Geometric Constructions through Python

G V V Sharma*

Contents

***Abstract*—This manual shows how to construct geometric figures using Python. Exercises are based on NCERT math textbooks of Class 9 and 10.**

1 Triangle

1.1 Draw $\triangle ABC$ where $\angle B = 90°, a = 4$ and $b = 3$.

1.2 Draw a line segement of length 7.6 cm and divide it in the ratio 5 : 8.

1.3 Construct a triangle of sides $a = 4$cm, $b = 5$ cm and $c = 6$ cm.

1.4 Construct a triangle of sides $a = 5$cm, $b = 6$ cm and $c = 7$ cm. Construct a similar triangle whose sides are $\frac{7}{5}$ times the corresponding sides of the first triangle.

1.5 Construct an isosceles triangle whose base is $a = 8$cm and altitude $AD = 4$cm

1.6 Draw $\triangle ABC$ with $a = 6, c = 5$ and $\angle ABC = 60°$.

1.7 Draw $\triangle ABC$ with $a = 7, \angle B = 45°$ and $\angle A = 105°$.

1.8 In $\triangle ABC$, $a = 7, \angle B = 75^\circ$ and $b + c = 13$. Find b and c and sketch $\triangle ABC$.

1.9 In $\triangle ABC$, $a = 8, \angle B = 45^\circ$ and $c - b = 3.5$. Sketch $\triangle ABC$.

1.10 In $\triangle ABC$, $a = 6, \angle B = 60^\circ$ and $b - c = 2$. Sketch $\triangle ABC$.

1.11 $\triangle ABC$ is right angled at **B**. If $a = 12$ and $b + c = 18$, find a, b, c and draw the triangle.

Solution: From Baudhayana's theorem,

$$b^2 = a^2 + c^2 \tag{1}$$

*The author is with the Department of Electrical Engineering, Indian Institute of Technology, Hyderabad 502285 India e-mail: gadepall@iith.ac.in.

1.12 In $\triangle ABC$, given that $a + b + c = 11, \angle B = 45^\circ$ and $\angle C = 45^\circ$, find a, b, c.

Solution: We have

$$a = b\cos C + c\cos B \tag{2}$$

$$b\sin C = c\sin B \tag{3}$$

$$a + b + c = 11 \tag{4}$$

resulting in the matrix equation

$$\begin{pmatrix} 1 & -\cos C & -\cos B \\ 0 & \sin C & -\sin B \\ 1 & 1 & 1 \end{pmatrix} \begin{pmatrix} a \\ b \\ c \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 11 \end{pmatrix} \tag{5}$$

Solving the equivalent matrix equation gives the desired answer.

1.13 Draw $\triangle ABC$, given that $a + b + c = 11, \angle B = 30^\circ$ and $\angle C = 90^\circ$, find a, b, c.

2 Circle

2.1 Draw a circle with centre **B** and radius 6. If **C** be a point 10 units away from its centre, construct the pair of tangents AC and CD to the circle.

Solution: From the given information, in $\triangle ABC, AC \perp AB, a = 10$ and $c = 6$.

$$b = \sqrt{a^2 - c^2} \tag{6}$$

2.2 Construct a tangent to a circle of radius 4 units from a point on the concentric circle of radius 6 units.

2.3 Draw a circle of radius 3 units. Take two points **P** and **Q** on one of its extended diameter each at a distance of 7 units from its centre. Draw tangents to the circle from these two points **P** and **Q**.

2.4 Draw a pair of tangents to a circle of radius 5 units which are inclined to each other at an angle of 60°.

2.5 Draw a line segment AB of length 8 units. Taking **A** as centre, draw a circle of radius

4 units and taking **B** as centre, draw another circle of radius 3 units. Construct tangents to each circle from the centre of the other circle.

2.6 Let ABC be a right triangle in which $a = 8, c = 6$ and $\angle B = 90^{\circ}$. BD is the perpendicular from **B** on AC. The circle through $\mathbf{B}, \mathbf{C}, \mathbf{D}$ is drawn. Construct the tangents from **A** to this circle.