1. Describe the domain of \( f(x, y, z) = \sqrt{25 - x^2 - y^2 - z^2} \).

2. Sketch the domain of \( f(x, y) = \sqrt{x^2 + y^2 - 4} \). Evaluate \( f(3 \sin t, 3 \cos t) \). Sketch the level curves \( z = 0, \sqrt{5}, \sqrt{12} \).

3. Identify the graph of \( \vec{r}(t) = \langle 2 \cos t, -3 \sin t, 1 \rangle \), \( 0 \leq t < 2\pi \).

4. Evaluate the indefinite integral \( \int (\sin t \vec{i} + e^t \vec{j}) \, dt \).

5. Find the velocity vector for the curve \( \vec{r}(t) = \langle \ln t, e^t, t^3 \rangle \), \( t > 0 \).

6. Find the parametric equation of the line tangent to \( \vec{r}(t) = \langle \ln t, e^t, t^3 \rangle \) at the point where \( t = 2 \).

7. Show that the graph of \( \vec{r}(t) = \langle \cos t, \sin t, \sin t \rangle \), \( 0 \leq t < 2\pi \), is an ellipse and find the lengths of the major and minor axes.

8. Find where the tangent line to the curve \( \vec{r}(t) = \langle e^{-2t}, \cos t, 3 \sin t \rangle \) at the point \( (1, 1, 0) \) intersects the \( yz \)-plane.

9. Sketch the domain of \( \ln(xyz) \).

10. Sketch the traces of the ellipsoid \( \frac{x^2}{9} + \frac{y^2}{16} + \frac{z^2}{4} = 1 \) in \( xy \), \( yz \), and \( xz \) planes.

11. Sketch the surface \( z = \sqrt{1 + x^2 + y^2} \).

12. Find all first-order partial derivatives of \( f(x, y, z) = ye^z \sin(xz) \).

13. Find all second partial derivatives of \( f(x, y) = 4x^2 - 8xy^4 + 7y^5 - 3 \).

14. Find all second partial derivatives of \( f(x, y) = 4x^2 - y \sin x + x \sqrt{y} \).

15. For what value of \( b \) is the function \( f(x, y) = x^3 + 3xy^2 - y^3 + bx^2y \) a solution to the equation \( \frac{\partial^2 f}{\partial x^2} - \frac{\partial^2 f}{\partial y^2} = 0 \)?
Extra Credit: Match the following equations with the graphs ON THE PREVIOUS PAGE. If there is no match, write "NO MATCH". (1 point each)

(8i) \[ \frac{x^2}{9} + \frac{y^2}{16} - \frac{z^2}{2} = 1 \] : _____________________________

(8ii) \[ \frac{x^2}{9} + \frac{y^2}{9} + \frac{z^2}{9} = 1 \] : _____________________________

(8iii) \[ \frac{x^2}{9} + \frac{y}{16} - \frac{z}{2} = 1 \] : _____________________________

(8iv) \[ \frac{x^2}{9} + \frac{y^2}{16} + \frac{z^2}{4} = 1 \] : _____________________________

(8v) \[ \frac{x^2}{7} - \frac{y^2}{6} - \frac{z}{5} = 0 \] : _____________________________

(8vi) \[ \frac{x}{9} + \frac{y}{16} - \frac{z}{2} = 1 \] : _____________________________

(8vii) \[ \frac{x^2}{9} + \frac{y^2}{16} + \frac{z^2}{4} = 0 \] : _____________________________

(8viii) \[ \frac{x^2}{9} + \frac{y^2}{16} - \frac{z}{4} = 0 \] : _____________________________

(8ix) \[ \frac{x^2}{9} + \frac{y^2}{16} - \frac{z^2}{4} = 0 \] : _____________________________

(8x) \[ \frac{x^2}{4} + \frac{y^2}{3} - \frac{z^2}{2} = -1 \] : _____________________________
5) Using the plots on the previous page, match the function graphs with their level curve plots (3 points each). **If you use one of letters A,B,C,D,E more than once, both occurrences will be counted wrong.**

1. _____________

2. _____________

3. _____________

4. _____________

5. _____________
2.

A

B

C

D

E

F

G

H
(2 points each) For each of the following formulas, write the letter of the picture on page 2 which corresponds to it. If there is no match, write NM.

1. $-x^2 + z^2 + y^2 = 1$ __________________

2. $z = x^2 - y^2$ __________________

3. $x^2 + y^2 + \frac{z^2}{4} = 1$ __________________

4. $y - x^2 - z^2 = 0$ __________________

5. $\frac{x^2}{16} + y^2 + z^2 = 1$ __________________

6. $x^2 - y^2 + z^2 = 1$ __________________

7. $y = z^2 - x^2$ __________________

8. $x^2 - y^2 + z^2 = -1$ __________________

9. $x^2 + y^2 - z^2 = 1$ __________________

10. $-y^2 - x^2 + z^2 = 1$ __________________