Al-Mansour University College

قسم الهندسة المدنية

Civil Eng. Dept.

المرحلة الاولى

1st. Stage

Engineering Drawing

2022 – 2023

Sheet- 1&2

الرسم الهندسي

Lec. Basher Faisal

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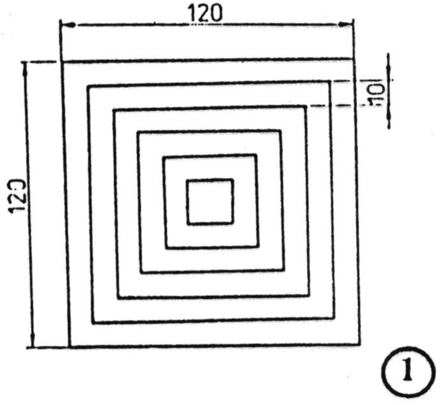

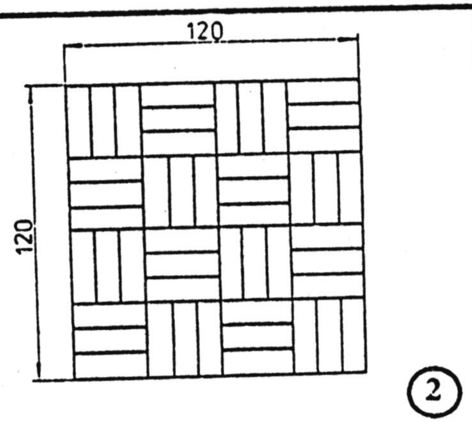

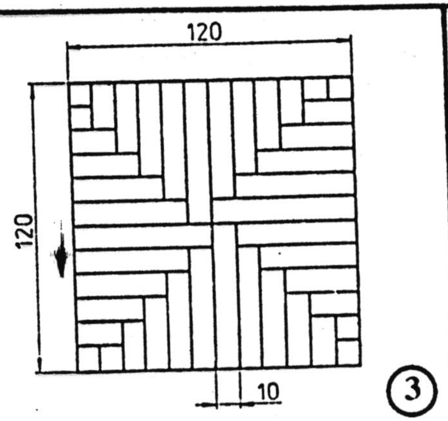

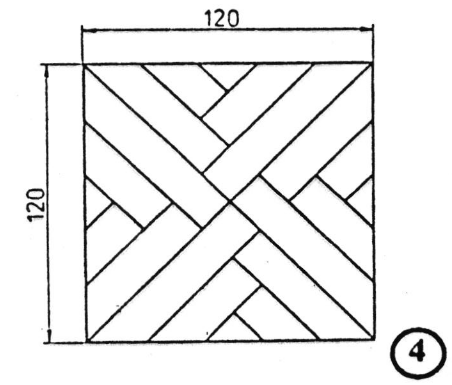

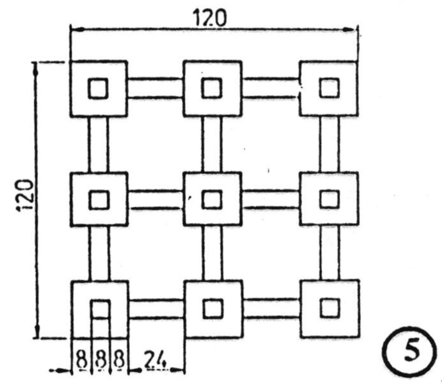

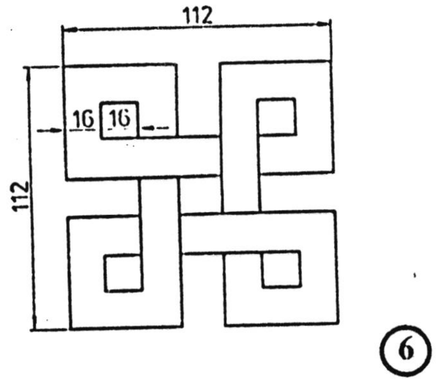

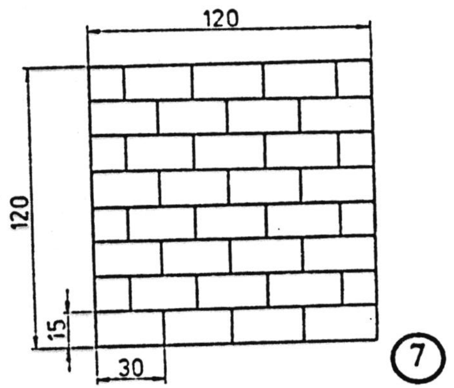

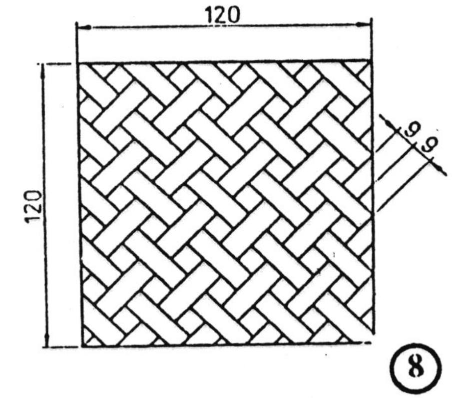

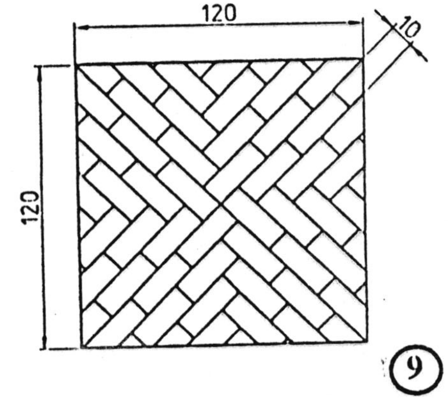

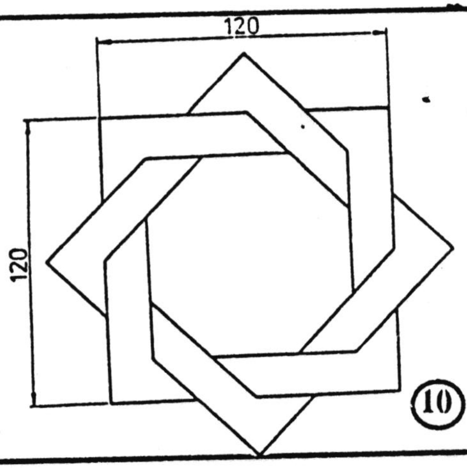

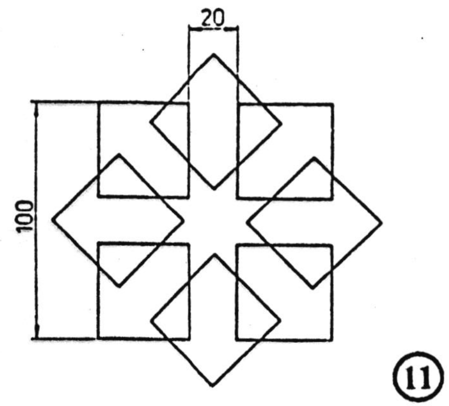

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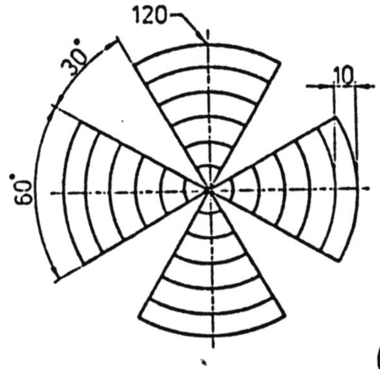

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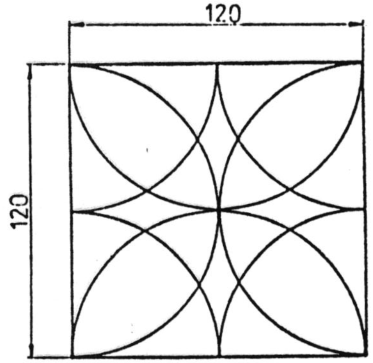

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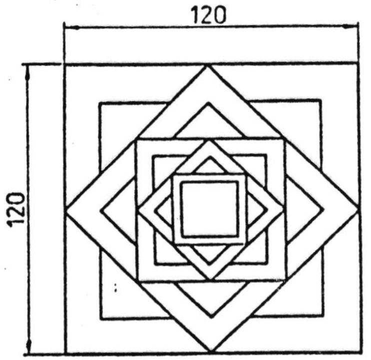

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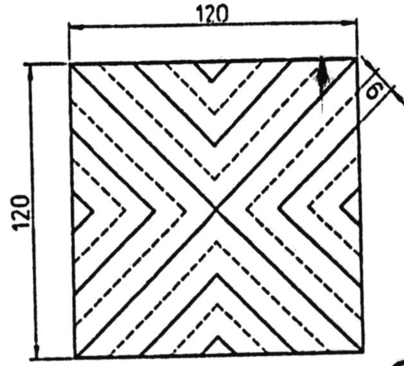

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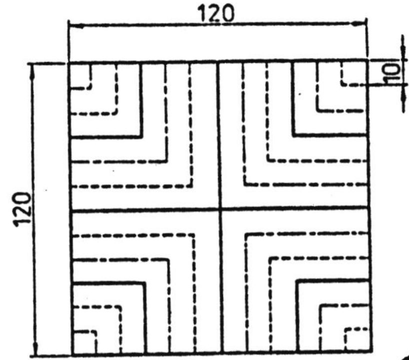

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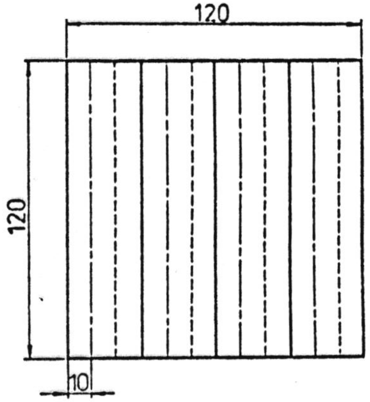

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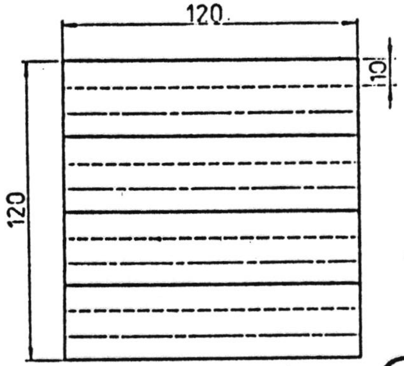

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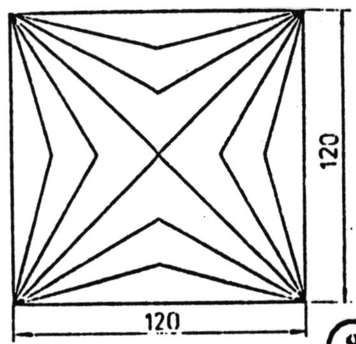

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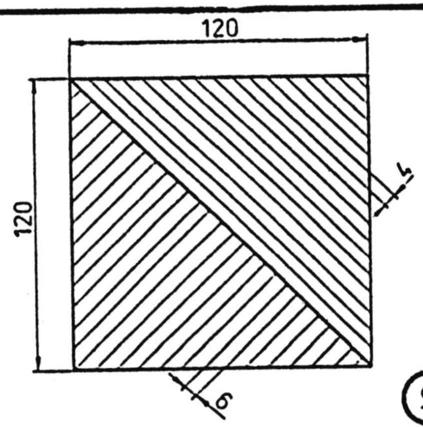

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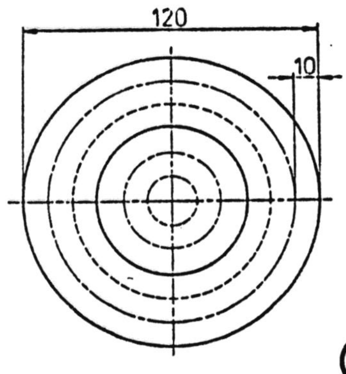

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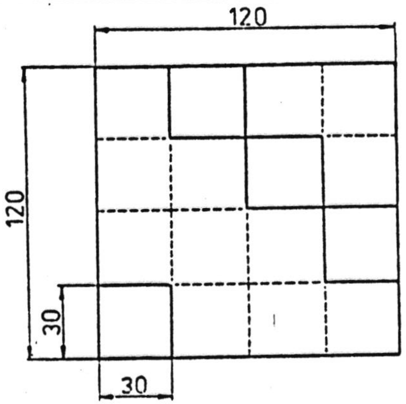

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Sh. No. 1
Bashar Faisal

Chapter 9
Geometrical constructions and tangency

Students will often experience difficulty in handling problems involving two and three dimensional geometrical constructions. The examples in Chapters 9 to 13 are included in order to provide a background in solving engineering problems connected with lines, planes and space. The separate chapters are grouped around applications having similar principles.

Copying a selection of these examples on the drawing board or on CAD equipment will certainly enable the reader to gain confidence. It will assist them to visualize and position the lines in space which form each part of a view, or the boundary, of a three dimensional object. It is a necessary part of draughtsmanship to be able to justify every line and dimension which appears on a drawing correctly.

Many software programs will offer facilities to perform a range of constructions, for example tangents, ellipses and irregular curves. Use these features where [redacted]

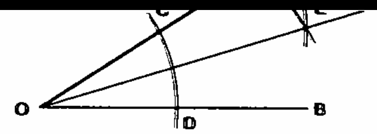

Fig. 9.1

3 Line OE bisects angle AOB.

To bisect a given straight line AB (Fig. 9.2)

1 With centre A and radius greater than half AB, describe an arc.

2 Repeat with the same radius from B, the arcs intersecting at C and D.

3 Join C to D and this line will be perpendicular to and bisect AB.

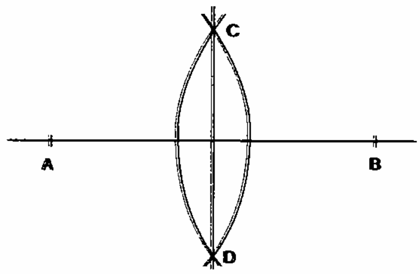

Fig. 9.2

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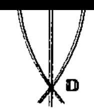

Fig. 9.3

To find the centre of a given arc AB (Fig. 9.4)

1 Draw two chords, AC and BD.
2 Bisect AC and BD as shown; the bisectors will intersect at E.
3 The centre of the arc is point E.

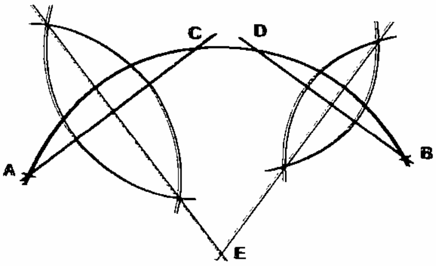

Fig. 9.4

To inscribe a circle in a given triangle ABC (Fig. 9.5)

1 Bisect any two of the angles as shown so that the bisectors intersect at D.
2 The centre of the inscribed circle is point D.

[redacted]

so that the bisectors intersect at D.
2 The centre of the circumscribing circle is point D.

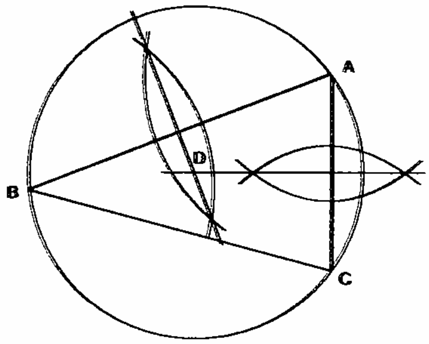

Fig. 9.6

سر اسي

To draw a hexagon, given the distance across the corners

Method A (Fig. 9.7(a))

1 Draw vertical and horizontal centre lines and a circle with a diameter equal to the given distance.
2 Step off the radius around the circle to give six equally spaced points, and join the points to give the required hexagon.

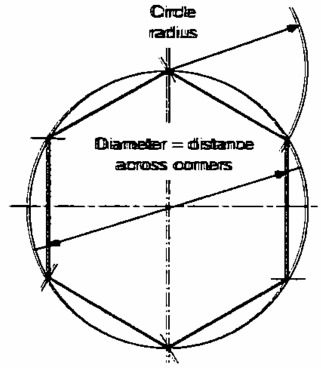

Fig. 9.7(a)

Method B (Fig. 9.7(b))

1 Draw vertical and horizontal centre lines and a circle

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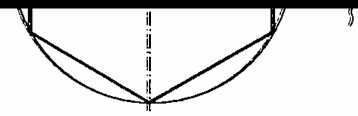

Fig. 9.7(b)

To draw a hexagon, given the distance across the flats (Fig. 9.8)

1 Draw vertical and horizontal centre lines and a circle with a diameter equal to the given distance.
2 Use a 60° set-square and tee-square as shown, to give the six sides.

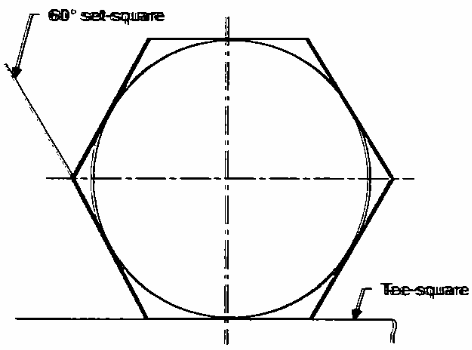

Fig. 9.8

To draw a regular octagon, given the distance across corners (Fig. 9.9)

Repeat the instructions in Fig. 9.7(b) but use a 45° set-square, then connect the eight points to give the required octagon.

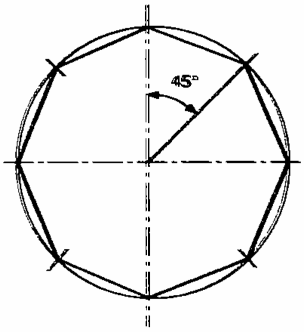

Fig. 9.9

To draw a regular octagon, given the distance across the flats (Fig. 9.10)

Repeat the instructions in Fig. 9.8 but use a 45° set-square to give the required octagon.

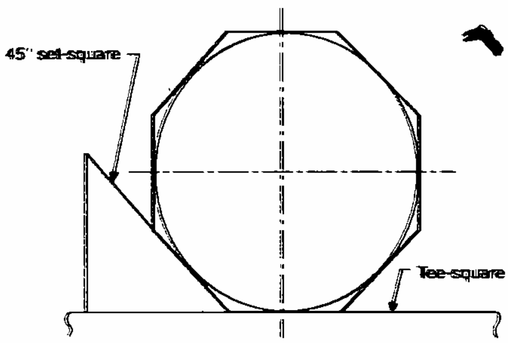

Fig. 9.10

To draw a regular polygon, given the length of the sides (Fig. 9.11)

Note that a regular polygon is defined as a plane figure which is bounded by straight lines of equal length and which contains angles of equal size. Assume the number of sides is seven in this example.

1 Draw the given length of one side AB, and with radius AB describe a semi-circle.
2 Divide the semi-circle into seven equal angles, using a protractor, and through the second division from the left join line A2.
3 Draw radial lines from A through points 3, 4, 5, and 6.
4 With radius AB and centre on point 2, describe an arc to meet the extension of line A3, shown here as point F.
5 Repeat with radius AB and centre F to meet the extension of line A4 at E.
6 Connect the points as shown, to complete the required polygon.

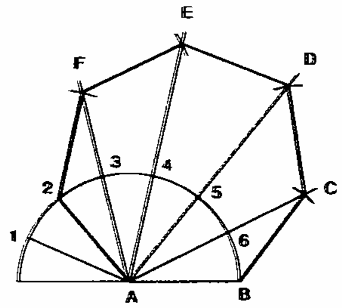

Fig. 9.11

Tangency

If a disc stands on its edge on a flat surface it will touch the surface at one point. This point is known as the point of tangency, as shown in Fig. 9.12 and the straight line which represents the flat plane is known as a tangent. A line drawn from the point of tangency to the centre of the disc is called a normal, and the tangent makes an angle of 90° with the normal.

The following constructions show the methods of drawing tangents in various circumstances.

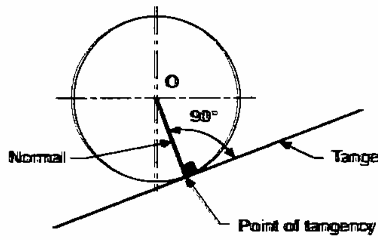

Fig. 9.12

To draw a tangent to a point A on the circumference of a circle, centre O (Fig. 9.13)

Join OA and extend the line for a short distance. Erect a perpendicular at point A by the method shown.

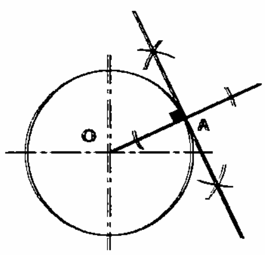

Fig. 9.13

To draw a tangent to a circle from any given point A outside the circle (Fig. 9.14)

Join A to the centre of the circle O. Bisect line AO so that point B is the mid-point of AO. With centre B, draw a semi-circle to intersect the given circle at point C. Line AC is the required tangent.

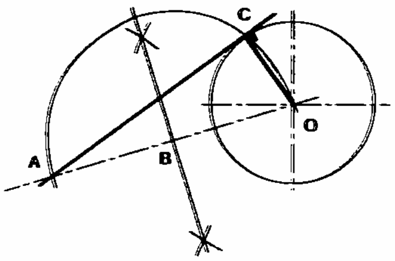

Fig. 9.14

To draw an external tangent to two circles (Fig. 9.15)

Join the centres of the circles by line AB, bisect AB, and draw a semi-circle. Position point E so that DE is equal to the radius of the smaller circle. Draw radius AE to cut the semi-circle at point G. Draw line AGH so that H lies on the circumference of the larger circle. Note that angle AGB lies in a semi-circle and will be 90°. Draw line HJ parallel to BG. Line HJ will be tangential to the two circles and lines BJ and AGH are the normals.

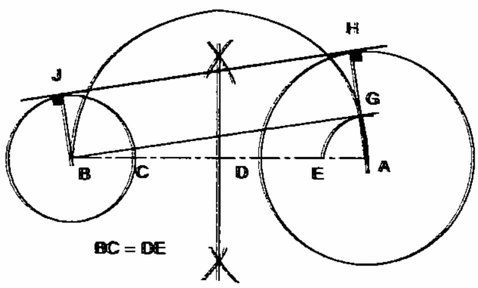

Fig. 9.15

To draw an internal tangent to two circles (Fig. 9.16)

Join the centres of the circles by line AB, bisect AB and draw a semi-circle. Position point E so that DE is equal to the radius of the smaller circle BC. Draw radius AE to cut the semi-circle in H. Join AH; this line crosses the larger circle circumference at J. Draw line BH. From J draw a line parallel to BH to touch the smaller circle at K. Line JK is the required tangent. Note that angle AHB lies in a semi-circle and will therefore be 90°. AJ and BK are normals.

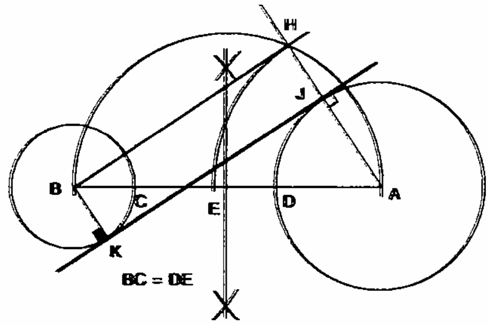

Fig. 9.16

To draw internal and external tangents to two circles of equal diameter (Fig. 9.17)

Join the centres of both circles by line AB. Erect perpendiculars at points A and B to touch the circumferences of the circles at points C and D. Line CD will be the external tangent. Bisect line AB to give point E, then bisect BE to give point G. With radius BG, describe a semi-circle to cut the circumference of one of the given circles at H. Join HE and extend it to touch the circumference of the other circle at J. Line HEJ is the required tangent. Note that again the angle in the semi-circle, BHE, will be 90°, and hence BH and AJ are normals.

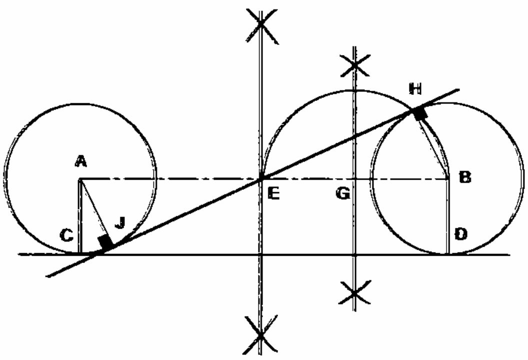

Fig. 9.17

To draw a curve of given radius to touch two circles when the circles are outside the radius (Fig. 9.18)

Assume that the radii of the given circles are 20 and 25 mm, spaced 85 mm apart, and that the radius to touch them is 40 mm.

With centre A, describe an arc equal to 20 + 40 = 60 mm.

With centre B, describe an arc equal to 25 + 40 = 65 mm.

The above arcs intersect at point C. With a radius of 40 mm, describe an arc from point C as shown, and note that the points of tangency between the arcs lie along the lines joining the centres AC and BC. It is particularly important to note the position of the points of tangency before lining in engineering drawings, so that the exact length of an arc can be established.

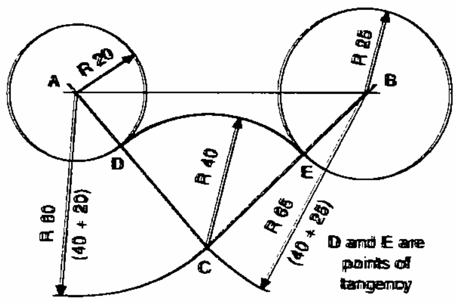

Fig. 9.18

To draw a curve of given radius to touch two circles when the circles are inside the radius (Fig. 9.19)

Assume that the radii of the given circles are 22 and 26 mm, spaced 86 mm apart, and that the radius to touch them is 100 mm.

With centre A, describe an arc equal to 100 – 22 = 78 mm.

With centre B, describe an arc equal to 100 – 26 = 74 mm.

The above arcs intersect at point C. With a radius of 100 mm, describe an arc from point C, and note that in this case the points of tangency lie along line CA extended to D and along line CB extended to E.

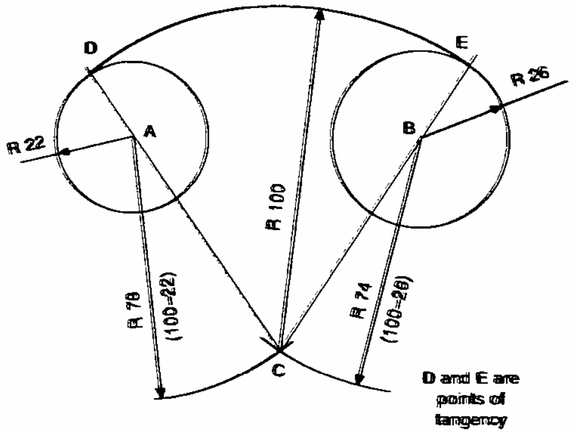

Fig. 9.19

To draw a radius to join a straight line and a given circle (Fig. 9.20)

Assume that the radius of the given circle is 20 mm and that the joining radius is 22 mm.

With centre A, describe an arc equal to 20 + 22 = 42 mm.

Draw a line parallel to the given straight line and at a perpendicular distance of 22 mm from it, to intersect the arc at point B.

With centre B, describe the required radius of 22 mm, and note that one point of tangency lies on the line AB at C; the other lies at point D such that BD is at 90° to the straight line.

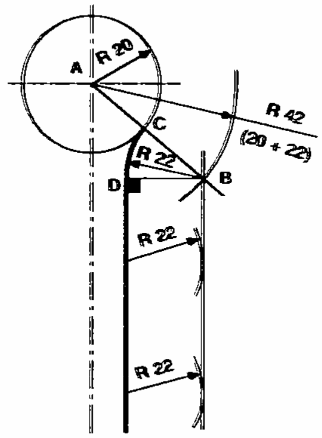

Fig. 9.20

To draw a radius which is tangential to given straight lines (Fig. 9.21)

Assume that a radius of 25 mm is required to touch the lines shown in the figures. Draw lines parallel to the given straight lines and at a perpendicular distance of 25 mm from them to intersect at points A. As above, note that the points of tangency are obtained by drawing perpendiculars through the point A to the straight lines in each case.

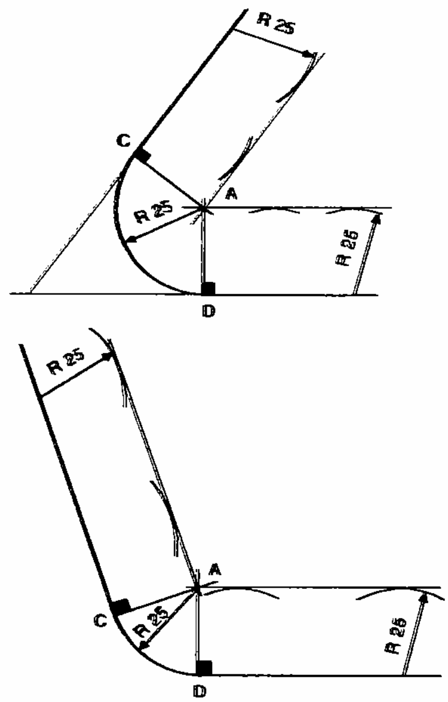

Fig. 9.21

Chapter 10
Loci applications

If a point, line, or surface moves according to a mathematically defined condition, then a curve known as a *locus* is formed. The following examples of curves and their constructions are widely used and applied in all types of engineering.

Methods of drawing an ellipse

1 Two-circle method

Construct two concentric circles equal in diameter to the major and minor axes of the required ellipse. Let these diameters be AB and CD in Fig. 10.1.

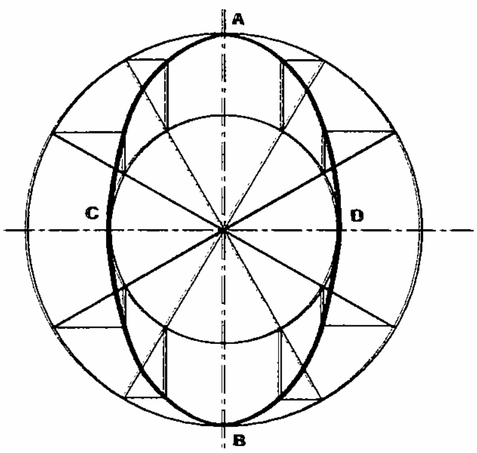

Fig. 10.1 Two-circle construction for an ellipse

Divide the circles into any number of parts; the parts do not necessarily have to be equal. The radial lines now cross the inner and outer circles.

Where the radial lines cross the outer circle, draw short lines parallel to the minor axis CD. Where the radial lines cross the inner circle, draw lines parallel to AB to intersect with those drawn from the outer circle. The points of intersection lie on the ellipse. Draw a smooth connecting curve.

2 Trammel method

Draw major and minor axes at right angles, as shown in Fig. 10.2.

Take a strip of paper for a trammel and mark on it half the major and minor axes, both measured from the same end. Let the points on the trammel be E, F, and G.

Position the trammel on the drawing so that point F always lies on the major axis AB and point G always lies on the minor axis CD. Mark the point E with each position of the trammel, and connect these points to give the required ellipse.

Note that this method relies on the difference between half the lengths of the major and minor axes, and where these axes are nearly the same in length, it is difficult to position the trammel with a high degree of accuracy. The following alternative method can be used.

Draw major and minor axes as before, but extend them in each direction as shown in Fig. 10.3.

Take a strip of paper and mark half of the major and minor axes in line, and let these points on the trammel be E, F, and G.

Position the trammel on the drawing so that point G always moves along the line containing CD; also, position point E along the line containing AB. For each position of the trammel, mark point F and join these points with a smooth curve to give the required ellipse.

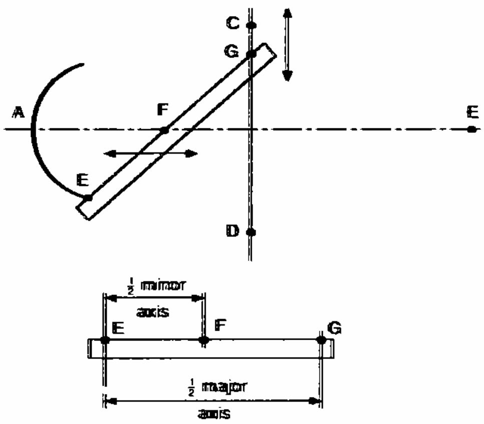

Fig. 10.2 Trammel method for ellipse construction