# Assignment 2

## Neeraj Kumar

## 1 QUESTION NO. 2.3 - QUADRATIC FORMS

Find the locus of all the unit vectors in the xy-plane

## 2 SOLUTION

let,the unit vector be $\mathbf{a} = 1$, $OA = \mathbf{a}$
We know that,

$$\mathbf{a} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k} \qquad (2.0.1)$$

since the vector in xy plane, there is no z-coordinate.Hence,

$$\mathbf{a} = x\mathbf{i} + y\mathbf{j} \qquad (2.0.2)$$

Taking a general vector
Angle AOB with x-axis in between is $\mathbf{a}$ and $\mathbf{i}$ is $\angle AOB$ we know that,

$$\mathbf{a}.\mathbf{b} = |\mathbf{a}||\mathbf{b}| \cos AOB \qquad (2.0.3)$$

$$\mathbf{a}.\mathbf{b} = |\mathbf{a}||\mathbf{b}| \cos AOB \qquad (2.0.4)$$

putting $a = a$, $b = i$ , as we know that a is unit vector

$$\mathbf{a}.\mathbf{i} = \cos AOB \qquad (2.0.5)$$

$$(x\mathbf{i} + y\mathbf{j} + z\mathbf{k}).\mathbf{i} = \cos AOB \qquad (2.0.6)$$

$$(x\mathbf{i} + y\mathbf{j} + z\mathbf{0})(x\mathbf{1} + y\mathbf{0} + z\mathbf{0}) = \cos AOB \qquad (2.0.7)$$

$$x = \cos AOB \qquad (2.0.8)$$

Angle with y-axis, in between $\mathbf{a}$, and $\mathbf{j}$ is $(90° − \angle AOB)$
so, angle between

$$\mathbf{a}.\mathbf{j} = |\mathbf{a}||\mathbf{j}|(90° − \cos AOB) \qquad (2.0.9)$$

$$\mathbf{a}.\mathbf{j} = (\sin AOB) \qquad (2.0.10)$$

$$(x\mathbf{i} + y\mathbf{j} + z\mathbf{k}).\mathbf{j} = \cos AOB \qquad (2.0.11)$$

$$(x\mathbf{i} + y\mathbf{j} + z\mathbf{0})(x\mathbf{0} + y\mathbf{1} + z\mathbf{0}) = \cos AOB \qquad (2.0.12)$$

$$y = \sin AOB \qquad (2.0.13)$$

Thus,

$$\mathbf{a} = x\mathbf{i} + y\mathbf{j} \qquad (2.0.14)$$

$$\mathbf{a} = (\cos AOB)\mathbf{i} + (\cos AOB)\mathbf{j} \qquad (2.0.15)$$
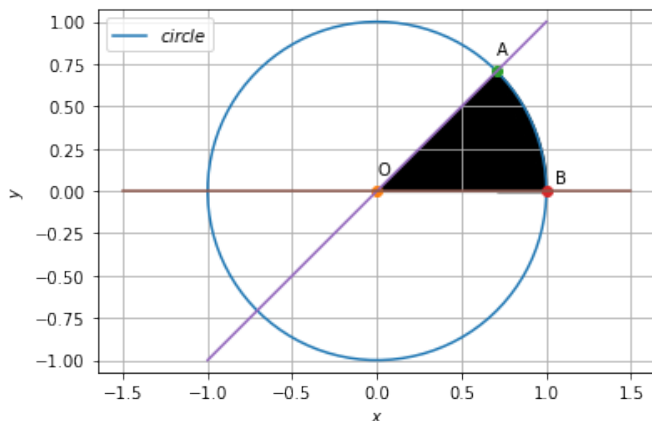
This value will be in all quadrants($0°$ to $360°$)



Fig. 0: unit vector