MA 262 Homework 1: Vectors, Matrices, Derivatives, and More.

For the ideas in Vector Calculus to make any sense, you have to do a fair amount of computation. Most of the problems in this homework assignment are intended to remind you of computations you've made in the past: cross products, partial derivatives, etc. If you find most of this assignment tedious – that's okay and probably good! I promise things will get more interesting soon. In the mean time, get your calculus chops warmed up and let's go...

Read Chapter 1 As you read, you should focus on the geometric meaning behind all the formulas. For example,

- what do vectors represent in "real-life",
- what is the relationship between the dot product and angle?
- what is the relationship between the cross product, area, and perpendicular vectors?

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pg 16: 11

For this problem, you will need to set up and solve several linear equations. For part c) I suggest you solve for c_1 and c_2 in terms of a_1, a_2, b_1, and b_2. Be sure to explain why your calculations answer the question.

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pg 37: 1, 3, 5, 10 Throughout this course we will use determinants and the cross product. These problems should serve as an excuse to remind yourself how to calculate these creatures. For problem 10, I suggest you figure out a way to use the cross product to answer the question.

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pg 58: 16, 17, 18, 21

These problems provide some practice with basic matrix operations. We won't be doing a lot of this in the course, but you should be able to do these calculations.

Section 1.7 (pg 71): 1,5

Hopefully, you've seen polar coordinates before. If not, now's a great time to learn! These problems just serve as a reminder of the relationship between polar coordinates and rectangular coordinates. Later on the course, we'll do more with this. Don't worry if you've never seen polar coordinates before, or if you're rusty on how to use them. You'll be able to pick up quickly on the limited amount you need to know. Of course, you're also encouraged to talk to your professor if you're confused!

Section 2.3 (pg 124): 1, 3, 9, 17, 19, 21, 22, 23, 25, 28, 31, 35, 37

Partial derivatives are a staple of MA 122 and are essential for this course. These problems remind you how to calculate them and give you some examples that will show up repeatedly in this course. The later problems in this section remind you how linear approximations work.

Note: For problems 35 and 37 to be at all useful or interesting, you need to base the linear approximation at a point other than where you are performing the approximation. I suggest that in problem 35 you base the linear function at the point (0,0) and in problem 37 that you base it at (1,2,2).

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pg 150: 3, 15, 18.

These problems give you some experience using the multivariable chain rule. The first two give examples of how it is relevant to "real life". The last is purely computational.

Here's an extra-credit problem for those who were bored by the previous set of problems. It concerns the Laplacian operator which plays an extremely important role in applied mathematics.

Given a twice-differentiable function f, the sum of its second unmixed partial derivatives in rectangular coordinates is called the Laplacian. For a two-variable function this means:

$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}.$$

For example, if $f(x,y) = x^2 y + y^3$, then

$$\nabla^2 f(x,y) = 8y$$

If we change coordinate systems the formula for the Laplacian must also change. Your task is to figure out the formula for the Laplacian in polar coordinates. (Hint: Think about problems 23, 24, and 25 on page 151. This problem involves less computation than those.)