

**INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY**  
**Department of Mechanical Engineering**

ME-119 Engineering Drawing & Graphics

2013-14 Semester II

Sheet 1: Engineering Curves

Note:

- Practice all problems roughly before coming to the Drawing Session.
- For more details of the exercises in this sheet, refer Chapters 6 & 7 of the text book (N. D. Bhatt, Engineering Drawing, 50<sup>th</sup> Ed.).
- The first five chapters give preamble details on drawing instruments, sheet layout, lines, lettering, dimensioning etc.
- Scale the drawings suitably.
- All problems carry equal weightage.
- 6 problems from this sheet will be randomly picked for you to practise in the Drawing Session.

- 1a. Construct an ellipse when the distance of the focus from the directrix is equal to 50mm and its eccentricity is 0.5.
- 1b. Construct a hyperbola when the distance of the focus from the directrix is equal to 50mm and its eccentricity is 2.0.
2. Construct an ellipse whose semi-major axis is 60mm and semi-minor axis 40mm using the following methods:
  - a. arcs of circles method
  - b. Concentric circles method
  - c. Oblong method
3. An ellipse has its semi-major axis as 60mm and semi-minor axis as 40mm. Draw it on the same place using (a) arcs of circles method and (b) Four arcs approximation method and determine the maximum deviation and its location.
4. Construct a parabola inscribed in a parallelogram of 120mm x 90mm x 60° using the following methods:
  - a. parallelogram method
  - b. Tangent method.
5. Fig. 1 shows the upper half of the section of a headlamp. The casing is in the form of a semi-ellipse. *F* is the focal point. The reflector section is in the form of a parabola. Draw in suitable scale (i) the semi-ellipse (left half) and (ii) the complete parabola inside the semi-ellipse. Use *arcs of circles method* for the ellipse and *rectangle method* for the parabola.

- 6a. Two straight lines OA and OB make an angle of  $75^\circ$  between them. P is a point 40mm from OA and 50mm from OB. Draw a hyperbola through P, with OA and OB as its asymptotes, marking at least 10 points.
- 6b. Two points A and B are 50mm apart. Draw the curve traced out by a point P moving in such a way that the difference between its distances from A and B is always constant and equals to 20mm.
7. A circular disc of 40mm diameter rolls along a line from left to right without slip as shown in Fig. 2. P is a point of this moving circle on its circumference initially in touch with the line. Q and R are also points of the moving disc, inside and outside the circumference respectively.  $PQ = PR = 5\text{mm}$ . Draw the loci of P, Q and R.
8. A circular disc of 40mm diameter rolls over another disc of same size clockwise without slip. P is a point on the circumference of the first circle initially in touch with the second. Q and R are also points of the moving disc, inside and outside the circumference respectively.  $PQ = PR = 5\text{mm}$ . Draw the loci of P, Q and R.
9. A square plate of 150mm side has a circular cutout of 120mm diameter. A circular disc of 40mm diameter rolls in the interior of the circular cutout without slip. P is a point on the circumference of the disc initially in touch with the cutout. Q and R are also points of the moving disc, inside and outside the circumference respectively.  $PQ = PR = 5\text{mm}$ .
10. Fig. 3 shows two discs of 40 mm and 50 mm diameters which roll along a horizontal line AB. Both discs start at the same point and roll in the same direction. Plot the curves for the movement of points *p* and *q* and find the perpendicular height of *p* above AB where *q* again coincides with the line AB.
- 11a. AB is a rope 1.6 m long, tied to a peg at B (Fig. 4). Keeping it tight, the rope is wound round the pole O. Draw the curve traced out by the end A. Use 1:10 scale.
- 11b. Draw a pentagon ABCDE (lettering order: CCW) of side 20mm with its bottom side EA horizontal. An inelastic string of 100mm long attached at A is wound counterclockwise from A while keeping it tight. Draw the locus of the tip of the string.
- 12a. A point P moves towards another point O, 75 mm from it and reaches it while moving around it once. Its movement towards O is uniform with its movement around it. Draw the curve traced out by the point P.
- 12b. A link of 225mm long swings on a pivot O from its vertical position of rest to the right through an angle of  $75^\circ$  and returns to its initial position at uniform velocity. During this period, a sleeve approximated as a point P initially at a distance of 20mm from the pivot O moving at uniform speed along the link reaches its end. Draw the locus of P.
- 13a. In a logarithmic spiral, the shortest radius is 40mm. The lengths of the adjacent radius vectors enclosing  $30^\circ$  are in the ratio of 9:8. Construct one revolution of the spiral.
- 13b. A rod (20 mm in length) rotates at uniform angular velocity around its center. An insect starts moving at uniform speed from one end of the rod and by the time the rod finishes one

revolution, it crosses the center and reaches the other end of the rod exactly. Draw the path traced by the insect.

- 14a. A helix has a pitch of 50mm and diameter of 75mm. Draw its front view.
- 14b. An insect starts climbing a cylindrical container at the bottom. The height of the cylinder is 80 mm and the radius of the cylinder is 40 mm. The insect moves up with constant speed. At the same time the cylinder starts rotating at a constant angular speed. It takes two full revolutions of the cylinder by the time the insect reaches the top of the cylinder. Trace the path of the insect as it looks to an outside observer.
15. A shape consists of half a circle and the other half made of three sides of a regular hexagon. The diameter of the circle is 60 mm. A string is tied at one junction and is wound around the shape such that it first wraps around half the circle and then over the three sides of the hexagon. The string is just enough to go around the shape exactly twice. If the string is held tightly at each instance, plot the path traced by the outermost point of the string.
16. A circle (diameter = 50 mm) starts rolling on a flat surface. After it completes one revolution, the path starts curving up in the arc of a circle till it becomes vertical and then the path becomes vertical. During the curved part of path, the circle performs exactly half a revolution and then completes the other half of the revolution on the vertical path. Plot the locus of a point which was initially in contact with the ground.
17. A circle of diameter 50 mm starts rolling on the inside of another circle of diameter 100 mm. When the smaller circle finishes one revolution, the path changes and it is moving on the outside of a circle of diameter 100 mm till it finishes one more revolution. Plot the trace of a point on the smaller circle that is just touching the base initially.

