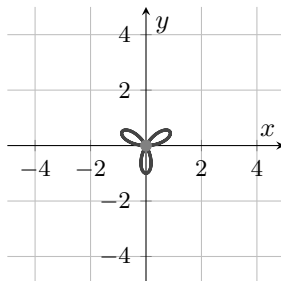
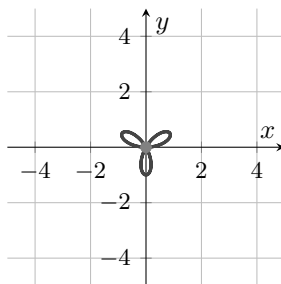


Question 5**Problem**

Find the tangent directions at the pole for the rose $r = \sin 3\theta$.



Question 5 – Solution



Solution

1. Write the polar curve parametrically as

$$x(\theta) = r(\theta) \cos \theta, \quad y(\theta) = r(\theta) \sin \theta.$$

Differentiation gives

$$\frac{dx}{d\theta} = r' \cos \theta - r \sin \theta, \quad \frac{dy}{d\theta} = r' \sin \theta + r \cos \theta.$$

2. Wherever $dx/d\theta \neq 0$, compute

$$\frac{dy}{dx} = \frac{r' \sin \theta + r \cos \theta}{r' \cos \theta - r \sin \theta}.$$

Test numerator and denominator separately when locating horizontal or vertical tangents.

3. The pole occurs when $3\theta = k\pi$, so the tangent rays satisfy $\theta = k\pi/3$.
4. The distinct unoriented lines are

$$\theta = 0, \quad \theta = \pi/3, \quad \theta = 2\pi/3.$$