

$$(2)(c) \quad f(p, q) = e^{-p+q^4} + pq + 9$$

$$\bullet \quad \frac{\partial f}{\partial p} = -e^{-p+q^4} + q$$

$$\bullet \quad \frac{\partial f}{\partial q} = 4q^3 e^{-p+q^4} + p$$

$$(3)(a) \quad \frac{df}{dt} = \frac{\partial f}{\partial x} \cdot \frac{dx}{dt} + \frac{\partial f}{\partial y} \cdot \frac{dy}{dt}$$

$$= \frac{1}{3t^2 + e^{-2t}} \cdot 6t + \frac{2e^{-t}}{3t^2 + e^{-2t}} (-e^{-t})$$

$$(7) \quad f(x, y) = \sqrt{x^3 y + 1} \quad ; \quad (2, 3)$$

$$L(x, y) = f(2, 3) + f_x(2, 3)(x-2) + f_y(2, 3)(y-3)$$

$$f_x = \frac{3x^2 y}{2\sqrt{x^3 y + 1}} \quad \left. \begin{array}{l} \text{" } 5 \\ \text{" } \frac{18}{5} \\ \text{" } \frac{4}{5} \end{array} \right\}$$

$$f_y = \frac{x^3}{2\sqrt{x^3 y + 1}} \quad \Rightarrow \quad L(x, y) = 5 + \frac{18}{5}(x-2) + \frac{4}{5}(y-3)$$

$$\text{Then, } f(1.9, 3.1) \approx L(1.9, 3.1)$$

$$5 - \frac{1.8}{5} + \frac{0.4}{5} = 5 - \frac{1.4}{5} = 4.72$$