PHYS 2052: SECOND PRACTICE EXAM

Campus/Centre:	( ) Downtown campus (x) Loa Campus

Examination Day:	TBD	Examination Date:	TBD
Examination Time:	TBD	Duration:	75 min

Course Abbreviation & Number:	PHYS 2052
Course Title:	General Physics II

Name of Student: ______________________________

Student Number: ______________________________

INSTRUCTIONS TO CANDIDATES

1. This examination consists of 5 pages.
2. There are 8 conceptual and 7 quantitative questions in this examination. Answer ALL questions.
3. **All working must be shown.**
4. **Units must be shown.**
5. A list of selected formulae is provided below.

LIST OF SELECTED FORMULAE

Magnetic force

$\vec{F} = q\vec{v}\times\vec{B}$

$F = I\vec{\ell}\times\vec{B}$

Motion in B-field

$R = \dfrac{mv}{|q|B}$

Magnetic moment

$\vec{\mu} = I\vec{A}$

$\vec{\tau} = \vec{\mu}\times\vec{B}$

$U = -\vec{\mu}\cdot\vec{B}$

Magnetic flux

$\Phi_B = \int \vec{B}\cdot d\vec{A}$

Spherical integration

$dV = dr(rd\phi)dz$

Gauss's law

$\oint \vec{E}\cdot d\vec{A} = \dfrac{q_{\text{enclosed}}}{\epsilon_0}$

$\oint \vec{B}\cdot d\vec{A} = 0$

B-field

$\vec{B} = \dfrac{\mu_0}{4\pi}\dfrac{q\vec{v}\times\hat{r}}{r^2}$

$d\vec{B} = \dfrac{\mu_0}{4\pi}\dfrac{I\,d\vec{\ell}\times\hat{r}}{r^2}$

Cylindrical integration

$dV = dr(rd\phi)(r\sin\theta\ d\theta)$

Hall effect

$nq = \dfrac{J_x B_y}{E_z}$

Ampere's law

$\oint \vec{B}\cdot d\vec{\ell} = \mu_0 I_{\text{enc}}$

$\oint \vec{B}\cdot d\vec{\ell} = \mu_0\left(i_C + \varepsilon_0\dfrac{d\Phi_E}{dt}\right)$

Faraday's law

$\mathcal{E} = -\dfrac{d\Phi_B}{dt}$

Motional emf

$\mathcal{E} = \oint(\vec{v}\times\vec{B})\cdot d\vec{\ell}$

Common B-fields

$B = \dfrac{\mu_0 I}{2\pi r}$ (long wire)

$B = \dfrac{\mu_0 I a^2}{2(x^2+a^2)^{3/2}}$ (loop)

$B = \dfrac{\mu_0 N I}{2a}$ (center of coil)

$B = \mu_0 I\dfrac{N}{\ell}$ (inside solenoid)

Induced E-fields

$\oint \vec{E}\cdot d\vec{\ell} = -\dfrac{d\Phi_B}{dt}$

Inductor circuits

$\tau = \dfrac{L}{R}$ (R-L)

$\omega = \dfrac{1}{\sqrt{LC}}$ (L-C)

$\omega' = \sqrt{\dfrac{1}{LC} + \dfrac{R^2}{4L^2}}$ (R-L-C)

Inductance

$M = \dfrac{N_2\Phi_{B2}}{I_1}$

$\mathcal{E} = -L\dfrac{dI}{dt}$

$U = \dfrac{1}{2}LI^2$

$\mathcal{E}_2 = -M\dfrac{dI_1}{dt}$

Transformers

$\dfrac{V_2}{V_1} = \dfrac{N_2}{N_1}$

$V_1 I_1 = V_2 I_2$

Resistances

$R_{\text{ser}} = \sum R_i$

$\dfrac{1}{R_{\text{par}}} = \sum \dfrac{1}{R_i}$

Resistance/reactance

$V_R = IR$

$V_C = IX_C = \dfrac{I}{\omega C}$

$V_L = IX_L = I\omega L$

Impedance

$Z = \sqrt{R^2 + (X_L - X_C)^2}$

$\tan\phi = \dfrac{X_L - X_C}{R}$

rms

$I_{\text{rms}} = \dfrac{I_{\text{peak}}}{\sqrt{2}}$

$V_{\text{rms}} = \dfrac{V_{\text{peak}}}{\sqrt{2}}$

Constants

$\epsilon_0 = 8.854\times10^{-12}\ \text{C}^2/\text{Nm}^2$

$\mu_0 = 4\pi\times10^{-7}\ \text{kg/s}^2\text{A}^2$

$e = 1.602\times10^{-19}\ \text{C}$

Kirchoff's rules

Junction: $\sum I = 0$

Loop: $\sum V = 0$

AC power

$P_{\text{avg}} = I_{\text{rms}}V_{\text{rms}}\cos\phi$

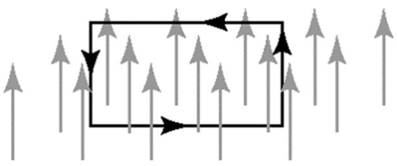
<u>Conceptual Section</u> (Circle the correct answer)

1. As additional resistors are connected in series to a constant voltage source, how is the power supplied by the source affected? [2]

   A. The power supplied by the source decreases.
   B. The effect on the power supplied by the source cannot be determined.
   C. The power supplied by the sources remains constant.
   D. The power supplied by the source increases.

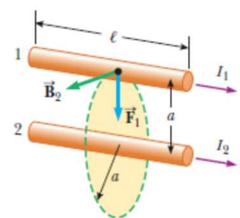
2. A rectangular loop is placed in a uniform magnetic field as shown. If a current is made to flow through the loop in the sense shown by the arrows, the field exerts on the loop [2]

   A. A net force only.
   B. A net torque only.
   C. A net force and a net torque.
   D. Neither a net force or net torque.



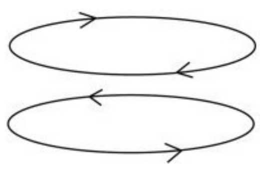
3. Assume $I_1 = 2$ A and $I_2 = 6$ A. What is the relationship between the magnitude F_1 of the force exerted on wire 1 and the magnitude F_2 of the force exerted on wire 2? [2]

   A. $F_1 = 6F_2$
   B. $F_1 = 3F_2$
   C. $F_1 = F_2$
   D. $F_1 = F_2/3$



4. A ring with a clockwise current (as seen from above the ring) is centered directly above another ring with a counter-clockwise current. What direction is the net magnetic force on the top ring? [2]

   A. To the left.
   B. Downward.
   C. To the right.
   D. Upward.



5. Consider a magnetic force acting on an electric charge in a uniform magnetic field. Which of the following statements is true? [2]

   A. An electric charge moving parallel to a magnetic field experiences a magnetic force.
   B. The direction of the magnetic force is always perpendicular to the direction of motion.
   C. A magnetic force is exerted on a stationary electric charge in a uniform magnetic field.
   D. An electric charge moving perpendicular to a magnetic field experiences a magnetic force.

6. Two long parallel wires are placed side by side on a horizontal table. The wires carry equal currents in the same direction. Which of the following statements is true? [2]

   A. The magnetic field is a maximum at a point midway between the two wires.
   B. The magnetic force between the two wires is repulsive.
   C. The magnetic forces between the two wires does not obey Newton's third law.
   D. The magnetic field at a point midway between the two wires is zero.

7. An inductor is connected across an AC source. Suppose the frequency of the source is doubled. What happens to the inductive reactance of the inductor? [2]

   A. The inductive reactance is quadrupled.
   B. The inductive reactance is doubled.
   C. The inductive reactance remains constant.
   D. The inductive reactance is halved.

8. An ideal resistor, inductor, and capacitor are connected in series to an AC source. What is the phase angle between the voltages of the inductor and capacitor in this RLC circuit? [2]

   A. The phase angle is 0°.
   B. The phase angle is 90°.
   C. The phase angle is 180°.
   D. The phase angle is 270°.

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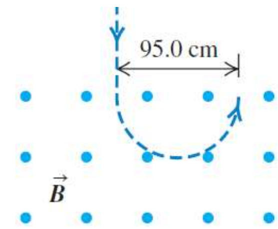
Quantitative Section

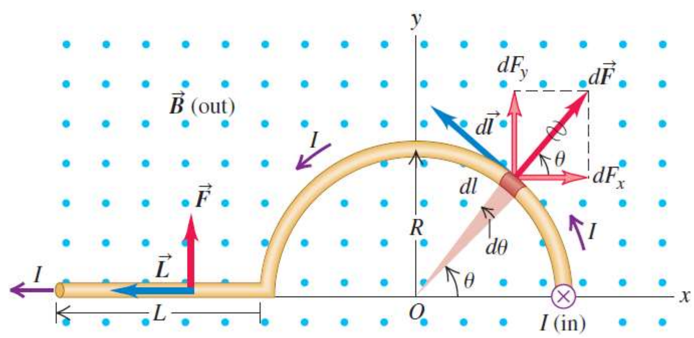


1. A vertical beam of particles that have charge of magnitude $|q| = 3e$ and mass that is 12 times the proton mass enters a uniform horizontal magnetic field of 0.250 T. The beam bends in a semicircle of diameter 95.0 cm. [Mass of a proton is 1.67×10^{-27} kg]

   (a) Determine the speed of the particles. [4]

   (b) Determine the time an individual particle spends in the magnetic field. [3]

   (c) What is the sign of the charged particles? __________________. [2]



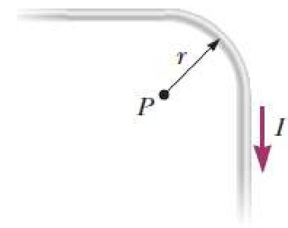
2. The magnetic field is uniform and perpendicular to the plane of the figure, pointing out of the page. The conductor, carrying current I to the left as shown, has three segments: (I) a straight segment with length L perpendicular to the plane of the figure, (II) a semicircle with radius R in the plane of the page, and (III) another straight segment with length parallel to the x-axis in the plane of the page.

   (a) Determine the magnitude of force in line segment (I) perpendicular to the plane due to the magnetic field. [2]

   (b) Determine the magnitude of force in the semicircle segment (II) in the page's plane due to the magnetic field. [3]

   (c) Determine the magnitude of force in line segment (III) along the x-axis in the page's plane due to the magnetic field. [3]

3. A long, straight wire carries a current I. A right-angle bend is made in the middle of the wire. The bend forms an arc of a circle of radius r as shown. Determine an expression for the total magnetic field magnitude at point P (include contributions from the both straight parts and bend of the wire). [6]



4. A rectangular coil of $N = 60$ turns with side lengths of $a = 12.0$ cm and $b = 20.0$ cm carrying a resistance of $R = 12.0\ \Omega$ rotates in a magnetic field with an angular speed of $\omega = 8.00$ rad/s about the y-axis. The magnetic field is oriented along the x-direction with magnitude $B = 1.20$ T. We take $t = 0$ to be the time when the magnetic field is in the direction normal to the plane of the rectangle.

   (a) Determine the maximum induced emf in the coil. [4]

   (b) Determine the maximum current in the coil. [2]

5. A solenoidal coil with 35 turns of wire is wound tightly around another coil with 200 turns. The inner solenoid is 20.0 cm long and has a diameter of 1.50 cm. At a certain time, the current in the inner solenoid is 0.220 A and is increasing at a rate of 2300 A/s.

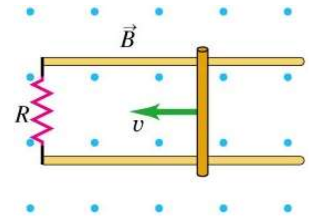
   (a) At this time, determine the average magnetic flux through each turn of the inner solenoid. [2]

   (b) At this certain time, determine the mutual inductance of the two solenoids. [2]

   (c) At this certain time, find the emf induced in the outer solenoid caused by the inner solenoid. [2]

6. A 30.0 cm long metal bar is pulled to the left by an applied force F and moves to the left at a constant speed of 5.90 m/s. The bar rides on parallel metal rails connected through a 50.0 Ω resistor as shown. The circuit is in a uniform 0.600 T magnetic field that is directed out of the plane.

   (a) Determine the induced emf. [3]

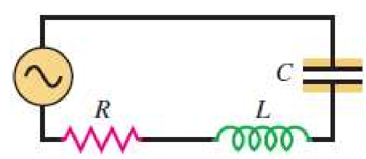


   (b) Determine the induced current in the circuit. [2]

   (c) Determine the rate of work (power) that the force is doing to keep a constant speed. [2]

   (d) Is the induced current in the circuit clockwise or counterclockwise?___________________. [2]

7. You have a 200 Ω resistor, a 0.400 H inductor, a 5.00 μF capacitor, and a variable-frequency AC source with an amplitude of 3.10 V. You connect all four elements together to form a series circuit.



   (a) At what frequency will the current in the circuit be greatest? [2]

   (b) What will be the current amplitude at this frequency? [2]

   (c) What will be the impedance of the circuit at an angular frequency of 500 rad/s? [2]

   (d) What will be the current amplitude at an angular frequency of 500 rad/s? [2]

END OF EXAMINATION