



## Center for Academic Resources in Engineering (CARE) Peer Exam Review Session

Phys 212 — University Physics: Electricity and Magnetism

### Midterm 3 Worksheet

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*The problems in this review are designed to help prepare you for your upcoming exam. Questions pertain to material covered in the course and are intended to reflect the topics likely to appear in the exam. Keep in mind that this worksheet was created by CARE tutors, and while it is thorough, it is not comprehensive. In addition to exam review sessions, CARE also hosts regularly scheduled tutoring hours.*

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Tutors are available to answer questions, review problems, and help you feel prepared for your exam during these times:

Session 1: Mon, Apr. 22th 7:00-9:00pm Ray, Krish

Session 2: Wed, Apr. 24th, 4:00-6:00pm Devansh, Ray

Can't make it to a session? Here's our schedule by course:

<https://care.grainger.illinois.edu/tutoring/schedule-by-subject>

Solutions will be available on our website after the last review session that we host.

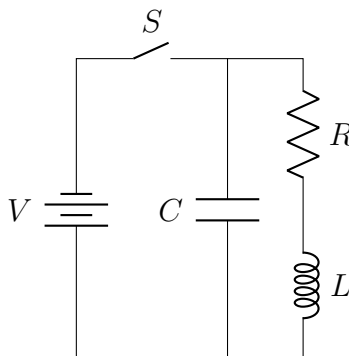
Step-by-step login for exam review session:

1. Log into Queue @ Illinois: <https://queue.illinois.edu/q/queue/848>
2. Click "New Question"
3. Add your NetID and Name
4. Press "Add to Queue"

Please be sure to follow the above steps to add yourself to the Queue.

Good luck with your exam!

1. A circuit is composed of a battery with voltage  $V = 10\text{ V}$ , one resistor  $R = 75\ \Omega$ , a capacitor  $C = 20\text{ pF}$ , an inductor  $L = 20\text{ mH}$  and a switch  $S$ . The switch has been open for a long time; at  $t = 0$ , it is closed.



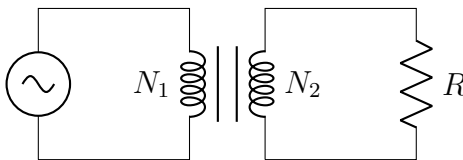
- (i) What is the voltage across the capacitor after the switch has been closed for a long time?
- a)  $10\text{ V}$
  - b)  $0\text{ V}$
  - c)  $15\text{ V}$
  - d)  $7.5\text{ V}$
- (ii) What is the charge across the capacitor at this time?
- a)  $20\text{ pC}$
  - b)  $0\text{ C}$
  - c)  $0.2\text{ nC}$
  - d)  $2\text{ nC}$
- (iii) What is the voltage across  $R$  after the switch has been closed for a long time?
- a)  $7.5\text{ V}$
  - b)  $10\text{ V}$
  - c)  $0\text{ V}$
  - d)  $5\text{ V}$
- (iv) If the switch is now reopened after a long period of time, what will the initial current going through  $R$  be?
- a)  $0.133\text{ A}$
  - b)  $0\text{ A}$
  - c)  $0.5\text{ A}$
  - d)  $0.167\text{ A}$

2. The electric field for a plane electromagnetic wave in a vacuum is given by

$$\vec{E}(y, t) = 2100 \sin(\omega t + 0.8y) \hat{x}$$

- (i) What is the frequency of the wave?
- (ii) What is the magnitude of the magnetic field?
- (iii) What is the direction of the Poynting vector?
  - a)  $\hat{y}$
  - b)  $-\hat{y}$
  - c)  $-\hat{z}$
  - d)  $\hat{z}$
- (iv) What is the direction of  $\vec{B}$ ?
  - a)  $\hat{y}$
  - b)  $-\hat{y}$
  - c)  $-\hat{z}$
  - d)  $\hat{z}$
- (v) What is the average intensity of the electromagnetic wave?

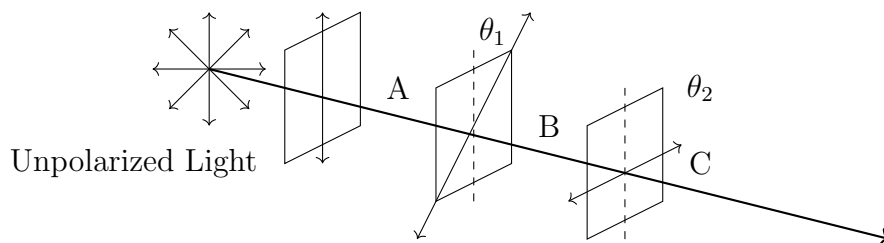
3. An ideal transformer has  $N_1 = 100$  turns in the primary coil and  $N_2 = 10$  turns in the secondary coil. An RMS voltage of  $V = 120$  V and 60Hz AC voltage is connected to the primary coil. A resistor with resistance  $R = 20 \Omega$  is connected to the secondary coil as shown in the figure.



- (i) What is the average voltage across the resistor?
  - a) 120 V
  - b) 1200 V
  - c) 12 V
  - d) 24 V
- (ii) What is the average power in the resistor?

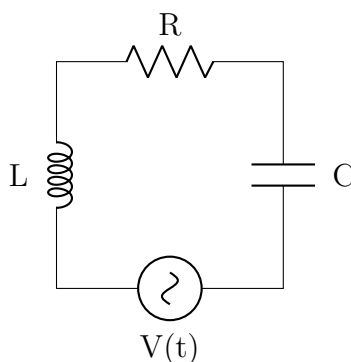
- a) 0 W
- b) 14.4 W
- c) 0.6 W
- d) 7.2 W

4. A beam of unpolarized light of intensity  $I_0$  passes through a series of ideal polarizing filters with their transmission axis turned to various angles, as shown in the figure ( $\theta_1 = 75^\circ$  and  $\theta_2 = 90^\circ$ , both relative to the vertical)



- (i) What is the light intensity (in terms of  $I_0$ ) in regions A, B and C?
- (ii) If we remove the middle filter, what will be the intensity at point C?
- (iii) If the second filter was rotated  $15^\circ$  clockwise, what would the light intensity be at point C?
- (iv) How far should the first filter be rotated in order to maximize the intensity of light at point C?

5. An AC circuit is shown below. The generator follows  $V(t) = 1500\cos(50t)$ . The Resistor has resistance  $R = 60\ \Omega$ . The inductance  $L$  is 40 H. The capacitance  $C$  is  $10\ \mu F$ .



- (i) Find the magnitude of the current through the circuit at  $t = 73$  s. (Hint: what is the phase difference between the generator and the current?)
- (ii) The frequency of the generator has been decreased to 40. Does the generator voltage now lags the current or leads the current?
- (iii) The frequency of the generator is still set to 40. At a certain instant  $t_0$ , the generator voltage has its maximum. What is the magnitude of the current in the circuit at that instant?