UNIVERSITY IBN TOFAIL

Electricity I

Problem Set III

Exercise 1:

A solid conducting sphere S_1 of radius R_1 is brought to a potential V_1. A second hollow conducting sphere S_2, with radius $R_2 > R_1$, is concentric with S_1. The sphere S_2 is brought to a potential V_2.

1. Determine the expressions for:
   - The charge Q_1 on the sphere S_1,
   - The charge Q_2' on the inner surface of S_2,
   - The charge Q_2'' on the outer surface of S_2.
2. Deduce the capacitance and influence coefficients. Verify that $C_{11} > 0$, $C_{22} > 0$, $C_{12} < 0$, and that $C_{11} + C_{12} = 0$.
3. What happens if both spheres are brought to the same potential V_2?

Correction

Exercise 2:

A cylindrical capacitor of length L is formed by two coaxial cylinders A_1 and A_2, with radii R_1 and R_2 respectively ($R_1 < R_2$). The capacitor carries a charge Q. The potentials of A_1 and A_2 are V_1 and V_2, respectively. Assuming $L \gg R_2$ to neglect edge effects, determine the capacitance C of this capacitor.

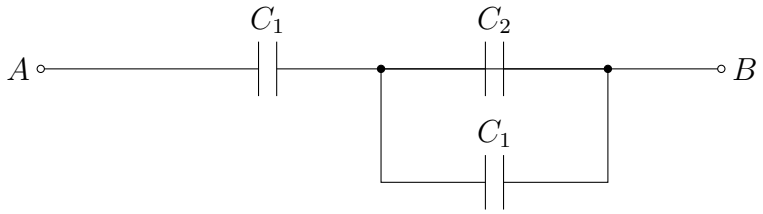
Correction

Exercise 3:

Three capacitors are connected as shown in the figure below.

1. What value must C_2 have so that the equivalent capacitance of the system equals C_2, given that $C_1 = 3\,\mu F$?

2. A voltage $U_0 = 400\,\mathrm{V}$ is applied between points A and B. Determine the charge and voltage across each capacitor in the case where C_1 and C_2 have the values found in part (1).



Correction

Exercise 4:

Determine the electrostatic energy of a sphere of radius R charged with a uniform volumetric charge density ρ using two different methods:

1. By using the expression for energy in terms of the potential.
2. By using the expression for local energy density.

Correction

Exercise 5:

A capacitor is formed by two horizontal circular plates of surface area S, parallel to each other, with radius R and separated by a distance e. The capacitor is charged using a voltage generator V. Express all results in terms of R.

1. Determine the charge Q acquired by the capacitor (its capacitance is $C = \frac{\varepsilon_0 S}{e}$).
2. Determine the energy W_c stored in the capacitor.
3. What is the energy density W? Deduce the intensity E of the electric field.
4. Determine the energy W_G supplied by the generator. Compare it with W_c and interpret the result.

Correction