Midterm Exam No. 02 (2024 Spring)

PHYS 205B: UNIVERSITY PHYSICS

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

Date: 2024 Mar 21

(Name) (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 4.
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 $C_1 = 1.0\,\mu\text{F}$, $C_2 = 2.0\,\mu\text{F}$, $C_3 = 3.0\,\mu\text{F}$, and $C_4 = 4.0\,\mu\text{F}$.

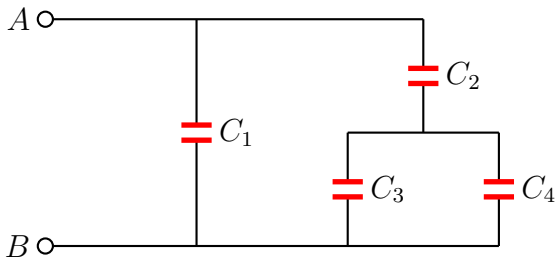

Figure 1: Problem 1

2. (**5 points.**) The electric potentials at the two ends of a $R = 1.5\,\mathrm{k}\Omega$ resistor in a circuit is measured to be $V_a = 6.0\,\mathrm{V}$ and $V_b = 1.5\,\mathrm{V}$. Refer Figure 2. Determine the current passing through the resistor.

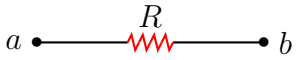

Figure 2: Problem 2

3. (**5 points.**) What is the dimension of the physical quantity associated with the product of a resistance R and a capacitance C, that is,

$$RC. \tag{1}$$

4. (**5 points.**) A loop in the shape of a right triangle of sides $a = 3.0\,\text{cm}$ and $b = 2.0\,\text{cm}$, carrying a current $I = 2.0\,\text{A}$, is placed in a uniform magnetic field $0.30\,\text{T}$ going into the page. See Figure 3. Determine the magnitude and direction of the total force on the triangular loop of wire.

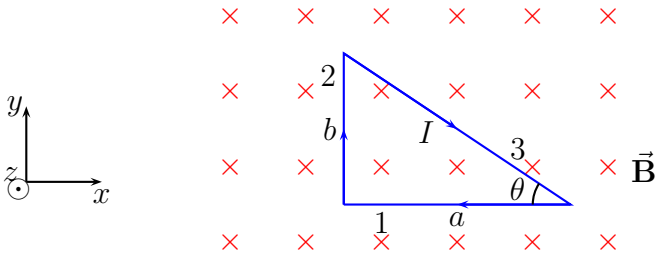

Figure 3: Problem 4.

5. (**10 points.**) Consider the circuit in Figure 4. Given $R_1 = 10.0\,\Omega$ and $R_2 = 20.0\,\Omega$, $V = 10.0\,\text{V}$. Determine the current in each resistor.

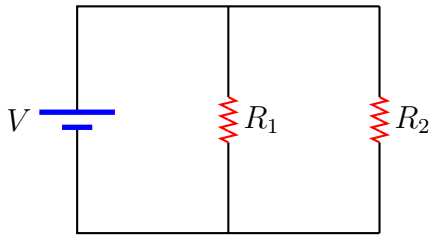

Figure 4: Resistors in parallel.

6. (**10 points.**) Consider the circuit in Figure 5. 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 $V_a = 10.0\,\mathrm{V}$, $V_b = 20.0\,\mathrm{V}$, $V_b = 30.0\,\mathrm{V}$. Determine the current in each resistor.

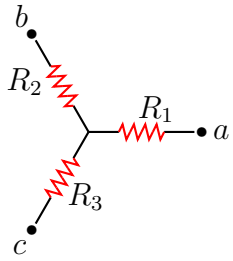

Figure 5: Problem 6

7. (**10 points.**) A loop in the shape of a semi circle of radius R, carrying a current I, is placed in a magnetic field $\mathbf{B}$. See Figure 6. Determine the expression for magnitude and direction of the total force acting on the semi-circular part of the wire.

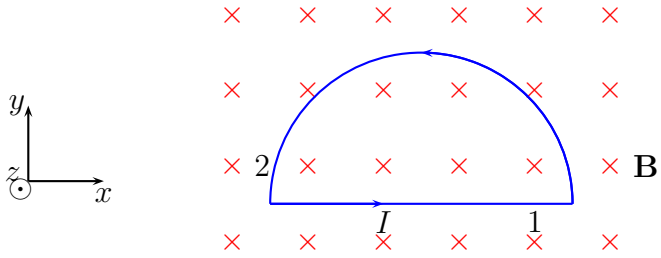

Figure 6: Problem 7.