INSTRUCTIONS: Do your work on the ANSWER SHEETS which I am providing. You need not re-write the problem. Just do the work and box your answer. Circle any significant sub-results along the way. Do no more than three (3) problems per page. Label each problem. Draw a horizontal line between problems. Don’t crowd your work. Write on one side (the front side) only. Keep the top and left margins that I have drawn. (Do not write ANYTHING except the page number & total pages in the “circle” provided). When you are finished, put your pages in order with this test paper on top, come up to my desk and sign-out. You will do the stapling.

If you don’t get an acceptable answer but do show your work, I’ll give as much partial credit as I can, determined by your work. Full credit will be given only for an acceptable answer AND acceptable work. Extra Credit may be given.

Today you have 5 problems. Each problem counts 10 points. I will take off points if you do not follow these instructions.

1. Find the equation for the tangent plane and the parametric equations for the normal line at the point \( P_0 (1, 2, 2) \) on the surface \( 3x^2 + y^2 + 4z^2 = 23 \).

2. The function \( f(x, y) = x^2 + xy + y^2 + 5x - 2y + 5 \) has a local minimum value. Find the critical point. Show that it does in fact yield a local minimum. And state what that local minimum value is.

3. Using LaGrange multipliers, find the maximum and the minimum values of \( f(x, y, z) = 2x - 7y + 5z \) on the sphere \( x^2 + y^2 + z^2 = 78 \). Show your work.

4. Find the Linearization \( L(x, y) \) of the function \( f(x, y) = (x + y + 2)^2 \) at the point \( P_0 (1, 2) \).

5. Find the parametric equations for the line tangent to the curve of intersection of the two surfaces \( x^2 + y^2 - 2 = 0 \) (a cylinder) and \( x + z - 4 = 0 \) (a plane) in 3-space at the point \( P_0 (1, 1, 3) \).