

# ASSIGNMENT 3

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Download all python codes from

<https://github.com/AmulyaTallamraju/EE3900/blob/main/Assignment-3/codes/Assignment-3.py>

and latex-tikz codes from

<https://github.com/AmulyaTallamraju/EE3900/blob/main/Assignment-3/Assignment-3.tex>

Where

$$\angle M = \theta \quad (2.0.3)$$

$$\angle O = \alpha \quad (2.0.4)$$

$$\angle R = \delta \quad (2.0.5)$$

$$\|\mathbf{O} - \mathbf{M}\| = a, \quad (2.0.6)$$

$$\|\mathbf{R} - \mathbf{O}\| = b, \quad (2.0.7)$$

$$\|\mathbf{R} - \mathbf{E}\| = c \quad (2.0.8)$$

$$\|\mathbf{M} - \mathbf{E}\| = d \quad (2.0.9)$$

$$\|\mathbf{M} - \mathbf{R}\| = e \quad (2.0.10)$$

$$\theta = \theta_1 + \theta_2 \quad (2.0.11)$$

$$\delta_1 = \angle ERM \quad (2.0.12)$$

$$\delta_2 = \angle ORM \quad (2.0.13)$$

$$\gamma = \angle E \quad (2.0.14)$$

$$d = e \times \left( \frac{\sin \left( \delta - \sin^{-1} \left[ \sin \alpha \times \left( \frac{b}{e} \right) \right] \right)}{\sin (360^\circ - (\alpha + \theta + \delta))} \right) \quad (2.0.15)$$

$$e = \sqrt{a^2 + b^2 - 2 \times a \times b \cos \alpha} \quad (2.0.16)$$

## 1 CONSTRUCTION 2.10

Construct a quadrilateral MORE where  $MO = 6$ ,  $OR = 4.5$ ,  $\angle M = 60^\circ$ ,  $\angle O = 105^\circ$  and  $\angle R = 105^\circ$ .

## 2 SOLUTION

**Lemma 2.1.** *If three angles and two sides of a quadrilateral are known, then the coordinates of the vertices can be expressed as*

$$\mathbf{R} = \mathbf{O} + b \times \begin{pmatrix} \cos (180^\circ - \alpha) \\ \sin (180^\circ - \alpha) \end{pmatrix} \quad (2.0.1)$$

$$\mathbf{E} = d \begin{pmatrix} \cos \theta \\ \sin \theta \end{pmatrix} \quad (2.0.2)$$

*Proof.* Using angle sum rule of quadrilaterals

$$\gamma = 360^\circ - (\alpha + \theta + \delta) \quad (2.0.17)$$

Now, using cosine formula in  $\triangle MOR$  we can find  $e$ :

$$e^2 = a^2 + b^2 - 2 \times a \times b \cos \alpha \quad (2.0.18)$$

Using sine rule,

$$\frac{\sin \alpha}{e} = \frac{\sin \delta_2}{b} \quad (2.0.19)$$

$$\delta_2 = \sin^{-1} \left[ \sin \alpha \times \left( \frac{b}{e} \right) \right] \quad (2.0.20)$$

$$(2.0.21)$$

Now in  $\triangle MER$ ,

$$\delta_1 = \delta - \delta_2 \quad (2.0.22)$$

Using sine law of triangle,

$$\frac{\sin \gamma}{e} = \frac{\sin \delta_1}{d} \quad (2.0.23)$$

$$\Rightarrow d = e \times \left( \frac{\sin \delta_1}{\sin \gamma} \right) \quad (2.0.24)$$

From the above equations, we get

$$d = e \times \left( \frac{\sin \left( \delta - \sin^{-1} \left[ \sin \alpha \times \left( \frac{b}{e} \right) \right] \right)}{\sin (360^\circ - (\alpha + \theta + \delta))} \right) \quad (2.0.25)$$

where

$$e = \sqrt{a^2 + b^2 - 2 \times a \times b \cos \alpha} \quad (2.0.26)$$

□

Calculating the co-ordinates of **R**:

Putting the values in the above equation we get,

$$\Rightarrow \mathbf{R} = \begin{pmatrix} 6 \\ 0 \end{pmatrix} + 4.5 \begin{pmatrix} -\cos 105^\circ \\ \sin 105^\circ \end{pmatrix} \quad (2.0.27)$$

$$\Rightarrow \mathbf{R} = \begin{pmatrix} 6 \\ 0 \end{pmatrix} + \begin{pmatrix} 1.16 \\ 4.35 \end{pmatrix} \quad (2.0.28)$$

$$\mathbf{R} = \begin{pmatrix} 7.16 \\ 4.35 \end{pmatrix} \quad (2.0.29)$$

Calculating the co-ordinates of **E**:

Putting the values in the above equation we get,

$$\Rightarrow \mathbf{E} = 7.34 \begin{pmatrix} \cos 60^\circ \\ \sin 60^\circ \end{pmatrix} \quad (2.0.30)$$

$$\Rightarrow \mathbf{E} = \begin{pmatrix} 3.67 \\ 6.36 \end{pmatrix} \quad (2.0.31)$$

Now, we have the coordinate of vertices **M**, **O**, **R**, **E** as,

$$\mathbf{M} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \mathbf{O} = \begin{pmatrix} 6 \\ 0 \end{pmatrix}, \mathbf{R} = \begin{pmatrix} 7.16 \\ 4.35 \end{pmatrix}, \mathbf{E} = \begin{pmatrix} 3.67 \\ 6.36 \end{pmatrix}. \quad (2.0.32)$$

On constructing the given quadrilateral on python we get:

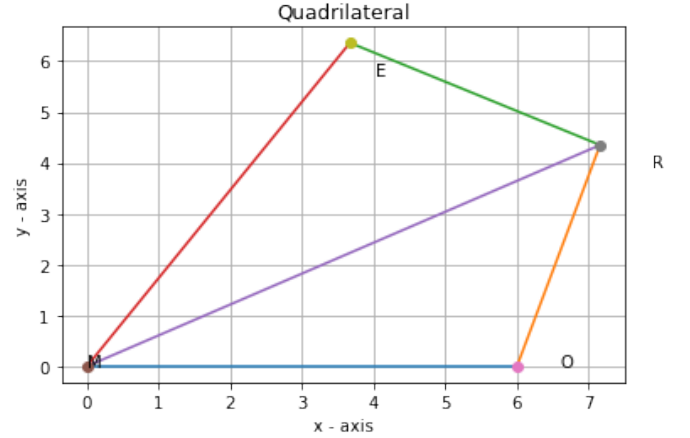


Fig. 0: Quadrilateral MORE