1. Find the equation of the plane passing through the points $(1,2,1)$, $(-1,3,2)$, and $(0,-1,5)$.

2. Determine whether the planes $3x + 2y - 3z = 10$ and $-6x - 10y + z = 10$ are parallel, orthogonal or neither. If neither, what is the angle between the two planes?

3. Find an equation of the line of intersection of the planes $Q : 2x - y + 3z - 1 = 0$ and $R : -x + 3y + z - 4 = 0$

4. Consider the cylinder $x = z^2 - 4$ in $\mathbb{R}^3$. Identify the coordinate axis to which the cylinder is parallel. Sketch the cylinder.

5. Identify and briefly describe the surface $x^2 + y^2 + z^2 + 2x - 4y - 16 = 0$.

6. Identify and briefly describe the surface $y = 4x^2 + z^2$.

7. Find $\dfrac{\partial z}{\partial x}$ for $xe^{yz} + ye^{xz} + ze^{xy} = 5$, assuming that $z = f(x, y)$

8. Find the linear approximation to the function, $f(x, y) = \sqrt{x^2 + y^2}$ at the point $P(3, -4)$. Use it to estimate $f(3.06, -3.92)$.

9. Sketch the domain of the function $f(x, y) = \sqrt{y - x}\ln(y + x)$ in the $xy$-plane.

10. Given the function $f(x, y, z) = e^{xy^2z^3}$
    a. Find $\dfrac{\partial f}{\partial x}$
    b. Find $\dfrac{\partial^2 f}{\partial x^2}$
    c. Find $\dfrac{\partial^2 f}{\partial x \partial y}$
    d. Find $\dfrac{\partial^3 f}{\partial z \partial y \partial x}$

11. Find the directional derivative to the surface given by the function $f(x, y) - 7 + 10x\sqrt{y}$ at the point $P(5, 16)$ in the direction of the vector $\vec{v} = \langle -4, 3\rangle$.

12. Find an equation of the plane tangent to the surface given by the function $f(x, y) = x^3 - x^2y$ at the point $P(2, 1)$.

13. For $f(x, y) = x^2 - y^2$, find a line in the $x$ direction tangent to the surface defined by $f$ at $(1, 2)$.

14. Suppose that the temperature $w$ (in degrees Celsius) at the point $(x, y)$ is given by $w = f(x, y) = 5 + 0.002x^2 + 0.003y^2$. In what direction should the grasshopper hop from the point $(10, 20)$ to get warmer as quickly as possible? What is the rate of change of the temperature in this direction?

15. Find the directional derivative to the function $f(x, y, z) = 2z\sqrt{xy}$ at the point $(2, 2, 3)$ in the direction of the vector $\mathbf{v} = \langle 1, 1, 1\rangle$.

16. Use the method of Lagrange mulitipliers to find the dimensions of a rectangular box (with a lid) with largest volume, if the total surface area is 96 $\text{cm}^2$.

17. Find $\dfrac{\partial z}{\partial t}$ for $z = sin(x^2y)$, $x = \dfrac{s}{t}$, and $y = t^2e^{st}$.

18. Find the limit or state that it does not exist:

$$\lim_{(x,y)\to(0,0)} e^{\sin(x+y-\pi/2)}$$

19. Show the following limit does not exist:

$$\lim_{(x,y)\to(0,0)} \frac{4xy}{3x^2+y^2}$$

20. Find $\nabla f$ for $f(x, y, z) = xy + xz + yz + 4$.

21. Find the direction in which the function $f(x, y, z) = xe^z - ye^x$ decreases most rapidly from the point $P(0, 2, 0)$.

22. For the function $f(x, y) = x^2 - y$, make a sketch of several level curves. Label at least two level curves with their $z$-values.

23. A rectangular box has a square base. Find the rate at which its volume is changing if its base edge is increasing at 2 cm/min and its height is decreasing at 3 cm/min at the instant when each dimension is 1 meter.

24. Use the method of Lagrange Multipliers to find the minimum value of the function $f(x, y) = x^2 + y + 2z$ subject to the constrain $x^2 + 2y^2 + z^2 = 1$.

25. Locate and classify the critical points of the function $f(x, y) = 3xy - x^2y - xy^2$.

26. According to postal regulations, the largest cylindrical container that can be sent has girth $2\pi r$ plus length $l$ of 108 inches. What is the largest cylindrical container that can be mailed?

For additional problems, check out the review problems for Chapter 12. Note the questions above are simply a sample of possible questions possible for the exam; it is possible that other types of questions may appear on your exam.