Midterm Exam No. 02 (Fall 2024)

PHYS 205B: UNIVERSITY PHYSICS

School of Physics and Applied Physics, Southern Illinois University–Carbondale

Date: 2024 Oct 15

(Name) (Signature)

Instructions

1. Seating direction: On even-numbered seats in alternate rows A, C, E, ...
2. Total time = 75 minutes.
3. There are 4 short questions and 3 homework-style problems in this exam.
4. Equation sheet is provided separately.
5. To be considered for partial credit you need to present your work in detail and organize it clearly.
6. A simple calculator (with trigonometric functions) is allowed.
7. Use of smart devices, including smart watches, is strictly prohibited. They should stay out of reach during the exam.
8. Restroom breaks are allowed. Under questionable circumstances this might lead up to a Makeup Exam.
9. Academic misconduct will lead to a failing grade in the course.

1. (**5 points.**) Determine the equivalent capacitance between points A and B in the circuit in Figure 1. Given $C_1 = 1.0\,\mu\text{F}$, $C_2 = 2.0\,\mu\text{F}$, $C_3 = 3.0\,\mu\text{F}$, $C_4 = 4.0\,\mu\text{F}$, and $C_5 = 5.0\,\mu\text{F}$.

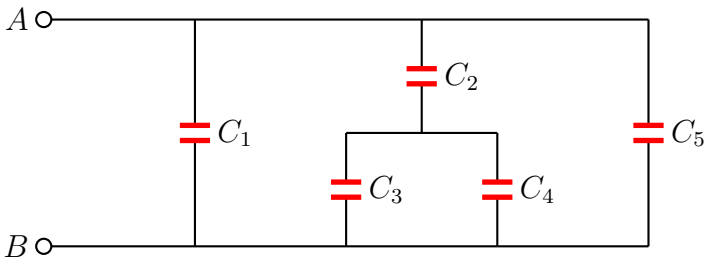

Figure 1: Problem 1

2. (**5 points.**) Given current I flows through the resistor in the circuit on the left (in the shape of rectangle) in Figure 2, what can you deduce about the current that flows in the same resistor R connected to the same battery V using circular shaped wires as shown in the circuit on the right in Figure 2.

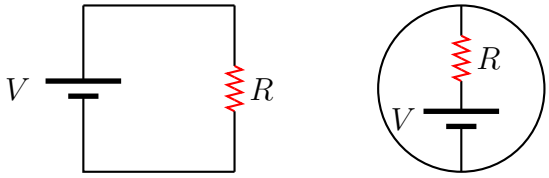

Figure 2: Problem 2

3. (**5 points.**) Given R is resistance and C is capacitance, deduce the dimension of the quantity represented by the product

$$RC. \tag{1}$$

4. (**5 points.**) Skies in Carbondale flared up with northern lights few times recently. During such an event electrons moving at $1.0 \times 10^7\,\mathrm{m/s}$ spiral along helical paths guided by Earth's terrestrial magnetic field of $0.50 \times 10^{-4}\,\mathrm{T}$ before interacting with molecules in the atmosphere. What can you conclude about the radius of these helical paths.

5. (**10 points.**) A potential difference $V = 10.0\,\mathrm{V}$ is applied across a resistor arrangement with two resistances connected in series, see Figure 3. Given $R_1 = 100.0\,\Omega$ and $R_2 = 200.0\,\Omega$.

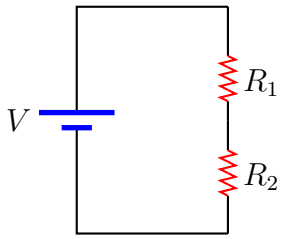

Figure 3: Problem 5

(a) Find the equivalent resistance.

(b) Find the currents I_1 and I_2 flowing through the resistors.

(c) Find the voltages V_1 and V_2 across each of the resistors.

(d) Find the power P_1 and P_2 dissipated in each of the resistors.

6. (**10 points.**) Consider the circuit in Figure 4. Given $R_1 = 10.0\,\Omega$, $R_2 = 20.0\,\Omega$, $R_3 = 30.0\,\Omega$, Further, the electric potentials at points a, b, and c, are $V_a = 10.0\,\mathrm{V}$, $V_b = 20.0\,\mathrm{V}$, $V_c = 30.0\,\mathrm{V}$. Determine the current in each resistor.

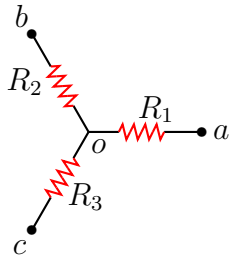

Figure 4: Problem 6

7. (**10 points.**) A loop in the shape of a semicircle of radius 5.0 cm, carrying a current 1.0 A, is placed in a uniform magnetic field of strength 0.010 T. See Figure 5. Determine the expression for magnitude and direction of the total force acting on the semi-circular part, labeled *a*-*t*-*b*, of the wire.

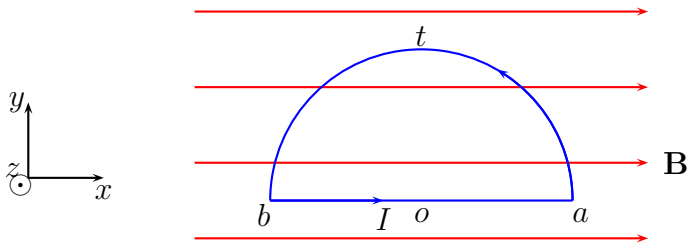

Figure 5: Problem 7.