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
```

Download latex-tikz codes from

```
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

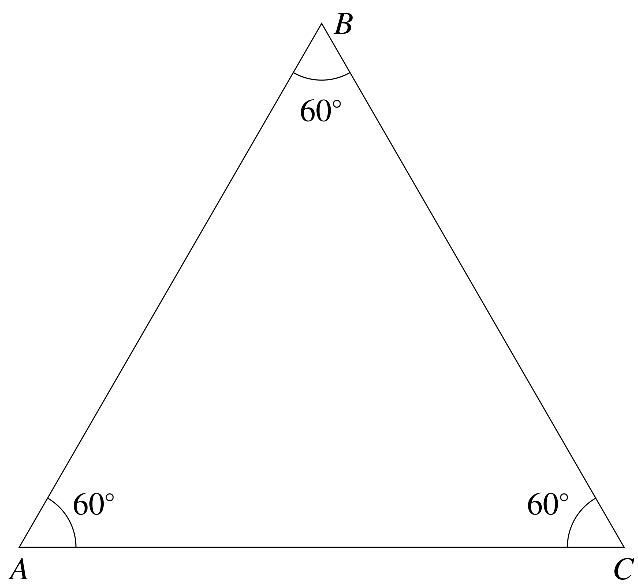

Fig. 1: Equilateral $\triangle ABC$ with A,B and C as vertices

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:

$$\|A\| = \sqrt{x_1^2 + y_1^2} \tag{2.0.1}$$

$$\|B\| = \sqrt{x_2^2 + y_2^2} \tag{2.0.2}$$

$$\|C\| = \sqrt{x_3^2 + y_3^2} \tag{2.0.3}$$

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

$$\|A\| = \|B\| = \|C\| \tag{2.0.4}$$

Now taking inner product we have:

$$\mathbf{A}^T\mathbf{B} = (\sqrt{x_1^2 + y_1^2}\sqrt{x_2^2 + y_2^2})\cos\theta = (x_1^2 + y_1^2)\cos\theta \tag{2.0.5}$$

$$\mathbf{B}^T\mathbf{C} = (\sqrt{x_2^2 + y_2^2}\sqrt{x_3^2 + y_3^2})\cos\theta = (x_1^2 + y_1^2)\cos\theta \tag{2.0.6}$$

$$\mathbf{C}^T\mathbf{A} = (\sqrt{x_3^2 + y_3^2}\sqrt{x_1^2 + y_1^2})\cos\theta = (x_1^2 + y_1^2)\cos\theta \tag{2.0.7}$$

From 2.0.5 2.0.6 and 2.0.7 we have

$$\mathbf{A}^T\mathbf{B} = \mathbf{B}^T\mathbf{C} = \mathbf{C}^T\mathbf{A} \tag{2.0.8}$$