1.
Use polar co-ordinates and show the continuity of $(f(x,y)$.
Use definitions to show $f_x(0,0)$ and $f_y(0,0)$ does not exist. **2.**
a. $f_x = 2x, \quad f_y = 2y$
b. $f_x = 3\cos(3x+4y), \quad f_y = 4\cos(3x+4y)$
c. $f_x = -ye^{-x} + y, \quad f_y = e^{-x} + x$

3.
a. $f_x(0,0) = 0, \quad f_y(0,0) = 0, \quad f_x(0,y) = 1, \quad f_y(x,0) = 1$
b. $f_x(0,0) = 0, \quad f_y(0,0) = 0, \quad f_x(0,y) = y, \quad f_y(x,0) = x$
c. $f_x(0,0) = 0, \quad f_y(0,0) = 0, \quad f_x(0,y) =$ does not exist, $\quad f_y(x,0) =$ does not exist.

4.
Use definition to show that the function $f(x,y)$ is differentiable at $(0,0)$.
5.
Use definition to show that the function $f(x,y)$ is not differentiable at $(0,0)$.
6.
Use definition to show that the function $f(x,y)$ is not differentiable at $(0,0)$.
Use definitions to find $f_x(0,0)$ and $f_y(0,0)$ and their continuity.
7.
Use definition to show that the function $f(x,y)$ is not differentiable at $(0,0)$.
8. $f_{xx}(0,0) = 0$, $f_{xy}(0,0)$ does not exist, $f_{yx}(0,0) = 0$, $f_{yy}(0,0)$ does not exist. [Hint: Use definition of partial derivatives]
The function $f(x,y)$ is not differentiable at $(0,0)$.

9.
Use definition to find $f_{xy}(0,0) = 1$ and $f_{yx}(0,0) = 0$. Use definition to show that the function $f(x,y)$ is differentiable at $(0,0)$.

10.
a. $f_{yxx}(x,y) = 36x^2\cos 3y, \quad f_{xyx}(x,y) = 36x^2\cos 3y.$
b. $f_{yxx}(x,y) = 60x^3y^2, \quad f_{xyx}(x,y) = 60x^3y^2.$
c. $f_{yxx}(x,y) = 2xe^{xy}\sec^2 x\tan x + 2xye^{xy}\sec^2 x + 2e^{xy}\sec^2 x + xy^2e^{xy}\tan x + 2ye^{xy}\tan x + 12xy$,
$f_{xyx}(x,y) = e^{xy}\sec^2 x + xye^{xy}\sec^2 x + 2xe^{xy}\sec^2 x\tan x + (xy+1)e^{xy}(\sec^2 x + y) + ye^{xy}\tan x + 12xy.$
11.
a. $\mathrm{d}w = (2x + y^2 + y^2z^3)\mathrm{d}x + 2xy(1+z^3)\mathrm{d}y + (3xy^2z^2)\mathrm{d}z.$
b. $\mathrm{d}z = \dfrac{y}{x^2+y^2}\mathrm{d}x - \dfrac{x}{x^2+y^2}\mathrm{d}y.$
c. $\mathrm{d}u = 2e^{x^2+y^2+z^2}(x\mathrm{d}x + y\mathrm{d}y + z\mathrm{d}z).$
d. $\mathrm{d}w = 3\cos(3x+4y)\mathrm{d}x + 4\cos(3x+4y)\mathrm{d}y + 5e^z\mathrm{d}z.$