

1. To construct a regular polygon (say a pentagon) given the length of the side 40mm (GENERAL METHOD)

Solution:

1.

Draw lines AB AND BC with lengths of 40mm using Line command L. Draw a line joining A and C using Line command L. Mark the text using MTEXT command.

2. Draw a circle with 40mm radius and B as centre using Circle command C. Trim the extra portion of circle using Trim command TR.

3. Create a bisecting line at a distance of 20mm from BC using Offset command O.

4. Mark point 4 at the intersection of AC and bisecting line and 6 at the intersection of arc and bisecting line. Mark the points using MTEXT command.

5. Create a point at the midpoint of 4 and 6 using Offset command O. Mark the point as 5 using MTEXT command.

6. With offset command O, Create a line at 8 with distance equal to 4-6.

5. Create a point at the midpoint of 6 and 8 using Offset command O. Mark the point as 7 using MTEXT command.

6. With A5 radius, 5 as centre draw a circle using Circle command C.

7. With AB radius, A as centre draw an arc on circle using Circle command C. Mark a

point 1 at the intersection of two circles using MTEXT command.

8. Using above procedure, draw arcs 2, 3 for pentagon shape. Center for 2 arc is 1 and center for 3 arc is 2.

9. Join points A-1, 1-2, 2-3, 3-B using Line command L.

10. Final diagram is the pentagon shape.

2. To construct a regular polygon Hexagon given the length of the side 40mm (GENERAL METHOD)

Solution:

1.

Draw lines AB AND BC with lengths of 40mm using Line command L. Draw a line joining A and C using Line command L. Mark the text using MTEXT command.

DEPARTMENT OF MECHANICAL ENGINEERING2. Draw a circle with 40mm radius and B as centre using Circle command C. Trim the extra portion of circle using Trim command TR.

DEPARTMENT OF MECHANICAL ENGINEERING3. Create a bisecting line at a distance of 20mm from BC using Offset command O.

4. Mark point 4 at the intersection of AC and bisecting line and 6 at the intersection of arc and bisecting line. Mark the points using MTEXT command.

5. Create a point at the midpoint of 4 and 6 using Offset command O. Mark the point as 5 using MTEXT command.

6. With offset command O, Create a line at 8 with distance equal to 4-6.

5. Create a point at the midpoint of 6 and 8 using Offset command O. Mark the point as 7 using MTEXT command.

DEPARTMENT OF MECHANICAL ENGINEERING6. With A6 radius,

Polygon Construction Steps

- 6 as centre draw a circle using Circle command C.
- 7. With AB radius, A as centre draw an arc on circle using Circle command C. Mark a point 1 at the intersection of two circles using MTEXT command.
- DEPARTMENT OF MECHANICAL ENGINEERING8. Using above procedure, draw arcs 2, 3, 4 for Hexagon shape. Center for 2 arc is 1, center for 3 arc is 2 and center for 4 arc is 3.
- 9. Join points A-1, 1-2, 2-3, 3-4, 4-B using Line command L.
- 10. Final diagram is the Hexagon shape. tell in tableform



Sure! Here's the procedure for constructing a regular polygon (Pentagon and Hexagon) given the side length in a table format:

Regular Pentagon Construction (Side = 40mm)

Step	Description	Command
1	Draw lines AB and BC with lengths of 40mm. Draw a line joining A and C. Mark text at relevant points.	L (Line), MTEXT
2	Draw a circle with 40mm radius and B as the center. Trim the extra portion of the circle.	C (Circle), TR (Trim)
3	Create a bisecting line at a distance of 20mm from BC.	O (Offset)
4	Mark point 4 at the intersection of AC and bisecting line, and point 6 at the intersection of the arc.	MTEXT
5	Create a point at the midpoint of 4 and 6. Mark it as point 5.	O (Offset), MTEXT
6	Create a line at point 8 with distance equal to the distance between 4 and 6.	O (Offset)
7	Create a point at the midpoint of 6 and 8. Mark it as point 7.	O (Offset), MTEXT
8	With A5 radius, center at 5, draw a circle.	C (Circle)
9	With AB radius, center at A, draw an arc on the circle. Mark the intersection point as point 1.	C (Circle), MTEXT
10	Draw arcs 2 and 3 for the pentagon shape. Centers for arcs are 1 and 2.	-
11	Join points A-1, 1-2, 2-3, 3-B using the Line command.	L (Line)
12	Final diagram is the pentagon shape.	-

Regular Hexagon Construction (Side = 40mm)

Step	Description	Command
1	Draw lines AB and BC with lengths of 40mm. Draw a line joining A and C. Mark text at relevant points.	L (Line), MTEXT
2	Draw a circle with 40mm radius and B as the center. Trim the extra portion of the circle.	C (Circle), TR (Trim)
3	Create a bisecting line at a distance of 20mm from BC.	O (Offset)
4	Mark point 4 at the intersection of AC and bisecting line, and point 6 at the intersection of the arc.	MTEXT
5	Create a point at the midpoint of 4 and 6. Mark it as point 5.	O (Offset), MTEXT
6	Create a line at point 8 with distance equal to the distance between 4 and 6.	O (Offset)
7	Create a point at the midpoint of 6 and 8. Mark it as point 7.	O (Offset), MTEXT
8	With A6 radius, center at 6, draw a circle.	C (Circle)
9	With AB radius, center at A, draw an arc on the circle. Mark the intersection point as point 1.	C (Circle), MTEXT
10	Draw arcs 2, 3, and 4 for the hexagon shape. Centers for arcs are 1, 2, and 3.	-

Step	Description	Command
11	Join points A-1, 1-2, 2-3, 3-4, 4-B using the Line command.	L (Line)
12	Final diagram is the hexagon shape.	-

Let me know if you need further details or clarification!



CONIC SECTIONS

ELLIPSE:

- The Ellipse may defined as the locus of a point moving in a plane in such a way
- That the ratio of its distances from a fixed point and a fixed straight line is always
- Constant. And It Less than one $e < 1$
- Ellipses are mostly found as harmonic oscillators, phase visualization, elliptical gears, Ellipse wings.

DEPARTMENT OF MECHANICAL ENGINEERING Draw an ellipse with the distance of the focus from the directrix at 50 mm and Eccentricity $= 2/3$ Also draw a tangent and a normal to the ellipse at a point 40 mm from the directrix. (Eccentricity method)

Solution:

1.

Draw A Vertical Line AB Called Directrix Using Line Command L with Some

Height and F8 on, mark AB on vertical line using Text command

DEPARTMENT OF MECHANICAL ENGINEERING 2. At Any point C In the Directrix Draw Horizontal Line CD called Axis with Some Length using Line

command L and F8 on, mark CD on horizontal line using Text command Mtext

3. Mark a Focus point F on the Axis Making Offset 50 mm Distance From Directrix line $CF = 50$ mm using Offset command O

DEPARTMENT OF MECHANICAL ENGINEERING 4. Mark a Vertex (V) on CD at a distance of 20 mm from F, because $e = 2/3$ ($e < 1$) ($e = VF/VC$) using

Offset command O

5. Mark distances of $VF = 20$ mm and $VC = 30$ mm using Dimension command DIMLIN

DEPARTMENT OF MECHANICAL ENGINEERING 6. Mark a point E with 20 mm distance FROM V (VF perpendicular to VE)

7. Draw a line, joining C and E and extend up to some length using Line

command L.

DEPARTMENT OF MECHANICAL ENGINEERING 8. Draw a line from F with 45° using line Command. (both CE extension line and 45° line must coincide).

9. Divide VD line into number of equal parts using Offset command O.

DEPARTMENT OF MECHANICAL ENGINEERING 10. Mark numbers 1, 2, 3, etc. on VD line and mark as 1I, 2I, etc. at the intersection points of CE extension line and offset lines.

DEPARTMENT OF MECHANICAL ENGINEERING • 11. Measure the distance between 1 to 1I, 2 to 2I, etc.. Using MEASURE (MEA) command.

• 12. Draw the circles with F as centre by taking distance 1 to 1I, 2 to 2I, etc.. as radius using Circle command C.

• 13. Create the points at the intersection of circle and 1-1 I, 2 - 2I, etc.. line above and below CD line using point command PO.

DEPARTMENT OF MECHANICAL ENGINEERING 14. Mark the points P 1, P 2, etc. and P 1 I, P 2 I, etc... on both sides of

CD line for developing Ellipse.

DEPARTMENT OF MECHANICAL ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING • 15. Mark a point P ON ELLIPSE at a distance of 40 mm from directrix using offset command O.

DEPARTMENT OF MECHANICAL ENGINEERING • 16 . Draw a line by joining P and F, Draw a line from F perpendicular to the directrix using line command L. Mark a point T on Directrix line.
• 17. Make lines FP and FT perpendicular, select parametric from MENU

BAR - geometric constraints - perpendicular - Select two lines
DEPARTMENT OF MECHANICAL ENGINEERING • 18. Draw a Tangent line by joining from T to P and extend some distance and mark as T₁

DEPARTMENT OF MECHANICAL ENGINEERING • 19. Draw a Normal line to Tangent line TT₁ and extend some distance and mark as NN₁

• 20. Make lines TT₁ and NN₁ perpendicular, select parametric from MENU

BAR - geometric constraints - perpendicular - Select two lines .
DEPARTMENT OF MECHANICAL ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING in table form

Here is the solution for constructing an ellipse using the eccentricity method, including the drawing of a tangent and normal at a point, presented in table form:

Ellipse Construction (Eccentricity Method)

Step	Description	Command
1	Draw a vertical line AB called the Directrix using the Line command. Mark AB on the vertical line using Text.	L (Line), MTEXT
2	Draw a horizontal line CD called the Axis at any point C in the Directrix, using the Line command. Mark CD on the horizontal line using Text.	L (Line), MTEXT
3	Mark a focus point F on the Axis, 50mm away from the Directrix (CF = 50mm) using the Offset command.	O (Offset)
4	Mark a vertex (V) on CD at a distance of 20mm from F (since $e = 2/3$, $e = VF / VC$) using the Offset command.	O (Offset)
5	Mark the distances VF = 20mm and VC = 30mm using the Dimension command.	DIMLIN
6	Mark a point E, 20mm away from V, ensuring that VF is perpendicular to VE.	O (Offset)
7	Draw a line joining points C and E, and extend it.	L (Line)
8	Draw a line from F at a 45° angle, ensuring the line coincides with both the CE extension line and the 45° line.	L (Line)
9	Divide the VD line into equal parts using the Offset command.	O (Offset)
10	Mark numbers (1, 2, 3, etc.) on the VD line, and label intersections as 1 _I , 2 _I , etc., at the points where the CE extension line intersects the offset lines.	MTEXT, O (Offset)
11	Measure the distance between corresponding points (1 to 1 _I , 2 to 2 _I , etc.) using the MEASURE (MEA) command.	MEA (Measure)
12	Draw circles with F as the center, using the measured distances (1 to 1 _I , 2 to 2 _I , etc.) as radii.	C (Circle)
13	Create points at the intersections of the circles and lines 1-1 _I , 2-2 _I , etc., both above and below the CD line using the Point command.	PO (Point)
14	Mark points P ₁ , P ₂ , etc., and P _{1I} , P _{2I} , etc., on both sides of the CD line to develop the ellipse.	MTEXT
15	Mark point P on the ellipse, located 40mm from the Directrix using the Offset command.	O (Offset)
16	Draw a line from P to F and a perpendicular line from F to the Directrix. Mark the intersection as point T.	L (Line)

Step	Description	Command
17	Make lines FP and FT perpendicular using the parametric geometric constraint in the Menu Bar.	-
18	Draw a tangent line from T to P and extend it. Mark the extended point as T1.	L (Line)
19	Draw a normal line to the tangent line TT1, and extend it. Mark the extended point as NN1.	L (Line)
20	Make lines TT1 and NN1 perpendicular using the parametric geometric constraint in the Menu Bar.	-

This table summarizes the steps to construct an ellipse using the eccentricity method, along with the construction of the tangent and normal at a point on the ellipse. Let me know if you need any more details!



Draw a parabola with the distance of the focus from the directrix at 50mm Also draw a tangent and a normal to the parabola at a point 60 mm from the directrix. (Eccentricity method)

Solution:

1 . Draw A Vertical Line AB Called Directrix Using Line Command L with

Some Height and F8 on, mark AB on vertical line using Text command

2.At Any point C In the Directrix Draw Horizontal Line CD called Axis with

Some Length using Line command L and F8 on, mark CD on horizontal

line using Text command Mtext

DEPARTMENT OF MECHANICAL ENGINEERING3.Mark a Focus

point F on the Axis Making Offset 50 mm Distance

From Directrix line $CF=50$ mm using Offset command O.

DEPARTMENT OF MECHANICAL ENGINEERING4. Mark a Vertex

(V) on CD at a distance of 25 mm from F, because e

$= 1$ ($e = VF/VC$)

5. Mark distances of $VF = 25$ mm and $VC = 25$ mm using Dimension command DIMLIN

DEPARTMENT OF MECHANICAL ENGINEERING6. Mark a point E

with 25 mm distance FROM V (VF perpendicular to VE)

DEPARTMENT OF MECHANICAL ENGINEERING7. Draw a line,

joining C and E and extend up to some length using Line command L and Extend command EX.

DEPARTMENT OF MECHANICAL ENGINEERING8. Divide VD line into number of equal parts using Offset command O.

9. Mark numbers 1,2,3, etc. on VD line and mark as 1I, 2I,etc. at the

intersection points of CE extension line and offset lines.

DEPARTMENT OF MECHANICAL ENGINEERING10. Measure the distance between 1 to 1I, 2 to 2I, etc.. Using MEASURE (MEA) command.

11. Draw the circles with F as centre by taking distance 1 to 1I, 2 to 2I, etc..

as radius using Circle command C.

DEPARTMENT OF MECHANICAL ENGINEERING12. Create the points at the intersection of circle and 1-1 I, 2 - 2I, etc.. line above and below CD line using point command PO.

13. Mark the points P 1, P 2, etc..and P 1 I, P 2 I, etc... on both sides of CD line for

developing Parabola.

DEPARTMENT OF MECHANICAL ENGINEERING14. Draw curve using Spline Command SPL.

DEPARTMENT OF MECHANICAL ENGINEERING15. Mark a point P on Parabola at a distance of 60 mm from directrix using offset command O.

DEPARTMENT OF MECHANICAL ENGINEERING16. Draw a line by

joining P and F, Draw a line from F perpendicular to the directrix using line command L. Mark a point T on Directrix line.

17. Make lines FP and FT perpendicular, select parametric from MENU BAR

geometric constraints

perpendicular

Select two lines

DEPARTMENT OF MECHANICAL ENGINEERING

18. Draw a Tangent line by joining from T to P and extend some distance and mark as T₁

DEPARTMENT OF MECHANICAL ENGINEERING

19. Draw a Normal line to Tangent line TT₁ and extend some distance and mark as NN₁

20. Make lines TT₁ and NN₁ perpendicular, select parametric from MENU

BAR - geometric constraints – perpendicular - Select two lines.

DEPARTMENT OF MECHANICAL ENGINEERING

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Here is the procedure for drawing a parabola using the eccentricity method, including the construction of a tangent and normal at a point on the parabola, presented in a table format:

Parabola Construction (Eccentricity Method)

Step	Description	Command
1	Draw a vertical line AB called the Directrix with some height, using the Line command. Mark AB with Text.	L (Line), MTEXT
2	Draw a horizontal line CD called the Axis at any point C in the Directrix using the Line command. Mark CD with Text.	L (Line), MTEXT
3	Mark a focus point F on the Axis, 50mm away from the Directrix (CF = 50mm) using the Offset command.	O (Offset)
4	Mark a vertex (V) on CD at a distance of 25mm from F (since $e = 1$, $e = VF / VC$) using the Offset command.	O (Offset)
5	Mark the distances VF = 25mm and VC = 25mm using the Dimension command.	DIMLIN
6	Mark a point E, 25mm away from V, ensuring that VF is perpendicular to VE.	O (Offset)
7	Draw a line joining points C and E, and extend it.	L (Line), EX (Extend)
8	Divide the VD line into equal parts using the Offset command.	O (Offset)
9	Mark numbers (1, 2, 3, etc.) on the VD line and label intersections as 1 _i , 2 _i , etc., at the points where the CE extension line intersects the offset lines.	MTEXT, O (Offset)
10	Measure the distance between corresponding points (1 to 1 _i , 2 to 2 _i , etc.) using the MEASURE (MEA) command.	MEA (Measure)
11	Draw circles with F as the center, using the measured distances (1 to 1 _i , 2 to 2 _i , etc.) as radii.	C (Circle)
12	Create points at the intersections of the circles and lines 1-1 _i , 2-2 _i , etc., both above and below the CD line using the Point command.	PO (Point)
13	Mark points P ₁ , P ₂ , etc., and P _{1i} , P _{2i} , etc., on both sides of the CD line to develop the parabola.	MTEXT
14	Draw the curve using the Spline command (to approximate the parabola).	SPL (Spline)
15	Mark point P on the parabola, located 60mm from the directrix using the Offset command.	O (Offset)
16	Draw a line from P to F, and draw a perpendicular line from F to the Directrix. Mark the intersection as point T.	L (Line)
17	Make lines FP and FT perpendicular using the parametric geometric constraint in the Menu Bar.	-
18	Draw a tangent line from point T to point P, and extend it. Mark the extended point as T ₁ .	L (Line)

Step	Description	Command
19	Draw a normal line to the tangent line TT ₁ , and extend it. Mark the extended point as NN ₁ .	L (Line)
20	Make lines TT ₁ and NN ₁ perpendicular using the parametric geometric constraint in the Menu Bar.	-

This table outlines the steps to construct a parabola using the eccentricity method, along with the construction of a tangent and normal to the parabola at a specific point. Let me know if you need any further assistance!



Draw a Hyperbola with the distance of the focus from the directrix at 50mm and Eccentricity

$=\frac{3}{2}$ Also draw a tangent and a normal to the Hyperbola at a point 60 mm from the directrix. (Eccentricity method)

Solution:

1. Draw A Vertical Line AB Called Directrix Using Line Command L with Some Height and F8

on, mark AB on vertical line using Text command

2. At Any point C In the Directrix Draw Horizontal Line CD called Axis with Some Length using

Line command L and F8 on, mark CD on horizontal line using Text command Mtext

DEPARTMENT OF MECHANICAL ENGINEERING3. Mark a Focus point F on the Axis Making Offset 50 mm Distance From Directrix line CF=50 mm

using Offset command O.

DEPARTMENT OF MECHANICAL ENGINEERING4. Mark a Vertex (V) on CD at a distance of 30 mm from F, because $e = \frac{3}{2}$ ($e = \frac{VF}{VC}$)

5. Mark distances of VF = 30mm and VC = 20mm using Dimension command DIMLIN

DEPARTMENT OF MECHANICAL ENGINEERING6. Mark a point E with 30 mm distance FROM V (VF perpendicular to VE)

7. Draw a line, joining C and E and extend up to some length using Line command L and Extend command EX.

DEPARTMENT OF MECHANICAL ENGINEERING8. Divide VD line into number of equal parts using Offset command O.

9. Mark numbers 1,2,3, etc. on VD line and mark as 1_I, 2_I,etc. at the intersection points of CE extension line and offset lines.

DEPARTMENT OF MECHANICAL ENGINEERING10. Measure the distance between 1 to 1_I, 2 to 2_I, etc.. Using MEASURE (MEA) command.

11. Draw the circles with F as centre by taking distance 1 to 1_I, 2 to 2_I, etc.. as radius using Circle command C.

DEPARTMENT OF MECHANICAL ENGINEERING12. Create the points at the intersection of circle and 1-1_I, 2 - 2_I, etc.. line above and below CD line using point command PO.

13. Mark the points P 1, P 2, etc..and P 1_I, P 2_I, etc... on both sides of CD line for developing Hyperbola.

DEPARTMENT OF MECHANICAL ENGINEERING14. Draw curve using Spline command SPL.

DEPARTMENT OF MECHANICAL ENGINEERING15. Mark a point P on Hyperbola at a distance of 60 mm from directrix using offset command O.

DEPARTMENT OF MECHANICAL ENGINEERING16. Draw a line by joining P and F, Draw a line from F perpendicular to the directrix

using line

command L. Mark a point T on Directrix line.

17. Make lines FP and FT perpendicular, select parametric from MENU BAR geometric

constraints perpendicular Select two lines.

DEPARTMENT OF MECHANICAL ENGINEERING18. Draw a Tangent line by joining from T to P and extend some distance and mark as T₁

DEPARTMENT OF MECHANICAL ENGINEERING19. Draw a Normal line to Tangent line TT₁ and extend some distance and mark as NN₁

20. Make lines TT₁ and NN₁ perpendicular, select parametric from MENU BAR - geometric constraints - perpendicular - Select two lines.

Here is the solution for constructing a hyperbola using the eccentricity method, including the drawing of a tangent and a normal at a point on the hyperbola, presented in table form:

Hyperbola Construction (Eccentricity Method)

Step	Description	Command
1	Draw a vertical line AB called the Directrix with some height using the Line command. Mark AB with Text.	L (Line), MTEXT
2	Draw a horizontal line CD called the Axis at any point C in the Directrix using the Line command. Mark CD with Text.	L (Line), MTEXT
3	Mark a focus point F on the Axis, 50mm away from the Directrix (CF = 50mm) using the Offset command.	O (Offset)
4	Mark a vertex (V) on CD at a distance of 30mm from F (since $e = 3/2$, $e = VF / VC$) using the Offset command.	O (Offset)
5	Mark the distances VF = 30mm and VC = 20mm using the Dimension command.	DIMLIN
6	Mark a point E, 30mm away from V, ensuring that VF is perpendicular to VE.	O (Offset)
7	Draw a line joining points C and E, and extend it.	L (Line), EX (Extend)
8	Divide the VD line into equal parts using the Offset command.	O (Offset)
9	Mark numbers (1, 2, 3, etc.) on the VD line and label intersections as 1 _I , 2 _I , etc., at the points where the CE extension line intersects the offset lines.	MTEXT, O (Offset)
10	Measure the distance between corresponding points (1 to 1 _I , 2 to 2 _I , etc.) using the MEASURE (MEA) command.	MEA (Measure)
11	Draw circles with F as the center, using the measured distances (1 to 1 _I , 2 to 2 _I , etc.) as radii.	C (Circle)
12	Create points at the intersections of the circles and lines 1-1 _I , 2-2 _I , etc., both above and below the CD line using the Point command.	PO (Point)
13	Mark points P ₁ , P ₂ , etc., and P _{1I} , P _{2I} , etc., on both sides of the CD line to develop the hyperbola.	MTEXT
14	Draw the curve using the Spline command (to approximate the hyperbola).	SPL (Spline)
15	Mark point P on the hyperbola, located 60mm from the directrix using the Offset command.	O (Offset)
16	Draw a line from P to F, and draw a perpendicular line from F to the Directrix. Mark the intersection as point T.	L (Line)
17	Make lines FP and FT perpendicular using the parametric geometric constraint in the Menu Bar.	-
18	Draw a tangent line from point T to point P, and extend it. Mark the extended point as T ₁ .	L (Line)
19	Draw a normal line to the tangent line TT ₁ , and extend it. Mark the extended point as NN ₁ .	L (Line)

Step	Description	Command
20	Make lines TT ₁ and NN ₁ perpendicular using the parametric geometric constraint in the Menu Bar.	-

This table outlines the steps to construct a hyperbola using the eccentricity method, along with the construction of a tangent and normal to the hyperbola at a specific point. Let me know if you need any further assistance!



CYCLOIDAL CURVES

CYCLOID:

- In geometry, a cycloid is the curve traced by a point on a circle as it rolls along a straight line without slipping.
- A cycloid is a specific form of trochoid and is an example of a roulette, a curve generated by a curve rolling on another curve.
- Cycloid, the curve generated by a point on the circumference of a circle that rolls along a straight line. If r is the radius of the circle and θ (theta) is the angular displacement of the circle, then the polar equations of the curve are $x = r(\theta - \sin \theta)$ and $y = r(1 - \cos \theta)$.

DEPARTMENT OF MECHANICAL ENGINEERING
A circle of 50 mm diameter rolls along a straight line without slipping. Draw the curve traced out by a point P on the circumference, for one complete revolution of the circle. Name the curve. Draw a normal and tangent to the curve at a distance 40 mm from Directrix line.

Solution:

1. With Circle Command C Draw a generating Circle center O with radius 25mm, using circle Command C.

2. Assuming point P to be the initial position of the generating Point, draw a Horizontal line PA, by using Line Command L, mark the dimension as $L = \pi d$ using command DIMLIN.

DEPARTMENT OF MECHANICAL ENGINEERING
3. Divide Circle into 12 equal parts by using DIV Command

4. Give Numbering to All divisions of circle in anti-clock wise direction like 1,2,3..11 by using Text Command MTEXT.

DEPARTMENT OF MECHANICAL ENGINEERING
5. Divide Directrix Line PA in to 12 equal parts by using DIV command and Give numbering 1', 2' . . 11' by using MTEXT command.

6. Draw the line OB, parallel and equal to PA using offset

command O. OB is the locus of the centre of the generating Circle.

DEPARTMENT OF MECHANICAL ENGINEERING
7. Draw Horizontal lines from all divisions of Circle Parallel to PA by using Line Command L

8. Draw vertical lines at 1', 2', 3', etc., meeting OB at C1, C2.....C12 using Line command L.

Mark as C1, C2 using MTEXT command.

DEPARTMENT OF MECHANICAL ENGINEERING
9. Draw a circle with C1 as centre and 25 mm radius using circle command C, create a point P1

at the intersection of circle and 1 st horizontal line using POINT command PO

10. Draw a circle with C2 as centre and 25 mm radius, using circle command C create a point P2 at the intersection of circle and 2nd horizontal line using

POINT command PO.

DEPARTMENT OF MECHANICAL ENGINEERING11. Repeat the above procedure and mark remaining points P3 to P12.

DEPARTMENT OF MECHANICAL ENGINEERING12. With The help of SPLINE Command SPL Join all the points P1 to P12 for the generating cycloid.

DEPARTMENT OF MECHANICAL ENGINEERINGTo draw a normal and tangent to a cycloid.

13. Mark a point M on the cycloid curve at 40 mm distance from the directing line by Using

OFFSET command O.

DEPARTMENT OF MECHANICAL ENGINEERING14. With M as a centre and the radius 25 R, Draw Circle, which will cut the centre line OB at point

R using Circle command C. After locating Point R remove Circle by using Trim Command TR.

DEPARTMENT OF MECHANICAL ENGINEERING15. Through point R, draw a line perpendicular to PA, Which meets PA at Point N using Line command L.

16. Join NM and extend it to N'. The line NN' is the required normal line.

DEPARTMENT OF MECHANICAL ENGINEERING17. Through Point M, draw a line TT' Perpendicular to NN'. The line TT' is the required tangent line.

18. Make lines TT' and NN' perpendicular, select parametric from MENU BAR - geometric constraints - perpendicular - Select two lines.

DEPARTMENT OF MECHANICAL ENGINEERINGDEPARTMENT OF MECHANICAL ENGINEERING

Cycloidal Curve Construction

Below is a step-by-step solution for constructing a cycloidal curve with a circle of 50 mm diameter (radius = 25 mm) rolling along a straight line, and drawing the tangent and normal at a point 40 mm from the directrix.

Step	Description	Command
1	Draw the generating circle with a center at O and radius 25mm using the Circle command.	C (Circle)
2	Draw a horizontal line PA by using the Line command (L) to represent the initial position of point P. Mark the dimension as $L = \pi d$ using DIMLIN command.	L (Line), DIMLIN
3	Divide the generating circle into 12 equal parts using the DIV command.	DIV (Divide)
4	Number the divisions of the circle in an anticlockwise direction (1, 2, 3, ..., 11) using the MTEXT command.	MTEXT
5	Divide the Directrix Line PA into 12 equal parts using the DIV command.	DIV (Divide)
6	Number the divisions of PA (1', 2', 3', ..., 11') using the MTEXT command.	MTEXT
7	Draw a parallel line OB equal to PA using the Offset command. OB represents the locus of the center of the generating circle.	O (Offset)
8	Draw horizontal lines from all divisions of the circle parallel to PA using the Line command (L).	L (Line)
9	Draw vertical lines at points 1', 2', 3', ..., meeting OB at C1, C2, ..., C12 using the Line command (L). Mark them as C1, C2, ... using MTEXT.	L (Line), MTEXT
10	Draw a circle with C1 as center and radius 25 mm using the Circle command. Create a point P1 at the intersection of the circle and the first horizontal line using the Point command (PO).	C (Circle), PO (Point)
11	Repeat step 10 for points P2 to P12 by drawing circles with centers at C2, C3, ..., C12.	C (Circle), PO (Point)

Step	Description	Command
12	Use the Spline command (SPL) to join all points P1 to P12 to form the generating cycloid.	SPL (Spline)
13	Mark a point M on the cycloid curve at a distance of 40 mm from the directing line PA using the Offset command (O).	O (Offset)
14	With M as center and radius 25 mm, draw a circle that intersects the center line OB at point R using the Circle command (C). Remove the circle after intersection using the Trim command (TR).	C (Circle), TR (Trim)
15	Draw a line through point R, perpendicular to PA. This will meet PA at point N using the Line command (L).	L (Line)
16	Join points N and M, and extend the line to N'. The line NN' is the required normal to the cycloid.	L (Line)
17	Draw a line through point M, perpendicular to the normal line NN'. Extend the line to T'. This is the tangent line.	L (Line)
18	Ensure that lines TT' and NN' are perpendicular by using the parametric geometric constraints from the menu bar.	-

Summary of Key Points:

- **Cycloid Curve:** The curve traced by a point on a circle as it rolls along a straight line.
- **Equation for Cycloid:** $x = r(\theta - \sin \theta), y = r(1 - \cos \theta)$
- **Normal and Tangent Construction:** At a specific point (40mm from the directrix), draw the normal and tangent lines using geometric methods and constraints.

This table represents the complete process to generate the cycloid curve, as well as to calculate and draw the normal and tangent lines at a given point on the curve. Let me know if you need further clarification!



CYCLOIDAL CURVES
EPICYCLOID:
• In geometry, an epicycloid or hypercycloid is a plane curve produced by tracing the path of a chosen point on the circumference of a circle—called an epicycle—which rolls without slipping around a fixed circle. It is a particular kind of roulette.
DEPARTMENT OF MECHANICAL ENGINEERINGA circle of 50 mm diameter rolls on another circle of 150 mm diameter without slipping.
Draw the curve traced out by a point P on the circumference, for one complete revolution of the circle. Name the curve. Draw a tangent to the curve at a point M 120mm radius from the center of the directrix.
Solution:
1. $R = 75$, and $r = 25$ mm
2. Angle $\Theta = r/R * 360 = 120^\circ$
3. Draw two lines at an angle of 60° from vertical line.
DEPARTMENT OF MECHANICAL ENGINEERING4. Draw a Directrix circle with 75mm radius with O as centre using Circle command C. Trim the circle outside the lines using Trim command TR.
5. Draw a generating circle with 25mm radius above the directrix circle. The end of the generating circle should touch the end point of directrix arc as shown in the below figure.
DEPARTMENT OF MECHANICAL ENGINEERING6. Divide the generating circle in to equal parts using division command DIV. Mark the points

as 1, 2, 3 etc. using Text command MTEXT.

7. Draw circles with centre O, passing through centre and outer point of generating circle using

Circle command C.

DEPARTMENT OF MECHANICAL ENGINEERING8. Divide the directrix arc in to equal parts using Division command DIV. Draw lines from O

to the points using Line Command L.

9. Extend the center lines to center arc using Extend command EX. Mark the points as 1',

2',...12' at the intersection of directrix arc and lines using Text command MTEXT.

DEPARTMENT OF MECHANICAL ENGINEERING10. Mark the points as C, C1, C2,C12 at the center arc using Text command MTEXT.

11. Draw circles passing through all divided points of generating circle with centre O using

Circle command C. Remove extra portion using Trim command TR.

DEPARTMENT OF MECHANICAL ENGINEERING12. With centres C, C1, C2,C12 and radius 25mm draw circles using Circle command C.

DEPARTMENT OF MECHANICAL ENGINEERING13. Create points at the intersection of circles and the arcs. Mark points as P1, P2, P3....P12

using Text command MTEXT. Trim the circles using Trim command TR.

DEPARTMENT OF MECHANICAL ENGINEERING14. Create a curve by joining points P1, P2, P3....P12 using Spline command SPL to create

Epicycloid.

DEPARTMENT OF MECHANICAL ENGINEERINGTo draw Tangent and Normal Lines

15. Draw a circle with center O and radius 120mm using Circle command C. Create a point at

the intersection of Epicycloid and circle using command PO. Mark point as M using Text

command MTEXT. Remove some portion of circle using Trim command TR.

DEPARTMENT OF MECHANICAL ENGINEERING16. Draw a circle with center M and generating circle radius 25mm using Circle command C.

DEPARTMENT OF MECHANICAL ENGINEERING17. Draw a line joining O and M using line command L. Create a point at the intersection of

line OM and directrix arc using Point command PO. Mark point as N using Text command MTEXT.

DEPARTMENT OF MECHANICAL ENGINEERING18. Draw a line joining M and N to create normal line using line command L. Extend the line

using Extend command EX. Mark point N'. NN' is the normal line.

DEPARTMENT OF MECHANICAL ENGINEERING19. Draw a line TT' passing through M and normal to NN' using Line command L. Extend the

line using Extend command EX. Make lines TTi and NNi perpendicular, select

parametric from MENU BAR - geometric constraints - perpendicular - Select two lines.

Construction of an Epicycloid Curve and Tangent/Normal Lines

The following steps describe how to construct an **epicycloid** when a circle of 50 mm diameter rolls on another circle of 150 mm diameter, along with drawing a tangent and a normal line at a given point on

the curve.

Step	Description	Command
1	Define the radius of the fixed circle ($R = 75$ mm) and the radius of the generating circle ($r = 25$ mm).	-
2	Calculate the angle $\theta = \frac{r}{R} \times 360 = 120^\circ$, which represents the angular displacement for one complete revolution of the generating circle.	-
3	Draw two lines at an angle of 60° from the vertical line to guide the positioning of the circles.	L (Line)
4	Draw the directrix circle with a 75 mm radius and center at O using the Circle command (C). Trim the circle outside the lines using the Trim command (TR).	C (Circle), TR (Trim)
5	Draw the generating circle with a radius of 25 mm above the directrix circle. Ensure the end of the generating circle touches the endpoint of the directrix arc.	C (Circle)
6	Divide the generating circle into equal parts using the Division command (DIV). Label the divisions as 1, 2, 3, etc., using the Text command (MTEXT).	DIV (Divide), MTEXT
7	Draw circles with center O passing through the center and outer points of the generating circle using the Circle command (C).	C (Circle)
8	Divide the directrix arc into equal parts using the Division command (DIV). Draw lines from O to each of these points.	DIV (Divide), L (Line)
9	Extend the center lines to meet the center arc using the Extend command (EX). Mark the intersection points as 1', 2', ..., 12' with the Text command (MTEXT).	EX (Extend), MTEXT
10	Label the points as C, C1, C2, ..., C12 at the center arc using the Text command (MTEXT).	MTEXT
11	Draw circles passing through all the divided points of the generating circle with center O. Use the Circle command (C) and remove the extra portions using Trim (TR).	C (Circle), TR (Trim)
12	For each point (C, C1, C2, ..., C12), draw circles with a radius of 25 mm using the Circle command (C).	C (Circle)
13	Create points at the intersections of the circles and arcs. Label them as P1, P2, P3, ..., P12 using the Text command (MTEXT). Remove any extra portions of the circles using the Trim command (TR).	PO (Point), MTEXT, TR (Trim)
14	Join all the points (P1, P2, ..., P12) using the Spline command (SPL) to form the epicycloid curve.	SPL (Spline)

To Draw the Tangent and Normal Lines at a Point on the Curve:

Step	Description	Command
15	Draw a circle with center O and radius 120 mm using the Circle command (C). Create a point at the intersection of the epicycloid and the circle using the Point command (PO). Label the point as M using Text command (MTEXT). Remove extra portions of the circle using Trim (TR).	C (Circle), PO (Point), MTEXT, TR (Trim)
16	Draw a circle with center M and radius equal to the generating circle (25 mm) using the Circle command (C).	C (Circle)
17	Draw a line joining O and M using the Line command (L). Create a point at the intersection of this line with the directrix arc using the Point command (PO). Label this point as N using Text command (MTEXT).	L (Line), PO (Point), MTEXT
18	Draw a line joining points M and N to create the normal line. Extend this line using the Extend command (EX). Label the extended line as NN', where NN' is the normal to the epicycloid.	L (Line), EX (Extend)
19	Draw a line passing through point M and normal to the normal line NN'. This is the tangent line. Extend the line using the Extend command (EX). Ensure that the lines TT' (tangent) and NN' (normal) are perpendicular by applying parametric constraints from the menu bar.	L (Line), EX (Extend), Parametric (Geometric Constraints)

Summary of Key Points:

- **Epicycloid Curve:** The curve traced by a point on the circumference of a circle (epicycle) rolling without slipping around a fixed circle.
- **Equation of the Epicycloid:** There is no simple direct formula like the cycloid, as it depends on both the radii of the fixed circle and generating circle. The construction process helps to visualize the epicycloid.
- **Tangent and Normal Construction:** After constructing the epicycloid, the tangent and normal lines can be drawn using geometric principles by creating perpendicular lines at a specific point on the curve.

This table provides a systematic way to create an epicycloid curve, and how to draw the tangent and normal lines at a given point. If you need further clarification or have additional questions, feel free to ask!



CYCLOIDAL CURVES

HYPOCYCLOID:

• In geometry, a hypocycloid is a special plane curve generated by the trace of a fixed point on a small circle that rolls within a larger circle. As the radius of the larger circle is increased, the hypocycloid becomes more like the cycloid created by rolling a circle on a line.

DEPARTMENT OF MECHANICAL ENGINEERING
A circle of 50 mm diameter rolls inside of another circle of 150 mm diameter without slipping. Draw the curve traced out by a point P on the circumference, for one complete revolution of the circle. Name the curve. Draw a tangent to the curve at a point P on it.

Solution:

1. $R = 75$, and $r = 25$ mm

2. Angle $\Theta = r/R * 360 = 120^\circ$

3. Draw two lines at an angle of 60° from vertical line.

DEPARTMENT OF MECHANICAL ENGINEERING
4. Draw a Directrix circle with 75mm radius with O as centre using Circle command C. Trim

the circle outside the lines using Trim command TR.

5. Draw a generating circle with 25mm radius below the directrix circle. The end of the generating circle should touch the end point of directrix arc as shown in the below figure

DEPARTMENT OF MECHANICAL ENGINEERING
6. Draw circles with centre O, passing through centre and inner point of generating circle using

Circle command C. . Trim the circle outside the lines using Trim command TR.

7. Divide the generating circle in to equal parts using division command DIV. Mark the points as 1, 2, 3 etc. using Text command MTEXT.

DEPARTMENT OF MECHANICAL ENGINEERING
8. Divide the directrix arc in to equal parts using Division command DIV. Mark the points as P,

P1, P2.... using Text command MTEXT.

9. Draw lines from O to the points using Line Command L.

DEPARTMENT OF MECHANICAL ENGINEERING
10. Draw circles passing through all divided points of generating circle with centre O using

Circle command C. Remove extra portion using Trim command TR.

11. Mark the intersection points of lines and center arc as C, C1,

C2.... C12 using Text command MTEXT.

DEPARTMENT OF MECHANICAL ENGINEERING12. With centres C, C1, C2,C12 and radius 25mm draw circles using Circle command C.

13. Create points at the intersection of circles and the arcs. Mark points as P1, P2, P3....P12 using Text command MTEXT. Trim the circles using Trim command TR.

DEPARTMENT OF MECHANICAL ENGINEERING14. Create a curve by joining points P1, P2, P3....P12 using Spline command SPL to create Hypocycloid.

DEPARTMENT OF MECHANICAL ENGINEERINGTo draw Tangent and Normal Lines

15. Draw a circle with center O and radius 60mm using Circle command C. Create a point at the intersection of Hypocycloid and circle using command PO. Mark point as M using Text command MTEXT. Remove some portion of circle using Trim command TR.

16. Draw a circle with center M and generating circle radius 25mm using Circle command C.

17. Draw a line joining O and M using line command L. Create a point at the intersection of line OM and directrix arc using Point command PO. Mark point as N using Text command MTEXT.

18. Draw a line joining M and N to create normal line using line command L. Extend the line using Extend command EX. Mark point N'. NN' is the normal line.

19. Draw a line TT' passing through M and normal to NN' using Line command L. Extend the line using Extend command EX. Make lines TTi and NNi perpendicular, select parametric from MENU BAR - geometric constraints - perpendicular - Select two lines.

Construction of a Hypocycloid Curve and Tangent/Normal Lines

The following steps describe how to construct a **hypocycloid** when a circle of 50 mm diameter rolls inside another circle of 150 mm diameter, along with drawing a tangent and normal line at a given point on the curve.

Step-by-Step Construction of Hypocycloid Curve:

Step	Description	Command
1	Define the radius of the larger circle (R = 75 mm) and the radius of the generating circle (r = 25 mm).	-
2	Calculate the angle $\theta = \frac{r}{R} \times 360 = 120^\circ$, which represents the angular displacement for one complete revolution of the generating circle.	-
3	Draw two lines at an angle of 60° from the vertical line to guide the positioning of the circles.	L (Line)
4	Draw the directrix circle with a 75 mm radius and center at O using the Circle command (C). Trim the circle outside the lines using the Trim command (TR).	C (Circle), TR (Trim)
5	Draw the generating circle with a radius of 25 mm below the directrix circle. Ensure the end of the generating circle touches the endpoint of the directrix arc.	C (Circle)

Step	Description	Command
6	Draw circles with center O, passing through the center and inner point of the generating circle. Trim the circle outside the lines using Trim (TR).	C (Circle), TR (Trim)
7	Divide the generating circle into equal parts using the Division command (DIV). Label the divisions as 1, 2, 3, etc., using the Text command (MTEXT).	DIV (Divide), MTEXT
8	Divide the directrix arc into equal parts using the Division command (DIV). Label the divisions as P, P1, P2, ..., using the Text command (MTEXT).	DIV (Divide), MTEXT
9	Draw lines from O to the divided points using the Line command (L).	L (Line)
10	Draw circles passing through all the divided points of the generating circle with center O. Use the Circle command (C). Remove extra portions using Trim (TR).	C (Circle), TR (Trim)
11	Mark the intersection points of the lines and the center arc as C, C1, C2, ..., C12 using the Text command (MTEXT).	MTEXT
12	With centers C, C1, C2, ..., C12, draw circles with a radius of 25 mm using the Circle command (C).	C (Circle)
13	Create points at the intersections of the circles and arcs. Label these points as P1, P2, P3, ..., P12 using the Text command (MTEXT). Trim the circles using Trim (TR).	PO (Point), MTEXT, TR (Trim)
14	Join the points P1, P2, ..., P12 using the Spline command (SPL) to create the hypocycloid.	SPL (Spline)

To Draw Tangent and Normal Lines:

Step	Description	Command
15	Draw a circle with center O and radius 60 mm using the Circle command (C). Create a point at the intersection of the hypocycloid and the circle using the Point command (PO). Mark the point as M using the Text command (MTEXT). Remove some portion of the circle using Trim (TR).	C (Circle), PO (Point), MTEXT, TR (Trim)
16	Draw a circle with center M and radius 25 mm (radius of the generating circle) using the Circle command (C).	C (Circle)
17	Draw a line joining O and M using the Line command (L). Create a point at the intersection of line OM with the directrix arc using the Point command (PO). Mark this point as N using the Text command (MTEXT).	L (Line), PO (Point), MTEXT
18	Draw a line joining M and N to create the normal line. Extend this line using the Extend command (EX). Label the extended line as NN', where NN' is the normal to the hypocycloid.	L (Line), EX (Extend)
19	Draw a line TT' passing through point M and normal to the normal line NN'. This line is the tangent. Extend the line using the Extend command (EX). Ensure that lines TT' (tangent) and NN' (normal) are perpendicular by applying parametric constraints from the menu bar.	L (Line), EX (Extend), Parametric (Geometric Constraints)

Summary of Key Points:

- **Hypocycloid Curve:** The hypocycloid is formed when a smaller circle rolls inside a larger fixed circle, tracing the path of a point on the circumference of the smaller circle.
- **Equation for Hypocycloid:** Like the epicycloid, the hypocycloid doesn't have a simple formula but can be generated geometrically using the described construction methods.
- **Tangent and Normal Lines:** Once the hypocycloid curve is created, tangent and normal lines at a specific point on the curve are drawn by constructing perpendicular lines at the point and joining them to the center or generating point.

This method gives you a detailed process for constructing a **hypocycloid curve** along with the **tangent and normal lines** at a specified point. Let me know if you need further clarification or have additional questions!