PHYSICS 211
Final Spring 2012-2013
TIME: 90 minutes

June 20, 2013

DO NOT OPEN THIS EXAM BEFORE YOU ARE TOLD TO BEGIN

NAME_____

ID Number _____

Useful information
$\varepsilon_0=8.85\text{x}10^{-12}\ C^2/N.m^2$
$\mu_0=4\pi\ \text{x}\ 10^{-7}\ Tm/A$
$q = 1.6 \times 10^{-19}\ C$
$m_e= 9.1\text{x}10^{-31}\ kg$
$m_p= 1.67\times10^{-27}\ kg$
$k_e=8.9875\text{x}10^{9}\ Nm^2/C^2$

Grading

I	
II	
III	
IV	
V	
VI	
Total	

Score:_____

☐ Check if solution is continued on the back.

I- (22) Ampere's law

1- (10) The magnetic field of a solenoid with length l, radius a and number of turns N is uniform when a current I flows in it. Demonstrate that $B=\mu_0 nI$.

2- (4) Use the definition of inductance to show that $L=\mu_0 V n^2$; what it V here?

3- (3) What is the energy per unit volume stored as a function of B?

Score:_____

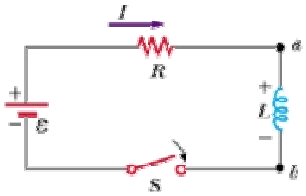
☐ Check if solution is continued on the back.

4- (5) The solenoid is turned now to make a torus with radius *R*, re-determine the magnetic field strength inside the torus.

II- (24) Faraday's law

1- (6) Show that, for a time varying current, that the back emf is: $|\mathcal{E}|=L di/dt$

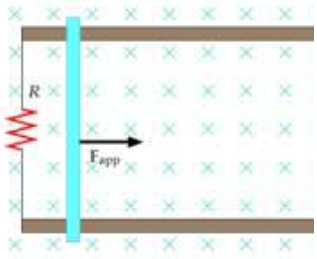
(3) In an RL-circuit shown to the right, discuss the different forms of energy.



Score:_____

☐ Check if solution is continued on the back.

2- (11) A bar, with length *l* and mass *m* is sliding in one direction subject to a constant force $\mathbf{F}_{app}$, Determine the current amplitude and direction flowing as a function of time in **<u>two different ways</u>**.



3- (4) Based on the above calculation, comment on what does Faraday's law reflects.

Score:_____

☐ Check if solution is continued on the back.

III- (16) Ampere and Faraday's laws

Consider a current I flowing in a long straight wire with a radius a and length l.

1. (10) Determine the magnetic field **magnitude and direction** for $r<a$ and for $r>a$.

2. (6) Let the current increase as a function of time according to $I = \alpha t + I_0$, determine the amplitude and the direction of the **induced potential** for $r<a$ [Hint: First determine the magnetic flux area].

Score:_____

☐ Check if solution is continued on the back.

IV- (20) AC Circuits

We consider a circuit composed of an AC power source, supplying a current $I = I_{max}\sin(\omega t)$, a resistor R and an inductor L.

(a)(4) Consider that the **resistance alone** is connected to the power supply, determine the expression of the potential difference across it.

(b)(4) Consider that the **inductor alone** is connected to the power supply, determine the expression of the potential difference across it.

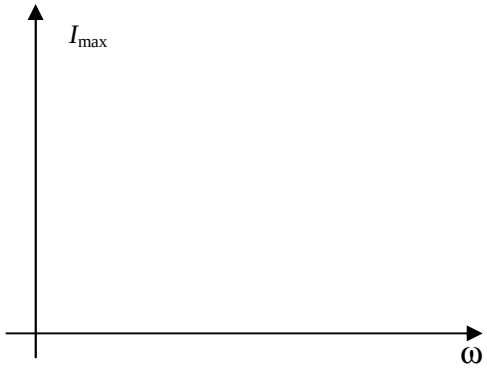
(c)(6) When both R and L are put in series, determine the impedance of the circuit.

Score:_____

☐ Check if solution is continued on the back.

(d)(2) Determine the expression of the circuit phase.

(e)(4) Discuss the behavior of this circuit at low frequencies ($\omega \rightarrow 0$) and for ($\omega \rightarrow \infty$) and plot the current I_{max} vs. ωt and comment on the results.

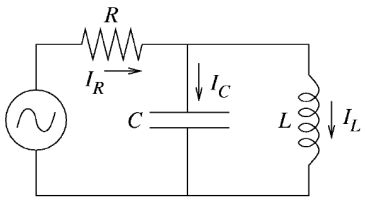


Score:_____

☐ Check if solution is continued on the back.

V- (10) AC Circuits

We insert a capacitor in parallel to the inductor as shown in the figure below and the AC power source produces now a potential difference $\mathcal{E} = \mathcal{E}_0 \cos(\omega t)$.



(f)(5) What are the maximum values of I_L, I_c and I_R in the case where $\omega \rightarrow 0$

(g)(5) What are the maximum values of I_L, I_c and I_R in the case where $\omega \rightarrow \infty$

VI-(8) Write down the <u>full</u> four equations of Maxwell and comment with one sentence on each about what does it reflect.

Score:_____

☐ Check if solution is continued on the back.

SCRATCH PAPER

Nothing on this page will be graded

Score:_____

☐ Check if solution is continued on the back.