

**Directions:** Do not simplify unless indicated. No calculators are permitted. Show all work as appropriate for the methods taught in this course. Partial credit will be given for any work, words or ideas which are relevant to the problem.

**Please put problem 1 on answer sheet 1**

1. (a) Sketch the graph of the function  $f(x, y) = 4 - \sqrt{x^2 + y^2}$ . Include some sense of size and position. Name the shape. [5 pts]
- (b) Sketch the graph of the function  $f(x, y) = \sqrt{4 - x^2 - y^2}$ . Include some sense of size and position. Name the shape. [5 pts]
- (c) All together in one  $xy$ -plane sketch the level curves for  $f(x, y) = \frac{y}{|x|+1}$  for  $c = 0, 1, 2$ . Label each curve with its value of  $c$ . [10 pts]

**Please put problem 2 on answer sheet 2**

2. (a) Give the equation of the cylinder of radius 3 whose axis is the  $y$ -axis. [5 pts]
- (b) Use tangent plane approximation to approximate  $\sqrt[3]{(4.01) + (1.95)^2}$ . [15 pts]

**Please put problem 3 on answer sheet 3**

3. (a) Find a vector perpendicular to the surface  $x^2y + xz^3 = 1$  at  $(1, 2, -1)$ . [5 pts]
- (b) Suppose you are traveling along  $\vec{r}(t) = t\hat{i} + t^3\hat{j}$  and the temperature in  $^{\circ}\text{C}$  at  $(x, y)$  is  $f(x, y) = x^2 + y^2$ . What temperature change are you experiencing at the instant  $t = 1$ ? Assume distance is in meters and include units. [15 pts]

**Please put problem 4 on answer sheet 4**

4. Find and categorize the critical points for the function  $f(x, y) = x^2y - 4x^2 - 2y^2$ . [20 pts]  
Note: There are three critical points.

**Please put problem 5 on answer sheet 5**

5. Use Lagrange Multipliers to find the maximum and minimum values of the function  $f(x, y) = xy$  on the ellipse  $2x^2 + y^2 = 16$ . [20 pts]  
Note: Your system should have four solutions.

**The End and the TA Section List**

Liam	0111 = 8:00	0121 = 9:30
Patrick	0112 = 8:00	0122 = 9:30
Phil	0131 = 12:30	0141 = 2:00
Jon	0132 = 12:30	0142 = 2:00