RC circuits

Charge | Discharge

INTERNATIONAL UNIVERSITY (IU) – VIETNAM NATIONAL UNIVERSITY - HCMC

MIDTERM EXAMINATION – CLASS

Student Name:_____ Student ID:_____

Date: April 2017

Duration: 90 minutes

SUBJECT: PHYSICS 3	
Chair of Department of Physics: Signature: Full name: Phan Bảo Ngọc	Lecturer: Signature: Full name: Phan Bảo Ngọc

INSTRUCTIONS: This is a closed book examination. Use of cell phones, laptops and dictionaries is not allowed.

1/ (20 pts) An electric dipole, of charge 1.6×10^{-19} C and distance 1.0×10^{-6} m, is placed in an electric field of 10^5 N/C. Find the difference in potential energy corresponding to dipole orientations parallel and anti-parallel to the field.

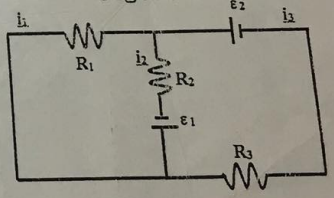
2/ (20 pts) A point charge q = +5.3 μC is placed at the center of a conducting spherical shell. The net electric flux outside the shell is $+1.0\times10^6$ N.m^2/C. Determine the net charge of the shell. (Permittivity constant $\varepsilon_0 = 8.85\times10^{-12}$ C^2.N^{-1}.m^{-2})

3/ (20 pts) Capacitors A and B have the same capacitance. Capacitor A is charged with energy of 6.0 J and capacitor B is uncharged. The two capacitors are then connected in parallel:

(a) What will be the total stored energy after the combination?

(b) Does the total energy stay the same, increase or decrease? Explain your result.

Figure 1



4/ (20 pts) A circuit is given as shown in Figure 1, R_1 = 100 Ω, R_2 = 10 Ω, R_3 = 5 Ω, and ε_1 = 12 V, ε_2 = 6 V. Determine the magnitude and direction of the currents in the resistors.

5/ (20 pts) In the circuit of Figure 2, ε = 85 V, C = 2 μF, R_1 = 60 Ω, R_2 = 40 Ω, and R_3 = 10 Ω.

First, the switch is closed for a long time so that the steady state is reached.

(a) Find the charge on the capacitor.

(b) Then the switch S is opened at time t = 0. At what time has the charge on the capacitor decreased to 10% of its initial value? (For a discharging capacitor: $q = q_0 e^{-t/RC}$)

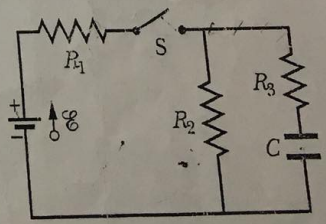


Figure 2

END OF QUESTION PAPER

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1| $U = -pE\cos\theta$; $p = q.d = 1{,}6.10^{-19}.1.10^{-6} = 1{,}6.10^{-25}$ (C.m)

$\Delta U = U_{anti} - U_{par} = -pE(\cos 180^\circ - \cos 0^\circ) = 2pE = 2.1{,}6.10^{-25}.10^{5}$
$= 3{,}2.10^{-20}$ (J)

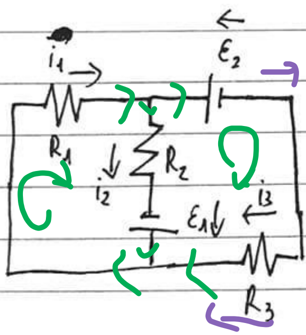
2| $\begin{cases} \varepsilon_0 . \phi = q_{enc} \\ q_{enc} = q + q_{shell} \end{cases} \Rightarrow \begin{cases} q_{enc} = 8{,}85.10^{-6} \\ q_{shell} = q_{enc} - q = 3{,}55.10^{-6} \text{ (C)} \end{cases}$

3|

a| $C_{eq} = C_A + C_B = 2C_A$; $6 = \dfrac{q^2}{2C_A} \Rightarrow \dfrac{q^2}{4C_A} = 3$

b| Total stored energy must descrease, as q stay the same while C increases. However, total Energy must stay the same, it just converted into different forms.

4|



$\begin{cases} -i_1R_1 - i_2R_2 + \varepsilon_1 = 0 \\ -\varepsilon_2 - i_3R_3 - \varepsilon_1 + i_2R_2 = 0 \\ i_1 = i_2 + i_3 \end{cases}$

$\Rightarrow \begin{cases} i_1 = 0 \\ i_2 = 6/5 \\ i_3 = -6/5 \end{cases}$

5| a| $q_0 = C.V_{23}$ (1) $\quad R_{23} = \dfrac{R_2.R_3}{R_2+R_3} = 8$

$\begin{cases} \dfrac{V_1}{R_1} = \dfrac{V_{23}}{R_{23}} \\ V_1 + V_{23} = 85 \end{cases} \Leftrightarrow \begin{cases} 8V_1 = 60V_{23} \\ V_1 + V_{23} = 85 \end{cases} \Rightarrow \begin{cases} V_1 = 75 \text{ (V)} \\ V_{23} = 10 \text{ (V)} \end{cases}$ (2)

(1) and (2) $\Rightarrow q_0 = 2.10^{-6}.10 = 20.10^{-6}$ (C)

Bài 5 này nạp điện qua hệ thống 3 điện trở, nhưng xả qua 2, mn cẩn thận

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Ngày . . No.

b| $q = q_0 \cdot e^{-t/RC}$; $R = R_2 + R_3$ (Ngắt $S_1 \Rightarrow R_2 nt R_3$)

$= 50\ \Omega$

$\frac{q}{q_0} = 0,1 \Rightarrow e^{-t/RC} = 0,1 \Leftrightarrow \frac{-t}{RC} = -2,3 \Rightarrow t = 2,3.10^{-4}$ (s)