

# Assignment 4

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## Geometry

**Abstract**—This documnet contains the solution to prove angles of a equilateral triangles are 60 degrees through Linear Algebra .

Download all python codes from

[https://github.com/shivangi-975/EE5609-Matrix\\_Theory/tree/master/Assignment4/Codes](https://github.com/shivangi-975/EE5609-Matrix_Theory/tree/master/Assignment4/Codes)

Download latex-tikz codes from

[https://github.com/shivangi-975/EE5609-Matrix\\_Theory/blob/master/Assignment4/Assignment4.tex](https://github.com/shivangi-975/EE5609-Matrix_Theory/blob/master/Assignment4/Assignment4.tex)

### 1 PROBLEM

To prove angles of equilateral triangles are 60°each.

### 2 SOLUTION

Considering A,B and C as the vertices of triangle:

$A = \begin{pmatrix} x_1 \\ y_1 \end{pmatrix}$   $B = \begin{pmatrix} x_2 \\ y_2 \end{pmatrix}$   $C = \begin{pmatrix} x_3 \\ y_3 \end{pmatrix}$  Expressing each side in terms of norm we have:

$$\|A\| = \sqrt{x_1^2 + y_1^2} \quad (2.0.1)$$

$$\|B\| = \sqrt{x_2^2 + y_2^2} \quad (2.0.2)$$

$$\|C\| = \sqrt{x_3^2 + y_3^2} \quad (2.0.3)$$

we know for equilateral triangle all sides are equal,Hence we have:

$$\|A\| = \|B\| = \|C\| \quad (2.0.4)$$

Now taking inner product we have:

$$\mathbf{A}^T \mathbf{B} = |A||B| \cos \theta \quad (2.0.5)$$

$$= (\sqrt{x_1^2 + y_1^2} \sqrt{x_2^2 + y_2^2}) \cos \theta = (x_1^2 + y_1^2) \cos \theta \quad (2.0.6)$$

$$\mathbf{B}^T \mathbf{C} = |B||C| \cos \theta \quad (2.0.7)$$

$$= (\sqrt{x_2^2 + y_2^2} \sqrt{x_3^2 + y_3^2}) \cos \theta = (x_2^2 + y_2^2) \cos \theta \quad (2.0.8)$$

$$\mathbf{C}^T \mathbf{A} = |C||A| \cos \theta \quad (2.0.9)$$

$$= (\sqrt{x_3^2 + y_3^2} \sqrt{x_1^2 + y_1^2}) \cos \theta = (x_3^2 + y_3^2) \cos \theta \quad (2.0.10)$$