Geometrical Constructions

Engineering Graphics and Design (BTME-101-21)

TO BISECT A STRAIGHT LINE

(*i) Draw a given straight line AB.*

(*ii) With centre A and radius greater than half AB, draw arcs on either side of AB.*

(*iii) With centre B and same radius, draw arcs intersecting the above arcs at C and D.*

(*iv) Draw a line joining C and D to interest the given line AB at E. The point E bisects the line AB* and the line *CD is called the perpendicular bisector of the line AB, as shown in Fig. 1*

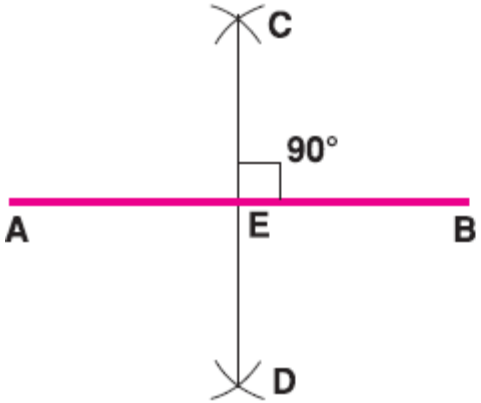

Fig. 1 To bisect a straight line

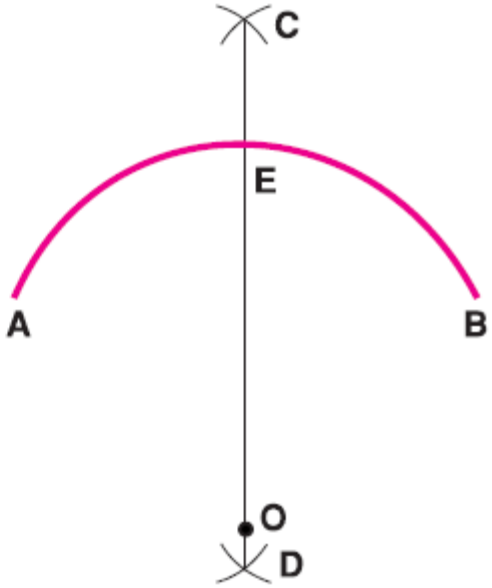

Fig. 2 To bisect an arc

Note : The above procedure may be followed to bisect given arc *AB. See Fig. 2.*

TO DIVIDE A LINE

(*a) To divide a given straight line into a specified number of equal parts, say six*

Method I

(*i) Draw the given line AB.*

(*ii) Through A, draw a line AC, making an acute angle with AB.*

(*iii) From A and along AC, lay off six equal divisions of any convenient length with a compass as* shown in Fig. 3.

(*iv) Draw a line joining 6′ and B.*

(*v) With the help of mini-draughter, draw lines through 1′, 2′, 3′ etc. parallel to 6′ B to meet the line AB at 1, 2, 3..... etc.* The points 1, 2, 3 etc. divide the line *AB into six equal parts.*

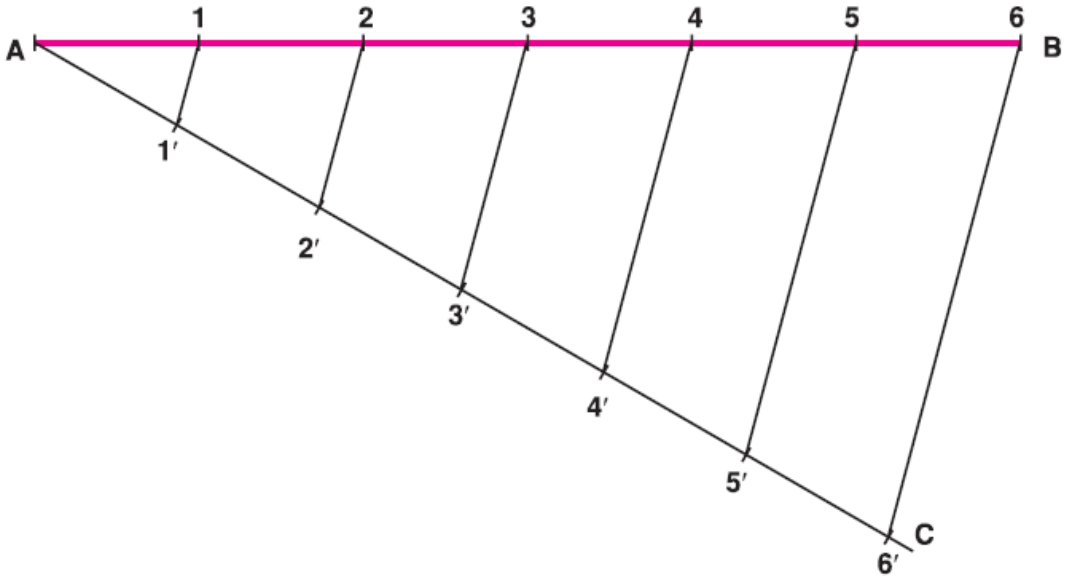

Fig. 3 To divide a line into a number of equal parts (Method I)

Method II

(i) Draw the given line AB.

(ii) Draw AC and BD at the same angle ϑ to AB (AC is parallel to BD).

(iii) Mark the required number of equal divisions (say six) of any suitable length on AC and BD.

(iv) Join 111', 212' etc. which interests the line AB into six equal parts. See Fig. 4.

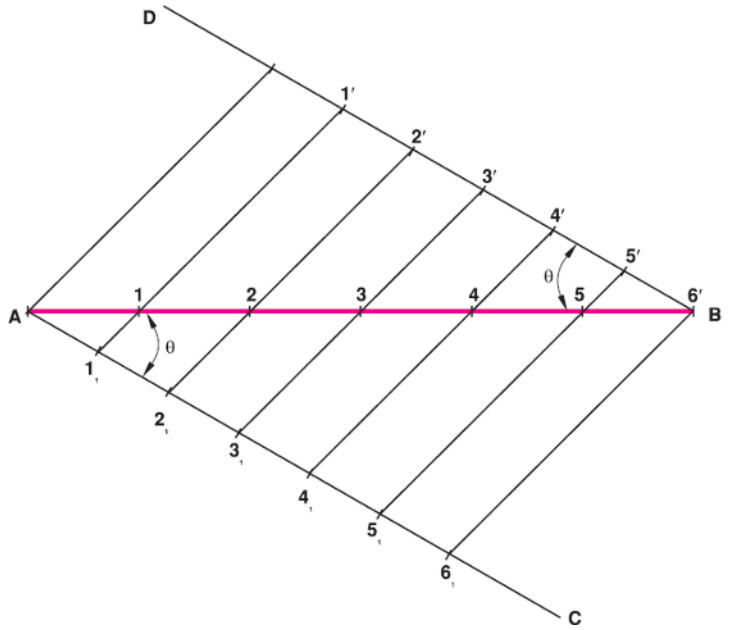

Fig. 4 To divide a line into a number of equal parts (Method II)

(*b) To divide a given straight line into unequal parts*

(i) Draw a given straight line AB.

(ii) Erect perpendicular AD and BC at the points A and B respectively. Complete square or rectangle ABCD.

(iii) Draw the diagonals AC and BD intersecting at E.

(iv) Through E, drop a perpendicular to AB, meeting the mid-point F of the line AB.

(v) Join D and F. The line meets the diagonals AC at G and then draw a perpendicular from G to AB. (AH = 1/3 AB).

(vi) Similarly, for obtaining 1/4 AB and 1/5 AB, make constructions as shown in Fig. 5.

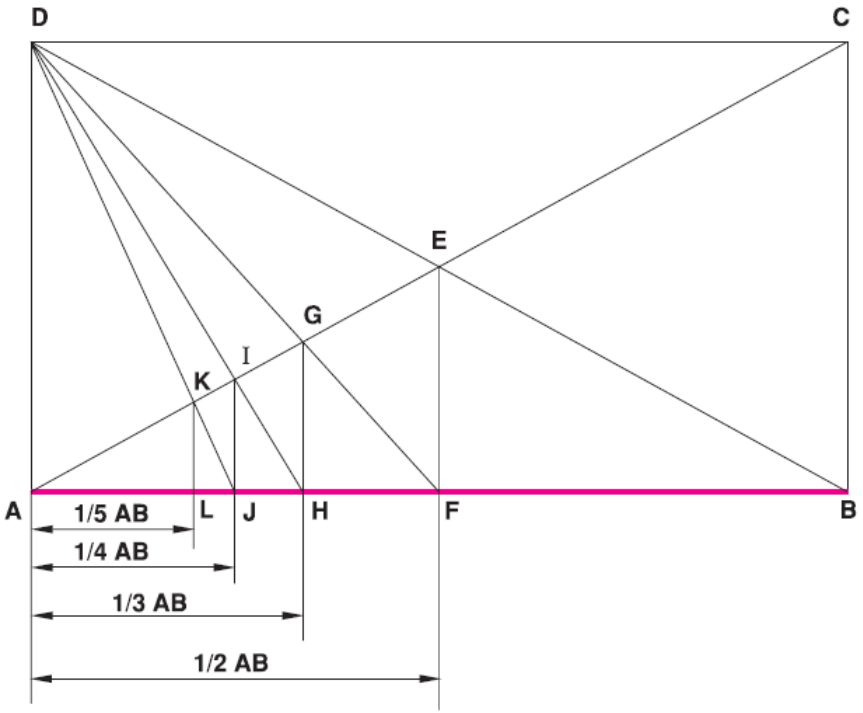

Fig. 5 To divide a line proportionately

TO DRAW A LINE PARALLEL TO A GIVEN STRAIGHT LINE

(a) To draw a line parallel to a given straight line through a given point

(i) Draw a given straight line AB and P be the given point.

(ii) With P as centre and any convenient radius, draw an arc CD cutting AB at Q.

(iii) With Q as centre and same radius, draw an arc cutting AB at R.

(iv) Again, with Q as centre and same radius equal to RP, draw an arc to interect CD at S.

(v) Draw a straight line through P and S. Then the line PS is the required parallel line.

See Fig. 6.

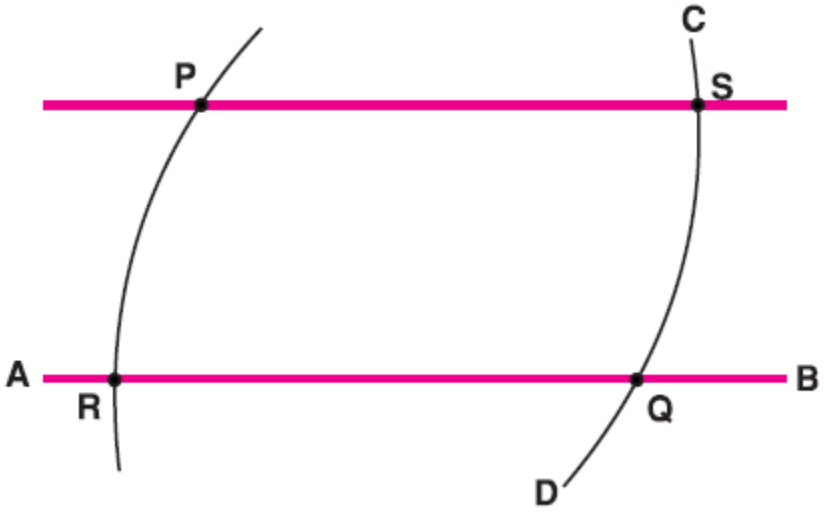

Fig. 6 To draw a line parallel to a given straight line through a given point

(*b) To draw a line parallel to and at a given distance from a given straight line*

(*i) Draw a given straight line AB and 'x' be the given distance.*

(*ii) Take two points C and D on a given line AB at a suitable distance apart.*

(*iii) With C and D as centres, draw arcs on one side of AB with 'x' as radius.*

(*iv) Draw a line PQ just to touch the top surface of the two arcs. Then the line PQ is the* required parallel line. See Fig. 7.

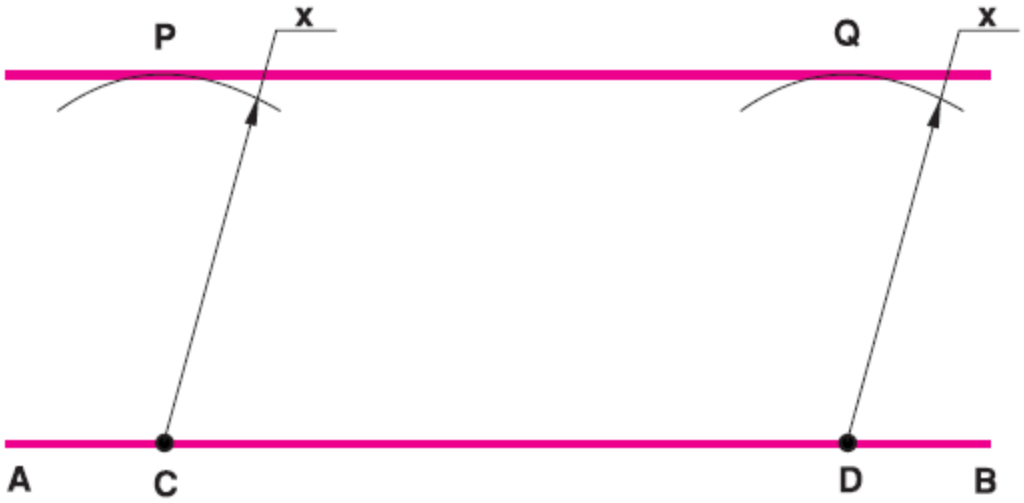

Fig. 7 To draw a line parallel to and at a given distance from a given straight line

TO CONSTRUCT REGULAR POLYGONS

(a) To construct a regular pentagon, given the length of side

Method I

(i) Draw a line AB equal to the given length of side

(ii) Bisect AB at P.

(iii) Draw a line BQ perpendicular and equal to AB at point B.

(iv) With centre P and radius PQ, draw an arc intersecting AB produced at R.

(v) Then AR is the length of the diagonal of the pentagon.

(vi) With centres A and B and radii equal to AR and AB respectively, draw arcs intersecting at point *C.*

(vii) With centres A and B and radius AR, draw arcs intersecting at point D.

(viii) Again with centres A and B and radii equal to AB and AR respectively, draw arcs intersecting at point *E.*

(ix) Draw lines AB, BC, CD, DE and EA, thus completing the regular pentagon. See Fig. 8.

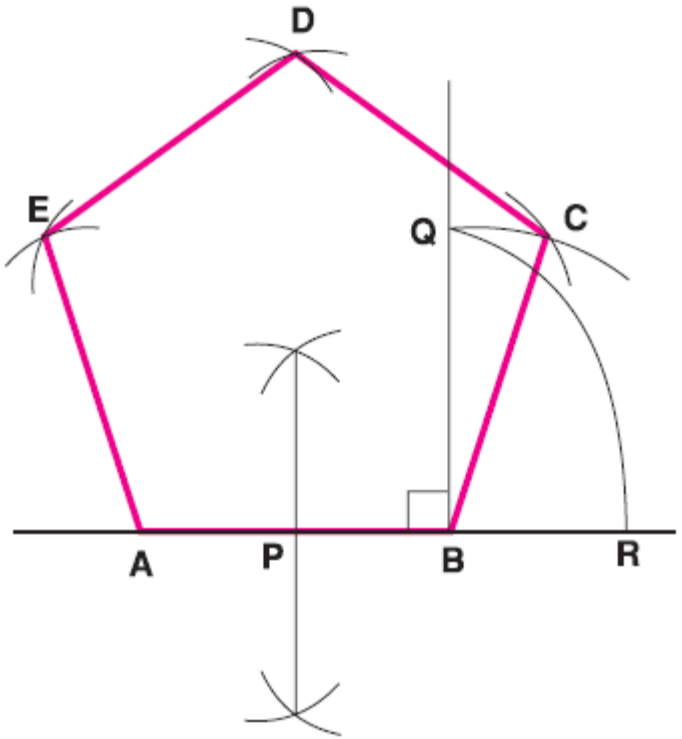

Fig. 8 Construction of a regular pentagon (Method I)

Method II

(*i) Draw a line AB equal to the given length of side.*

(*ii) With centre A and radius AB, draw a circle and mark it as circle .*

(*iii) Similarly with centre B and the same radius, draw a circle and mark it as circle cutting* circle at *P and Q.*

(*iv) With centre P and the same radius, draw an arc to cut circle and circle at R and S* respectively.

(*v) Draw a perpendicular bisector of the line AB to cut the arc RS at G.*

(*vi) Draw a line RG and produce it to cut circle at C.*

(*vii) Similarly, draw a line SG and produce it to cut circle at E.*

(*viii) With C and E as centres and AB as radius, draw arcs intersecting each other at D.*

(*ix) Draw lines AB, BC, CD, DE and EA, thus completing the regular pentagon. See Fig. 9.*

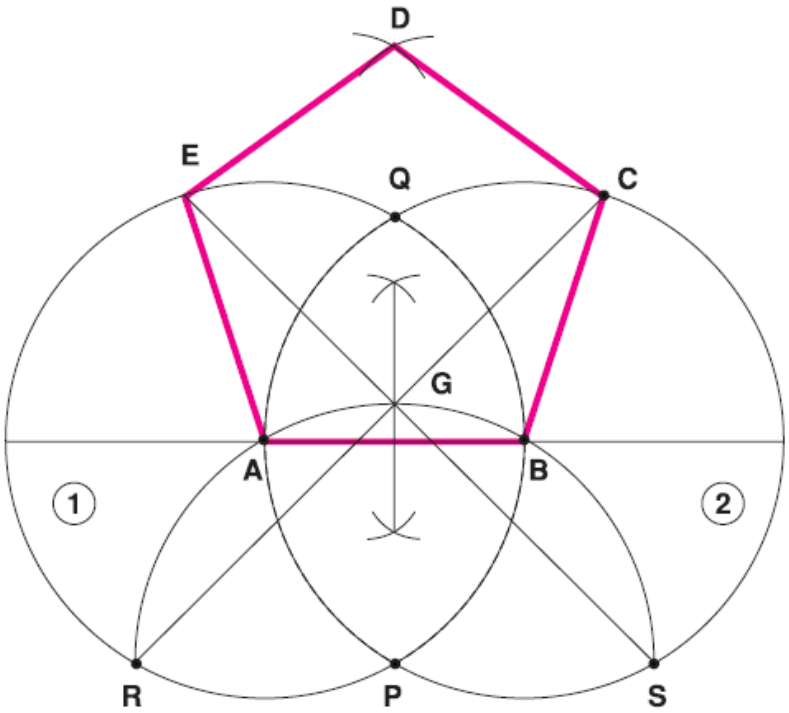

Fig. 9 Construction of a regular pentagon (Method II)

Method III

(*i) Draw a line AB equal to the given length of the side.*

(*ii) Draw an angle of 54° at each point A and B, meeting at point O.*

(*iii) With centre O and radius OA or OB, draw a circle.*

(*iv) With centre B and radius AB, draw an arc intersecting the circle at point C.*

(*v) Similarly with centre A and radius AB, draw an arc intersecting the circle at point E.*

(*vi) With C and E as centres and radius AB, draw arcs intersecting each other at point D on the* circle.

(*vii) Draw lines AB, BC, CD, DE and EA, thus completing the regular pentagon. See Fig. 10.*

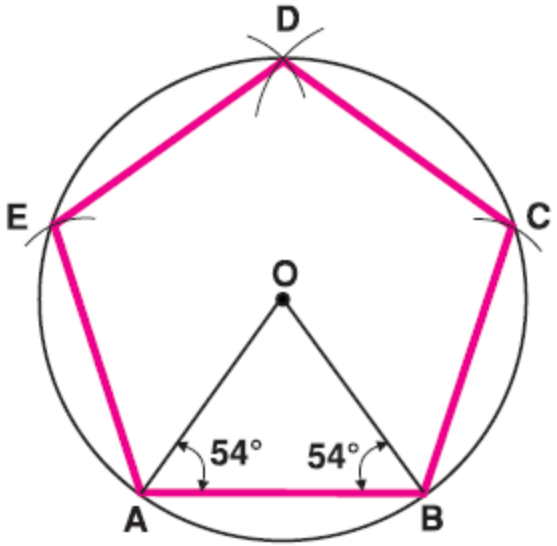

Fig. 10 Construction of a regular pentagon (Method III)

(b) To construct a regular hexagon, given the length of side

Method I

Draw a line AB equal to the given length of the side.

(ii) With centre A and radius AB, draw a semi-circle.

(iii) Divide the semi-circle into the same number of equal parts as the number of sides n (i.e. six).

(iv) Draw radial lines through 2, 3, 4, 5, etc.

(v) With centre B and radius AB, draw an arc intersecting the radial line through 5 at C.

(vi) With centre C and radius AB, draw an arc intersecting the radial line through 4 at D.

(vii) Repeat this procedure till the point on the radial line through 3 is obtained.

(viii) Draw lines AB, BC, CD, DE etc., thus completing the regular hexagon. See Fig. 11.

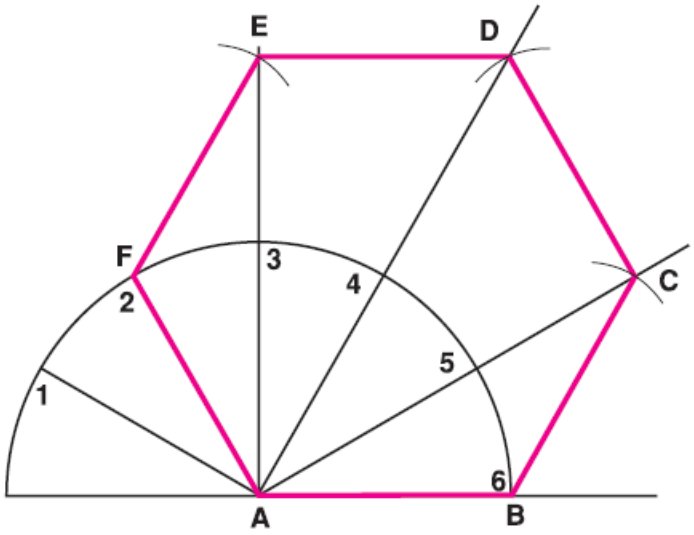

Fig. 11 Construction of a regular hexagon (Method I)

Method II

(i) Follow the same steps from (i) to (iv) as discussed above.

(ii) Draw perpendicular bisectors of lines 2A and AB, intersecting at point O.

(iii) With centre O and radius OA, draw a circle passing through the points 2 and B.

(iv) Locate the corners C, D etc. of the polygon where the circle meets the radial lines.

(v) Draw lines AB, BC, CD etc., thus completing the regular hexagon. See Fig. 12.

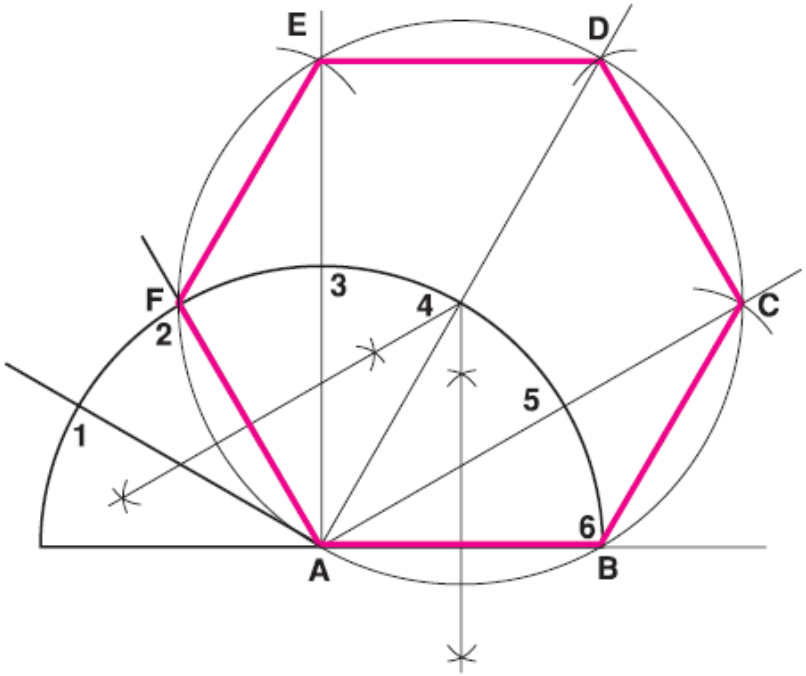

Fig. 12 Construction of a regular hexagon (Method II)

Method III

(i) Draw a line AB equal to the given length of the side.

(ii) Draw an angle of 60° at each point A and B, meeting at point O.

(iii) With centre O and radius OA or OB, draw a circle.

(iv) With centre B and radius AB, draw an arc intersecting the circle at point C.

(v) Similarly with centres A and C and same radius AB, draw arcs intersecting the circle at points F and D respectively.

(vi) With centres D and F and radius AB, draw arcs intersecting each other at point E on the circle.

(vii) Draw lines AB, BC, CD etc., thus completing the regular hexagon. See Fig. 13.

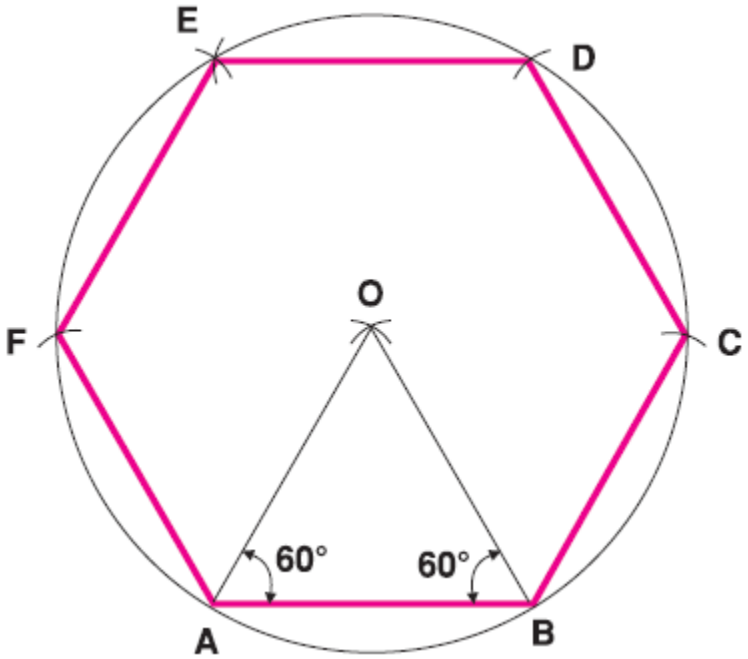

Fig. 13 Construction of a regular hexagon (Method III)

(*c) General Method for drawing any polygon*

(*i) Draw a line AB equal to the given length of side.*

(*ii) At B, draw a line BP perpendicular and equal to AB.*

(*iii) Draw a line joining A with P.*

(*iv) With centre B and radius AB, draw the quadrant AP.*

(*v) Draw the perpendicular bisector of AB to intersect the straight line AP in 4 and the arc AP* is 6.

(*vi) A square of a side equal to AB can be inscribed in the circle drawn with centre 4 and* radius A4.

(*vii) Locate the mid-point of the line 4-6 and number it 5.*

(*viii) Along the bisector, locate the points 7, 8 etc., such that the distances 4 – 5 = 5 = 6 = 6 – 7* etc.

(*ix) A regular pentagon of side equal to AB can be inscribed in the circle drawn with centre* 5 and radius A5.

(*x) Similarly, a regular hexagon of side equal to AB can be inscribed in the circle drawn*

with centre 6 and radius A6. A polygon of any number of sides, *N can be inscribed in a* circle drawn with centre *N and radius AN. See Fig. 14.*

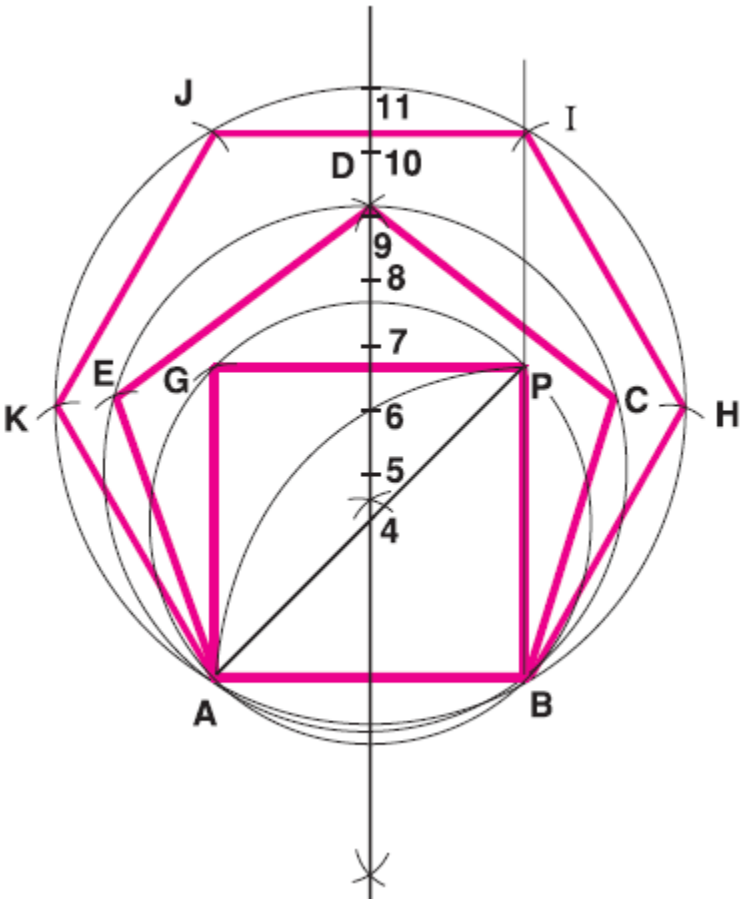

Fig. 14 Construction of a regular polygon (General Method)

TO DRAW TANGENTS

(*a*) To draw a tangent to a given circle at any point on it

(*i*) With centre *O*, draw the given circle and mark the given point *P* on it. (*ii*) Join *O* with *P* and extend it.

(*iii*) Draw a perpendicular *TT* to the above line at point *P*. The line *TT* is the required tangent. See Fig. 15.

(*b*) To draw a tangent to a given circle from any point outside the circle

(*i*) With centre *O*, draw the given circle. (*ii*) Locate the given point *P* outside it.

(*iii*) Join *O* and *P* and locate its mid-point *A*.

(iv) With centre *A* and radius *AO*, draw an arc to intersect the given circle at *B* and *C*.

(v) Join *P* to *B* and *P* to *C* and extend it.

The lines *PB and PC are the two possible tangents. See Fig. 16.*

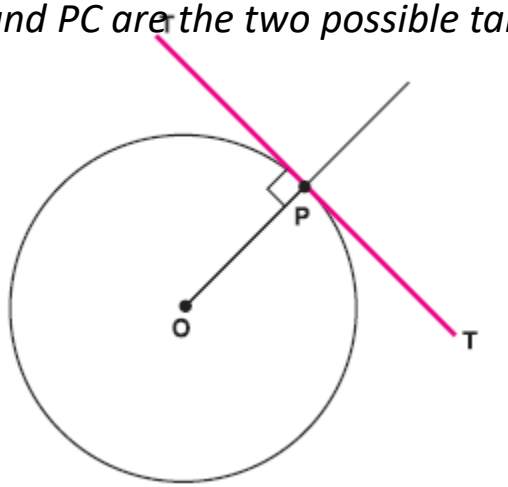

Fig. 15 Tangent to a circle at a point on it

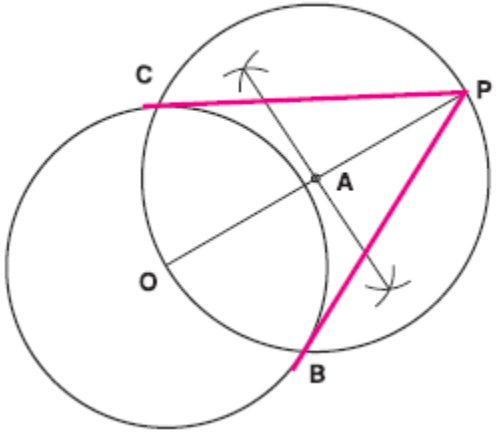

Fig. 16 Tangent to a circle from an outside point

(c) To draw a tangent to a given arc of inaccessible centre at any point on it

(i) Draw a given arc AB and locate the given point P on it.

(ii) With centre P and any suitable radius, draw an arc to intersect the given arc at C and D.

(iii) Draw perpendicular bisector EF of the chord CD passing through P.

(iv) Through P, draw a line GH perpendicular to EF. Thus GH is the required tangent.

See Fig. 17.

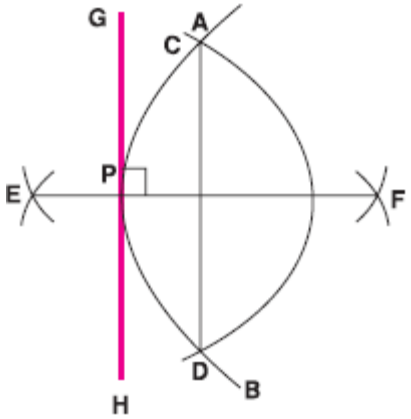

Fig. 17 Tangent to an arc having inaccessible centre

INSCRIBED CIRCLES

(*a) To inscribe a circle in a given triangle*

(*i) Let ABC be the triangle.*

(*ii) Bisect any two angles by lines intersecting each other at O.*

(*iii) Draw a perpendicular from O to any one side of the triangle, meeting at P.*

(*iv) With centre O and radius OP, draw the required circle. See Fig. 18.*

(*b) To inscribe a circle in a regular polygon of any number of sides, say a hexagon*

(*i) Let ABCDEF be the hexagon.*

(*ii) Bisect any two angles by lines intersecting each other at O.*

(*iii) From O, draw a perpendicular to any one side of the hexagon cutting it at P.*

(*iv) With centre O and radius OP, draw the required circle. See Fig. 19.*

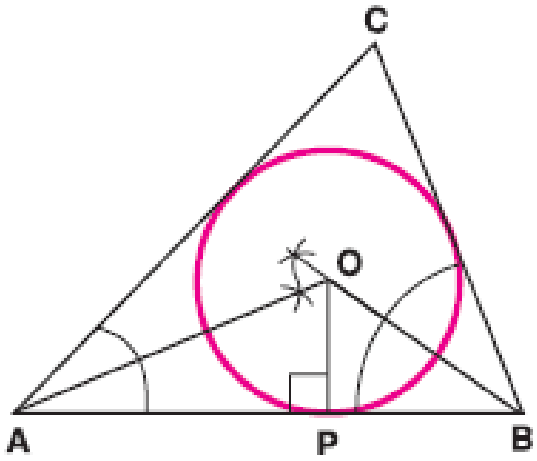

Fig. 18 Construction of a circle in a given triangle

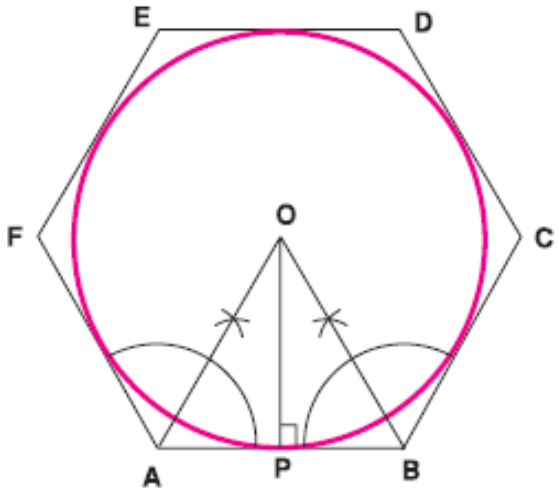

Fig. 19 Construction of a circle in a regular hexagon