Exam 2  Chapters 20 - 22 in Young 9e

Multiple choice questions. Circle the correct answer. No work needs to be shown and no partial credit will be given.

6 pts 1. Two long straight and parallel wires carry currents in the same direction, as shown in the sketch. What is the direction of the force that wire #2 exerts on wire #1?
   (a) the force is zero
   (b) toward wire #2 (attractive)
   (c) away from wire #2 (repulsive)

6 pts 2. A rectangular loop with area $A$ carries clockwise current $I$. The loop is in a uniform magnetic field $B$ that is parallel to the plane of the loop and directed toward the top of the page. For the axis shown, the magnitude of the torque exerted on the loop by the magnetic field is
   (a) $IAB$
   (b) $\frac{1}{2}IAB$
   (c) $2IAB$
   (d) zero
   (e) none of the above answers

6 pts 3. Two coils are close to each other and wound as shown in the sketch. The current in coil #1 is in the direction shown and is decreasing at a constant rate. Because of the current induced in coil #2, which end of the resistor $R$ is at higher potential, $a$ or $b$?
   (a) $a$
   (b) $b$
   (c) $a$ and $b$ are at the same potential

6 pts 4. A long straight wire carries current $I$ toward the top of the page, as shown in the sketch. A square conducting loop is moving toward the wire at constant speed $v$. The induced current in the square loop is
   (a) counterclockwise
   (b) clockwise
   (c) there is no induced current
(6 pts) 5. A metal bar is moving toward the bottom of the page, as shown in the sketch. The bar is in a uniform magnetic field $\mathbf{B}$ that is directed into the page. Which end of the bar, $a$ or $b$, is at higher potential?

(a) $a$
(b) $b$
(c) $a$ and $b$ are at the same potential

(6 pts) 6. A $20.0 \times 10^{-6}$ F capacitor is charged to $1.80 \times 10^{-4}$ C and then is connected across an inductor that has inductance $L = 0.0500$ H. During the subsequent current oscillations, the maximum current in the inductor is

(a) 0.090 A
(b) 0.18 A
(c) 0.36 A
(d) 9.00 A
(e) none of the above answers

(6 pts) 7. Consider the circuit shown in the sketch. The switch has been closed for a long time and then it is opened. Just after the switch is opened, the current in the 8.0 Ω resistor is

(a) zero
(b) 2.40 A
(c) 4.00 A
(d) 6.00 A
(e) none of the above answers

(6 pts) 8. Consider the series $R-L-C$ circuit shown in the sketch. The angular frequency of the source equals the resonance frequency. The voltage amplitude across the resistor is 300 V and the voltage amplitude across the inductor equals 400 V. What is the voltage amplitude across the capacitor?

(a) 100 V
(b) 300 V
(c) 400 V
(d) 500 V
(e) zero
(f) none of the above answers
On the following problems show all your work. Partial credit will be given, if earned. Write your answers in the blanks provided. All answers must include the correct plus or minus sign and the correct units.

(16 pts) 9. A small object has mass $3.00 \times 10^{-8}$ kg and net charge with magnitude $8.00 \times 10^{-6}$ C. At point $a$ it enters a region of uniform magnetic field $B = 2.00$ T that is directed into the plane of the page. As it enters the field, the object has velocity $\vec{v}$ that is perpendicular to the field. The object moves clockwise in a semicircular path that has radius $R = 0.600$ m, as shown in the sketch. It exits the field region at point $b$.

a) Is the charge of the object positive or negative? Ans. negative

b) What is the speed of the object as it enters the field region at point $a$? Ans. $320 \text{ m/s}$

c) What is the speed of the object as it leaves the field region at point $b$? Ans. $320 \text{ m/s}$
10. A conducting bar with length 0.0600 m slides without friction on conducting metal rails, as shown in the sketch. The apparatus is in a uniform magnetic field \( B = 2.50 \) T that is directed perpendicular to the page in the sketch. The resistance of the circuit is a constant 16.0 \( \Omega \). It is found that a constant external force \( F_{\text{ext}} = 5.00 \times 10^{-4} \) N must be applied perpendicular to the bar to move the bar to the right at a constant speed \( v \). The induced current \( I \) in the circuit (bar, rails, resistor) is counterclockwise.

a) Is the magnetic field \( \vec{B} \) directed into the page or out of the page?

\[ \text{Ans. into page} \]

b) What is the speed \( v \) of the bar?

\[ \text{Ans. } 0.356 \text{ m/s} \]

c) What is the rate at which the external force \( F_{\text{ext}} \) does work on the bar?

\[ \text{Ans. } 1.78 \times 10^{-4} \text{ W} \]
(18 pts) 11. The circuit shown in the sketch has an ac voltage source, a resistor and a capacitor connected in series. There is no inductor. The ac voltage source has voltage amplitude 900 V and angular frequency 20 rad/s. The voltage amplitude across the capacitor is 500 V. The resistor has resistance \( R = 300 \Omega \).

![Circuit Diagram]

a) What is the amplitude of the voltage across the resistor?  
Ans. \( 748 \sqrt{\text{V}} \)

b) What is the capacitance \( C \) of the capacitor?  
Ans. \( 2.49 \times 10^{-4} \text{ F} \)

c) Does the source voltage lag or lead the current?  
Ans. \( \text{lag} \)

d) What is the average rate at which the ac source is supplying electrical energy to the circuit (power output of the source)?  
Ans. \( 930 \text{ W} \)