1. (a) **(3 points)** If $f(x,y) = x^2 - 5y, h(t) = t^2$ and $g(x,y) = 5x - y^2$, compute $f(h(2), g(1,1))$ and $g(h(2), f(1,1))$.

   (b) **(3 points)** Sketch and shade the domain of the function $f(x,y) = \sqrt{x(y^2 - x)}$. Use dotted lines to indicate portions of the boundary that are not included and solid lines to indicate portions of the boundary that are included.

2. (a) **(3 points)** Compute

$$\lim_{(x,y)\to(0,0)} \frac{\tan 2\left(x^2+y^2\right) + 3\sin\left(x^2+y^2\right)}{\left(x^2+y^2\right)}.$$

   (b) **(3 points)** Show that

$$\lim_{(x,y)\to(1,2)} \frac{y-2}{x-1}$$

   does not exist.

3. (a) **(3 points)** Find a point P at which the function $f(x,y) = x^2y$ has a local linear approximation $L(x,y) = 4y - 4x + 8$.

   (b) Determine dw for $w = \sqrt{x} + \sqrt{y} + \sqrt{z}$.

4. (a) **(3 points)** Suppose $w = xy + yz,\ y = \sin x,\ z = e^x$. Use a chain rule to find $\dfrac{dw}{dx}$.

   (b) **(3 points)** Find $\dfrac{\partial z}{\partial x}, \dfrac{\partial z}{\partial y}$ for $ye^x - 5\sin 3z = 3z$.

5. (a) **(3 points)** Given that $f_x(-5,1) = -3,\ f_y(-5,1) = 2$, find the directional derivative of f at the point $P(-5,1)$ in the direction from P to $Q(-4,3)$.

   (b) **(3 points)** Find a unit vector in the direction in which the functions $f(x,y) = 4e^{xy}\sin z$ decreases most rapidly at the point $P\left(0,1,\frac{\pi}{3}\right)$ and find the rate of change of f at P in that direction.