

14.6, number 11: **Find the equation of the plane tangent to**  
 $z = \ln(x^2 + y^2)$  **at the point**  $P = (1, 0, 0)$ .

**Answer: Gradients are perpendicular to level sets!** View the given equation as level 0 of the function  $f(x, y, z) = \ln(x^2 + y^2) - z$ . Compute

$$\vec{\nabla} f = \frac{2x}{x^2 + y^2} \vec{i} + \frac{2y}{x^2 + y^2} \vec{j} - \vec{k};$$

thus,

$$\vec{\nabla} f|_P = 2\vec{i} + 0\vec{j} - \vec{k}.$$

The tangent plane is the plane through  $(1, 0, 0)$  perpendicular to  $2\vec{i} - \vec{k}$ :

$$\boxed{2(x - 1) - z = 0}.$$