1. (14 points) Find and classify the critical points of

$$f(x,y) = x^3 + y^3 + 3x^2 - 3y^2 - 8.$$

2. (14 points) Find an equation of the tangent plane to the surface $\cos(\pi x) - x^2y = 4 - yz - e^{xz}$ at the point (0,1,2).

3. (14 points) Evaluate the triple iterated integral

$$\int_0^3 \int_0^{\sqrt{9-y^2}} \int_{\sqrt{x^2+y^2}}^{\sqrt{18-x^2-y^2}} (x^2+y^2+z^2) \ dz dx dy.$$

4. (14 points) Evaluate the double iterated integral

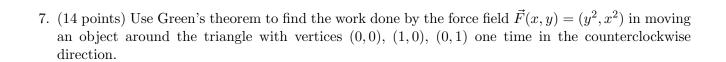
$$\int_{-1}^{0} \int_{-\sqrt{1-y^2}}^{0} \frac{2}{1+\sqrt{x^2+y^2}} dx dy.$$

5. (14 points) Evaluate the iterated integral

$$\int_0^3 \int_{y^2}^9 y \cos(x^2) dx dy.$$

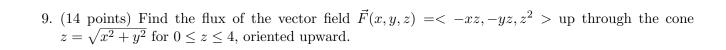
- 6. (16 points)
 - (a) If w = w(x), and x = x(r, s, t). Write down a chain rule formula for $\frac{\partial w}{\partial s}$.

(b) Find $\overrightarrow{curl} < xy, yz, xz >$.



- 8. (16 points) Given the force field $\vec{F}(x,y,z) = \langle y^2 \cos(xy) 3, \sin(xy) + 2y + xy \cos(xy), 2z \rangle$.
 - a. Find a potential function for this force field.

b. How much work is done by this force field in moving an object from (2,-1,1) to (1,3,0)?



10. (14 points) A rectangular box without a lid is made from 12 square feet of cardboard. Use Lagrange multipliers to find the maximum volume of such a box.

- 11. (14 points) Given $f(x,y) = \sqrt{x^2 + y^2}$.
 - a. Find the rate of change of f at (3,4) in the direction from the point (3,4) to the point (0,0).

- b. Find the maximum value of all of the directional derivitives of f at (3,4).
- c. Find a vector \vec{w} such that the rate of change of f at (3,4) in the direction of \vec{w} is zero.
- 12. (14 points) Find the quadratic approximation of $f(x,y) = 2 + 3x + 4y + x^2 2y^2$ near x = 2, y = 1.

13. (14 points) Find the equation of the plane passing through the points (2,1,-3), (1,2,1), and (1,-2,4).

14. (14 points) Use Stoke's theorem to evaluate the line integral $\int_C \vec{F} \cdot d\vec{r}$, where $\vec{F}(x,y,z) = <0, x^2, 0>$ and C is the intersection of the plane 2x+y+z=2 with the coordinate planes traversed counterclockwise as viewed from above.