - On material from lessons whose homework is due the previous week.
  - No more than 15 minutes long.
  - No make-up quizzes will be given.
  - 2 lowest quiz scores are dropped.

Exams

- Exam 1: Thursday, 02/25, 8:00pm – 9:00pm (Lessons 1-16)
- Exam 2: Wednesday, 04/21, 6:30pm – 7:30pm (Lessons 17-33)
- Final Exam: TBA by the Registrar (Comprehensive)

LOCATION AND MORE DETAILS BEFORE THE EXAM

Students with Accommodations & Academic Adjustments

- **Exams:** Please schedule directly with the DRC
- **Quizzes:** Please contact your recitation TA
- **Anything Else:** Please contact me

Academic Honesty

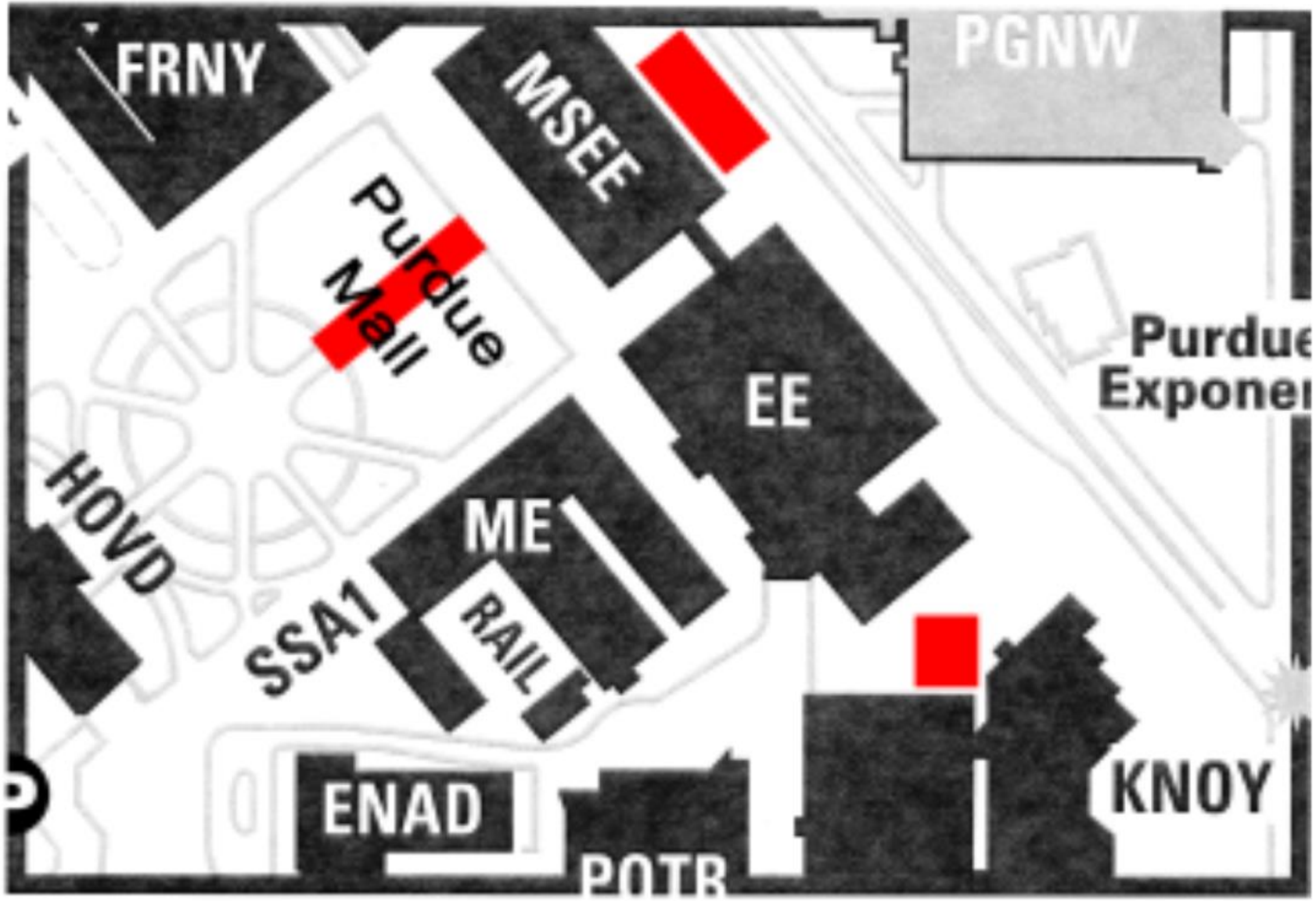
- Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breeches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information that is submitted provides the greatest opportunity for the university to investigate the concern.

- Purdue prohibits academic dishonesty. According to University policy cheating, plagiarism, lying and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid, abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest. If found guilty of academic dishonesty, possible penalties can range from receiving a zero on the assignment to expulsion from the University. For more details about the Purdue policy on academic dishonesty see: www.purdue.edu/odos/osrr/academicintegritybrochure.php

Campus Safety & Emergency Preparedness

- Emergency preparedness is your personal responsibility. Purdue University is continuously preparing for natural disasters or human-caused incidents with the ultimate goal of maintaining a safe and secure campus. Let's review the following procedures:
- To report an emergency, call 911.
- To obtain updates regarding an ongoing emergency, and to sign up for Purdue Alert text messages, view www.purdue.edu/ea
- There are nearly 300 Emergency Telephones outdoors across campus and in parking garages that connect directly to the Purdue Police Department (PUPD). If you feel threatened or need help, push the button and you will be connected immediately.
- If we hear a fire alarm, we will immediately suspend class, evacuate the building, and proceed to the area between WTHR and STEW. Do not use the elevator.
- If we are notified of a Shelter in Place requirement for a tornado warning, we will suspend class and shelter in the lowest level of this building away from windows and doors.
- If we are notified of a Shelter in Place requirement for a hazardous materials release, or a civil disturbance, including a shooting or other use of weapons, we will suspend class and shelter in our classroom, shutting any open doors or windows, locking or securing the door, and turning off the lights.

Emergency Evacuation



Advice to Succeed in this Class

- **PREPARE.** Before each class, review material from last class & look at the new material in the book.
- **OWN IT!.** Take ownership of your own learning.
- **CHECK IT!.** We all make mistakes. Check your work & ask yourself, does your answer make sense?
- **PERSIST!.** Persist and work through perceived failure.
- **COLLABORATE.** Positive experiences working in groups have been shown to contribute to overall learning, retention, & college success. You gain valuable skills like how to explain concepts to others and you get a support network that can help you learn the material better.
- **PARTICIPATE ACTIVELY.** Don't be a passive learner just taking notes. Ask questions. Chances are that others have the same question and will appreciate. Stay focused. It is your responsibility Answer questions. Posed by the instructor, TA, or other students.
- **ADDRESS ISSUES IMMEDIATELY!** Occasionally unexpected events may make it difficult to complete an assignment on time. It is much easier to address an issue right away and then stay on top of material. If you wait until the end of the semester, then it is too late to make up work.

Break

Take 3-4 minutes to meet people around you

Share your Name

Major

Favourite Calculus Topic

Highlight of your Winter Break

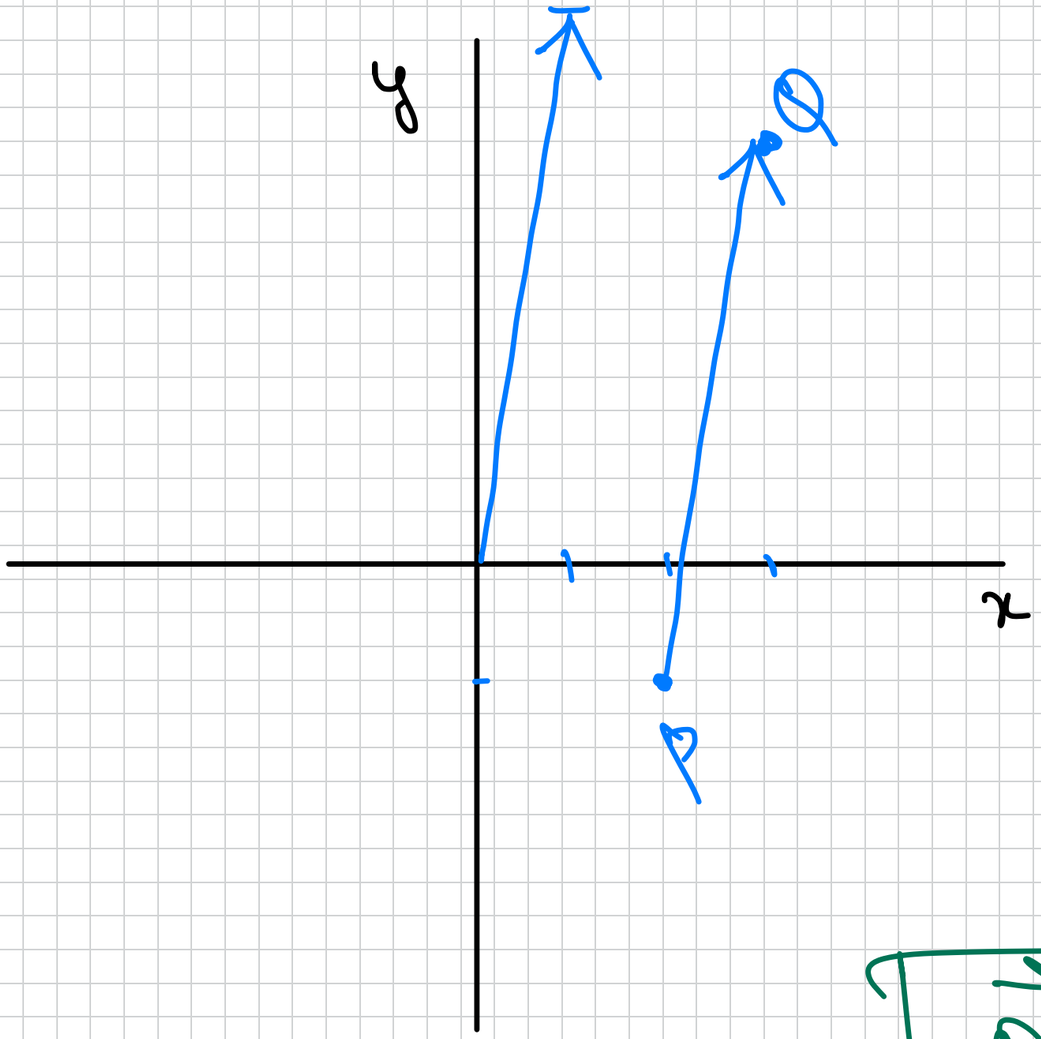
and/or

Anything else

Lesson 1: Review of Vectors (13.1 - 13.4)

A quantity that has magnitude & Direction.

P(2, -1), Q(3, 5)



$\overrightarrow{PQ}$ = vector from P to Q

$= \langle 3-2, 5-(-1) \rangle$

$= \langle 1, 6 \rangle$

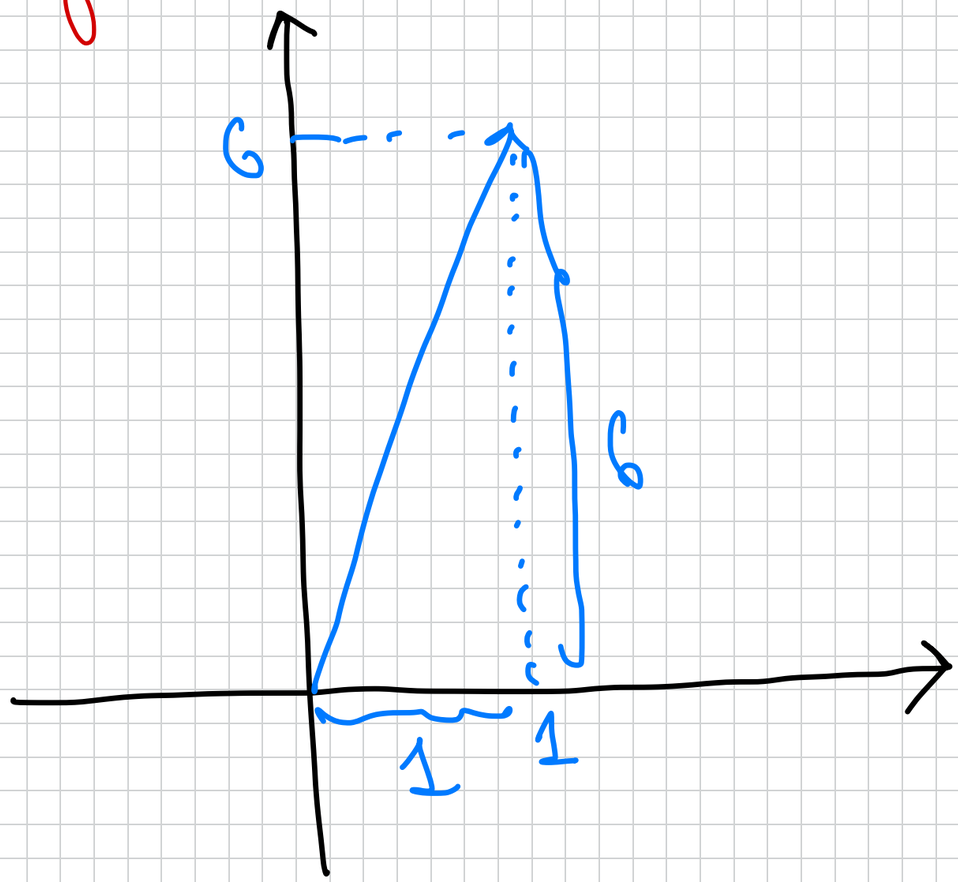
$\overrightarrow{QP}$ = vector from Q to P

$= \langle 2-3, -1-5 \rangle$

$= \langle -1, -6 \rangle$

$$\overrightarrow{QP} = -\overrightarrow{PQ}$$

Length of a vector:



$\vec{PQ} = \langle 1, 6 \rangle$

$|\vec{PQ}| = \sqrt{1^2 + 6^2} = \sqrt{37}$

$|\vec{QP}| = |\vec{PQ}| = \sqrt{37}$

in ~~General~~

$\vec{u} = \langle x, y, z \rangle$

$|\vec{u}| = \sqrt{x^2 + y^2 + z^2}$

Unit Vector: Vector of length 1

$\hat{u} = \dfrac{\vec{u}}{|\vec{u}|}$ ⇝ unit vector in direction of $\vec{u}$

Example: $\vec{u} = \langle 1, 2, -1 \rangle$

$$|\vec{u}| = \sqrt{1^2 + 2^2 + (-1)^2} = \sqrt{6}$$

$$-\vec{u} = \langle -1, -2, 1 \rangle = -(\vec{u}) \quad \& \quad |-\vec{u}| = |\vec{u}| = \sqrt{6}$$

Unit vector in direction of $\vec{u}$ $= \dfrac{\vec{u}}{|\vec{u}|} = \dfrac{\langle 1, 2, -1 \rangle}{\sqrt{6}}$

$$= \left\langle \frac{1}{\sqrt{6}}, \frac{2}{\sqrt{6}}, \frac{-1}{\sqrt{6}} \right\rangle$$

Vector of length 7 in direction opposite to $\vec{u}$

$$= 7\left(\frac{-\vec{u}}{|\vec{u}|}\right)$$

$$= \frac{7}{\sqrt{6}}\left(\langle -1, -2, 1 \rangle\right)$$

Adding and Subtracting Vectors

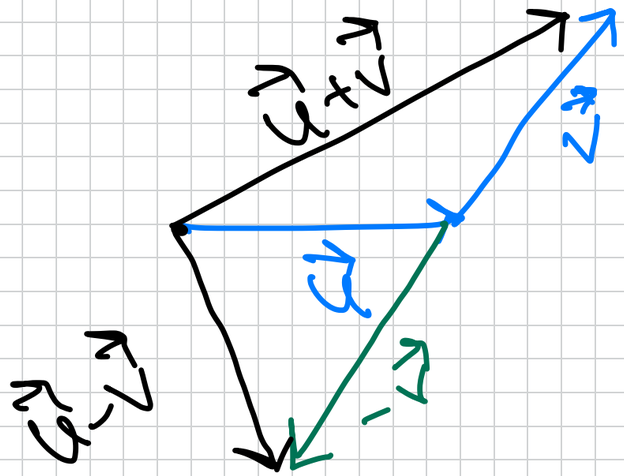
Algebraically! Component wise

$\vec{u} = \langle 1, 2, -1 \rangle$, $\vec{v} = \langle 2, 3, 4 \rangle$

$\vec{u} + \vec{v} = \langle 1+2, 2+3, -1+4 \rangle = \langle 3, 5, 3 \rangle$

$\vec{u} - \vec{v} = \langle 1-2, 2-3, -1-4 \rangle = \langle -1, -1, -5 \rangle$

Geometrically



Multiplication of Vectors

Dot product

Multiply 2 Vectors

get a Number

Cross product

Multiply 2 vectors

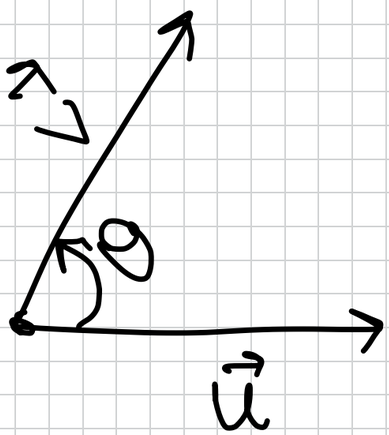
get a Vector

Dot Product

$\vec{u} = \langle 1, 2, -1 \rangle$, $\vec{v} = \langle 2, 3, 4 \rangle$

$\vec{u} \cdot \vec{v}$ = Multiply componenty & Add

$= (1 \cdot 2) + (2 \cdot 3) + (-1 \cdot 4) = 4$

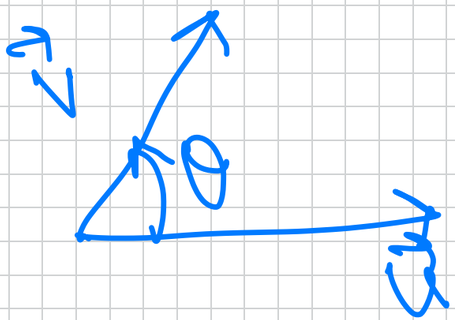


$\vec{u} \cdot \vec{v} = |\vec{u}||\vec{v}| \cos\theta$.

Cross Product

$\vec{u} = \langle 1, 2, -1 \rangle$, $\vec{v} = \langle 2, 3, 4 \rangle$

Length of $\vec{u} \times \vec{v} = |\vec{u} \times \vec{v}| = |\vec{u}||\vec{v}| \sin\theta$

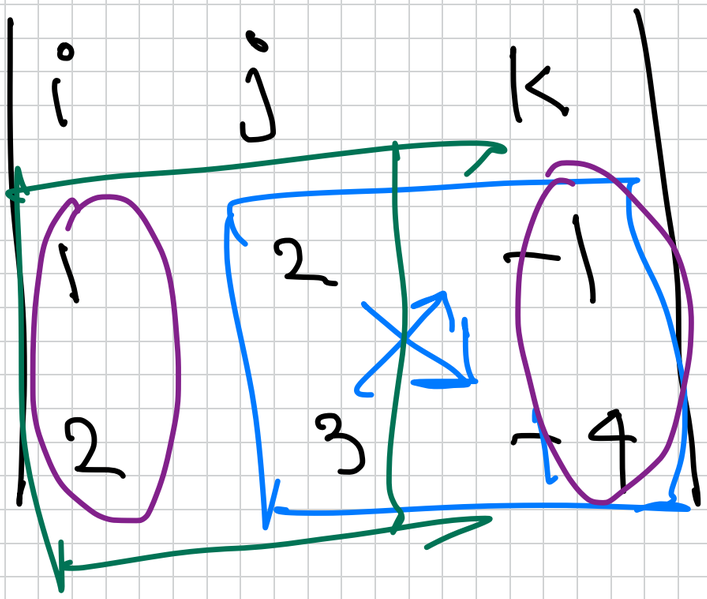


Direction! Use Right hand Rule

Thumb points direction of $\vec{u} \times \vec{v}$

$\vec{v} \times \vec{u} = -(\vec{u} \times \vec{v})$

$\vec{u} \times \vec{v} =$



$= \langle 11, -(6), -1 \rangle$