Name:

Physics 122 – Spring 2012 – MODIFIED Final Exam

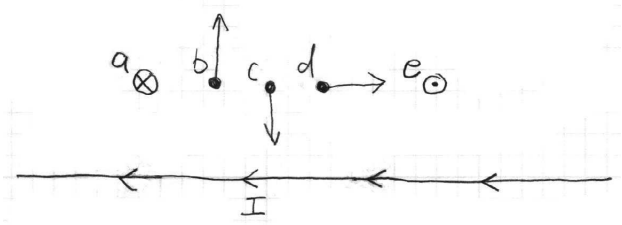
Instructions:

You may use a calculator and your 8.5x11" formula sheet. I MODIFIED A PREVIOUS FINAL EXAM TO MAKE THIS SAMPLE FINAL. THE TOPICS BELOW ARE A PRETTY GOOD LIST. I AM LIKELY TO MAKE THIS FINAL EXAM A LOT MORE MULTIPLE CHOICE RATHER THAN LONG WORK. THIS MEANS THERE WILL BE MORE PROBLEMS AND LESS OPPORTUNITY FOR PART CREDIT. I MAY DO SOMETHING LIKE LET YOU CHOOSE YOUR BEST 10 OUT OF 12 ...

1. *(5 pts.)* Mark each of the following statements about refraction true or false.

(a) Light rays refract when they cross an interface between materials with different refractive indices.
(b) Sound waves and Earthquake waves do not refract. Refraction is restricted to light waves.
(c) Radio waves do not refract. Refraction is restricted to light.
(d) Light rays refract when they slow down or when they speed up as they cross from one material to another.
(e) Total internal reflection can occur when light goes from a medium with smaller refractive index to one with larger refractive index.

2. *(5 pts.)* A very long wire carries a constant current toward the left as shown in the sketch. Five electrons (a–e) move at the same speed in different directions as indicated. Circle the electron (or electrons) that feel zero magnetic force.



Problem 2

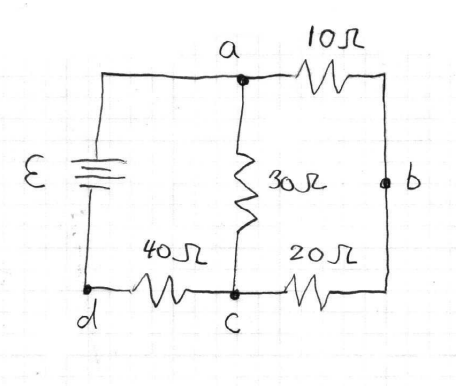
3. *(5 pts.)* A green (440 nm) laser beam passes through a double-slit (0.01 mm is the distance between the slits) and projects an interference pattern on a wall 2 m distant from the slits. What is the distance (on the wall) between the central bright spot and the third bright spot on either side? (Draw a simple sketch of the screen and indicate this distance so I understand your answer unambiguously.)

4. *(10 pts.)*

(a) A parallel plate capacitor has a 10 micron gap. If the plates are circular, what is their diameter so that the capacitance is 20 nF?
(b) What is the electric field in this capacitor when 10 V is applied to it?

5. *(15 pts.)* A 7-mm high object is placed 15 cm from a concave mirror with focal length ten cm.

(a) Sketch a diagram of the situation which includes principal rays, object, image and focal point at approximately correct distances and sizes.
(b) Using an appropriate formula, calculate more precisely the image distance and the size of the image.
(c) State whether the image is real or virtual, and explain how you decided.
(d) Repeat parts a, b, c if the object is now placed 5 cm from the mirror.



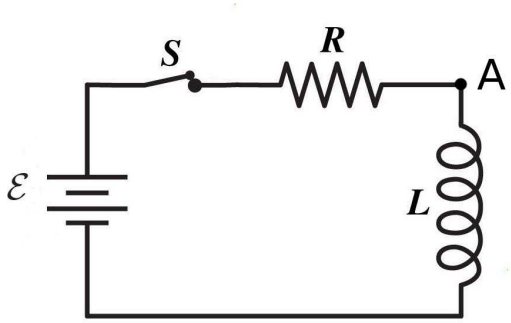
Problem 6

6. *(15 pts.)* The battery voltage in the figure is $\varepsilon = 220\ V$, and the resistor values are as shown. The negative terminal of the battery can be considered to be at ground potential (V=0). Answer the following:

(a) Redraw the schematic shown so that all resistors are vertical and the highest voltage parts are at the top of your sketch and ground is at the bottom. In the following questions, the word *voltage* means *voltage with respect to ground.*
(b) What current passes through the 40 Ω resistor?
(c) What is the voltage at point a?
(d) What is the voltage at point d?
(e) What is the voltage at point c?
(f) What is the voltage at point b?
(g) The ideal battery shown is replaced by a real battery with the same value of ε but an internal resistance of 10 Ω. What is the voltage at point a in this case?

7. *(15 pts.)* A 5000-turn solenoid 25 cm long and 2.0 cm in diameter carries 10 A.
Note: While proper units are required in general, you will lose 1 point per part if you do not show correct units on this problem.

(a) What is the magnitude of the magnetic field inside?
(b) What is the total magnetic flux enclosed by the solenoid?
(c) What is the inductance of this solenoid?
(d) How much magnetic energy does the solenoid contain?

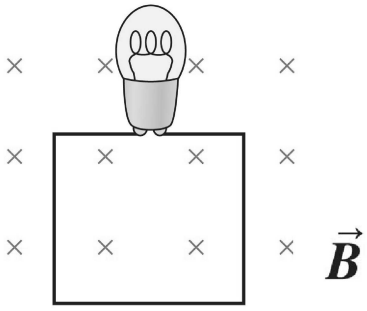


Problem 8: Switch S on the LR circuit is closed at time 0.

8. *(10 pts.)* Given a series RL circuit with a 15-V battery a 500 Ω resistor and a 200 mH inductor, find the current 0.5 ms after the switch is closed. What is the voltage at point A relative to ground at this time?

9. *(15 pts.)* The magnetic field through a square loop varies as $\vec{B}(t) = 5\ sin(2\pi ft)\ \hat{k}$ Tesla. $\hat{k}$ is defined as directed into the page as shown in the figure. Let f = 100 Hertz.

(a) How much power does the light-bulb consume at $t = 10$ ms?



Problem 9: Vector $\hat{k}$ is directed into the page as shown. The light bulb in the picture has a resistance of 50 Ω. It is attached to a square wire loop of side 20 cm.

(b) If the loop were turned (before t=0) so that it pointed out of the page at 45 degrees, what power would it consume at $t = 10$ ms?
(c) What direction (if any) does the induced current flow at t=0? An explanation is required.
(d) What direction (if any) does the induced current flow at t=15 ms? An explanation is required.
(e) What direction (if any) does the induced current flow at t=2.5 ms? An explanation is required.

10. *(10 pts.)* An incandescent (i.e., old-fashioned, not fluorescent or LED) 100 Watt light-bulb may be treated as a black-body (yes, black-bodies can be white!).

(a) A proton is traveling at 1000 km/s. What potential difference is required to stop it ?
(b) THIS PROBLEM IS NOT RELATED TO PART A. Three protons are arranged on the x-axis separated by 1 mm each. What is the direction and magnitude of the Electric field 1 mm above the right-most proton. (Give your answer in component form.)

Constant	Value
Planck's constant (J · s)	$h = 6.62 \times 10^{-34}$
Stefan-Boltzman constant (W/K^4m^2)	$\sigma = 5.67 \times 10^{-8}$
electron charge (C)	$q_e = 1.6 \times 10^{-19}$
electron mass (kg)	$m_e = 9.11 \times 10^{-31}$
proton mass (kg)	$m_p = 1.67 \times 10^{-27}$