

16.1

(11) IV

(12) III

(13) I

(14) II

(15) IV

(16) I

(17) III

(18) II

$$(29) f(x, y) = x^2 + y^2$$

$$\Rightarrow \nabla f = 2x \hat{i} + 2y \hat{j}$$

III

$$(30) f(x, y) = x^2 + xy$$

$$\nabla f = (2x + y) \hat{i} + x \hat{j}$$

IV

$$(31) f(x, y) = (x + y)^2 = x^2 + 2xy + y^2$$

$$\nabla f = (2x + 2y) \hat{i} + (2y + 2x) \hat{j}$$

V

$$(23) f(x, y) = \sin \sqrt{x^2 + y^2}$$

$$\nabla f = \cos(\sqrt{x^2 + y^2}) \left(\frac{1}{2}(x^2 + y^2)^{-1/2} \cdot 2x \right) \hat{i} \\ + \cos(\sqrt{x^2 + y^2}) \left(\frac{1}{2}(x^2 + y^2)^{-1/2} \cdot 2y \right) \hat{j}$$

I

$$= \frac{x \cos \sqrt{x^2 + y^2}}{\sqrt{x^2 + y^2}} \hat{i} + \frac{y \cos \sqrt{x^2 + y^2}}{\sqrt{x^2 + y^2}} \hat{j}$$