City University of Hong Kong

Department of Biomedical Engineering

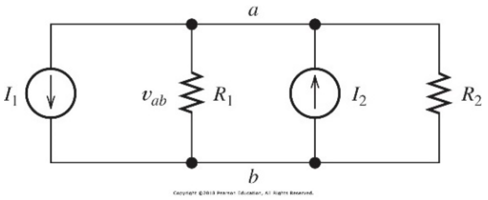
BME 2029
Electrical and Electronic Principles

Test

Question 1: (7)

Given a circuit in Fig. 1, where $I_1 = 3A, I_2 = 1A, R_1 = 12\Omega, R_2 = 6\Omega$, (a) find the value of v_{ab}, and (b) find the power for each element.

Fig. 1:



Solution:

(a) The currents flowing downward through the resistances are v_{ab}/R_1 and v_{ab}/R_2. Then, the KCL equation for node a (or node b) is

$$I_2 = I_1 + \frac{v_{ab}}{R_1} + \frac{v_{ab}}{R_2}$$

Substituting the values given in the question and solving yields $v_{ab} = -8\ V$.

(b) $P_{I1} = v_{ab} I_1 = -8 \times 3 = -24W$

$P_{I2} = -v_{ab} I_2 = 8 \times 1 = 8W$

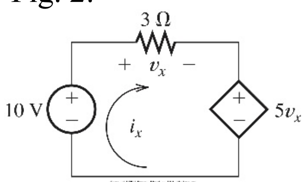
$$P_{R1} = \frac{v_{ab}^2}{R_1} = \frac{(-8)^2}{12} = 5.33W$$

$$P_{R1} = \frac{v_{ab}^2}{R_2} = \frac{(-8)^2}{6} = 10.67W$$

Question 2: (7)

Consider the circuit given in Fig. 2. (a) Find the values of v_x and i_x. (b) Find the power for each element in the circuit.

Fig. 2:



Solution:

(a) Applying KVL, we have $v_x + 5v_x = 10V$ which yields $v_x = \frac{10}{6} = 1.67V$.

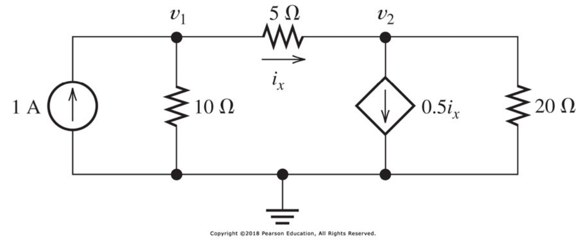
$i_x = \frac{v_x}{3} = \frac{10}{18} = 0.56A$.

(b) $P_{VS} = -10 \times \frac{10}{18} = -5.56W$, $P_R = \frac{10}{6} \times \frac{10}{18} = 0.93W$, $P_{DS} = \frac{50}{6} \times \frac{10}{18} = 4.63W$.

Question 3: (8)

Find the values of node voltages shown in Fig. 3. Then find the value of i_x.

Fig. 3



Solution:

First, we can write: $i_x = \frac{v_1 - v_2}{5}$.

Then, writing KCL equations at nodes 1 and 2, we have:

$$\frac{v_1}{10} + i_x = 1$$
$$\frac{v_2}{20} + 0.5i_x - i_x = 0$$

Substituting for i_x and simplifying, we have

$$0.3v_1 - 0.2v_2 = 1$$
$$-0.1v_1 + 0.15v_2 = 0$$

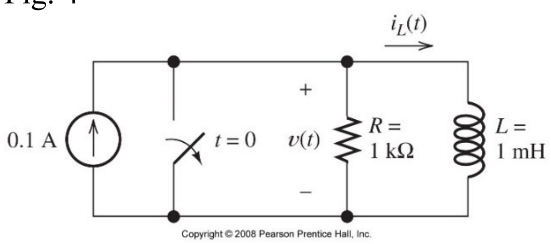
Solving, we have $v_1 = 6V$ and $v_2 = 4V$

Then, we have $i_x = 0.4A$.

Question 4: (8)

Consider the circuit shown in Fig.4. The initial current in the inductor is $i_L(0-) = 0$. Find the expressions for $i_L(t)$ and $v(t)$ for $t \geq 0$.

Fig. 4



Solution:

$$i_L(t) = K_1 + K_2 \exp(-Rt/L)$$

At $t = 0+$, we have

$$i_L(0+) = i_L((0-) = 0 = K_1 + K_2$$

At $t = \infty$, the inductance behaves as a short circuit, and we have

$$i_L(\infty) = 0.1 = K_1$$

Thus, the solution for the current is

$$i_L(t) = 0 \quad \text{for}\, t < 0$$
$$= 0.1 - 0.1\exp(-10^6 t) \quad \text{for}\, t > 0$$

The voltage is

$$v(t) = L\frac{di(t)}{dt}$$
$$= 0 \;\text{for}\, t < 0$$
$$= 100\exp(-10^6 t)\,\text{for}\, t > 0$$