

# Physics 380-001

## Short Exam B - IV

### April 27-May 1<sup>st</sup>, 2020

Your name: \_\_\_\_\_

Do not turn the page until you are told to begin. You will be given the week to complete this exam. Make sure all the work (even code and diagrams) are stapled to this exam.

You may use a calculator, Excel, and Matlab. You may speak with your group members. You may not look at a text book, the internet (except to google numbers or for coding help in good faith – ie if don't google the solution), or anyone's exam (that includes scratch paper and the whiteboard).

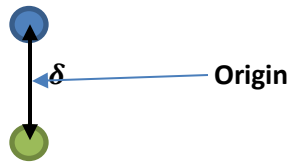
Do not write in the following table; it will be used for grading.

Problem 1	___ / 10
Problem 2	___ / 50
Problem 3	___ / 40
Total	___ / 100

**Problem 1: Fundamental Concept [10 pts]** What the crap is a gauge? Describe in detail how you can take advantage of the gauge to find the following equation?

$$\nabla^2 \vec{A} = -\mu_0 \vec{J}$$

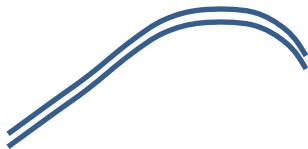
**Problem 2: You might find this at BNL [50 pts]:** Two infinitely long wires in the following configuration can act as a magnetic guide for a charged particle,  $q$ . One has a current  $I$  flowing in one direction. The other has a current  $I$  flowing in the opposite direction. The distance between the wires is  $\delta$ . The charged particles flow in a direction that is parallel with the wires.



- a) Show that the force near the center point between the wires (where the exact center between the wires is the origin), where  $k$  is some constant. Find the value of  $k$  in terms of other things in the problem. (I am going to use  $\vec{s}$  because the particle is being guided in the  $z$ -direction – thus no force.)

$$\vec{F} \approx -k\vec{s}$$

- b) If a proton was moving near the speed of light, the distance between the wires is given by  $\delta = 5 \text{ cm}$ , and the wires (continuing to be parallel) go around a large circle with the radius of 500 m, determine how far from the center of the two wires you need to be ( $I = 300 \text{ kA}$ )? Is this reasonable? Note the radius of curve is 0.5 km!!!!



**Problem 3: You're so Square [40 pts]:** You have a square loop of wire with a length  $R$  with current  $I$ , centered at the origin. The square is in the  $x$ - $y$  plane.

- a) Determine the exact Magnetic Field at the position  $(0,0,3R)$ .
- b) Determine the approximate magnetic field using the magnetic moment at  $(0,0,3R)$ .
- c) Compare answers (percent error)
- d) Determine the exact Magnetic Field at the position  $(R,2R,2R)$ .
- e) Determine the approximate magnetic field using the magnetic moment at  $(R,2R,2R)$ .
- f) Compare answers (percent error)