

Similarity of
Triangles

Srihari S

Question

Construction

Codes and figures

Construction
methods

Construction
methods

Construction
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Solution

a

b

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College of Engineering - Guindy

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Exercise 8.1(Q no.51)

O is a point in the interior of $\triangle ABC$. D is a point on OA. If $DE \parallel OB$ and $DF \parallel OC$. Show that $EF \parallel BC$.

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The python code for the figure is

```
./codes/similartriangle.py
```

The latex- tikz code is

```
./figs/constructionpic.tex
```

The above latex code can be compiled as standalone document

```
./figs/constructionpic_standalone.tex
```

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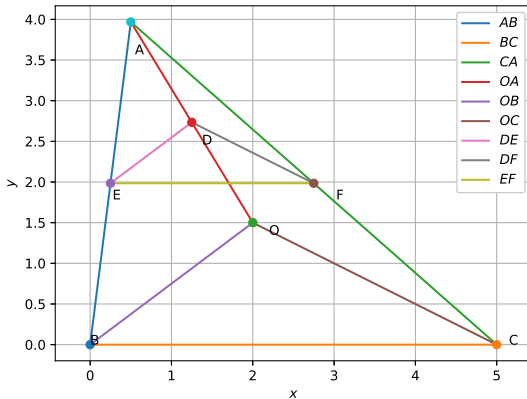
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(a) By Python

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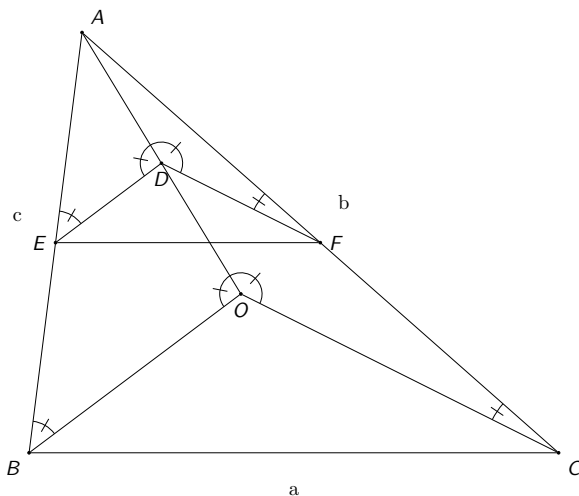


Figure: By Latex-tikz

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The values used for constructing the triangles in both Python and \LaTeX -Tikz is given below:

Initial Input Values	
Parameter	Value
a	5
b	6
c	4

Table: To construct $\triangle ABC$

Finding the coordinates of various points of $\triangle ABC$:

From the information provided, let

$$B = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \quad C = \begin{pmatrix} a \\ 0 \end{pmatrix} \quad A = \begin{pmatrix} p \\ q \end{pmatrix}$$

Given a point O, we need to determine whether it lies inside $\triangle ABC$.

A point O is said to lie inside $\triangle ABC$ if and only if all of the cross products $AB \times AO$, $BC \times BP$ and $CA \times CP$ are ≥ 0 .

Let the arbitrary interior point O be represented as $\begin{pmatrix} 2 \\ 1.5 \end{pmatrix}$.

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D is a point on line AO such that $DE \parallel OB$ and $DF \parallel OC$.

Determination of points D, E and F:

As $DE \parallel OB$, by basic proportionality theorem the points E and D, divide the lines AB and AO respectively in the same ratio.

Hence we choose points E and D such that

$$\frac{AE}{EB} = \frac{AD}{DO} \quad (1)$$

Similarly point F is chosen such that the points F and D, divide the lines AC and AO respectively in the same ratio such that

$$\frac{AF}{FC} = \frac{AD}{DO} \quad (2)$$

Derived Values	
Parameter	Value
p	0.5
q	3.96

Table: To construct $\triangle ABC$

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If the point D divides the line AO in the ratio $x:y$, the coordinates of D is given by section formula as:

$$D = \frac{yA + xO}{x + y} \quad (3)$$

Similarly the coordinates of points E and F is given by

$$E = \frac{yA + xB}{x + y} \quad (4)$$

$$F = \frac{yA + xC}{x + y} \quad (5)$$

Let us assume the points divide the respective lines in the ratio 1:1. Then the coordinates of points D, E and F is

$$D = \begin{pmatrix} 1.25 \\ 2.73 \end{pmatrix}$$

$$E = \begin{pmatrix} 0.25 \\ 1.98 \end{pmatrix}$$

$$F = \begin{pmatrix} 2.75 \\ 1.98 \end{pmatrix}$$

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$\triangle EAD \sim \triangle BAO$ by AAA Similarity:

Since $DE \parallel OB$,

① $\angle DEA = \angle OBA$ {Alternate Interior Angles}

② $\angle ADE = \angle AOB$ {Alternate Interior Angles}

③ $\angle EAD = \angle BAO$ {Common angle}

Therefore

$$\frac{AE}{AB} = \frac{AD}{AO} \quad (6)$$

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Similarly $\triangle FDA \sim \triangle COA$ by AAA Similarity:

Since $DF \parallel OC$,

$$\textcircled{1} \quad \angle DFA = \angle OCA \quad \{ \textit{Alternate Interior Angles} \}$$

$$\textcircled{2} \quad \angle ADF = \angle AOC \quad \{ \textit{Alternate Interior Angles} \}$$

$$\textcircled{3} \quad \angle FAD = \angle CAO \quad \{ \textit{Common angle} \}$$

Therefore

$$\frac{AF}{AC} = \frac{AD}{AO} \quad (7)$$

Hence from the above we conclude,

$$\frac{AF}{AC} = \frac{AE}{AB} = \frac{AD}{AO} \quad (8)$$

As the ratio of the sides is the same, $\triangle ABC \sim \triangle AEF$, which means $\angle AFE = \angle ACB$ and $\angle AEF = \angle ABC$ as similar triangles have same angles. i.e.

$$EF \parallel QR \quad (9)$$

Hence Proved.