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Hours: MWF 12:30-1:30 TuW 2:50-3:50

Vector: Collection of arrows sharing the same length and direction
- Notation: $\underline{a}$, $\vec{AB}$, $\mathbf{a}$, $\vec{a}$
- Length: $|\langle a_1, a_2\rangle| = \sqrt{a_1^2 + a_2^2}$
- Unit vector: $|\underline{a}| = 1$
- Special unit vectors: $\underline{i} = \langle 1, 0, 0\rangle$, $\underline{j} = \langle 0, 1, 0\rangle$, $\underline{k} = \langle 0, 0, 1\rangle$
- $\langle a_1, a_2, a_3\rangle = a_1\underline{i} + a_2\underline{j} + a_3\underline{k}$
- Unitization of $\underline{a}$: $\underline{u} = \frac{\underline{a}}{|\underline{a}|}$
- Scalar multiplication: $\alpha\langle a_1, a_2\rangle = \langle \alpha a_1, \alpha a_1\rangle$
- Addition: $\langle a_1, a_2\rangle + \langle b_1, b_2\rangle = \langle a_1 + b_1, a_2 + b_2\rangle$
- Distributivity: $\alpha(\underline{a} + \underline{b}) = \alpha\underline{a} + \alpha\underline{b}$

Dot product
- Definition: $\underline{a} \cdot \underline{b} = |\underline{a}|\,|\underline{b}| \cos(\gamma)$
- Coordinates: $\langle a_1, a_2\rangle \cdot \langle b_1, b_2\rangle = a_1 b_1 + a_2 b_2$
- Scalar projection of $\underline{b}$ onto $\underline{a}$: $\underline{u} \cdot \underline{b}$ where $\underline{u}$ is the unitization of $\underline{a}$
- Vector projection of $\underline{b}$ onto $\underline{a}$: $(\underline{u} \cdot \underline{b})\underline{u}$
- The length of the vector projection is the absolute value of the scalar projection
- Angle: $\cos(\gamma) = \frac{\underline{a}\cdot\underline{b}}{|\underline{a}|\,|\underline{b}|}$
- Perpendicular: $\underline{a} \perp \underline{b}$ if and only if $\underline{a} \cdot \underline{b} = 0$
- Length: $\underline{a}^2 := \underline{a} \cdot \underline{a} = |\underline{a}|^2$

Crossed product
- Notation: $\underline{a} \times \underline{b}$
- Definition: $|\underline{a} \times \underline{b}| = |\underline{a}|\,|\underline{b}| \sin(\gamma)$, $\underline{a} \perp \underline{a} \times \underline{b} \perp \underline{b}$, $(\underline{a}, \underline{b}, \underline{a} \times \underline{b})$ is a 'right system'
- Coordinates: $\langle a_1, a_2, a_3\rangle \times \langle b_1, b_2, b_3\rangle = \begin{vmatrix} \underline{i} & \underline{j} & \underline{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$
- Not commutative: $\underline{a} \times \underline{b} = -\underline{b} \times \underline{a}$
- Area of parallelogram: $|\underline{a} \times \underline{b}|$
- Signed volume of parallelepiped: $\underline{a} \cdot (\underline{b} \times \underline{c})$
- Parallel: $\underline{a} \parallel \underline{b}$ if and only if $\underline{a} \times \underline{b} = 0$

Equation of a line
- Vector form: $\underline{n} \cdot (\underline{r} - \underline{r}_0) = 0$
- Normal form: $Ax + By = C$ where $\underline{n} = \langle A, B\rangle$ and $C = Ax_0 + By_0$
- Parametric equation: $\underline{r} = \underline{r}_0 + t\underline{v}$
- Perpendicular lines: $\underline{n}_\perp = \langle -B, A\rangle$ if $\underline{n} = \langle A, B\rangle$
- Signed distance of the point $\underline{p}$ from the line $\underline{n} \cdot (\underline{r} - \underline{r}_0) = 0$ is: $d = \frac{\underline{n}}{|\underline{n}|} \cdot (\underline{p} - \underline{r}_0)$

Equation of a plain
- Vector form: $\underline{n} \cdot (\underline{r} - \underline{r}_0) = 0$
- Normal form: $Ax + By + Cz = D$ where $D = Ax_0 + By_0 + Cz_0$
- Signed distance of the point $\underline{p}$ from the plane $\underline{n} \cdot (\underline{r} - \underline{r}_0) = 0$ is: $d = \frac{\underline{n}}{|\underline{n}|} \cdot (\underline{p} - \underline{r}_0)$

Equation of a circle or a sphere
- Vector form: $|\underline{r} - \underline{c}| = r$
- Normal form: $(x - c_1)^2 + (y - c_2)^2 + (z - c_3)^2 = r^2$ (sphere)