

# Homework No. 04 (Fall 2021)

## PHYS 205B: University Physics

Due date: Thursday, 2021 Sep 23, 9:30 AM, on D2L

### Instructions

- Describe your thought process in detail and organize it clearly. Make sure your answer has the correct units and the right number of significant digits.
- 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 cylindrical conducting shell of radius  $b > a$ .

#### Solution

2. (**10 points.**) A capacitor of capacitance  $10.0\text{ nF}$  is connected to a  $10.0\text{ V}$  battery. 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  $C_1 = 1.0\ \mu\text{F}$ ,  $C_2 = 2.0\ \mu\text{F}$ ,  $C_3 = 3.0\ \mu\text{F}$ , 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  $C_2 = 20.0\ \mu\text{F}$ .
  - (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.

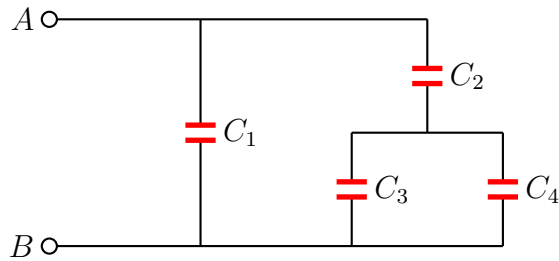


Figure 1: Problem 3

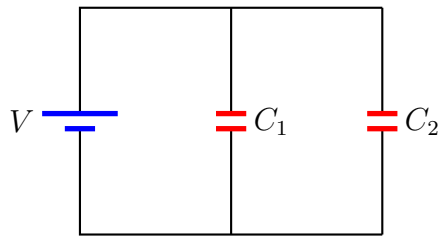


Figure 2: Problem 4

- (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  $C_2 = 20.0 \mu\text{F}$ .

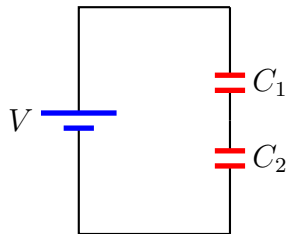


Figure 3: Problem 5

- (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  $C_3 = 30.0 \text{ nF}$ .

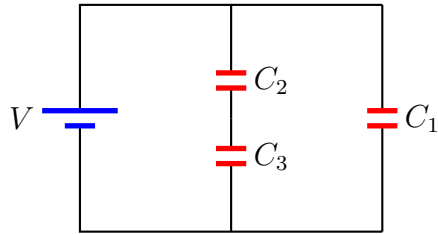


Figure 4: Problem 6.

**Solution** (Erratum: The units should be nF, not  $\mu\text{F}$ .)