EXERCISES MODULE 1: DC ELECTRIC CIRCUITS

September 29, 2016

PROBLEM 1.1

For the circuit in Figure 1, obtain the equations needed to determine the currents of each branch of the circuit.

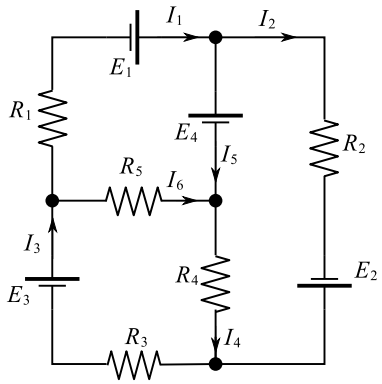

Figure 1

Result

$$\begin{cases} 0 = I_1 - I_2 + I_5 \\ 0 = -I_1 + I_3 - I_6 \\ 0 = -I_4 + I_5 + I_6 \\ E_1 - E_4 = R_1 \cdot I_1 - R_5 \cdot I_6 \\ E_3 = R_3 \cdot I_3 + R_4 \cdot I_4 + R_5 \cdot I_6 \\ E_2 + E_4 = R_2 \cdot I_2 - R_4 \cdot I_4 \end{cases}$$

PROBLEM 1.2

For the circuit of Figure 2:

a) Determine the current of each branch of the circuit.

b) Compute the potentials V_A, V_B and V_C

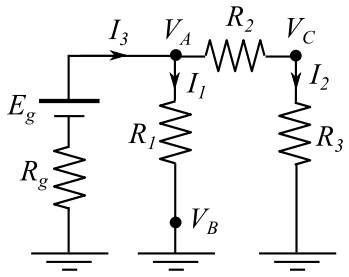

Figure 2

Data: $E_g = 10$ V; $\quad R_g = \dfrac{1}{2}\ \Omega$; $\quad R_1 = 4\ \Omega$; $\quad R_2 = R_3 = 2\ \Omega$

Result

a) $I_1 = I_2 = 2$ A; $\quad I_3 = 4$ A

b) $V_A = 8$ V; $\quad V_B = 0$ V; $\quad V_C = 4$ V

PROBLEM 1.3

Given the circuit in Figure 3:

a) Determine the power of the sources E_1 and E_2.

b) Compute the power absorbed by resistors R_1, R_2 and R_3. Verify the power balance of the circuit.

c) Calculate the electric potential difference V_{AB}.

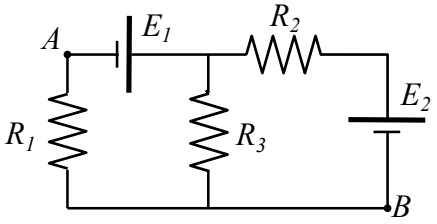

Figure 3

Data: $E_1 = 10$ V; $\quad E_2 = 5$ V; $\quad R_1 = 2\ \Omega$; $\quad R_2 = R_3 = 1\ \Omega$

Result

a) $P_{E_1} = 30$ W. Delivered; $\quad P_{E_2} = 5$ W. Delivered

b) $P_{R_1} = 18$ W; $\quad P_{R_2} = 1$ W; $\quad P_{R_3} = 16$ W

$$\sum P_{deli} = \sum P_{abs} = 35 \text{ W}$$

c) $V_{AB} = -6$ V

PROBLEM 1.4

For the circuit of Figure 4, calculate the power absorbed by resistors R_1, R_4 and R_5

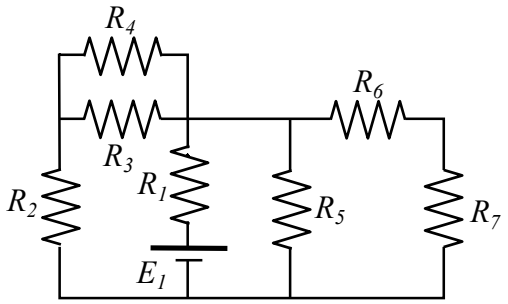

Figure 4

Data: $E_1 = 12$ V; $R_1 = 1\ \Omega$; $R_2 = 2\ \Omega$; $R_3 = R_4 = 4\ \Omega$; $R_5 = 8\ \Omega$; $R_6 = 6\ \Omega$; $R_7 = 2\ \Omega$

Result
$P_{R_1} = 16$ W; $P_{R_4} = 4$ W; $P_{R_5} = 8$ W

PROBLEM 1.5

Given the circuit of Figure 5:

a) Compute the potentials of points A and B

b) Determine the power of the sources, and the power absorbed by the resistors. Verify the power balance.

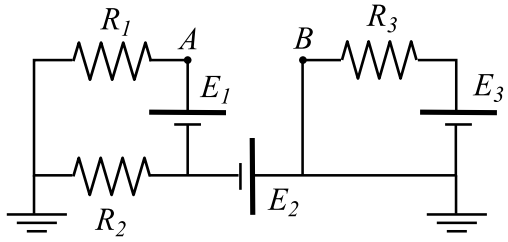

Figure 5

Data: $E_1 = 10$ V; $E_2 = 2$ V; $E_3 = 4$ V; $R_1 = 8\ \Omega$; $R_2 = R_3 = 4\ \Omega$

Result

a) $V_A = 8$ V; $V_B = 0$ V

b) $P_{E_1} = 10$ W; $P_{E_2} = -1$ W absorbs; $P_{E_3} = 4$ W; $P_{R_1} = 8$ W; $P_{R_2} = 1$ W; $P_{R_3} = 4$ W

PROBLEM 1.6

For the circuit in Figure 6:

a) Compute the potentials of points A, B and C.

b) Determine the power of the sources E_1 and E_2, and the power absorbed by the resistor R_1.

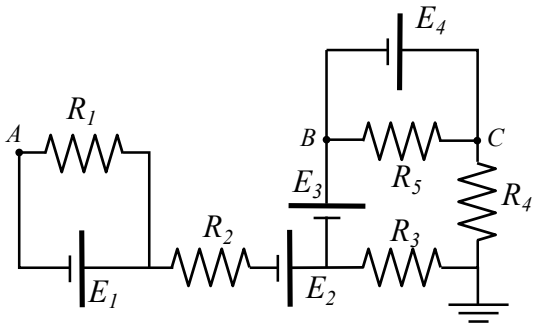

Figure 6

Data:

$E_1 = E_2 = 10$ V; $E_3 = 3$ V; $E_4 = 4$ V; $R_1 = 1\ \Omega$; $R_2 = 2\ \Omega$; $R_3 = 3\ \Omega$; $R_4 = 4\ \Omega$; $R_5 = 8\ \Omega$

Result

a) $V_A = -23$ V; $V_B = 0$ V; $V_C = 4$ V

b) $P_{E_1} = 100$ W; $P_{E_2} = 0$ W; $P_{R_1} = 100$ W

PROBLEM 1.7

Given the circuit in Figure 7:

a) Calculate the power absorbed by the resistors R_1, R_2 and R_3.

b) Calculate the power of the sources E_1, E_2 and E_3.

c) Determine the energy saved by L_1, L_2, C_1, C_2 and C_3.

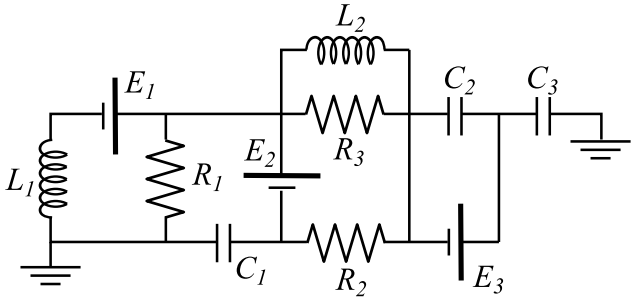

Figure 7

Data:

$$E_1 = 1\text{ V};\quad E_2 = 2\text{ V};\quad E_3 = 3\text{ V};\quad R_1 = 1\ \Omega;\quad R_2 = R_3 = 2\ \Omega;$$
$$C_1 = 1\ \mu\text{F};\quad C_2 = 1\ \mu\text{F};\quad C_3 = 3\ \mu\text{F};\quad L_1 = 2\text{ mH};\quad L_2 = 4\text{ mH}$$

Result

a) $P_{R_1} = 1\text{ W};\quad P_{R_2} = 2\text{ W};\quad P_{R_3} = 0\text{ W}$

b) $P_{E_1} = 1\text{ W};\quad P_{E_2} = 2\text{ W};\quad P_{E_3} = 0\text{ W}$

c) $W_{L_1} = 1\text{ mJ};\quad W_{L_2} = 2\text{ mJ};\quad W_{C_1} = \frac{1}{2}\ \mu\text{J};\quad W_{C_2} = 9\ \mu\text{J};\quad W_{C_3} = 24\ \mu\text{J}$

PROBLEM 1.8

For the following circuit 8:

a) Determine the power absorbed by resistors R_1, R_2, R_3 and R_4.

b) Calculate the power of the sources E_1 and E_2.

c) Compute the energy saved by L_1, L_2, C_1 and C_2.

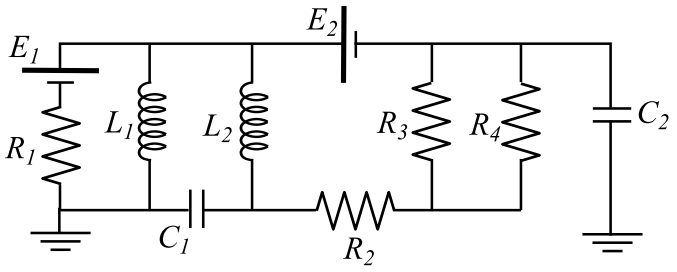

Figure 8

Data:

$$E_1 = 2\text{ V};\quad E_2 = 5\text{ V};\quad R_1 = 4\ \Omega;\quad R_2 = R_3 = 3\ \Omega;\quad R_4 = 6\ \Omega$$
$$C_1 = 7\text{ nF};\quad C_2 = 2\text{ nF};\quad L_1 = 8\ \mu\text{H};\quad L_2 = 2\ \mu\text{H}$$

Result

a) $P_{R_1} = 1\text{ W};\quad P_{R_2} = 3\text{ W};\quad P_{R_3} = \frac{4}{3}\text{ W};\quad P_{R_4} = \frac{2}{3}\text{ W}$

b) $P_{E_1} = 1\text{ W};\quad P_{E_2} = 5\text{ W}$

c) $W_{L_1} = 1\ \mu\text{J};\quad W_{L_2} = 1\ \mu\text{J};\quad W_{C_1} = 0\text{J};\quad W_{C_2} = 25\text{nJ}$

PROBLEM 1.9

Determine the equivalent resistance for the circuits shown in Figure 9 when they are in DC:

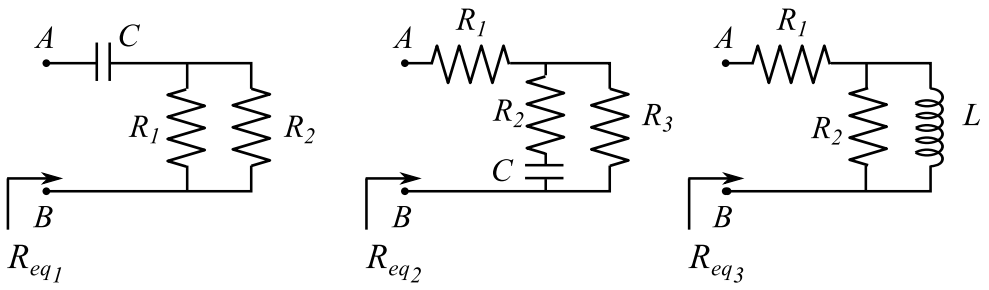

Figure 9

Data:

$$R_1 = 1\ \Omega; \quad R_2 = R_3 = 2\ \Omega; \quad C_1 = 1\ \mu\text{F}; \quad L_1 = 2\ \text{mH}$$

Result

$R_{eq_1} = \infty$, $R_{eq_2} = 3\ \Omega$ y $R_{eq_3} = 1\ \Omega$

PROBLEM 1.10

For the circuit in Figure 10 express the equations to obtain $v_1(t)$, $v_2(t)$, and $v_3(t)$ as a function of the currents $i_1(t)$ and $i_2(t)$.

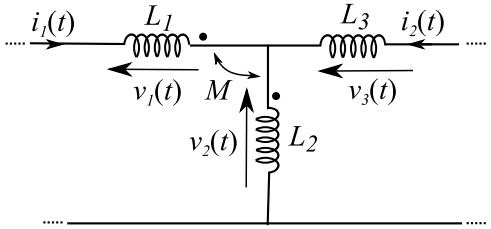

Figure 10

Result

$$\begin{cases} v_1(t) = L_1 \cdot \dfrac{di_1(t)}{dt} - M \cdot \dfrac{di_1(t)}{dt} - M \cdot \dfrac{di_2(t)}{dt} \\ v_2(t) = L_2 \cdot \dfrac{di_1(t)}{dt} + L_2 \cdot \dfrac{di_2(t)}{dt} - M \cdot \dfrac{di_1(t)}{dt} \\ v_3(t) = -L_3 \cdot \dfrac{di_2(t)}{dt} \end{cases}$$