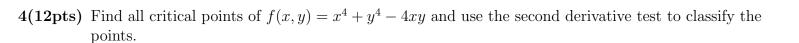
Instructions: You must show supporting work to receive full and partial credits. No text book, notes, formula sheets allowed.

1(10pts) (a) Find the directional derivative of function $z = f(x, y) = x^2 y$ at the point (1, 2) in the direction of the vector $\langle -3, 4 \rangle$.

- (b) Find the direction at (1,2) at which the function decreases the most rapidly.
- (c) Find the largest rate of change of the function at the point (1,2).

2(6pts) Consider the composition function z = f(x(t), y(t)). If $x(t) = t + t^2, y(t) = t^4$ and $f_x(2, 1) = -2, f_y(2, 1) = 3$, what is $\frac{dz}{dt}$ at t = 1?

3(6pts) Find the tangent plane of the ellipsoid $x^2 + y^2 + 2z^2 = 7$ at the point (2, -1, 1).



5(15pts) The temperature of a metal plate is given by $T(x,y) = \frac{300}{1+(x-1)^2+y^2}$, for points (x,y) on the circular plate defined by $x^2 + y^2 \le 4$. Use Lagrange multiplier method to find the maximum and minimum temperatures on the edge of the plate.

6(12pts) Evaluate the integral $\int_0^1 \int_{\sqrt{y}}^1 \cos x^3 dx dy$ by changing the order of integration.

7(15pts) (a) Sketch the solid over which the iterated triple integral $\int_0^2 \int_0^{\frac{6-3z}{2}} \int_0^{6-2y-3z} f(x,y,z) dx dy dz$ is set.

(b) Change the order of the iterated integral to dzdydx.

8(10pts) Set up an iterated integral in polar coordinate for the area of a region outside the unit circle, $x^2 + y^2 = 1$, and insider another, $x^2 + y^2 = 2y$. (Needed special fact: $\sin \frac{\pi}{6} = \frac{1}{2}$, $\cos \frac{\pi}{6} = \frac{\sqrt{3}}{2}$. Do not evaluate the integral.)

