Homework No. 05 (Spring 2025)

PHYS 205B-002: UNIVERSITY PHYSICS

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

Due date: Tuesday, 2025 Feb 25, 4:00 PM, on D2L

Instructions

- You are encouraged to use any of the resources to complete this homework. However, the extent to which you depend on resources while doing this homework is a measure of how much extra work you need to put in to master the associated concepts. Solutions should be the last resource.
- Links to solutions are provided.
- Variations of homework problems and additional problems with hyperlinks to old exams are available in Lecture Notes. These serve as practice problems.
- Describe your thought process in detail and organize it clearly. Make sure your answer has units and right number of significant digits.
- After completion, scan the pages as a single PDF file, and submit the file on D2L (under Assesments → Assignments). You can replace your PDF file as many times as you like, only the last file is graded. The deadline has an (undisclosed) buffer period, so do not hesitate to try submissions after the deadline.

Problems

1. (**10 points.**) Derive the capacitance of a cylindrical capacitor consisting of coaxial conducting cylinders of length L. The capacitor consists of a solid cylinder of radius a and another cylinderical conducting shell of radius $b > a$.

   Solution

2. (**10 points.**) A capacitor of capacitance 10.0 nF is connected to a 10.0 V balltery. Let us assume that the capacitor consists of two parallel plates of area A separated by distance d.

   (a) Determine the charge accumulated on each plate of the capacitor.

   (b) Determine the energy stored in the capacitor.

   Solution

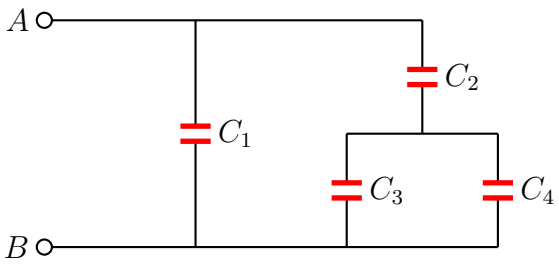

Figure 1: Problem 3

3. (**10 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 $C_4 = 4.0\,\mu\text{F}$.

   Solution

4. (**10 points.**) A potential difference $V = 10.0\,\text{V}$ is applied across a capacitor arrangement with two capacitances connected in parallel, $C_1 = 10.0\,\mu\text{F}$ and $C_2 = 20.0\,\mu\text{F}$. See Figure 2.

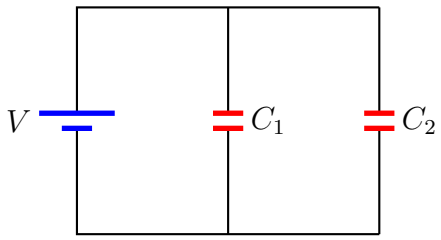

Figure 2: Problem 4

   (a) Find the equivalent capacitance.

   (b) Find the charges Q_1 and Q_2 on each of the capacitors.

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

   (d) Find the potential energies U_1 and U_2 stored inside each of the capacitors.

   (e) Find the ratio V_1/V_2 of the voltages across the capacitors.

   (f) Find the ratio Q_1/Q_2 of the charges on the capacitors.

   (g) Find the ratio U_1/U_2 of the potential energies stored inside the capacitors.

   Solution

5. (**10 points.**) A potential difference $V = 10.0\,\text{V}$ is applied across a capacitor arrangement with two capacitances connected in series, $C_1 = 10.0\,\mu\text{F}$ and $C_2 = 20.0\,\mu\text{F}$. See Figure 3.

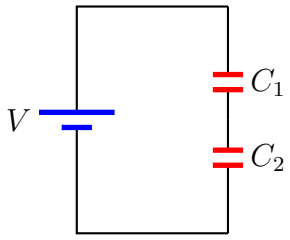

Figure 3: Problem 5

(a) Find the equivalent capacitance.

(b) Find the charges Q_1 and Q_2 on each of the capacitors.

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

(d) Find the potential energies U_1 and U_2 stored inside each of the capacitors.

(e) Find the ratio V_1/V_2 of the voltages across the capacitors.

(f) Find the ratio Q_1/Q_2 of the charges on the capacitors.

(g) Find the ratio U_1/U_2 of the potential energies stored inside the capacitors.

Solution

6. (**10 points.**) In the circuit in Figure 4 determine the charge on capacitor C_3. Let $V = 10.0\,\text{V}$, $C_1 = 10.0\,\text{nF}$, $C_2 = 20.0\,\text{nF}$, and $C_3 = 30.0\,\text{nF}$.

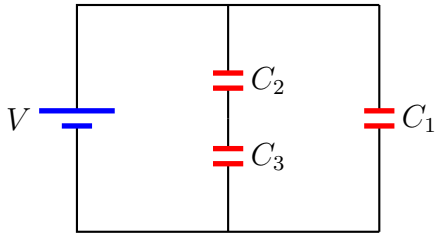

Figure 4: Problem 6.

Solution (Erratum: The units in Solution should be nF, not μF.)