Instructions: This exam should be done on your own paper. Your name should be on each sheet and on the back of the last sheet; the answers should appear written carefully and in order. If in doubt, show intermediate steps: Full credit may not be given, even for correct answers, unless work is arranged clearly and explained. This exam is closed book. You may leave after handing in your exam paper, but be sure to check your answers carefully. Each entire problem is worth 20 points.

1. Find a formula for the shortest distance between a point \((a, b, c)\) and the \(y\)-axis.

![Figure 1: The figure for problem 2](image)

2. Which of the following functions does the surface in Figure 1 represent? Explain fully why you chose the function you did.

   a) \(f(x, y) = x^2 + y^2\)  
   b) \(f(x, y) = x^2 \sin(y)\)  
   c) \(f(x, y) = x + y\)  
   d) \(f(x, y) = e^x - e^y\)  
   e) \(f(x, y) = x^2 + \sin(y)\)  
   f) \(f(x, y) = x^2 \cos(y)\)

3. Draw contours \(f(x, y) = c\) at levels \(c = 0\), \(c = 1\), and \(c = 2\), for the function

   \[ f(x, y) = x^2 + y. \]

4. Find the equation of the linear function \(z = c + mx + ny\) whose graph is the plane through the points \((1, 0, 0)\), \((0, 1, 0)\), and \((0, 0, 1)\). Draw a picture of the graph on a three-dimensional cartesian coordinate system.

5. Explain why each of the following functions does or does not have a limit at \((x, y) = (0, 0)\). Make sure your explanation is careful and complete.

   (a) \(f(x, y) = \frac{x^2 y^2}{x^4 + y^4}\)  
   (b) \(f(x, y) = \frac{x^2 - y^2}{x + y}\)