Tishk International University
Engineering Faculty
Petroleum and Mining Engineering Department
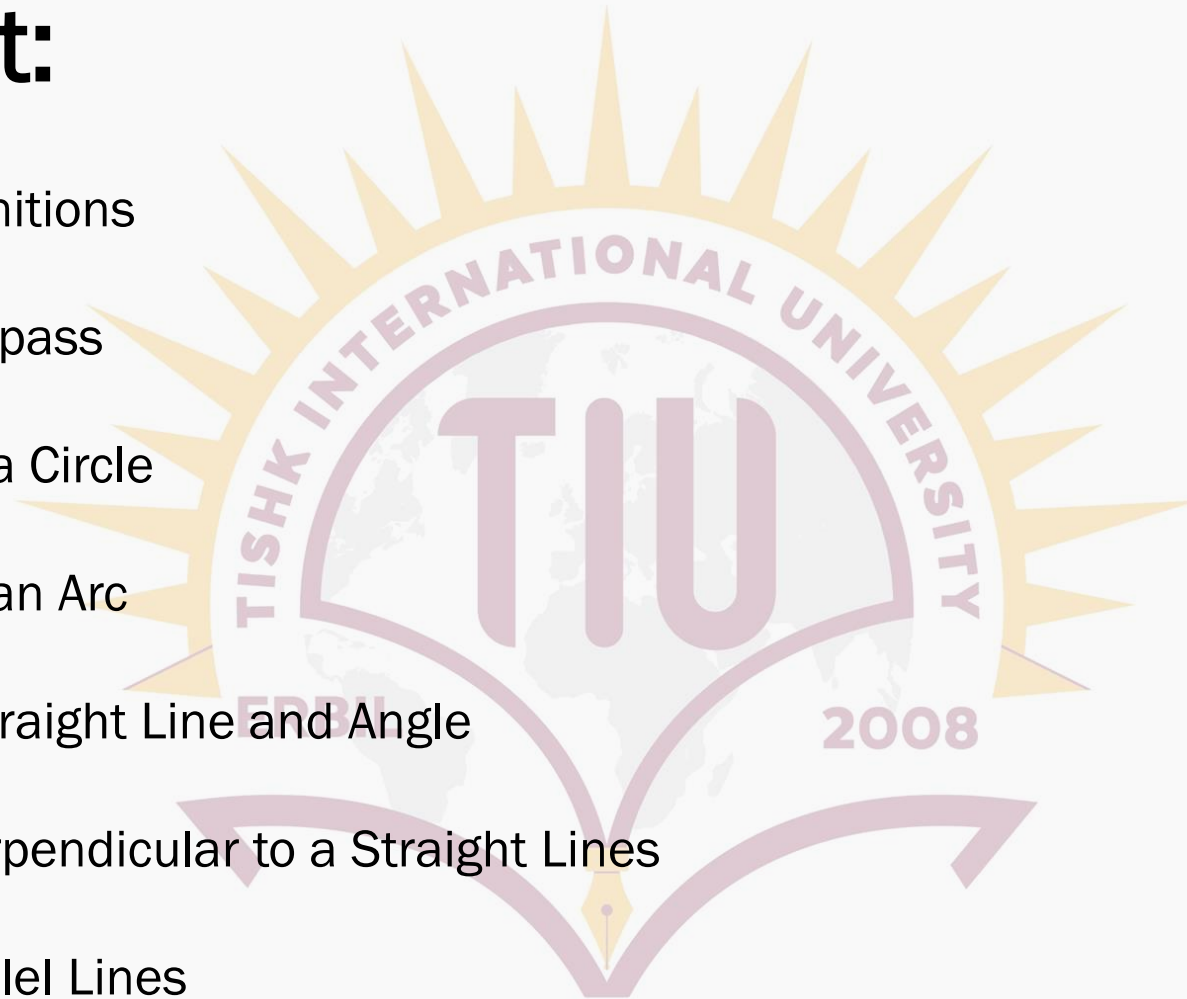
Engineering Drawing

Lecture 2: Geometrical Constructions

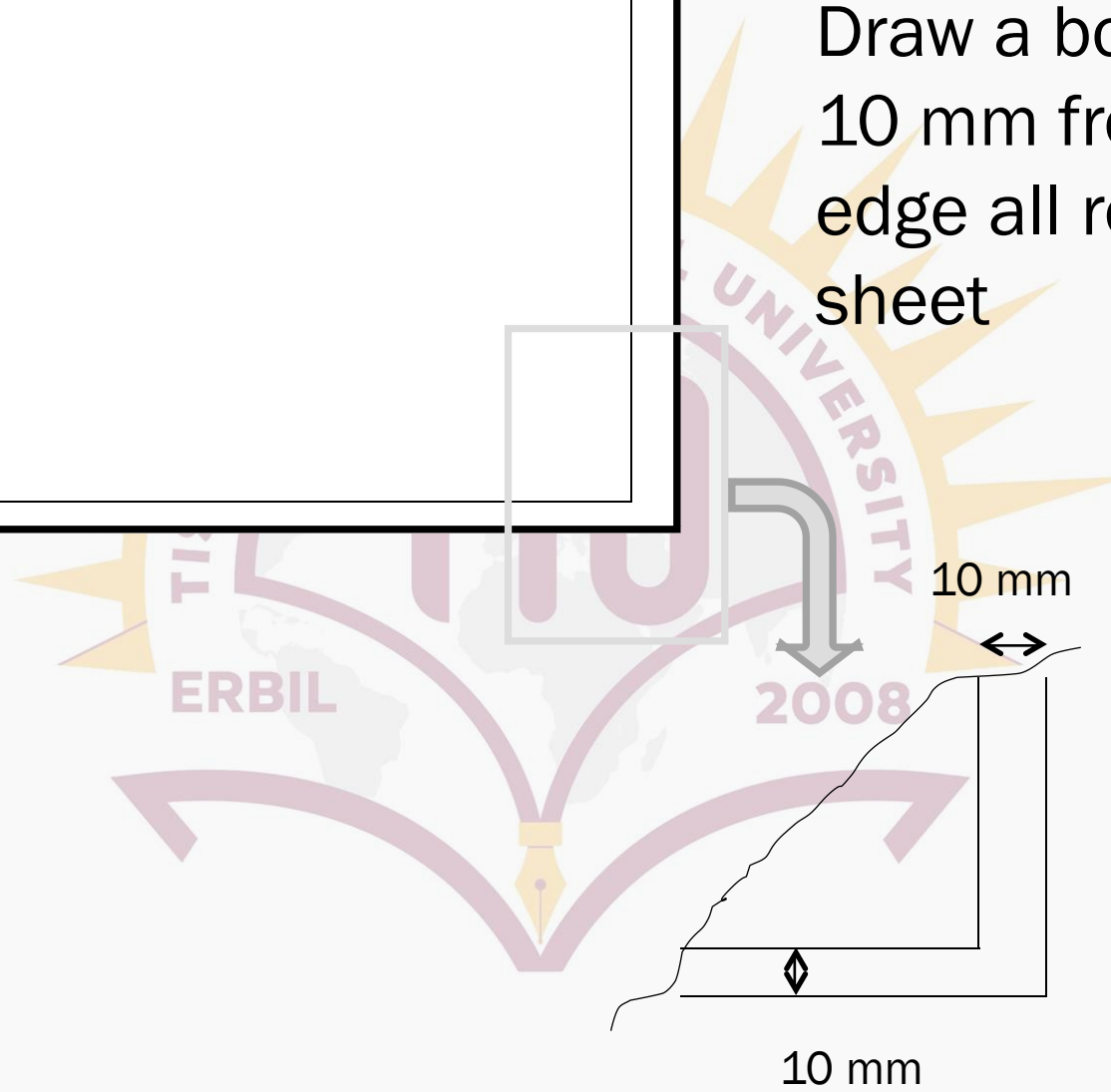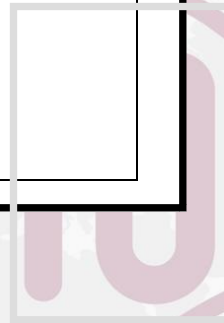**First Grade- Fall Semester 2020-2021**

Instructor: Sheida Mostafa Sheikheh

Content:

- Basic Definitions

- Using Compass

- Construct a Circle

- Construct an Arc

- Bisect a Straight Line and Angle

- Draw a Perpendicular to a Straight Lines

- Draw Parallel Lines

- Draw Tangent Lines
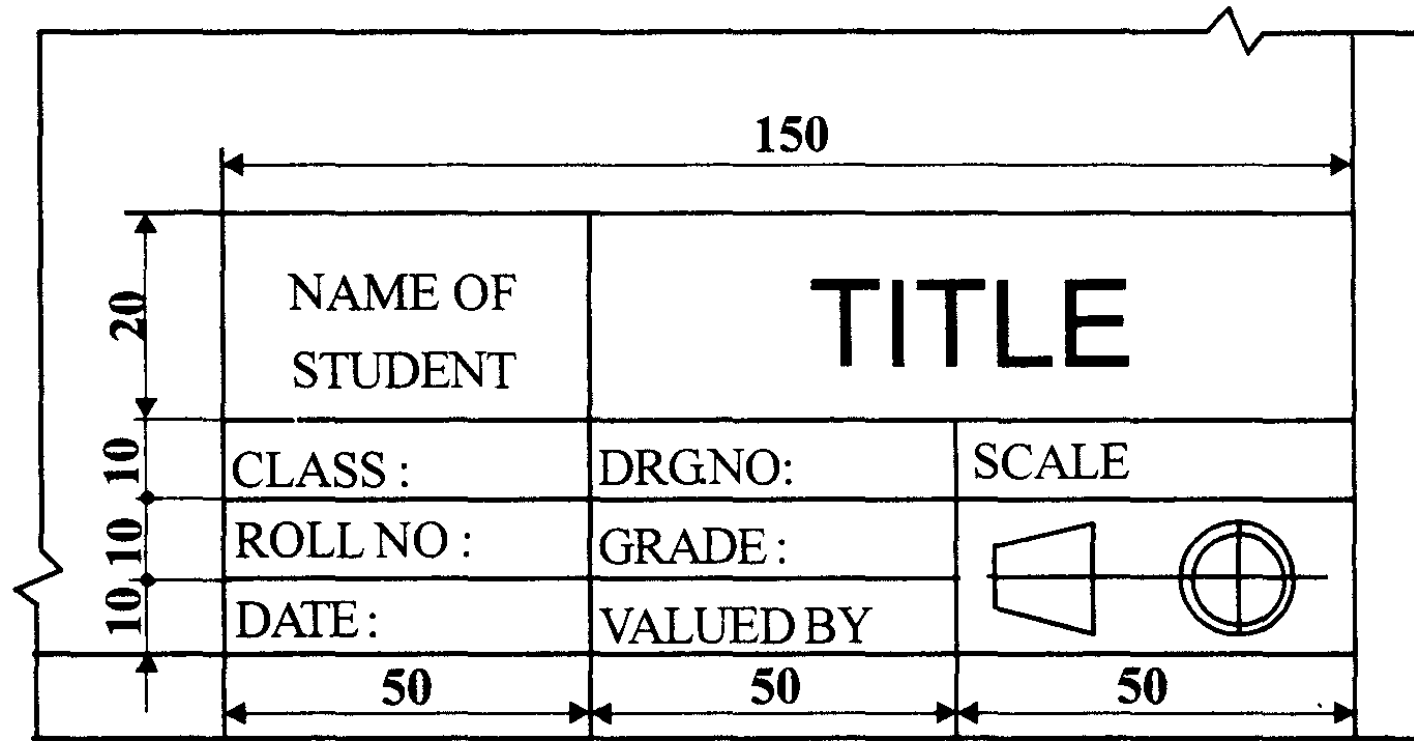
- Divide a line into equal parts

Draw a border line 10 mm from the edge all round the sheet

10 mm

10 mm

Title Block:

Basic Definitions:

■ **Circle:** Circle is a plane figure bounded by a curve, formed by the locus of a point which moves so that it is always at a fixed distance from a stationery point the "Centre".

■ **Radius:** The distance from the centre to any point on the circle is called the "Radius".

■ **Diameter:** The length of a straight line between two points on the curve, passing through the centre is called the "Diameter". (D: Dia or d) It is twice the radius.

■ **Circumference:** It is the linear length of the entire curve, equal to πD .

■ **Arc:** A part of the circle between any two points on the circumference or periphery is called an 'Arc'.

■ **Chord:** A straight line joining the ends of an arc is called the chord. (Longest chord of the circle is the diameter)
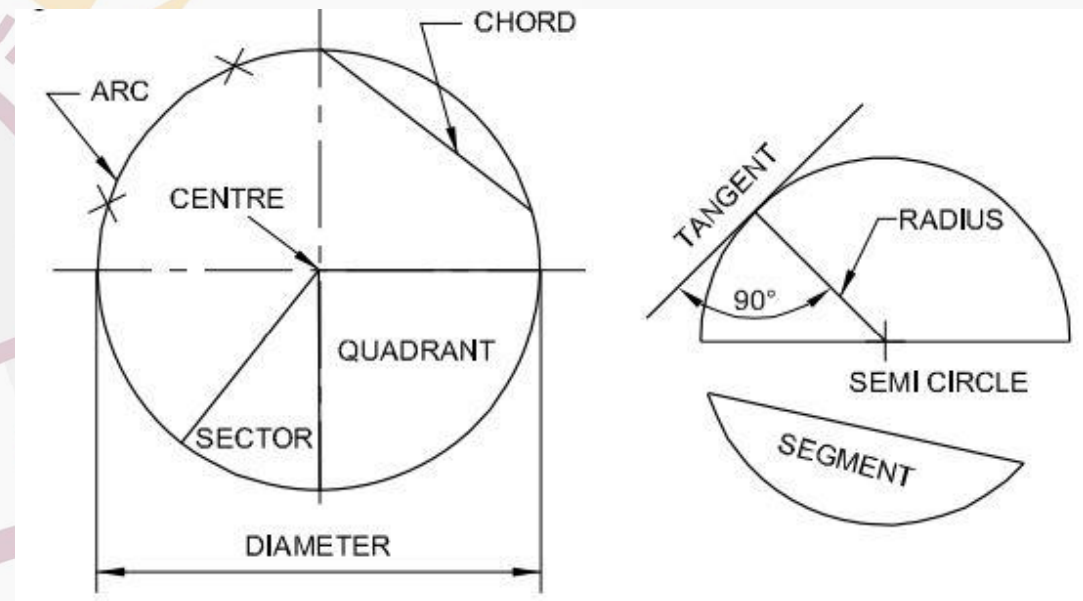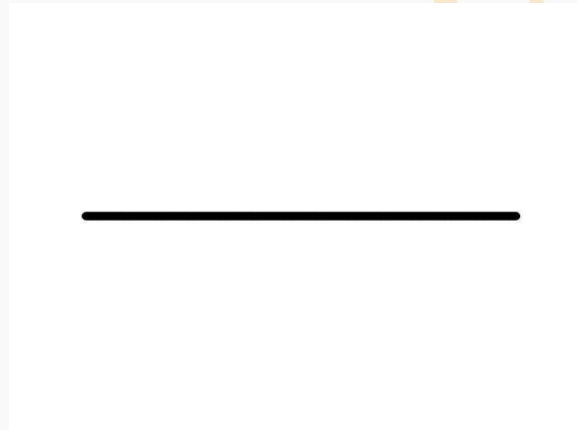
Basic Definitions:

- **Segment:** A part of the circle or area bound by the arc and chord is the segment of the circle.

- **Sector:** It is the part of a circle bounded by two radii (plural of radius) meeting at an angle and an arc.

- **Quadrant:** Part of a circle with radii making 90° with each other is a quadrant (one fourth of the circle). Half of the circle is called as semi-circle.

- **Tangent:** Tangent of a circle is a straight line just touching the circle at a point. It does not cut or pass through the circle when extended. The point where the tangent touches the circle is called the "point of tangency".

- **Concentric circles:** When two or more circles (drawn) having common centre, they are called concentric circles.
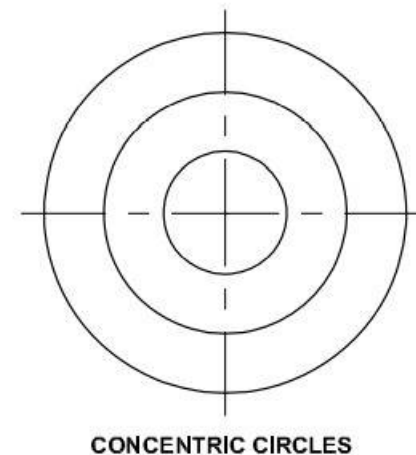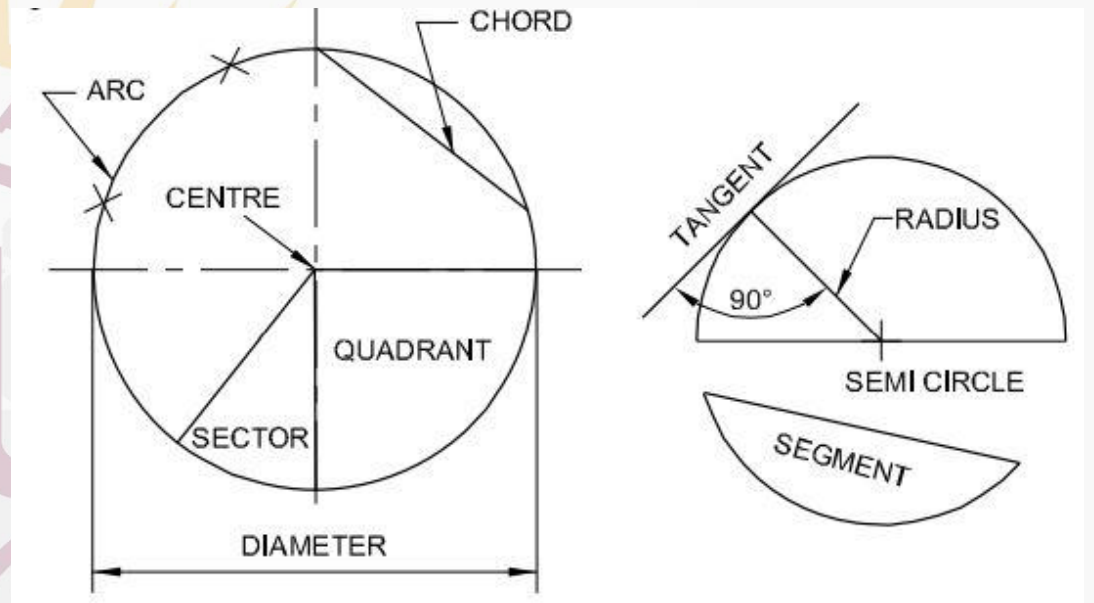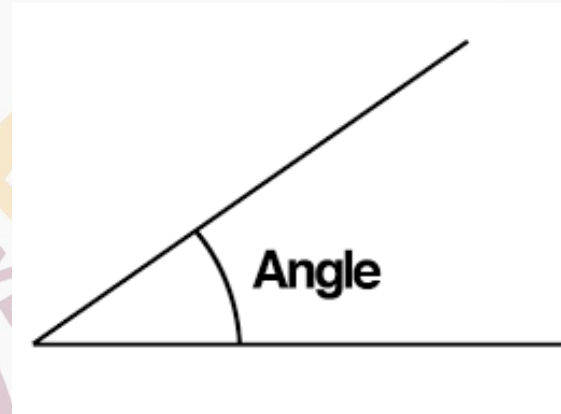
Basic Definitions:

- **Straight Line:** a straight line is the set of all points between and extending beyond two points.

- **Angle:** In geometry, an angle can be defined as the figure formed by two rays meeting at a common end point. An angle is represented by the symbol ∠.

- **Parallel Lines:** In geometry, parallel lines can be defined as two lines in the same plane that are at equal distance from each other and never meet.

- **Perpendicular Lines:** In geometry, a branch of mathematics, perpendicular lines are defined as two lines that meet or intersect each other at right angles (90°).
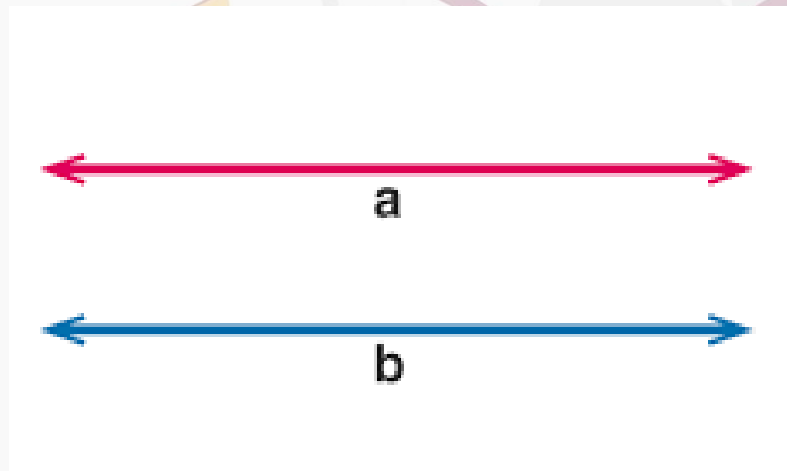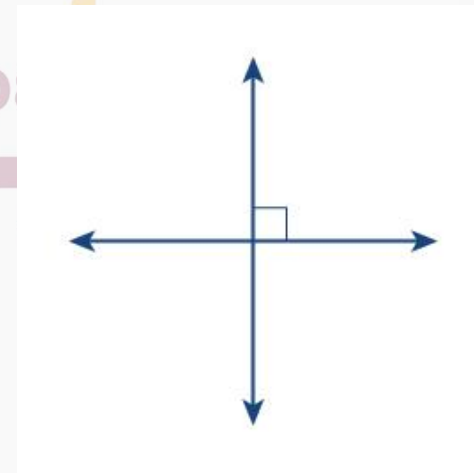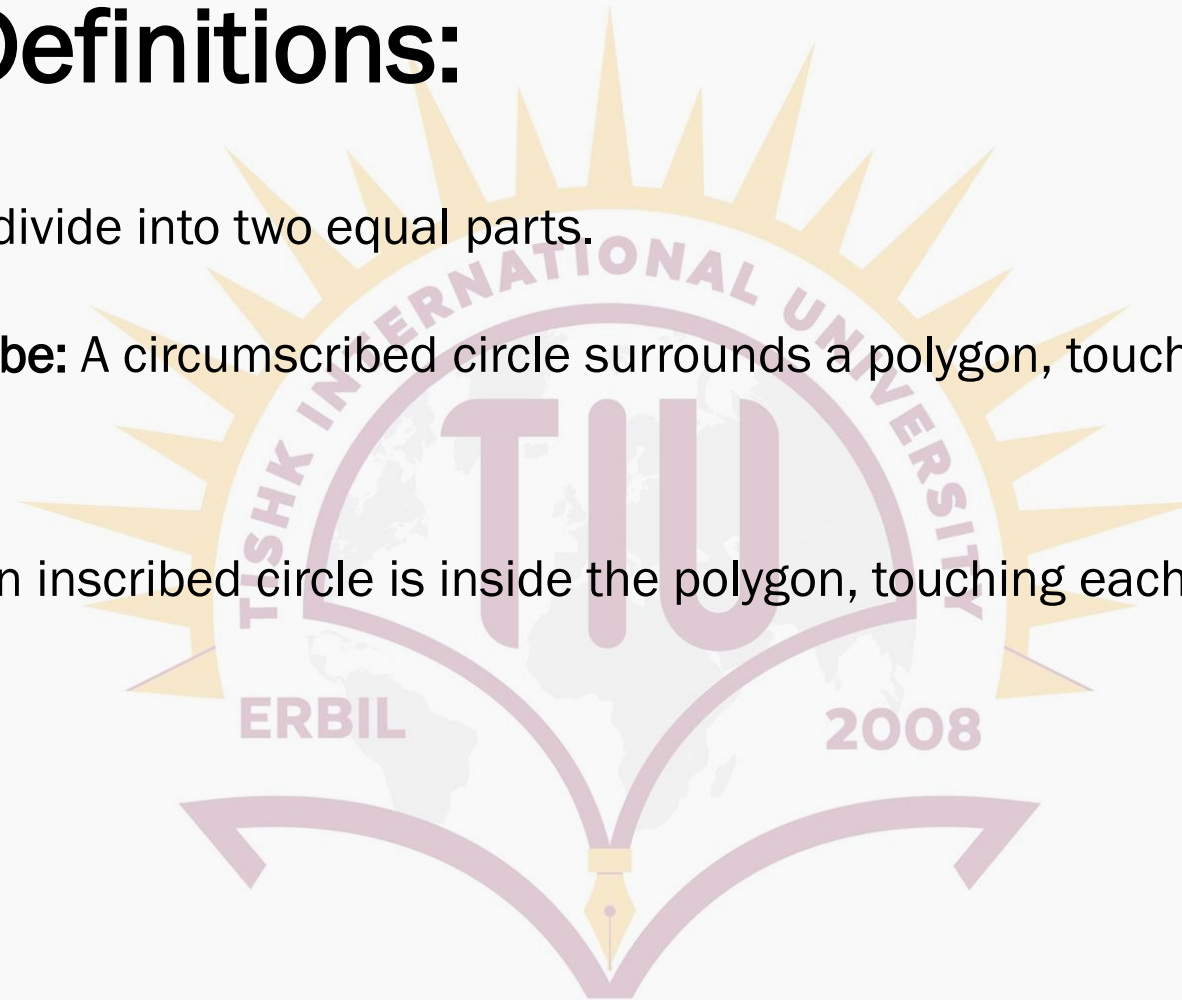
Basic Definitions:

Straight Line

Angle

Parallel Lines

Perpendicular Lines

Basic Definitions:

- **Bisect:** To divide into two equal parts.

- **Circumscribe:** A circumscribed circle surrounds a polygon, touching every vertex (corner).

- **Inscribe:** An inscribed circle is inside the polygon, touching each side at exactly one point.

Using Compass

1. Locate the center of the circle by two intersecting lines.

2. Adjust the distance between needle and lead to a distance equal to radius of the circle.

3. Set the needle point at center.
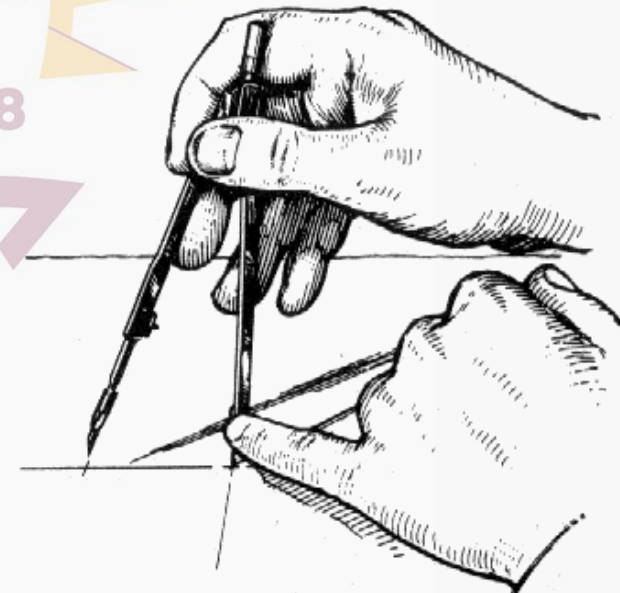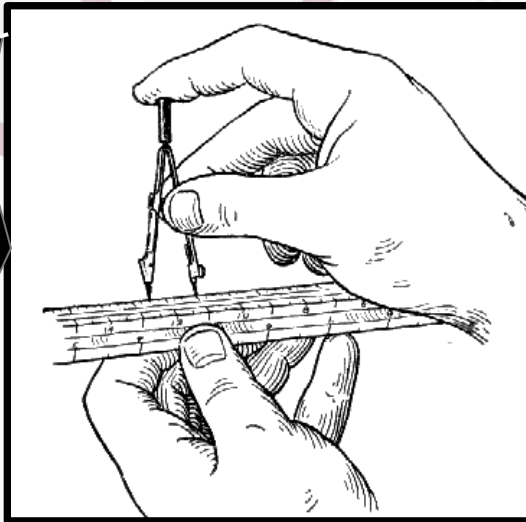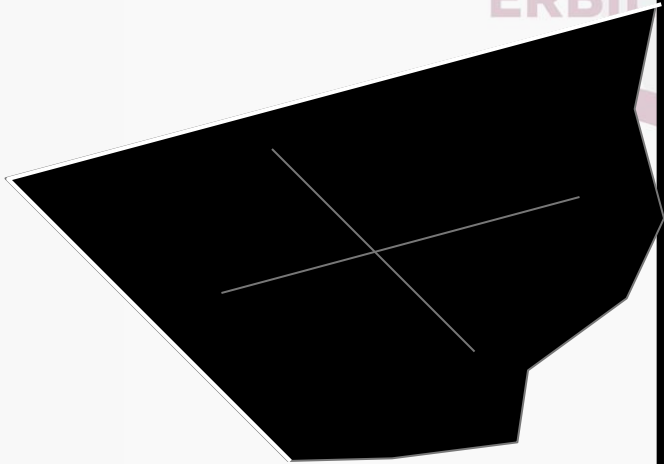
Using Compass
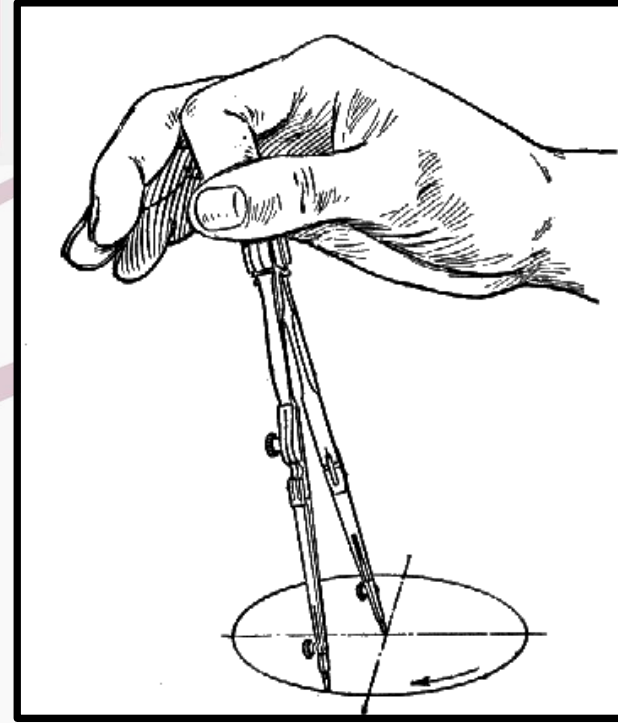
4. *Start circle.* Apply enough pressure to the needle, holding compass handle between thumb and index fingers.

5. *Complete circle*. Revolve handle clockwise.
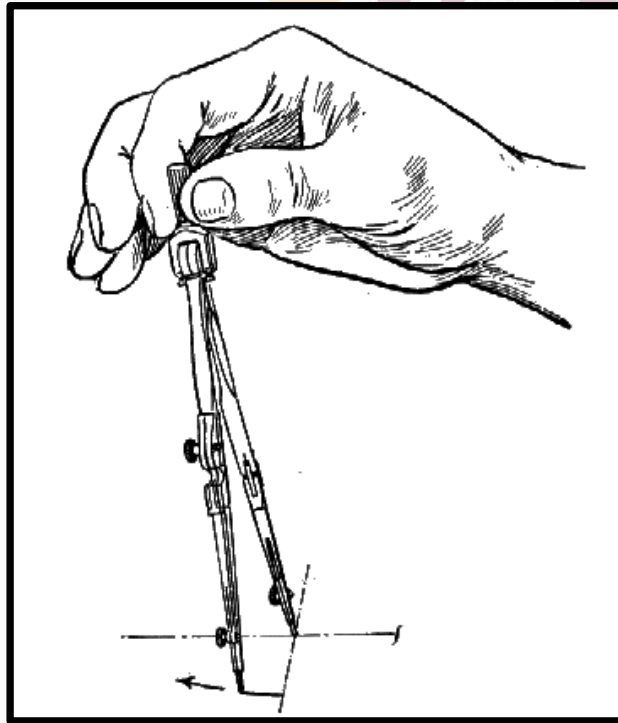
Construct a Circle:

- Draw a circle with radius of 50 mm.

- Draw a circle with the diameter of 60 mm from the center of the previous circle.

Construct an Arc:

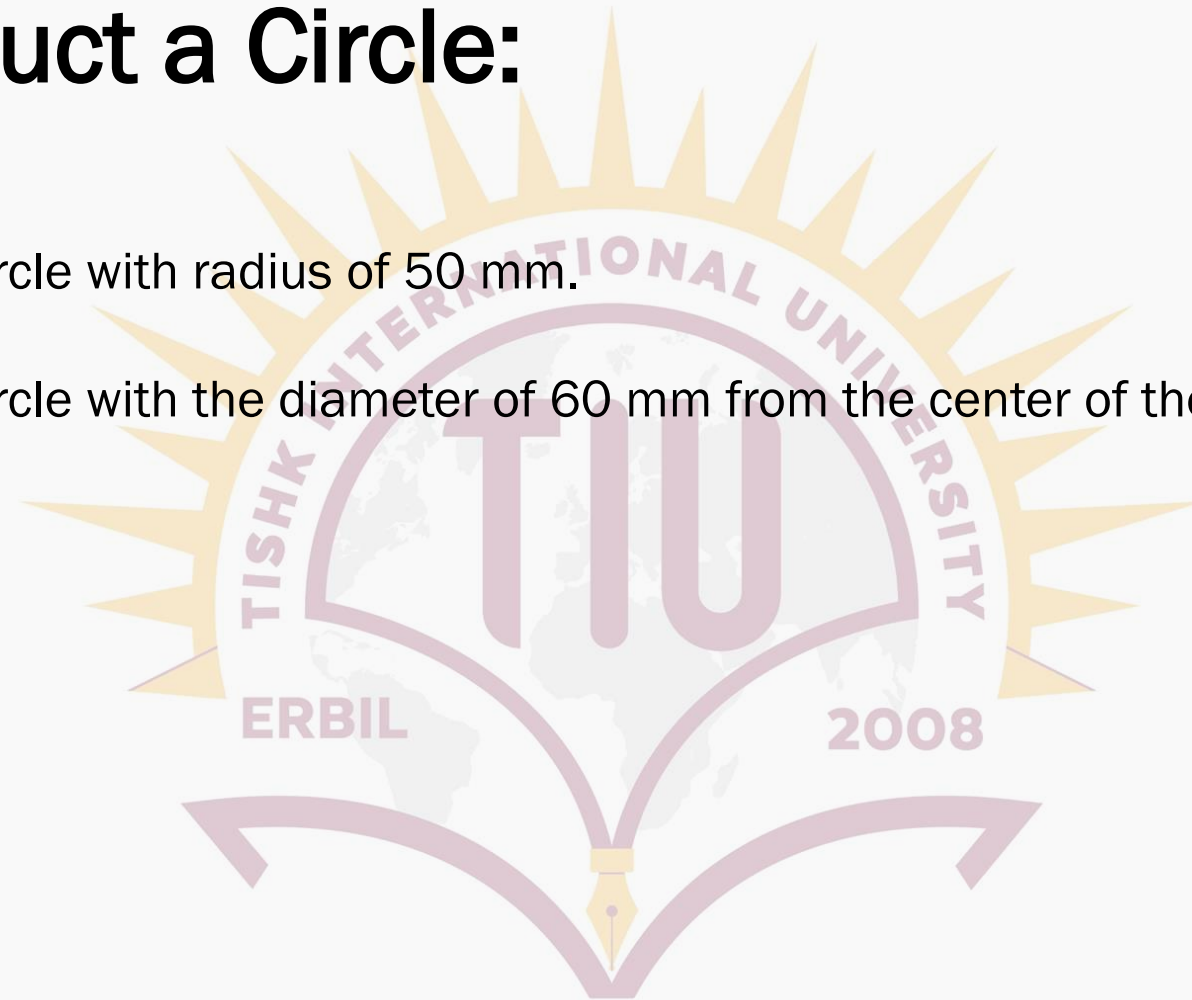- There are three different methods available for defining the arc - 3 points on arc; start, center, end point; start, center, angle:

1. 3 points on arc:

- The arc is defined by entering 3 points which are on the arc:

  1. The first point is the starting vertex of the arc entered in Step 1.
  2. The second point can be any intermediate point on the arc (e.g., the midpoint between the beginning and end points of the arc).
  3. The third point is the end vertex of the arc.
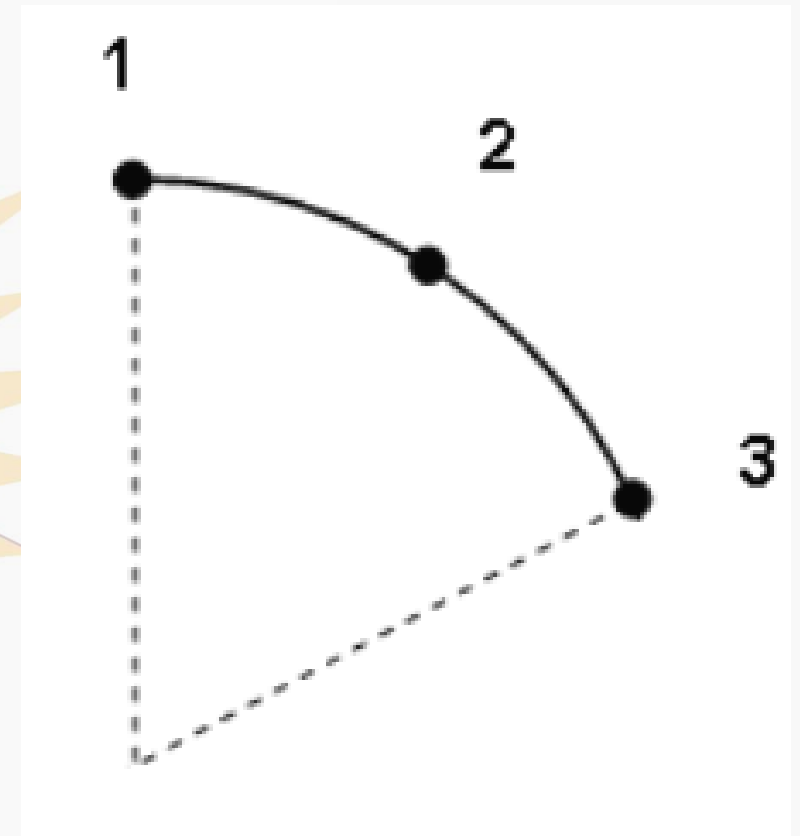
Construct an Arc:

1. 3 points on arc:

Construct an Arc:

1. 3 points on arc:

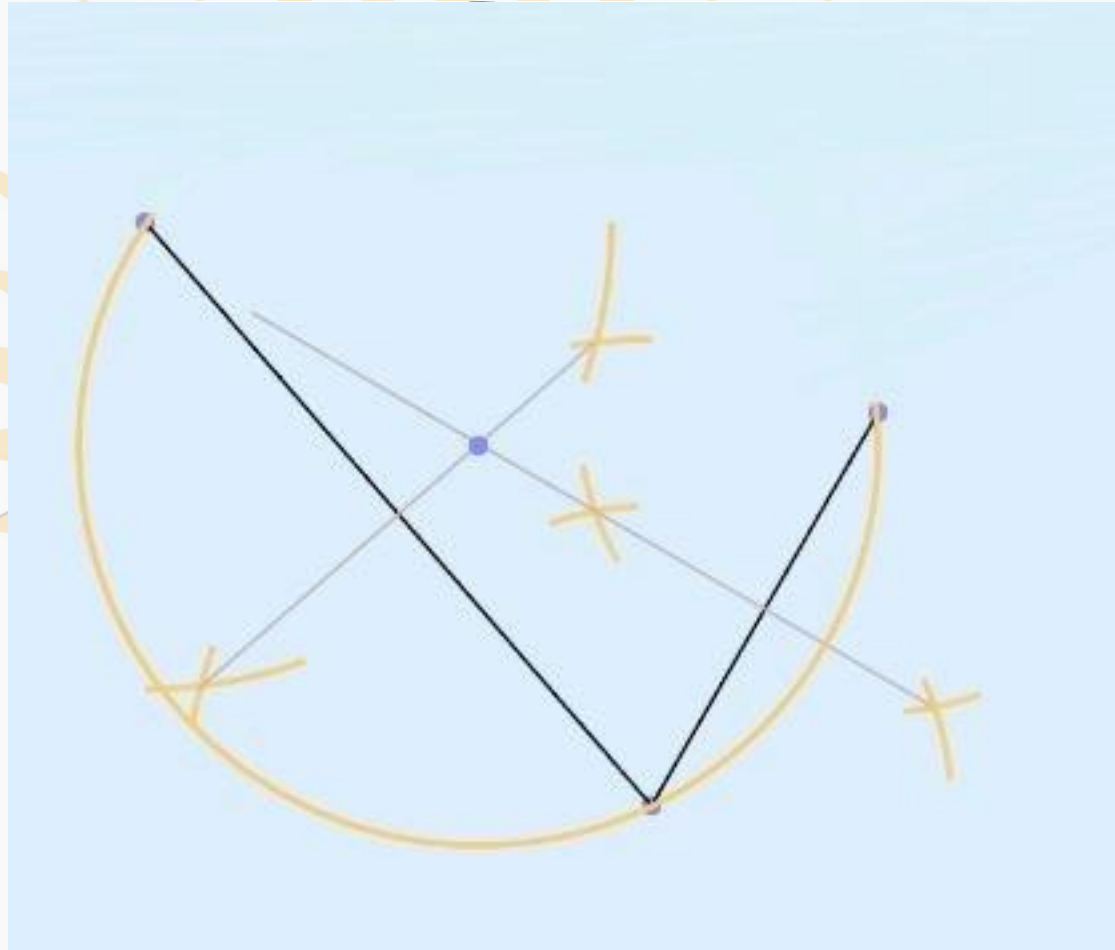Draw an arc from three arbitrary points.
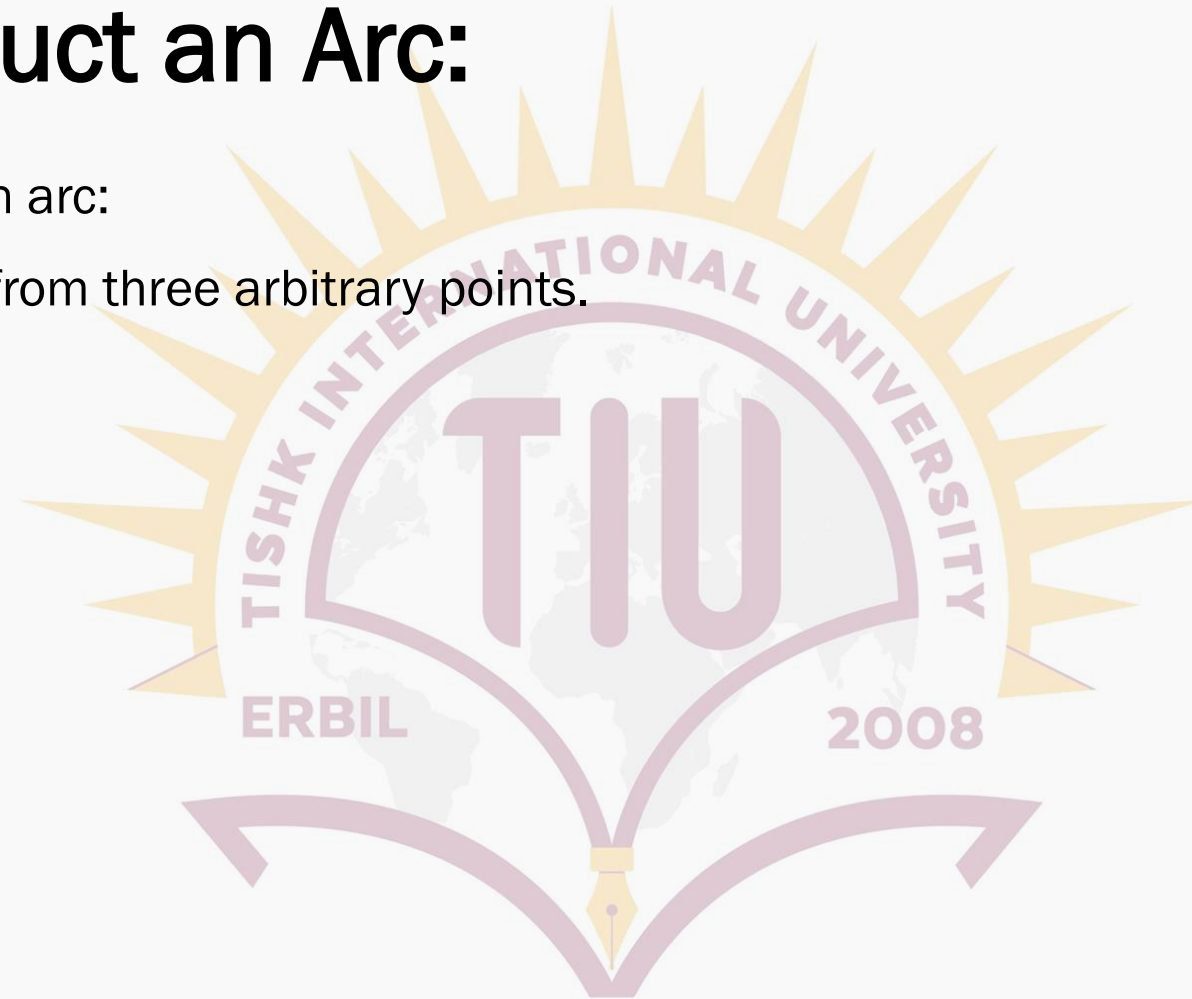
Construct an Arc:

- There are three different methods available for defining the arc - 3 points on arc; start, center, end point; start, center, angle:

2. start, center, end point:

- The arc is defined by entering a start point, center and end point:
    1. The first point is the starting vertex of the arc entered in Step 1.
    2. The "center" is the center of rotation of the arc.
    3. The third point is the end vertex of the arc.
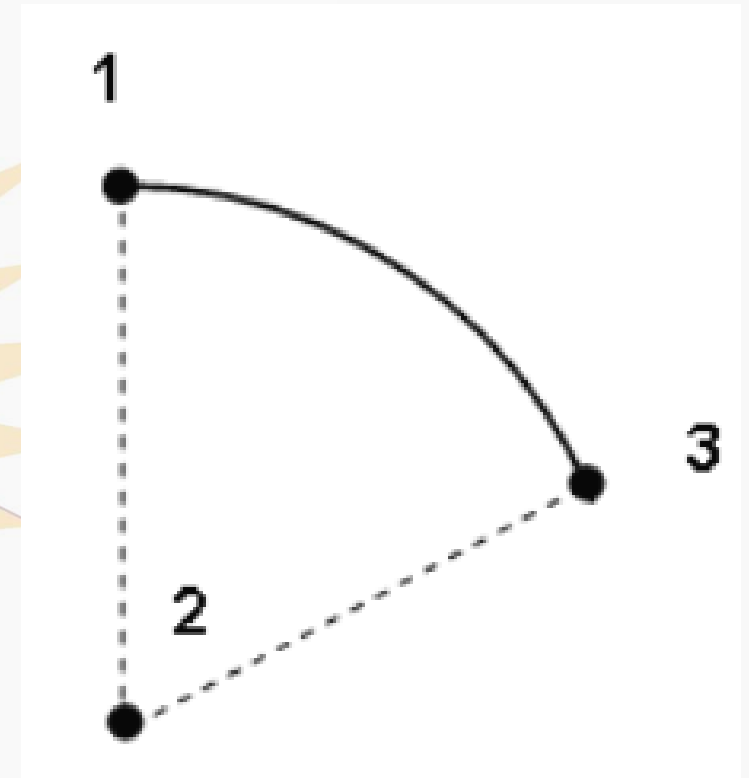
Construct an Arc:

2. start, center, end point:

Draw an arc with a radius of 50 mm.
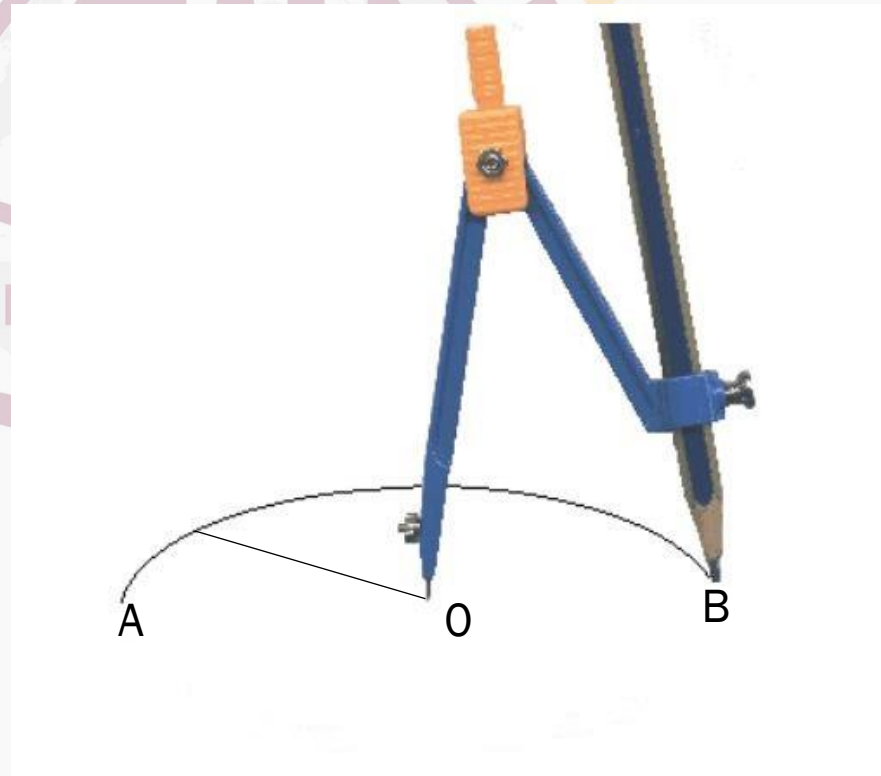
Construct an Arc:

- There are three different methods available for defining the arc - 3 points on arc; start, center, end point; start, center, angle:

3. start, center, angle:

- The arc is defined by entering a start point, center and angle.
    1. The start point is the starting vertex of the arc entered in Step 1 (above).
    2. The "center" is the center of rotation of the arc.
    3. The angle is the included angle of the arc (entered in the Arc Options dialog).
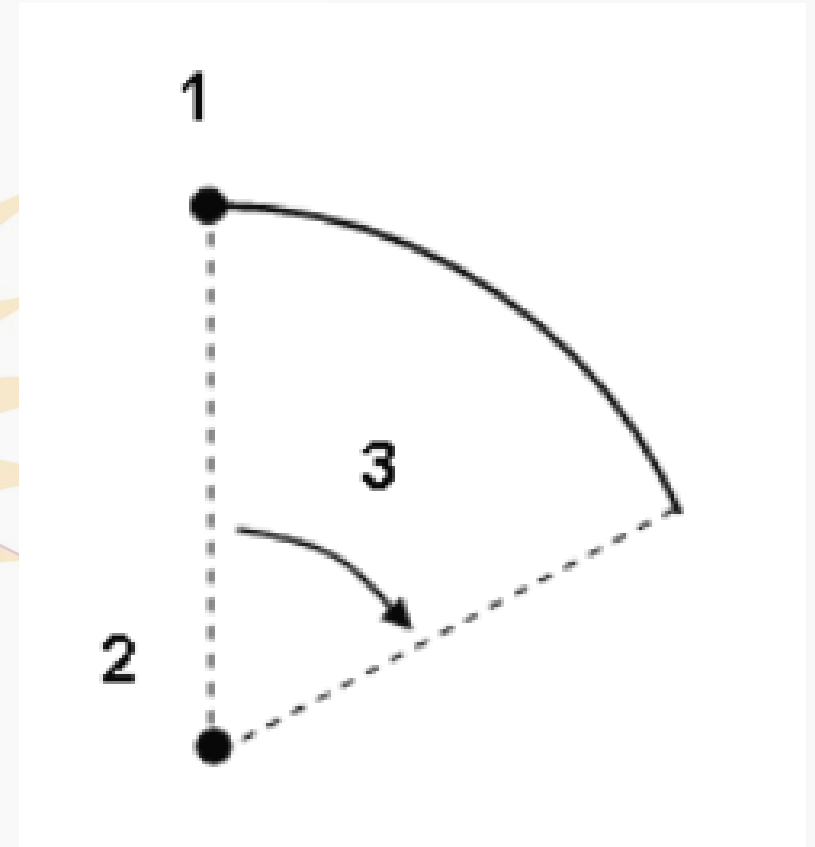
Construct an Arc:

3. start, center, angle:

■   Draw an arc with a radius of 50 mm and angle of 45°.
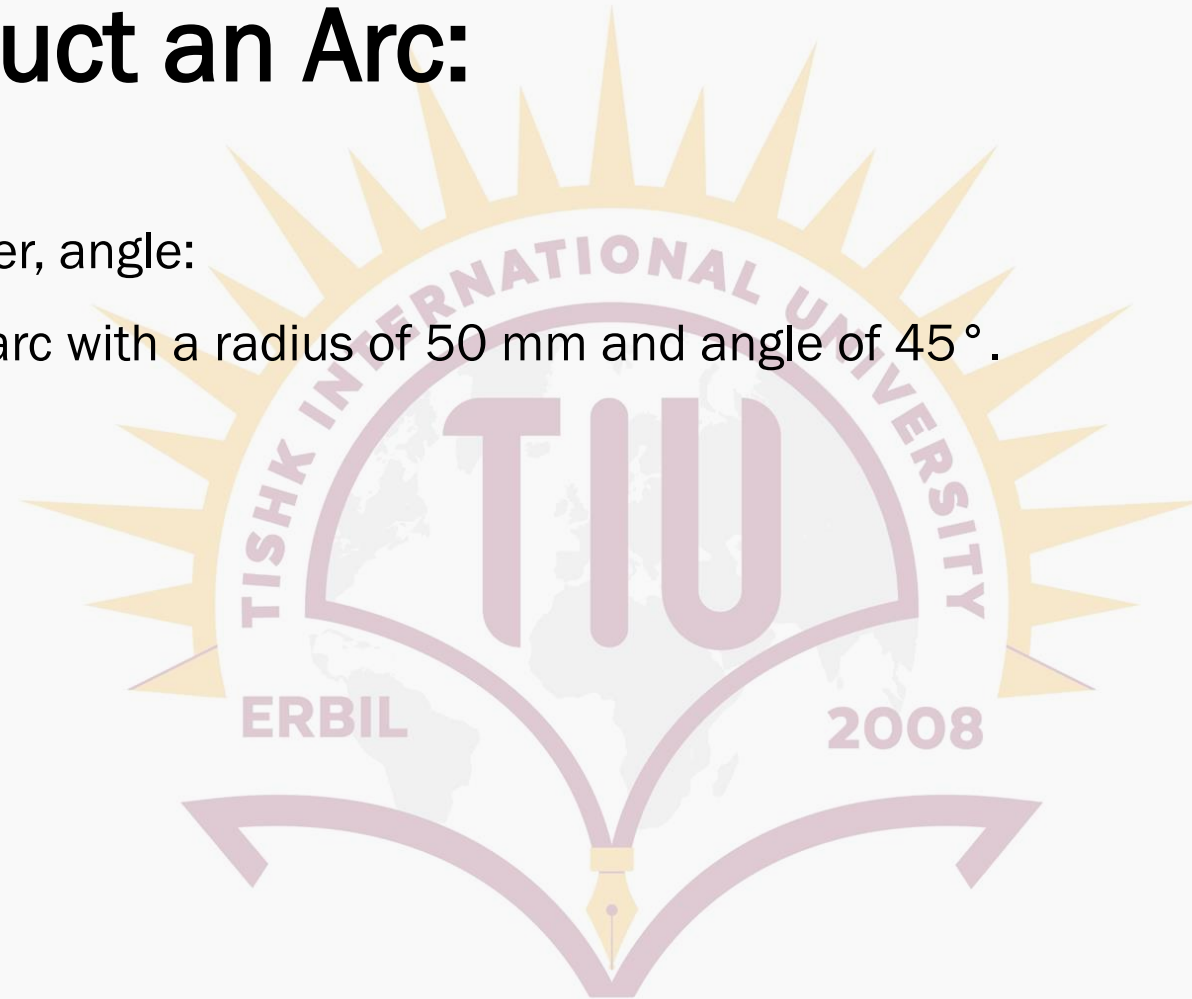
Bisect a Straight Line:

■ Draw a line AB of 70 mm long.

■ With A and B as centres, more than half of AB as radius describe arcs on either side of the line AB.

■ Let the arcs intersect at C & D.

■ Join CD, bisecting the line AB at O.

■ CD is the bisector of the line AB and AO = OB.
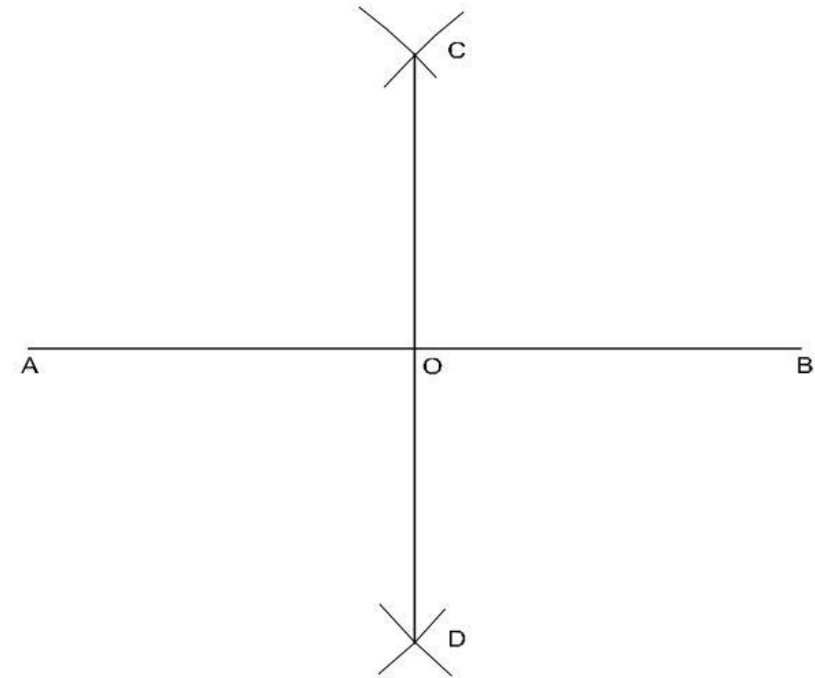
Draw a Perpendicular to a Straight Lines:

- ■ Draw a perpendicular to a given straight line, from a given point in it:

- `C' is the point on the line AB.

- `C' as centre draw arcs on the line AB at 1 & 2.

- 1 and 2 are centres draw arcs. The arcs intersect at D.

- Join DC.

- CD is the perpendicular line from the point `C'.
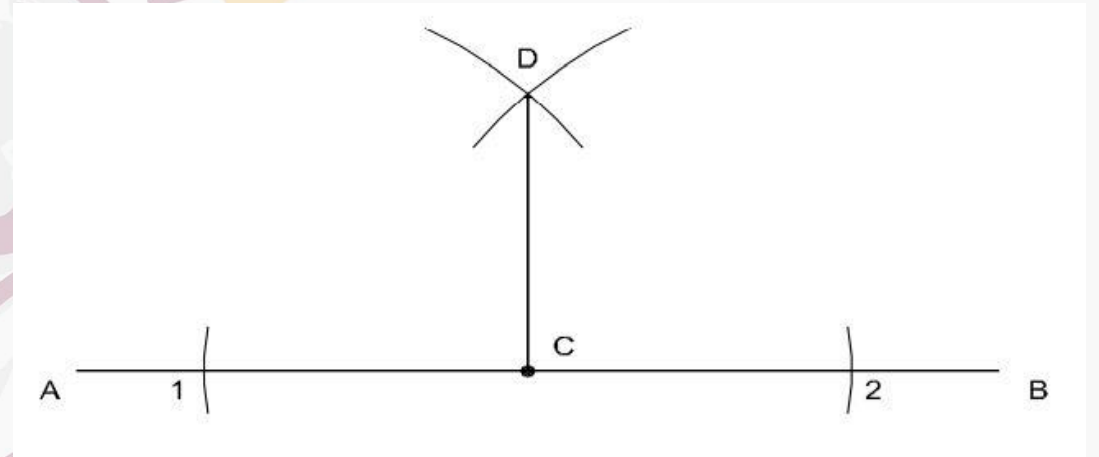
Draw Parallel Lines:

- ■ Draw a line parallel to a given line at a given distance:

- Draw a line AB to a convenient length (say 60 mm).

- Draw a line CD (40 mm) is the given distance.

- Mark points 1 & 2 near A & B respectively.

- With 1 & 2 as centres CD as radius draw arcs.

- At 1 & 2 erect perpendiculars by using setsquares, meeting at E & F respectively.

- Join the points E & F.

- EF is parallel to AB at the given distance of CD.
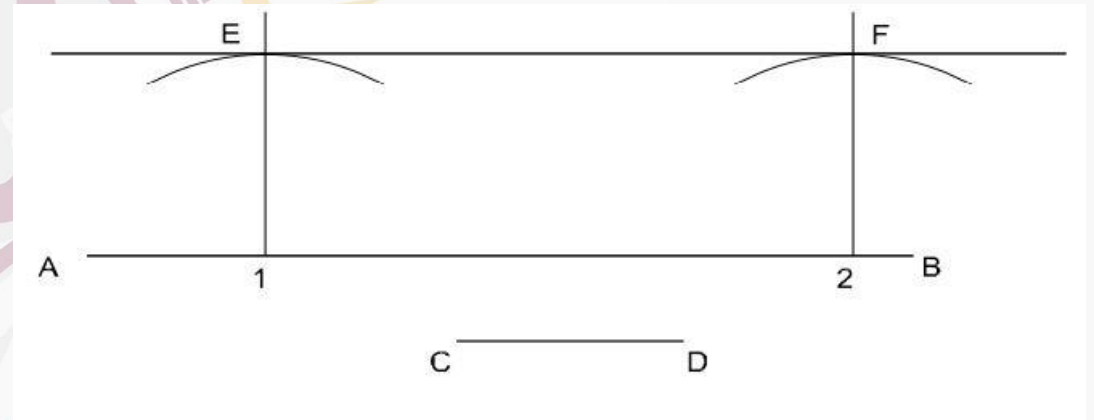
Draw a Tangent to a given Circle at any Point P:

1. With O as centre, draw the given circle. P is any point on the circle at which tangent to be drawn.

2. Join O with P and produce it to p1 so that OP = pp1.

3. With O and p1 as centres and a length greater than OP as radius, draw arcs Intersecting each other at Q.

4. Draw a line through P and Q. This line is the required tangent that will be perpendicular to OP at P.
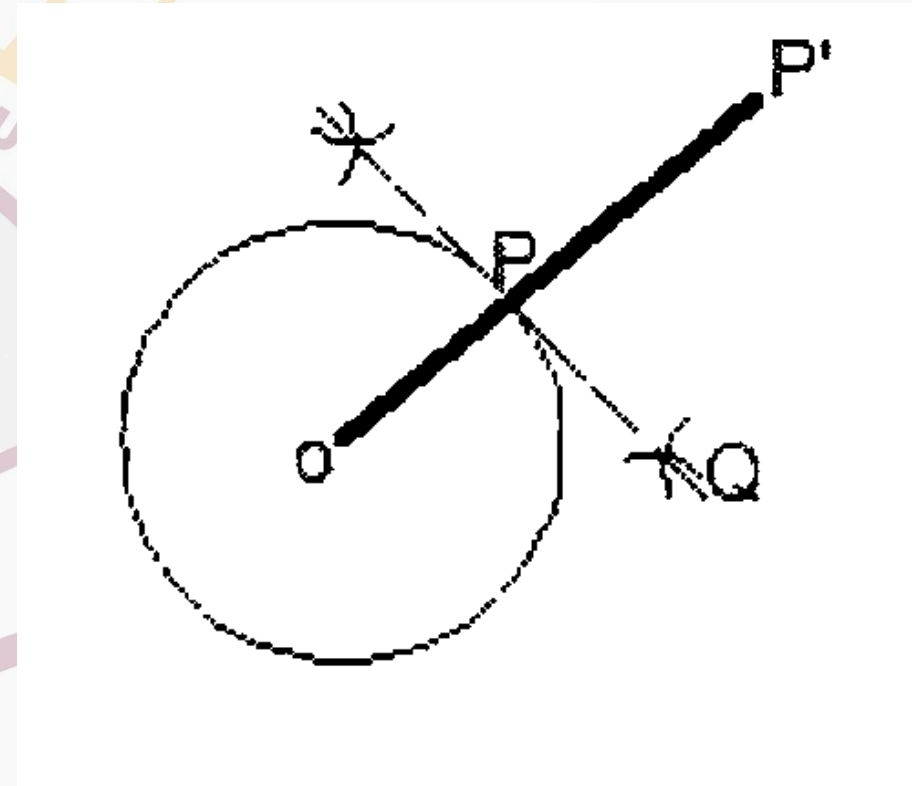
Draw a Tangent to a given Circle at any Point Outside the Circle:

1. With 0 as centre, draw the given circle. P is the point outside the circle from which tangent is to be drawn to the circle.

2. Join 0 with P. With OP as diameter, draw a semi-circle intersecting the given circle at M. Then, the line drawn through P and M is the required tangent.

3. If the semi-circle is drawn on the other side, it will cut the given circle at MI. Then the line through P and MI will also be a tangent to the circle from P.
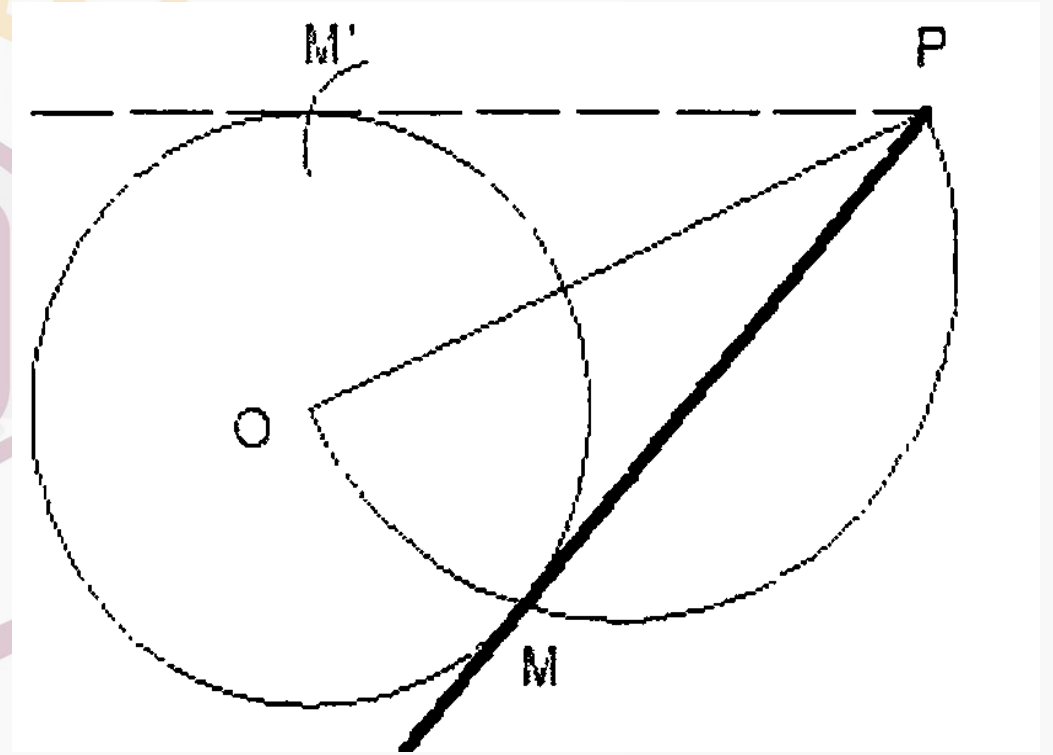
Draw an Arc to Touch to Two Straight Lines:

- Draw an arc of given radius (R 20 mm) to touch to two straight lines (50 mm each) at right angles:

- Draw the lines AB and AC (50 mm each) at right angles.

- With `A' as centre and given radius (R 20 mm) draw an arc to cut lines AB and AC at E and F.

- With E and F as centres and the radius given (R 20 mm), draw arcs to intersect each other at `O'.

- Use `O' as centre and with same radius (R 20) draw a curve (arc) which will just touch the given lines AB and AC.
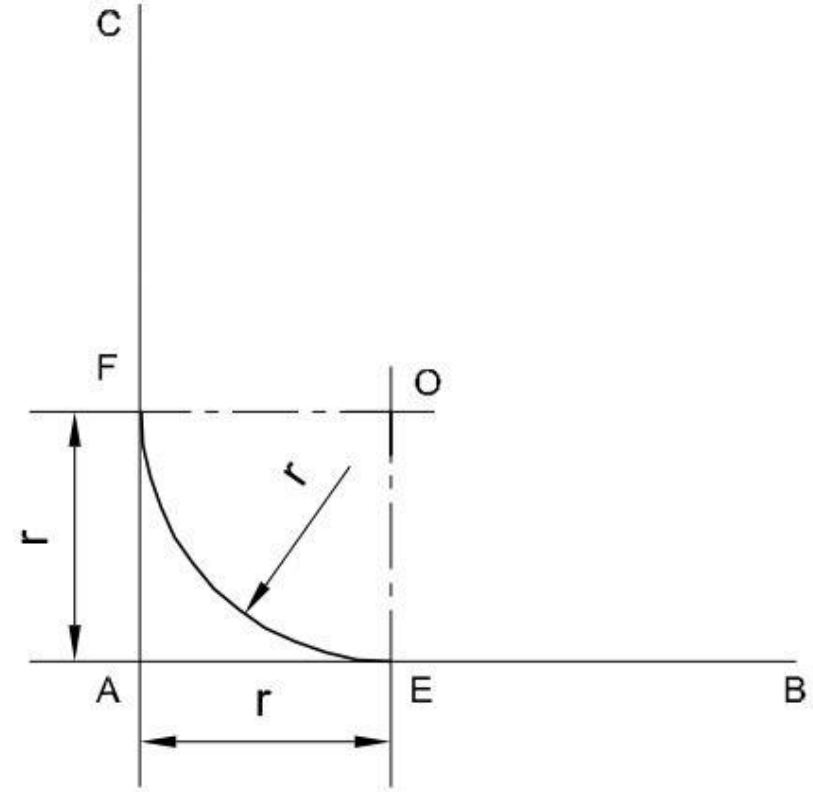
Draw an Arc to Touch an Acute angle:

■ Draw an arc of given radius (R 20 mm) to touch the given lines which make an acute angle between them (assume 60°):

• Draw an acute angle BAC (60°).

• Draw a horizontal parallel line EF at a distance equal to the given radius (20 mm).

• Draw another angular parallel line GH at a distance of given radius 20 mm. Both the parallel lines drawn meet at `O'.

• With `O' as centre and `r' as radius (20 mm) draw an arc touching both lines AB and AC.
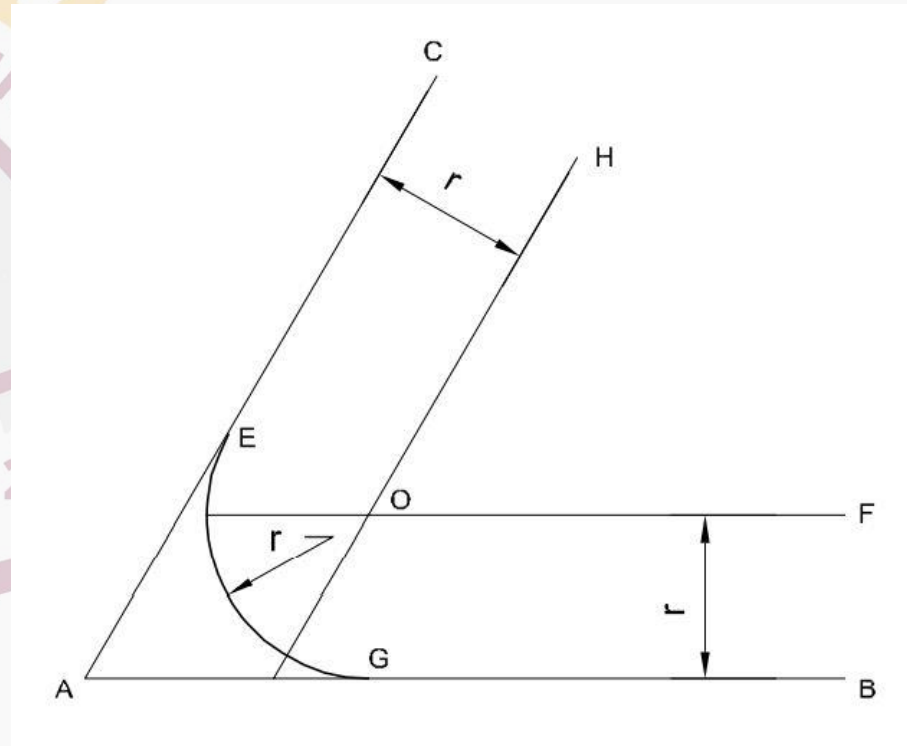
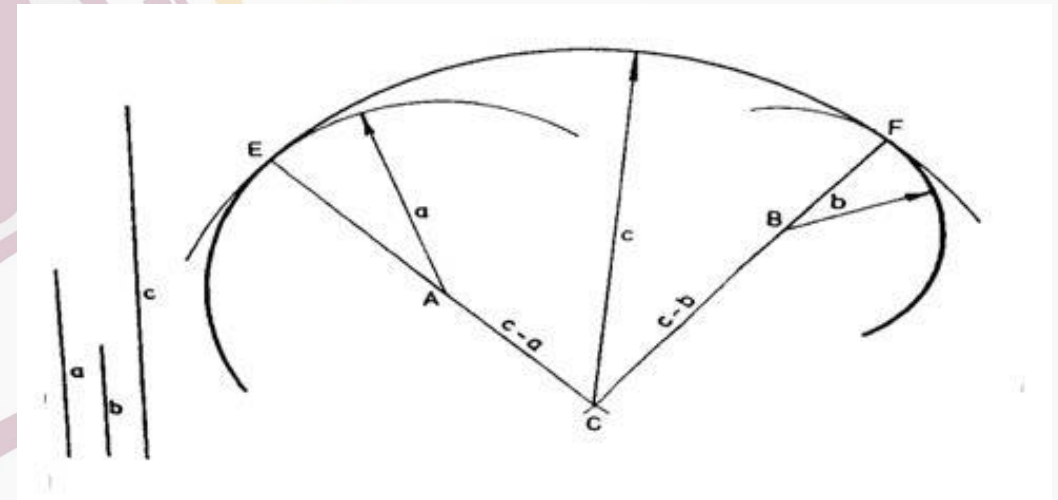# How to Draw an Arc Tangential to two Arcs Internally

A and B are the centres of two given arcs of radius a and b respectively, and c is the required tangential arc radius:

1. From A and B describe arcs equal to c – a (c minus a) and c – b (c minus b) respectively to intersect at C.

2. With centre C and radius c describe an arc which will be tangential to the given arcs.

3. Produce CA and CB to intersect the curve at E and F respectively. These are the points of tangency of the arcs.

Where c= 4.6 cm

a= 2.5 cm

b= 1.5 cm

How to Draw an Arc Tangential to two Arcs Externally

A and B are the centres of the given arcs of radius a and b respectively, and c is the external arc radius:
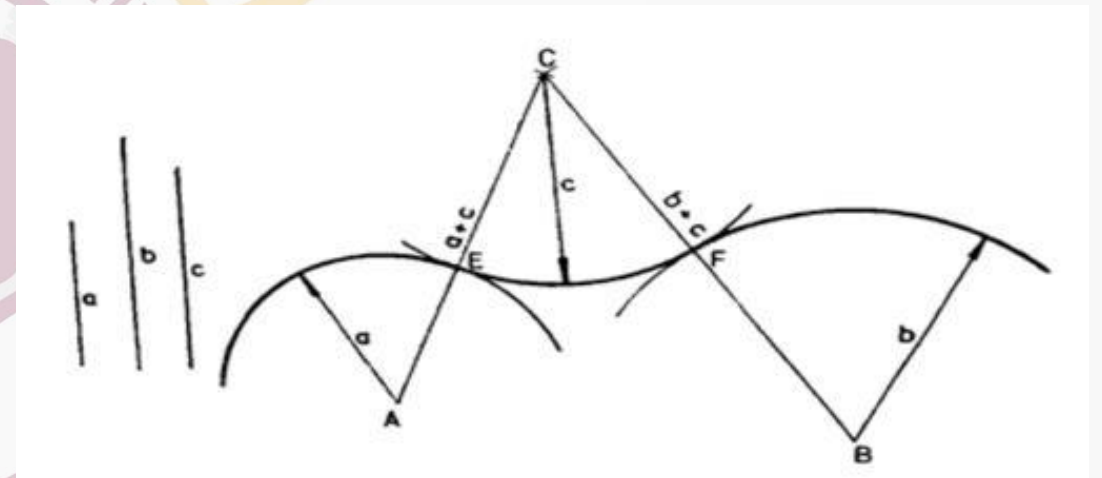
1. From centres A and B describe two arcs equal to a + c (a plus c) and b + c (b plus c) respectively to intersect at C.

2. With centre C and radius c describe an arc which will be tangential to the given arcs.

E and F are the points of tangency of the three arcs.

Where a= 1.6 cm

        b= 2.6 cm

        c= 2.3 cm

Divide a Straight Line into Equal Parts:

- Divide a line into any number of equal parts:

- Draw a line AB to a convenient length (say 65 mm).

- At `A' draw a line AC to a required length, forming an angle BAC. (Always it is better to form an acute angle)

- Set off 5 equal arcs on the line AC meeting at 1,2,3,4 & 5. (As many equal parts as required)

- Join 5 & B.

- From the points 4,3,2 & 1 draw lines parallel to 5-B meeting the line AB at 4', 3', 2' & 1'.

- Now the line AB is divided into 5 equal parts.
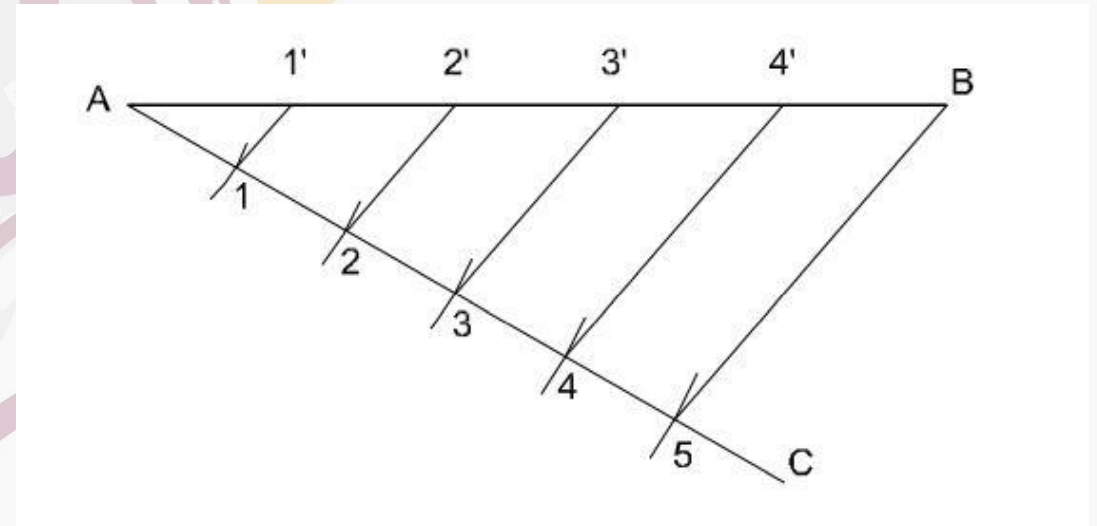
Divide a Straight Line into Equal Parts:

1. Draw AC at any angle Ө to AB.

2. Construct the required number of equal parts of convenient length on AC like 1, 2, 3.

3. Join the last point 5 to B.

4. Through 4, 3, 2, 1 draw lines parallel to 5B to intersect AB at 4′, 3′, 2′ and 1′,
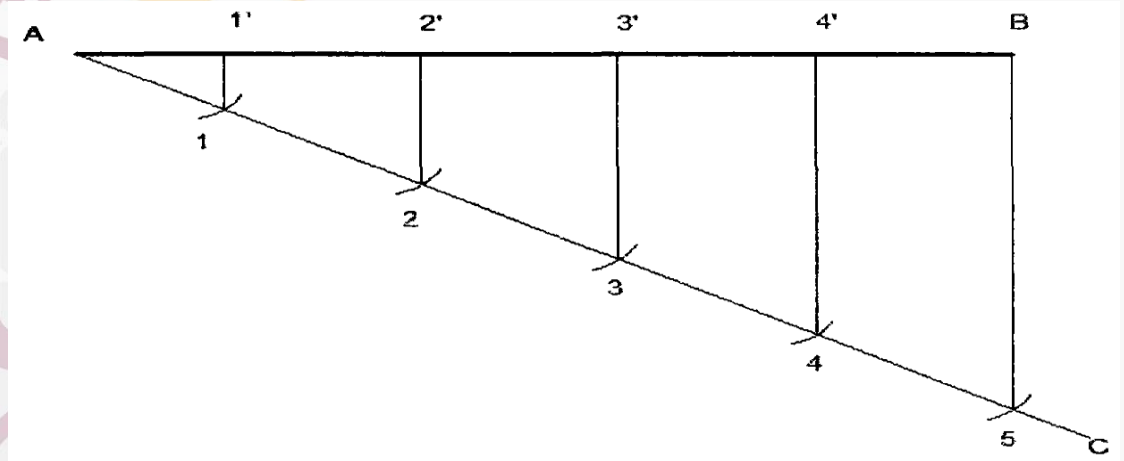
Bisect a given Angle:

■ Bisect a given angle:

• Construct an angle BAC (say 30°).

• `A' as centre to a convenient radius draw an arc to cut line AC at `E' and AB at `D'.

• Bisect the arc DE at `O'.

• Join AO.

• AO is the bisector of the angle BAC.

• Now ∠OAC = ∠OAB .

∠ OAB = ∠ OAC
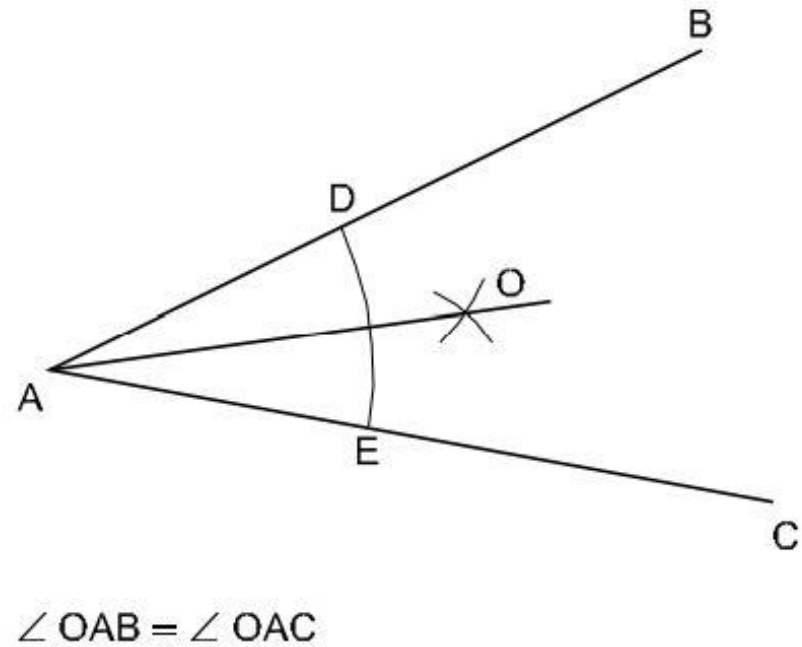
Homework 2.1:

1. Construct a circle from three given points (ABC) when the distance between A and B is 60 mm and distance between B and C is 80 mm.

2. Construct concentric circles with diameter of 100 mm, 80 mm and 60 mm, respectively.

3. Draw a tangent line to a circle (diameter= 80 mm) with a point of 50 mm outside the circumference of the circle.

4. Draw an arc of given radius (R 20 mm) to touch the given lines which make an acute angle of 60° between them.

5. Divide a line of 100 mm in the ratio 1 : 3 : 4.

6. Bisect an angle of 70°.

Homework 2.2: Draw: