

Name: \_\_\_\_\_

EMPLID: \_\_\_\_\_

1. (5 points) Find the directional derivative  $D_{\hat{u}}f(0, \frac{\pi}{3})$  when  $f(x, y) = 3e^x \sin y$  and  $\hat{u}$  points in the direction  $\vec{v} = \langle -6, 8 \rangle$ .

2. (5 points) Find the maximum rate of change of  $f(p, q, r) = \arctan(pqr)$  at the point  $P(1, 4, 1)$  and the direction in which it occurs.

3. (5 points) Is there a direction  $\hat{u}$  in which the change of temperature function  $T(x, y, z) = 2xy - yz$  (temperature in degrees Celcius, distance in feet) at  $P(1, -1, 1)$  is  $-3^\circ \text{ C/ft}$ ? Justify your answer for full credit.

4. (5 points) Sketch the level curve  $f(x, y) = -4$  together with  $\nabla f$  at the point  $(2, -2)$ .



5. (5 points) Find the local maximum and minimum values and saddle points of  $f(x, y) = 2xy - x^2 - 2y^2 + 3x + 4$ .



6. (5 points) Find the volume of the solid under the plane  $4x + 8y - 2z + 13 = 0$  and above the rectangle  $R = \{(x, y) \mid -1 \leq x \leq 4, -1 \leq y \leq 1\}$ .



7. (5 points) Evaluate  $\int_{-6}^6 \int_0^{\frac{\pi}{2}} (y - y^2 \cos x) dx dy$ .

8. (5 points) Evaluate  $\iint_R ye^{-xy} dA$  when  $R = [0, 2] \times [0, 5]$ .

9. (5 points) Set up iterated integrals for both orders of integration  $\iint_D y dA$ , when  $D$  is bounded by  $y = x - 42, x = y^2$ . Then evaluate the double integral using either order.

10. (5 points) Use polar coordinates to find the volume of the solid above the cone  $z = \sqrt{x^2 + y^2}$  and below the sphere  $x^2 + y^2 + z^2 = 9$ .

11. (5 points) Find the mass and the center of mass of the lamina that occupies the region  $D$  bounded by the curves  $y = e^{-x}$ ,  $y = 0$ ,  $x = 0$ ,  $x = 2$  with density function  $\rho(x, y) = xy$ .

12. (5 points) Find the absolute maximum and minimum values of  $f(x, y) = x^2 + y^2 + x^2y + 9$  on  $D = \{(x, y) \mid |x| \leq 1, |y| \leq 1\}$ .