PHYS 106: Flux Concept Discovery Lab   Name & Partner's Name___________________

What the Flux?

Let's take a quick detour and hop into our cars. Have you ever stuck your hand out the window while the car was going fast? When you have your palm facing the ground, the air seems to move really easily around it, and it doesn't interact with your hand much. Conversely, when your hand is vertical, a lot of air hits your hand. Next, *picture* your hand as semi-transparent (like, ya know, with a bright light, but in this case with air). Which orientation of your hand would have more air going ***through*** it? Well, the horizontal orientation only has a little, while the vertical orientation has a lot! (**What determines the *ratio* between the two?**)

> Even if the analogy above doesn't quite make sense to you, it's okay. Luckily, this lab is here to help you to construct your own mental model for the concept of flux !

For this lab, you have been supplied with two magnetic plates that attract each other, but are **kept apart**. The space *between* them contains a (fairly) uniform magnetic field that is much, much stronger than the earth's magnetic field (which you can neglect). This configuration is mounted onto a turntable, so that you can *adjust* the direction that this magnetic field points. (That is, the field doesn't have to point north; you can make it point east, west, or south, or anywhere in between.) Regardless of how you orient the magnets, a ***fixed*** sensor (suspended into the field) will be used to take measurements. All you have to do is to measure the turntable's orientation (an angle) and the output from the sensor (a DC voltage that is ***proportional*** to the signal being measured). You can enter a *collection* of such data points (for different turntable orientations) into *Igor Pro* and (hopefully) **fit** your observations to a simple physical model.

Procedure:

1) Read through the instructions beforehand. Please.
2) Adjust the mechanical suspension, to move the sensor (a **black component** in the circuit) to the **middle** of the region between the magnetic plates. (Re-check this, as you work.)
3) Use the chart below, to connect the leads coming from the sensor circuit to an external power source and to a voltmeter.

Red Sensor Lead	**Red** (+) Output of Power Supply
Black Sensor Lead	Power Supply **Ground** *and* **Common** of Voltmeter
...Yellow(-ish)... Sensor Lead	("Non-Comm") Input of Voltmeter

   a) The red, black, and yellow wires can be attached to "alligator clips" on one side and "banana plugs" on the other. (Keep different connections from touching.)
   b) The black lead coming from your sensor should be connected to two points: the ground on the power source *and* "common" on the voltmeter.

c) Duct Tape may be useful in securing the wiring, so that nothing ends up getting sucked into the magnetic pole pieces.

4) Before you apply power to your circuit check with a TA or Professor to make sure everything is wired correctly.
5) Before turning on any power source, set dials all the way counterclockwise, making the initial current and voltage zero.
6) Then apply power.
7) Your voltmeter should be set to measure DC voltages, and *not* AC voltages:

8) Turn the current up until the green light turns on on the voltage side of the power source.
9) Set the power source to 4.5 or 5 volts. **DON'T EXCEED 5.5 VOLTS, MAX!**
10) Set the turntable to an angle of interest, and begin to fill in the table below. The table below merely provides a suggestion for a minimum number of data points to take: if you want to take *more*, then go for it!

Angle (degrees)	Signal (arb. units)

11) Create a graph in *Igor Pro* **as soon as you have data for two angles**. The graph will then automatically update as you continue.
12) Take data at whatever set of angles you deem appropriate. Does it make sense to take more data in regions where the response is changing most rapidly, rather than, say, always spacing your data by even increments in your control variable (here, the angle)?
13) (If you observe *no change* in the sensor output, as you change the orientation of your turntable, please ask a TA or Professor for help.)
14) (Keep in mind that the voltmeter reading will never go as low as zero while the chip is between the magnets; if you remove the sensor from the magnetic field and check what the multimeter reads; it should be close to zero when the magnets are far away from the sensor.)
15) The *x* axis of your graph should be your independent variable (*i.e.*, what you control) while the *y* axis should be the dependent variable (*i.e.*, the *response* that you measure).
16) **SHOW YOUR DATA PLOT to your TA/Instructor**, to see if there is any problem with it!
17) Once your data set is deemed complete, as usual, take the time to make the graph neatly-presented and clearly descriptive: add a title/labels, specify the involved units, choose clear markers for your data points, and colors contrasting with any fit that you'll make later, *etc*.
18) Orient your turntable so as to MAXIMIZE your measured signal. Whatever angle measurement you currently read can be, if you wished, "lopped off" of your data, as an offset, simply by using the command line in *Igor Pro*, to subtract this value from the wave containing all of the angular measurements that you'd previously entered (e.g., if that wave is called Angle, and the offset turned out to be 273 degrees, in the command line you would type: Angle = Angle - 273, and hit enter.
19) Take a good look at your graph and try and get a feel for the shape you're seeing. Does it look familiar? Your next step is to try and fit the data to this shape you're thinking of. That is, think up an equation that you think might explain the phenomenon at hand. This process is essentially how physicists continue to discover new models to describe the world.
20) Your goal is to use *Igor Pro's* Curve Fitting to fit a simple **physical** model to your data. — When we say "a simple physical model," we mean that you are not just looking for an equation that fits your observations, but for an argument as to *why* a particular equation seems appropriate to you!
21) Remember to include your graph, with your best fit, in your *OneNote* lab notebook, and to include *commentary* on what you've found.

Questions:

You know that the output from the sensor is a DC voltage that is ***proportional*** to the signal being measured. What do you think that the sensor is measuring? What is causing the *change* in sensor response, as you change the orientation of the magnetic field?

What is your physical model for the relationship between the turntable orientation and the sensor response?

Write a cohesive conclusion about what the data means, including the meaning of the values of the ***fitting parameters*** found during curve fitting, and possible sources of error. (Don't say human error, cause that's just a "cop out!")

How would your model change if the sensor were *infinitesimally* thin?

What is Flux?

QED

Initiative?