ECE35 Homework #1 (Spring 2023, Taur)

<u>All homework problems come from the textbook, "Introduction to Electric Circuits", by Svoboda & Dorf, 9th Edition.</u>

P 1.2-6 An electroplating bath, as shown in Figure P 1.2-6, is used to plate silver uniformly onto objects such as kitchen ware and plates. A current of 600 A flows for 20 minutes, and each coulomb transports 1.118 mg of silver. What is the weight of silver deposited in grams?

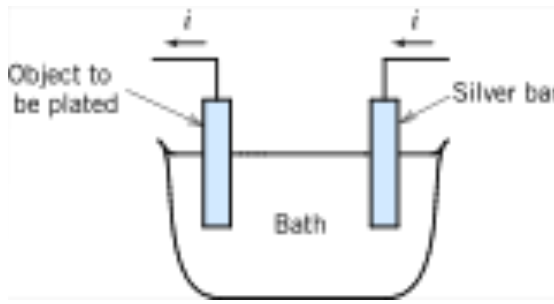


Figure P 1.2-6

Solution:

1.118 (mg/coul) × 600 (coul/s) × 20 × 60 s = 805 g.

P1.5-1 Figure P1.5-1 shows four circuit elements identified by the letters *A*, *B*, *C*, and *D*.

(*a*) Which of the devices supply 30 mW?
(*b*) Which of the devices absorb 0.03 W?
(*c*) What is the value of the power received by device *B*?
(*d*) What is the value of the power delivered by device *B*?
(*e*) What is the value of the power delivered by device *C*?

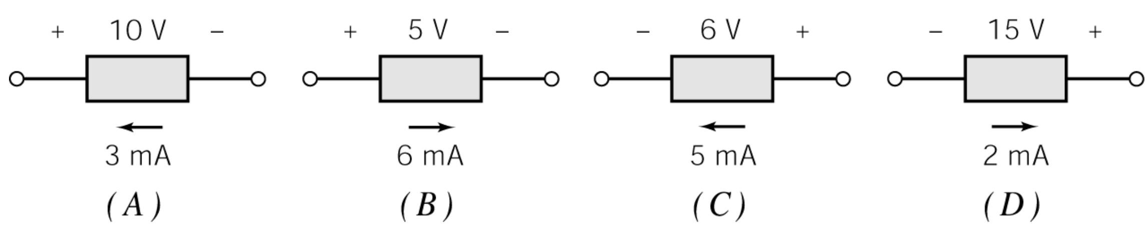


Figure P1.5-1

Solution:

(a) *A* and *D.*
(b) *B* and *C.*
(c) 30 mW.
(d) –30 mW.
(e) –30 mW.

P 1.5-6 Find the power, $p(t)$, supplied by the element shown in Figure P 1.5-6 when
$v(t) = 4 \sin 3t$ V and $i(t) = (1/12) \sin 3t$ A. Evaluate $p(t)$ at t=0.5 s and t = 1 s. Observe that the power supplied by this element has a positive value at some times and a negative value at other times.

Solution:
Power supplied p(t) = v(t) i(t) = (1/3) $\sin^2(3t)$ W, always ≥ 0.
p(0.5 s) = 0.33 W, p(1 s) = 0.0065 W.

P 1.5-7 Find the power, $p(t)$, supplied by the element shown in Figure P 1.5-6 when $v(t) = 8 \sin 3t$ V and $i(t) = 2 \sin 3t$ A.

Hint: $$(\sin at)(\sin bt) = \frac{1}{2}(\cos(a-b)t - \cos(a+b)t)$$

Answer: $p(t) = 8 - 8\cos 6t$ W

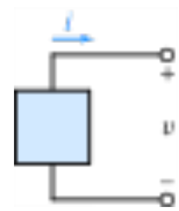


Figure P 1.5-6

P 1.7-3 The element currents and voltages shown in Figure P 1.7-3 are correct with one exception: the reference direction of exactly one of the element currents is reversed. Determine which reference direction has been reversed.

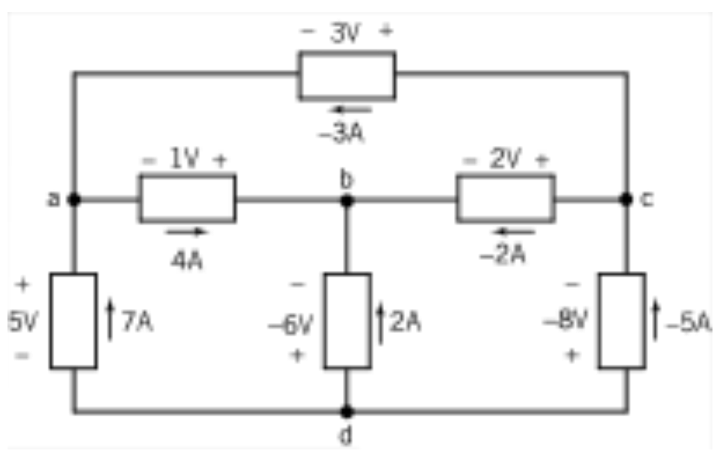


Figure P 1.7-3

Solution:
Let's tabulate the power received by each element. We'll identify each element by its nodes.

nodes	Power received, W

a	*c*	$(3)(-3) = -9$
a	*b*	$-(1)(4) = -4$
b	*c*	$(2)(-2) = -4$
a	*d*	$-(5)(7) = -35$
b	*d*	$(-6)(2) = -12$
c	*d*	$(-8)(-5) = 40$

So

$$\textit{Total power received} \;=\; -(9+4+4+35+12)+40 = -24 \neq 0$$

Changing the current reference direction for a particular element will change the total power by twice the power of the particular element. Since the element connected between nodes b and d receives -12 W, changing the reference direction of its current will increase the total power received by 24 W, as required. After making that change

$$\textit{Total power received} \;=\; -(9+4+4+35)+(12+40) = 0$$

P 2.4-5 A voltage source and two resistors are connected in parallel in the circuit shown in Figure P 2.4-5. Elements connected in parallel have the same voltage, so $v_1 = v_s$ and $v_2 = v_s$ in this circuit. Suppose that $v_s = 150$ V, $R_1 = 50\ \Omega$, and $R_2 = 25\ \Omega$. Calculate the current in each resistor and the power absorbed by each resistor.

Hint: Notice the reference directions of the resistor currents.

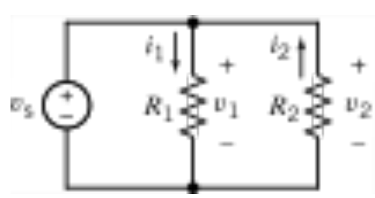
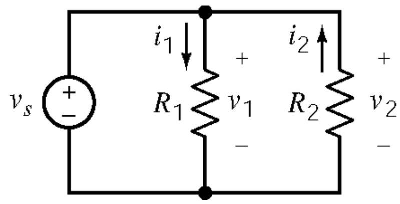


Figure P 2.4-5

Solution:



$v_1 = v_2 = v_s = 150$ V;

$R_1 = 50\ \Omega$; $R_2 = 25\ \Omega$

v_1 and i_1 adhere to the passive convention so

$i_1 = \frac{v_1}{R_1} = \frac{150}{50} = \underline{3\text{ A}}$

v_2 and i_2 do not adhere to the passive convention so $i_2 = -\frac{v_2}{R_2} = -\frac{150}{25} = \underline{-6\text{ A}}$

The power absorbed by R_1 is $P_1 = v_1 i_1 = 150 \cdot 3 = \underline{450\text{ W}}$

The power absorbed by R_2 is $P_2 = -v_2 i_2 = -150(-6) = \underline{900\text{ W}}$

P 2.5-1 A current source and a voltage source are connected in parallel with a resistor as shown in Figure P 2.5-1. All of the elements connected in parallel have the same voltage, v_s in this circuit. Suppose that $v_s = 15$ V, $i_s = 3$ A, and $R = 5\ \Omega$. (a) Calculate the current i in the resistor and the power absorbed by the resistor. (b) Change the current source current to $i_s = 5$ A and recalculate the current, i, in the resistor and the power absorbed by the resistor.

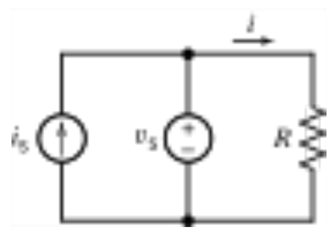


Figure P 2.5-1

Solution:

(a) $i = \frac{v_s}{R} = \frac{15}{5} = \underline{3\text{ A}}$ and $P = R\,i^2 = 5(3)^2 = \underline{45\text{ W}}$

(b) i and P do not depend on i_s.

The values of i and P are 3 A and 45 W, both when $i_s = 3$ A and when $i_s = 5$ A.

P 2.5-2 A current source and a voltage source are connected in series with a resistor as shown in Figure P 2.5-2. All of the elements connected in series have the same current, i_s, in this circuit. Suppose that $v_s = 10$ V, $i_s = 3$ A, and $R = 5\ \Omega$. (a) Calculate the voltage v across the resistor and the power absorbed by the resistor. (b) Change the voltage source voltage to $v_s = 5$ V and recalculate the voltage, v, across the resistor and the power absorbed by the resistor.

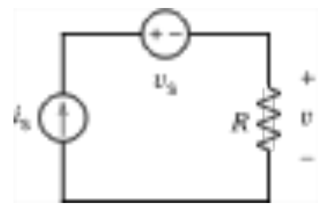


Figure P 2.5-2

Solution:

(a) From Ohm's law $v = R\, i_s = 5(3) = 15 \text{ V}$. (The resistor voltage does not depend on the voltage source voltage.) Next $P = \dfrac{v^2}{R} = \dfrac{15^2}{5} = \underline{45\ \text{W}}$.

(b) Since v and P do not depend on v_s the values of v and P are 15 V and 45 W

both when v_s=10V and when v_s=5V.

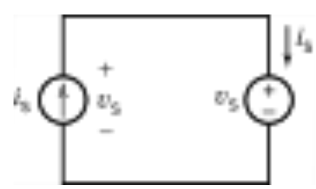


Figure P 2.5-3

P 2.5-3 The current source and voltage source in the circuit shown in Figure P 2.5-3 are connected in parallel so that they both have the same voltage, v_s. The current source and voltage source are also connected in series so that they both have the same current, i_s. Suppose that $v_s = 12$ V and $i_s = 3$ A. Calculate the power supplied by each source.
Answer: The voltage source supplies –36 W, and the current source supplies 36 W.

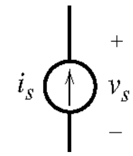
Solution:

Consider the current source:

i_s and v_s do not adhere to the passive convention,

so $P_{cs} = i_s v_s = 3 \cdot 12 = \underline{36\text{ W}}$

is the power supplied by the current source.



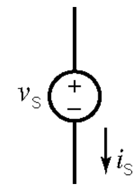
Consider the voltage source:

i_s and v_s do adhere to the passive convention,

so $P_{vs} = i_s\ v_s = 3 \cdot 12 = \underline{36\text{ W}}$

is the power absorbed by the voltage source.

$\therefore$ The voltage source supplies -36 W.



P 2.6-2 The current source in Figure P 2.6-2 supplies 40 W. What values do the meters in Figure P 2.6-2 read?

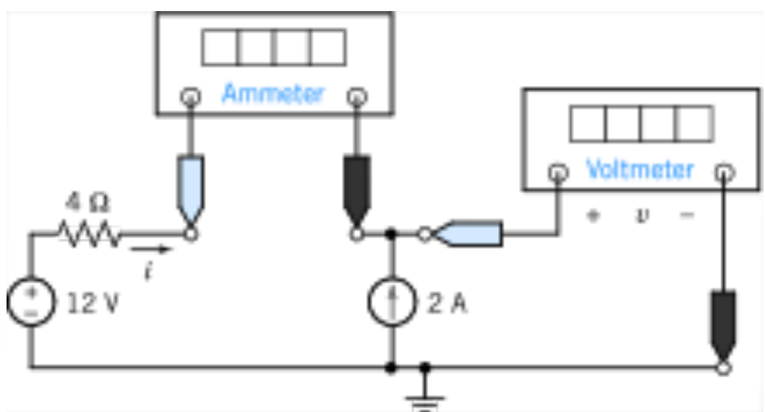


Figure P 2.6-2

Solution:

The voltmeter current is zero so the ammeter current is equal to the current source current except for the reference direction:

$$i = -2\text{ A}$$

The voltage v is the voltage of the current source. The power supplied by the current source is

40 W so

$$40 = 2\,v \quad \Rightarrow \quad v = 20 \text{ V}$$

P 2.7-6 Find the power supplied by the VCCS in Figure P 2.7-6.

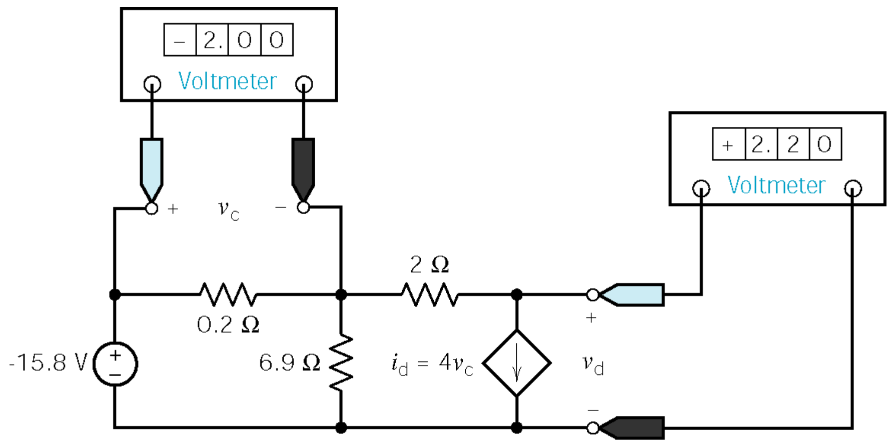


Figure P 2.7-6

Solution:

$$v_c = -2 \text{ V},\; i_d = 4\,v_c = -8 \text{ A and } v_d = 2.2 \text{ V}$$

i_d and v_d adhere to the passive convention so

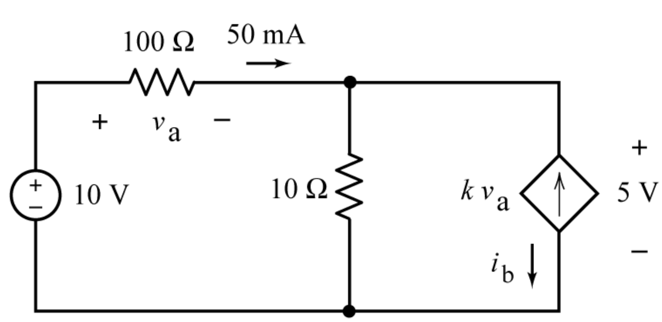
$$P = v_d\, i_d = (2.2)\,(-8) = \underline{-17.6 \quad \text{W}}$$

is the power received by the dependent source. The power supplied by the dependent source is 17.6 W.

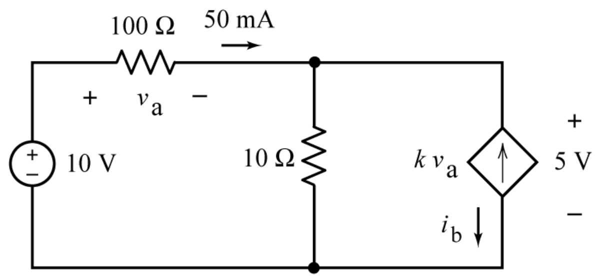
P2.7-10 The circuit shown in Figure P2.7-10 contains a dependent source. The gain of that dependent source is

$$k = 90\,\frac{\text{mA}}{\text{V}} = 0.09\,\frac{\text{A}}{\text{V}}$$

Determine the value of the current ib.



Solution:



$$v_a = 100(0.05) = 5\text{ V}$$

$$k = 90\ \frac{\text{mA}}{\text{V}} = 0.09\ \frac{\text{A}}{\text{V}}$$

$$i_b = -(0.09)(5) = -0.45\text{ A} = -450\text{ mA}$$

DP 2-1 Specify the resistance R in Figure DP 2-1 so that both of the following conditions are satisfied:

1. $i > 40$ mA.

2. The power absorbed by the resistor is less than 0.5 W.

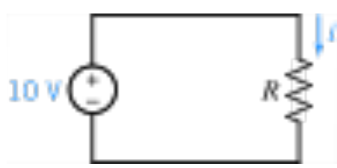


Figure DP 2-1

Solution:

1.) $$\frac{10}{R} > 0.04 \quad \Rightarrow \quad R < \frac{10}{0.04} = 250\ \Omega$$

2.) $$\frac{10^2}{R} < \frac{1}{2} \quad \Rightarrow \quad R > 200\ \Omega$$

Therefore $200 < R < 250\ \Omega$. For example, $R = 225\ \Omega$.