This is the ninth homework assignment for Math 122 and it is broken into two parts. The first part of the homework consists of textbook exercises you should do (and I'll expect you to do) but you needn't turn in. As these exercises will not be graded, if you would like help with them or just want to make sure you're doing them correctly, you should (always) feel free to come to office hours (mine or those of the TAs). The second part consists of written exercises, which again, you should do, but you need not turn in. As always, please come and see me early if you get stuck on any part of this assignment. I am here to help!

Part 1 (Do not turn in)

Exercise 1. *Please do Exercises #1-7odd, 11, 19-29 odd, 31ab, 37, 41-45odd from Section 13.4 of the textbook.*

Part 2 (Do not turn this in either!)

Problem 1. *In this problem, you will consider an alternate method for finding a tangent plane to a surface - one which is especially convenient for surfaces which are not written in the usual $z = f(x, y)$ form.*

1. *Consider the surface given by $x^2 + y^2 + z^2 = 1$. Describe this surface. Can this surface be described as a single function $z = f(x, y)$?*
2. *Instead of thinking of this surface as a function $z = f(x, y)$, this surface can be understood as a* **level surface** *of a three variable function $w = g(x, y, z)$. For example, we could choose $g(x, y, z) = x^2 + y^2 + z^2$, and consider this surface as the level set at $g(x, y, z) = 1$. Is there any other function $h(x, y, z)$ for which this surface could be a level set? (Hint: perhaps using a different constant?)*
3. *Using the function $g(x, y, z) = x^2 + y^2 + z^2$ given above, compute the gradient function ∇g. Would the gradient be different for another choice of function - for example, the alternate function $h(x, y, z)$ you found in the previous part?*
4. *In class, we have discussed the fact that the gradient $\nabla f(a, b)$ of a function $f(x, y)$ at a point (a, b) is perpendicular to the level curve through the point (a, b). By similar logic, we have that the gradient $\nabla g(a, b, c)$ at a point (a, b, c) will be perpendicular to the* **level set** *of $g(x, y, z)$ through the point (a, b, c). Using this fact, find a vector perpendicular to the surface $x^2 + y^2 + z^2 = 1$ at the point $(1/\sqrt{3}, 1/\sqrt{3}, 1/\sqrt{3})$.*
5. *Using the vector you found in the previous part, give an equation for the tangent plane to the surface $x^2 + y^2 + z^2 = 1$ at the point $(1/\sqrt{3}, 1/\sqrt{3}, 1/\sqrt{3})$. (Remember - to make an equation of a plane, you only need two things: a point on the plane, and a vector which is normal to the plane!)*
6. *Using the method we've gone through in the previous five parts, find the tangent plane to the surface $x^2y + e^{xz} + yz = 3$ at the point $(0, 1, 2)$.*