UNIVERSITY OF KHARTOUM, SURVEYING ENGINEERING DEPARTMENT

Assignment 1

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NOTES

This assignment should be fairly easy. Remember, start early and do not cheat! The first section of this assignment will be a programming one, the second one will be about math, the third (not in this assignment), will be a theoretical one.
This is a very easy assignment, please do not get intimidated by the code, or the equations the are presented here. Start early and work hard. Remember, you do not need to cheat. This course is not about the grade–it is very important however. You need to understand these materials, and this is the only way to do that. If you have any questions regarding any of these problems, you can ask them in our piazza forum https://www.piazza.com/uofk/spring2017/sur512, or you can ask me in the section (Tuesday 11:00am), or you can ask me in person during my office hours.

1 PROGRAMMING PROBLEMS

WRITE A FUNCTION THAT COMPUTES THE DOT PRODUCT Well, the dot product will be with us for a very long time during this course. I thought it would be cool to write a function that computes it. BTW, I know that MATLAB has a built-in function to compute, you are *not* allowed to use it. If you used it you will get zero. For any programming problem, you will be given a test cases, so that when you run your function you know that it works. These tests are–by no any means–exhaustive! We have other tests, so it is also your task to add them (Only submit in your assignment the solution, do not submit any test cases!)

```
>> a = [1, 2, 3];
>> b = [2, 5, -1];
```

```
>> c = dot_product(a, b)
ans = 7
>> c = dot_product(a) % Just one vector, you should raise an error
error: Invalid call to dot_product.  Correct usage is:

-- Function File: dot_product (ARG1, ARG2)
```

Notice that in the previous test I've raised an error. MATLAB by default will raise an error, however, you may want to implement your own error message function so that you will help the user better. If you want to add a custom error message you can check this link https://www.gnu.org/software/octave/doc/v4.0.3/Raising-Errors.html. It is for Octave, you can find a similar one for MATLAB.

WRITE A FUNCTION THAT COMPUTES THE VECTORIAL PRODUCT In the previous exercise you have implemented a dot product. A dot product is an operator that maps two vectors into a scalar. Vectorial product is a mapping from two vectors into other vector. Implementing a vectorial vector might be a little harder than the dot product.

```
function c = vectorial_product(a, b)
% Use this starter code to solve this problem.
% HINT: In the vectorial product computation we were computing the
% determinant! The first row of the matrix was just {i, j, k}, you are not
% asked to compute them, just replace them with?
... your code goes here
end
```

2 MATHEMATICAL PROBLEMS

Well, math is quite cool is not it? Assuming that you love it, we will go through some derivations and other cool stuffs. The aim of this section is, to help you understand the prerequisites of the class even better–and, to get familiar with LaTeX. Let us start, shall we?

ABOUT LAPLACE OPERATOR Ok, in the previous section, we have introduced the notion of Laplace's operator (remember that δ?). Newton's well know theory about the gravity assumes that we know the density of the body (e.g., the Earth). While Newton theory is very intuitive, it can not be used in geodesy (to compute e.g., the geoid). Hence, we use other theory, it is a little bit harder, and not so intuitive, but it works. Your task for this question is to prove that the *divergence* of the *gradient* of a *scalar field* is zero. Let us write that in a mathematical notation. Assume that $\mathbf{f}$ is a scalar field e.g., its gradient is

$$\left(\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}, \frac{\partial f}{\partial z}\right)$$

Computing the divergence of this should satisfies Laplace's equation

$$\nabla \cdot \nabla f = 0$$

or, using the convention Laplace's function

$$\triangle f = 0$$

Go ahead and prove it!

3 Collaboration Policy

Again, please write down the names of the students you have collaborated with. No penalty–or, credits–will be given to anyone. It will just give us an indicator that your work might be similar to other student(s).