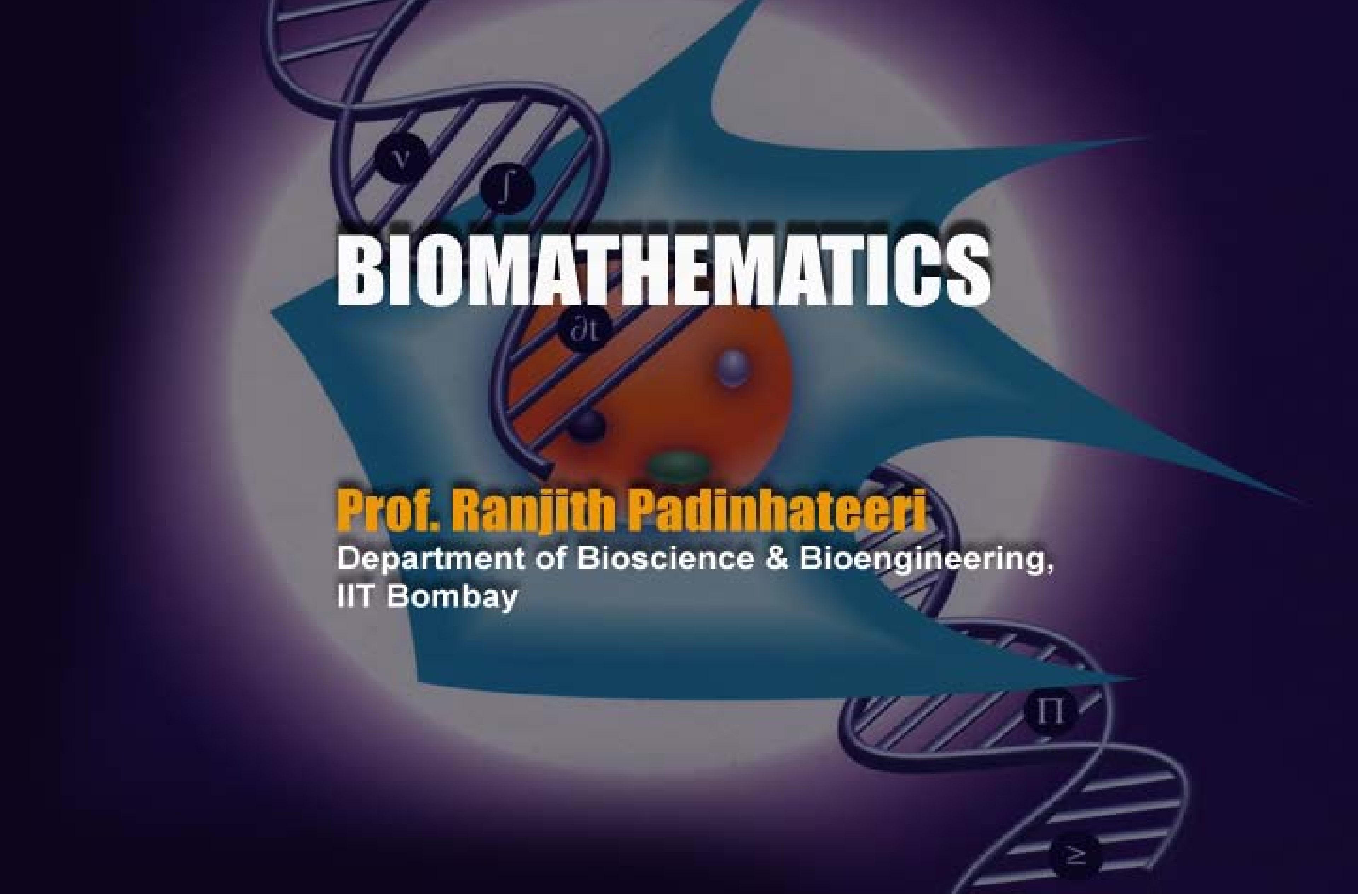

BIOMATHEMATICS

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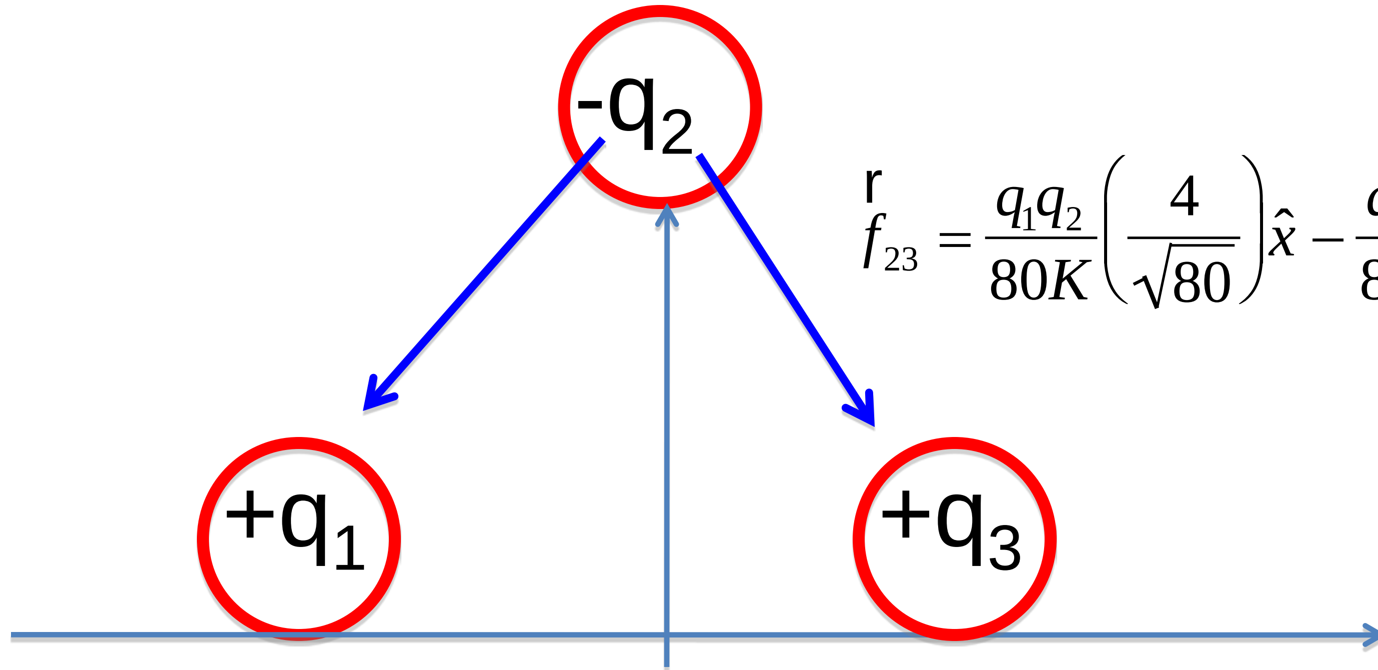
Lecture 16

Vectors-3



$$\vec{f}_{23} = \frac{q_1 q_2}{80K}\left(\frac{4}{\sqrt{80}}\right)\hat{x} - \frac{q_1 q_2}{80K}\left(\frac{8}{\sqrt{80}}\right)\hat{y}$$

$$\vec{f}_{21} = -0.6\frac{q_1 q_2}{100K}\hat{x} - 0.8\frac{q_1 q_2}{100K}\hat{y}$$

$$\vec{f}_2 = \vec{f}_{21} + \vec{f}_{23}$$

We learned about:

- Finding out resultant force
- Unit vector
- Magnitude of a vector
- Direction of a vector

Addition of vectors

Vectors can be added by adding individual components. E.g.

$$\vec{A} = a_1\hat{x} + a_2\hat{y} + a_3\hat{z}$$

$$\vec{B} = b_1\hat{x} + b_2\hat{y} + b_3\hat{z}$$

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

$$\vec{C} = (a_1 + b_1)\hat{x} + (a_2 + b_2)\hat{y} + (a_3 + b_3)\hat{z}$$

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Subtraction of vectors

Vectors can be subtracted by subtracting their individual components. E.g.

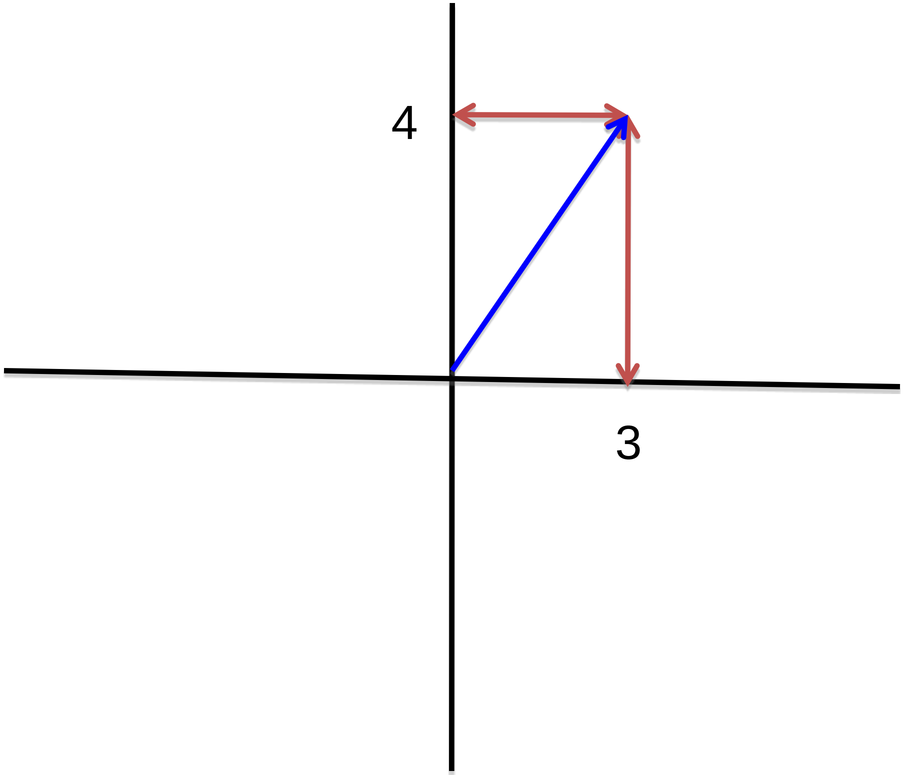
$$\vec{A} = a_1\hat{x} + a_2\hat{y} + a_3\hat{z}$$

$$\vec{B} = b_1\hat{x} + b_2\hat{y} + b_3\hat{z}$$

$$\vec{C} = \vec{A} - \vec{B}$$

$$\vec{C} = (a_1 - b_1)\hat{x} + (a_2 - b_2)\hat{y} + (a_3 - b_3)\hat{z}$$

We saw that two numbers specify a vector in 2D e.g. position of an atom

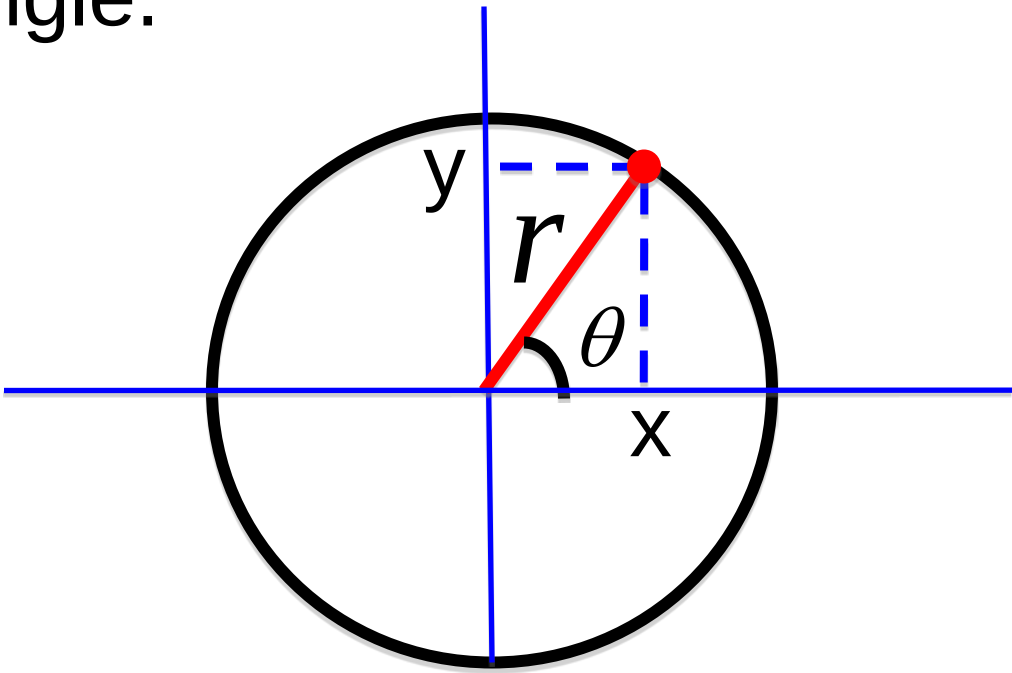


Plane polar co-ordinate

We can represent the same using a distance and an angle.

$$x = r\cos\theta$$

$$y = r\sin\theta$$



How do we find the product of two vectors ?

Product of vectors

You can imagine two situations

1) Product of two vectors is a scalar :
(Scalar product)

Eg. When you apply a force and change the position of an object, the product of force and displacement is work, which is a scalar

2) Product of two vectors is another vector : Vecto

Product of vectors

2) Product of two vectors is another vector
(Vector product)

Eg. Applying a force to twist DNA

or

Applying a force to rotate an object

Scalar product of vectors

$$\vec{f} = a_1\hat{x} + a_2\hat{y} + a_3\hat{z}$$

$$\vec{x} = b_1\hat{x} + b_2\hat{y} + b_3\hat{z}$$

$$C = \vec{f} \bullet \vec{x}$$

$$C = |\vec{f}||\vec{x}|\cos\theta$$

$$C = a_1b_1 + a_2b_2 + a_3b_3$$

Also known as “dot product”

Vector product

$$\vec{r} = r_1\hat{x} + r_2\hat{y} + r_3\hat{z}$$

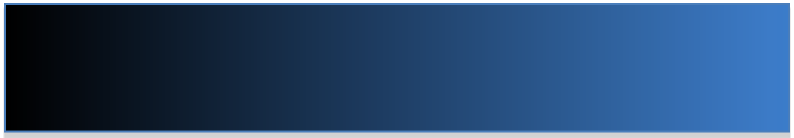
$$\vec{f} = f_1\hat{x} + f_2\hat{y} + f_3\hat{z}$$

$$\vec{T} = \vec{r} \times \vec{f}$$

$$\vec{T} = |\vec{r}||\vec{f}|\sin\theta\hat{n}$$

Also known as “cross product”

Gradient of a scalar



$$grad\,C = \vec{\nabla} C = \frac{\partial C}{\partial x}\hat{x}$$

Summary

- Plain polar co-ordinates
- Dot product and cross product
- Gradient