Show all work and no calculators allowed.

Name: ______________________________

1. Compute the following limits if they exist. If not show why.

   (a) $\displaystyle\lim_{(x,y)\to(0,0)} \frac{2x^2+y^2}{x^2+y^2}$

   (b) $\displaystyle\lim_{(x,y)\to(0,0)} \frac{1-e^{x^2+y^2}}{x^2+y^2}$

2. Find and classify extremma for $f(x, y) = x^3 + y^3 - 3x - 12y + 4$.

3. Find and classify extremma for $f(x, y, z) = x + 3y - z$ subject to $x^2 + y^2 + z^2 = 4$.

4. $\displaystyle\iint_R 4yx\,dA$ over the region R defined in the xy plane as under the parabola $y = 4 - x^2$ and above the x-axis

5. $\displaystyle\iint_R e^{x^2+y^2}\,dA$ over the region inside the circle $x^2+y^2=1$ in the first quadrant.

6. $\displaystyle\iint_R \frac{x+y}{2x-y}\,dA$ over the region defined the lines $y = 2x - 1$, $y = 2x - 4$, $y = -x + 1$ and $y = -x + 2$.

7. $\oint_C \langle 6x^3 - 2x + y, x + 3x^2 \rangle \cdot d\mathbf{r}$ over the region inside the triangle defined by the points $(0,0)$ to $(3,3)$ to $(3,-6)$ and back to $(0,0)$. Notice the path is clockwise.

Second Derivative Test

$$D(x,y) = f_{xx}(x,y)f_{yy}(x,y) - (f_{xy}(x,y))^2$$

1. If $D(x,y) > 0$ and $f_{xx}(x,y) < 0$ then the function has a Maximum.
2. If $D(x,y) > 0$ and $f_{xx}(x,y) > 0$ then the function has a Minimum.
3. If $D(x,y) < 0$ then the function has a Saddle Point.
4. If $D(x,y) = 0$ then the test is inconclusive.