Show all work. Part A. Problems 1-5, 6 points each.

1. Find the critical points of $f(x, y) = 9xy - x^3 - y^3 - 6$.

2. Use the Lagrange multiplier method to set up the system of equations (but do not solve them) for Maximizing the function $f(x, y, z) = xyz^2$ subject to the constraint $x + y + z = 6$

3. Evaluate $\int \int \sqrt{x + y} dydx$

4. Find the general solution for $\frac{dy}{dx} = \frac{e^x}{e^y}$

5. Find the general solution for $\frac{dy}{dx} = 3xy - 2$
Part B 6-12 10 Points each

6. Find the critical point(s) of \( f(x, y) = 3x^2 - 4xy = 3y^2 + 8x - 17y + 30 \) and determine if they are max(s), min(s) or saddle point(s).

7. Maximize the function \( f(x, y) = 4xy^2 \) subject to \( 3x - 2y = 5 \).

8. Evaluate \( dz \) if \( z = x^2 + 3xy + y^2, \ x = 2, y = -1, \ dx = .02 \) and \( dy = -.01 \).

9. Evaluate \( \int_1^3 \int_1^2 \frac{dy}{x} \)
10. A fish population is limited to 5000 by the food available. If there are 150 fish now and they are growing at a rate of 1% a year the equation $\frac{dy}{dx} = .01(5000 - y)$ models this population. Find the expected population at the end of 5 years.

11. Example 4 pg 509.

12. Solve the differential equation subject to the initial condition.

$$\frac{dy}{dx} + y = 2e^x; \quad y(0) = 100$$