Calc III Notes

Pierson

August 29, 2025

1 Multivariable calc goals

- vectors and geometry of R”
- functions of serval variables diff and int
- higher dimensional versions of FTC
- fund them for line integrals
- greens them
- stokes them
- divergence them

12 Chapter 12: vectors and geo of space

12.1

- $$R = line$$
  dist(x,y) = $|y - x|$
- $$R^2 = Plane$$
  Orders pairs of (x,y) of real numbers
- $$R^3 = space$$
  ordered triples of (x,y,z) of real numbers

right-hand rule: point fingers toward pos x-axis and curl towards pos y-axis, thumb should point to positive z

R^n = n-tuples $(x_1, x_2, ...x_n)$ n-dim space

Distance D from (0,0) to (x,y)

$$D^2 = x^2 + y^2$$

Distance D from (0,0,0) to (x,y,z)

$$D = \sqrt{x^2 + yy^2 + z^2}$$

Sphere with center X_0, Y_0, Z_0 and radius R has equation:

$$(X - X_0)^2 + (y - y_0)^2 + (z - z_0)^2 = r^2$$

Find equation of the set of points equidistanst from the points a1,4,2, and b 3,3,3

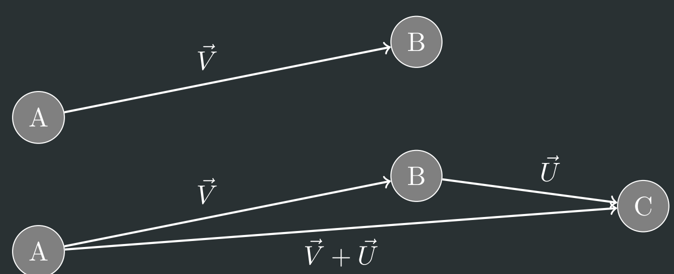
$$AX = \sqrt{(x-1)^2 + (y-4)^2 + (z-2)^2}$$
$$BX = \sqrt{(x-3)^2 + (y-3)^2 + (z-3)^2}$$

set AX = BX
Result is a **plane**

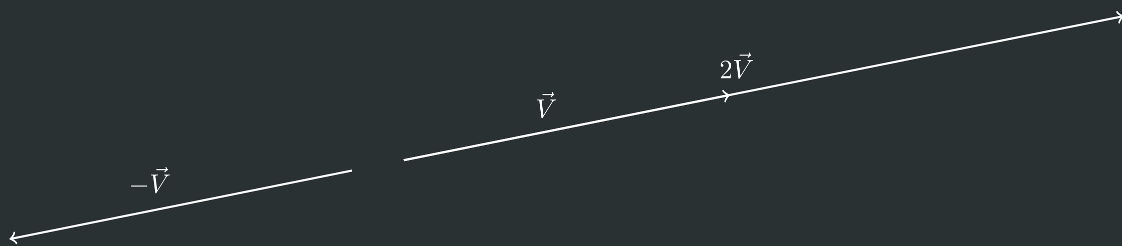
12.2 vectors and geo of space

scaler = magnitude ≤ 0
vector = magnitude + direction

$\vec{u} =< 5, 3 >$, $\vec{u} = 5\hat{i} + 3\hat{j}$



12.2.1 scaler multiple



Changes the length of the vectors, ie, stretches them in a direction.
Length of k$\vec{v} = |K| * |V|$
direction of $k\vec{V} = sameas\vec{V}ifk > 0$
real numbers work like scaling factors

Points = (a,b)
Vector = $< a, b >$

12.2.2 Vectors in R^3

Extra cords for points and extra comps for vectors
point = (a,b,c)
vector = $< a, b, c >$

$$if\vec{V} = P_1\vec{P}_2, then|\vec{V}| = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$$

$P(4, -1, -3)$
$Q(8, 0, -5)$
$R(0, -2, -1)$

$\vec{PQ} =< 8 - 4, 0 - -1, -5 - -3 >$

$$\vec{u} =< 3, 1, 3 >$$

$$\vec{v} =< 1, 3, 7 >$$

$$\vec{v} + \vec{v} =< 3 + 1, 1 + 3, 3 + 7 >$$

$$5 * \vec{v} =< 1 * 5, 3 * 5, 7 * 5 >$$

12.2.3 notation

$$V_n$$

set of all n-dim vectors $< V_1, V_2, ..., V_n >$
V_3 set of all vectors $< v_1, v_2, v_3 >$
$\hat{i} =< 1, 0, 0 >$

$\hat{j} =< 0, 1, 0 >$
$\hat{k} =< 0, 0, 1 >$

unit vector = vector of length 1
$\hat{i}, \hat{j}, \hat{k}$ are unit vectors
find the unit vector that has the same direction as $\vec{b} = 4\hat{i} - 2\hat{j} + 3\hat{k}$

$$\sqrt{4^2(-2)^2 + 3^2}$$

$$\sqrt{16 + 4 + 9}$$

$$\sqrt{29}$$

$$\frac{\vec{b}}{|\vec{b}|} = \frac{1}{\sqrt{29}}(4\hat{i} - 2\hat{j} + 3\hat{k})$$

12.2.4 dot product

dot product $\rightarrow$ 2 vectors $\rightarrow$ 1 scaler
cross product $\rightarrow$ 2 vectors $\rightarrow$ 1 vector

$$\vec{a} \cdot \vec{b} = a_1 b_1 + a_2 b_2 + a_3 b_3$$

Properties

$$\vec{a} \cdot \vec{a} = \vec{a}^2$$

if θ is the angle between the vectors $\vec{a}$ and $\vec{b}$, then $\vec{a} \cdot \vec{b} = |\vec{a}||\vec{b}| \cos(\theta)$

follows from the law of cosines

$\vec{a}$ and $\vec{b}$ are orthogonal (or perp) if te angle between them is $\theta = \frac{\pi}{2}$

the zero vector $\vec{0}$ is considered orthogonal to all vectors

$\vec{a} \cdot \vec{b} = 0 <=> \vec{a} \perp \vec{b}$, orthogonal, form 90deg angle

13 Chapter 13: vector functions

14 Chapter 14: partial derivate

15 Chapter 15: multiple integrals

16 Chapter 16: vector calculus