



3. (9 points for each part) Let  $z = f(x, y) = x^2 - 5xy$ .
- (a) Suppose  $x = 2 \cos(t)$  and  $y = \sin(t)$ . Use the chain rule to find  $dz/dt$  when  $t = 0$ .
- (b) Find  $\nabla f(1, 2)$
- (c) Suppose  $\vec{u} = \frac{\sqrt{5}}{5}\vec{i} + \frac{2\sqrt{5}}{5}\vec{j}$ . Find  $D_{\vec{u}}f(1, 2)$ , the directional derivative of  $f$  in the direction of  $\vec{u}$ .
- (d) Show that the only critical point of  $f$  is at  $(0, 0)$ . Is this a local extremum for  $z$ ?  
If so, is it a maximum or a minimum?

4. (10 points for each part) Let  $f(x, y) = \sqrt{x}e^y$ .

(a) Find the equation of the tangent plane to the graph of  $f$  at the point  $(1, 0)$ .

(b) Use the tangent plane to approximate  $f(0.99, 0.02)$

5. (9 points) Let  $f(x, y) = \frac{y}{x+y}$ . Find a unit vector  $\vec{u}$  for which  $D_{\vec{u}}f(2, 3) = 0$

6. (10 points) Find equations of the normal line to the level surface  $x^3y^2 + xyz = 10$  at the point  $(2, 1, 2)$

7. (10 points) Show that the following limit does not exist.

$$\lim_{(x,y) \rightarrow (0,0)} \frac{xy}{x^2 + 2y^2}$$