Homework No. 05 (Fall 2024)

PHYS 205B: UNIVERSITY PHYSICS

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

Due date: Thursday, 2024 Sep 26, 9:30 AM, 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 homework is usually a measure of how much extra work you need to put in to master the associated concepts. Solutions should be the last resource.
- Describe your thought process in detail and organize it clearly. Make sure your answer has units and the right number of significant digits.
- Additional problems, with hyperlinks to exams, are available in Lecture Notes.
- After completion, scan the pages as a single PDF file, and submit the file on D2L (under Assessments → Assignments).

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

3. (**10 points.**) Determine the equivalent capacitance between points A and B in the circuit in Figure 1. Given $C_1 = 1.0\,\mu$F, $C_2 = 2.0\,\mu$F, $C_3 = 3.0\,\mu$F, and $C_4 = 4.0\,\mu$F.

   Solution

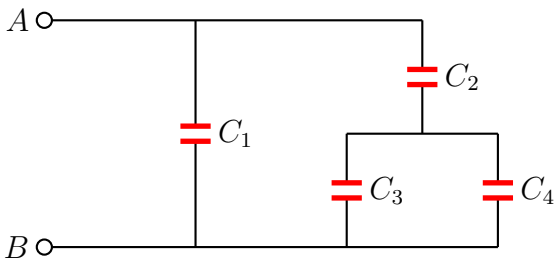

Figure 1: Problem 3

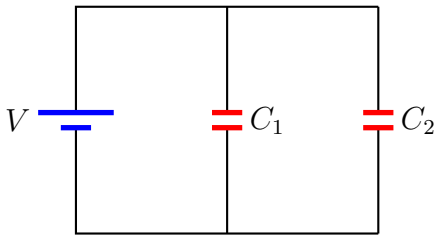

Figure 2: Problem 4

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.

   (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.

   (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.

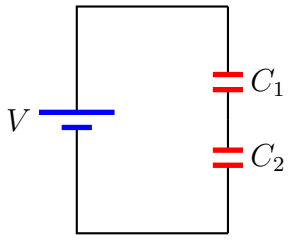

Figure 3: Problem 5

(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 $V = 10.0\,\mathrm{V}$, $C_1 = 10.0\,\mathrm{nF}$, $C_2 = 20.0\,\mathrm{nF}$, and $C_3 = 30.0\,\mathrm{nF}$.

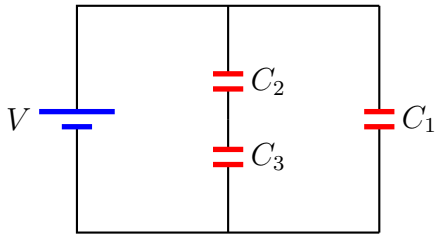

Figure 4: Problem 6.

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