**Multivariable Calculus - Test 1 Fall 2015**

Answer all questions carefully and completely. Put all work and your answers on the paper provided. Partial credit may be awarded, so please show all of your work.

**Do Not Use A Calculator For This Test.**

**Part 1 (20 points)**

In , let , and .

1. Give the parametric form of the line through and .
2. Give the equation of the plane containing the line in part A and the point .
3. Give the vector form of a line through that lies in the plane described in part B and is orthogonal to the line described in part A.

**Part 2 (20 points)**

Let be the space curve defined by .

1. At what points does meet the -plane?
2. Give the vector form of the line tangent to at .
3. Does the line in Part B intersect the line defined by ? Explain.

**Part 3 (20 points)**

1. Let be a function. Give the definition of the partial derivative, .
2. Give the equation of the plane tangent to the graph of at (3,0).
3. Give two non-parallel vectors that line on the plane described in Part B. Briefly explain.

**Part 4 (20 points)**

Let .

1. Sketch the level set of containing the point (3,12,1). What is the corresponding level?
2. Give the equation of the plane tangent to the graph of this level set at the point (3,12,1).
3. Give the parametric form of the line through the origin which is normal to the plane found in part B.

**Part 5 (20 points)**

A two dimensional coordinate system is placed over a lake. The depth in meters of a point in a lake is given by the function. A duck is floating at the position .

1. As she begins to swim towards a frog at ), does the water get more deep or less deep for the duck? Explain.
2. A pig is swimming in the lake at point . In which direction should he swim so that the water gets as shallow as it immediately can?
3. A macaque is swimming so that the coordinate of his position is always increasing and so that the depth of the water under him is always 11 meters. In which direction is he swimming as he passes the point ?

**Bonus:**

1. Which point on the plane described in Part 4 B is closest to the origin?
2. A particle moves in so that its position at time is given by the vector function . Assume that the length of is constant. Prove that, for any , is orthogonal to .