Show work on these sheets in 100 minutes ($(12 + 16 + 6 \times 12 = 100$ *points).*

Name ______________________________. *SocSecNo.* ______________________.

1. Find the Point on the Plane $x - y + z = 1$ that is closest to the Point $(1,1,1)$.

2. Find the Positions of Local Extrema and Saddle Points of $f(x, y) = x^2 + y^2 + 2x^2y + 3$ (The identification of critical points is part of the problem).

3. Find the Direction of the **Maximum** Rate of Change of $f(x, y, z) = \frac{z}{y} - x^2$ at $(1, -1, 1)$.

4. If $x + y - \cos(3x + 2y + z) = 0$, find the differential $dz =$

5. If $z = \cos(xy)$, $r = s\cos\theta$ and $y = r\sin\theta$, find

(a) $\frac{\partial z}{\partial r}$

(b) $\frac{\partial z}{\partial \theta}$

6. Find the Limit if it Exists, else show that it Does Not Exist:

$$\lim_{(x,y)\to(0,0)} \frac{xy}{3x^2 + 2y^2} =$$

7. Find the equation of the tangent plane to the 3-dimensional surface given by

$$xy^2z^3 - 12 = 0 \text{ at } (3,2,1):$$

8. (a) State any **one** of Kepler's Laws of Planetary Motion.
   (b) Explain why Sir Isaac Newton's deduction of Kepler's laws using Newton's second law of motion and the Law of Universal gravitation is one of the great accomplishments of Calculus.