Assignment 4

Shivangi Parashar

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

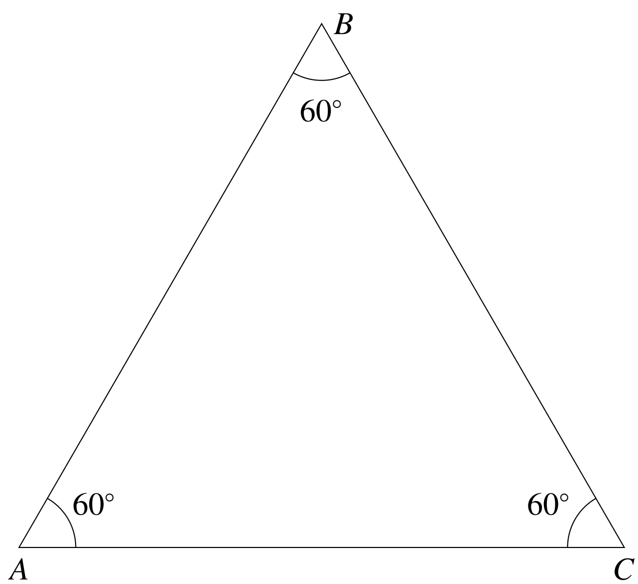

Fig. 1: Equilateral $\triangle ABC$ with A,B and C as vertices

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

$$A = \begin{pmatrix} 0 \\ 0 \end{pmatrix} B = \begin{pmatrix} x_1 \\ y_1 \end{pmatrix} C = \begin{pmatrix} x_2 \\ y_2 \end{pmatrix}$$

In equilateral triangle we have:

$$\|\mathbf{A} - \mathbf{B}\| = \|\mathbf{B} - \mathbf{C}\| = \|\mathbf{A} - \mathbf{C}\| \tag{2.0.1}$$

Taking square of Norm forms we have

$$\|\mathbf{A} - \mathbf{B}\|^2 = x_1^2 + y_1^2 \tag{2.0.2}$$

$$\|\mathbf{A} - \mathbf{c}\|^2 = x_2^2 + y_2^2 \tag{2.0.3}$$

$$\|\mathbf{B} - \mathbf{c}\|^2 = (x_2 - x_1)^2 + (y_2 - y_1)^2 \tag{2.0.4}$$

Taking inner products of side **AB** and **BC** we get $\angle BAC.Hence$,

$$\angle BAC = \|\mathbf{A} - \mathbf{B}\|^T \|\mathbf{B} - \mathbf{C}\|$$
$$\angle BAC = (x_1^2 + y_1^2)\cos\theta \tag{2.0.5}$$

Taking inner products of side **BC** and **AC** we get $\angle BCA$ .Hence,

$$\angle BCA = \|\mathbf{A} - \mathbf{B}\|^T \|\mathbf{B} - \mathbf{C}\|$$
$$\angle BCA = (x_1^2 + y_1^2)\cos\theta \tag{2.0.6}$$

Taking inner products of side **AB** and **BC** we get $\angle ABC$. Hence,

$$\angle ABC = \|\mathbf{A} - \mathbf{B}\|^T \|\mathbf{B} - \mathbf{C}\|$$
$$\angle ABC = (x_1^2 + y_1^2)\cos\theta \tag{2.0.7}$$

Hence from 2.0.5 ,2.0.6 and 2.0.7 we have for equilateral triangle $\angle BAC$=$\angle BCA$=$\angle ABC$.