Print your name neatly:

Last name: ____________________________

First name: ____________________________

Sign your name: ____________________________

Please fill in your Student ID number (UIN): __ __ __ __ __ __ __ __ __ __

IMPORTANT

Read these directions carefully:

• There are 5 problems totaling 100 points. Check your exam to make sure you have all the pages. Work each problem on the page the problem is on. You may use the back. If you need extra pages, I have plenty up front.

• **Indicate what you are doing!** We cannot give full credit for merely writing down the answer. **Neatness counts!** I will give generous partial credit if I can tell that you are on the right track. This means you must be neat and organized.

• Each problem with its associated figure is self explanatory. If you **must** ask a question, then come to the front, being as discrete as possible so as not to disturb others.

• Put your name on each page it is asked for. You will lose credit if you fail to print your name on each page it is asked for.

• A separate page of reference data, indefinite integrals, and some useful formulae is provided. **DO NOT TURN IT IN.**
Problem 1. 20 points.

Consider the circuit shown in the Figure. A 100 Volt battery is connected through a 2 \( \Omega \) resistor. The wire connecting them passes through a region of homogeneous magnetic field of magnitude \( B = 2 \) Tesla. The wire passes a distance \( a = 3 \) cm into the field, and then bends and goes a distance \( b = 4 \) cm before leaving the field.

Calculate the magnitude of the net force on the wire.

Warning! Warning! Warning! Force is a vector. I want the magnitude of this vector.

Double Warning! Warning! Warning! You must show your work. Zero points for just writing down the answer.
Problem 2. 20 points.

A very long thin wire carries current $i$ and is bent into the shape shown. The angle between the two long straight segments is 90 degrees, and the middle segment is a circular arc of radius $S$ centered at the extrapolated intersection of the two long straight segments.

Find the magnetic field at the point P. Explain your reasoning (that is, let me know how you arrived at the answer).
Problem 3. 25 points.

A rectangular circuit with net resistance $R$ is located near an infinitely long narrow wire carrying a current $i_0 \cos \omega t$ where $i_0$ and $\omega$ are constants. The self-inductance of the circuit can be ignored. Find the current in the rectangular circuit as a function of time. Make sure you indicate which direction (clockwise or counter-clockwise) you are taking to be positive.

Long straight wire, current $i = i_0 \cos \omega t$

Make sure you are being neat. Working neatly will help you get it right.
Consider the circuit shown below. Initially, both switches are open.

(a) Suppose the switch $S_1$ is closed. What is the current through $R_2$ immediately after this happens?

(b) Now suppose we wait a long time after closing switch $S_1$. What is the current through $R_2$ then?

(c) Now, after waiting a long time as above, suppose we close switch $S_2$. What is the current through $R_2$ immediately after that?

(d) Now, write an equation for the current through $R_2$ as a function of time, taking $t = 0$ to be the moment $S_2$ is closed (in part c).

Working neatly will help you think about what you are doing.
Problem 5. (10 points)

You have been provided with the following three inductors:

- $L_1 = 1 \text{ H (one Henry)}$
- $L_2 = 1 \text{ mH (one milli-Henry)}$
- $L_3 = 25 \mu\text{H (twenty-five micro-Henries)}$

and the following three capacitors:

- $C_1 = 1 \text{ F (one Farad)}$
- $C_2 = 1 \mu\text{F (one micro-Farad)}$
- $C_3 = 1000 \text{ pF (one thousand pico-Farads, i.e., 1 nano-Farad, or } 10^{-9} \text{ Farads.)}$

Draw a circuit using any or all of these elements that can oscillate at approximately 1 MHz (one mega-Hertz, or 1 million oscillations per second).

Be neat! If I can tell what you are doing I can find more points for you.