EECS2200 Electric Circuits

Chapter 2

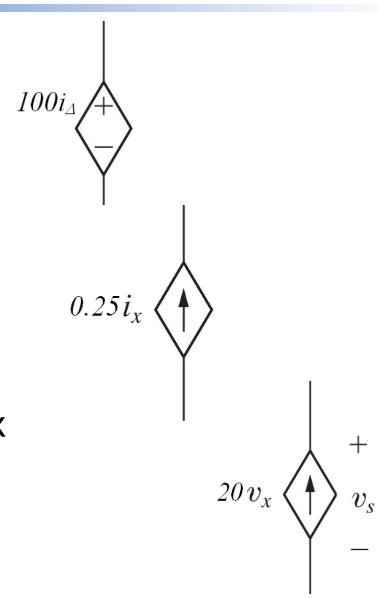
Activities

Activity 1

(a) If i_Δ is 15 mA, how much voltage does this dependent source supply?

(b) What units are associated with the gain 0.25 for this dependent source?

(c) Suppose the value of vx is 4 V. What is the value of vs?



Solution

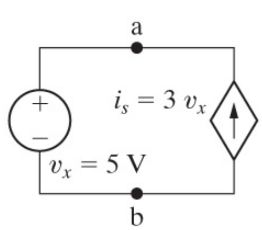
(a) v=100A/V * 15mA= 1.5V.

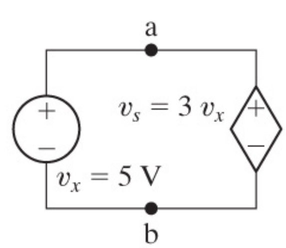
(b) Since this is the dependent current source, the output current $i=0.25*i_x$.
The unit of gain is A/A.

(c) This is a current source, we can't calculate the voltage v_s based on given information.

Activity 2

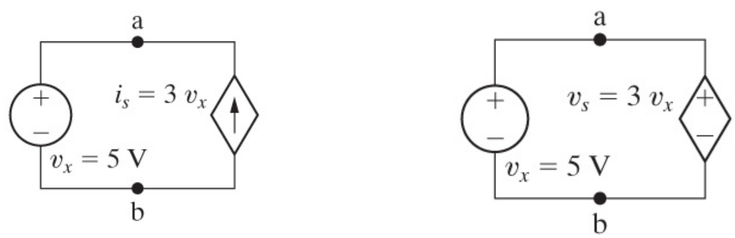
- Which of the circuits below is valid?





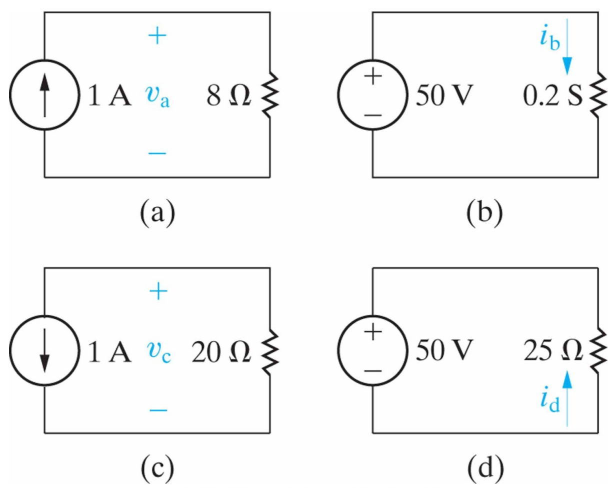
Solution

The circuit on the left is valid.



Activity 3

find *v* or *i* in every circuit



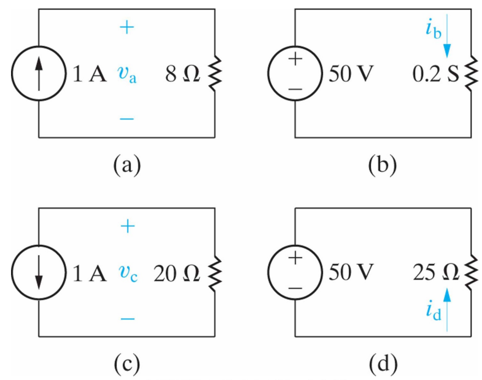
Solution

(a) $v_a = iR = 1*8 = 8V$

(b) $i_b = V/R = VG = 50*0.2 = 10A$

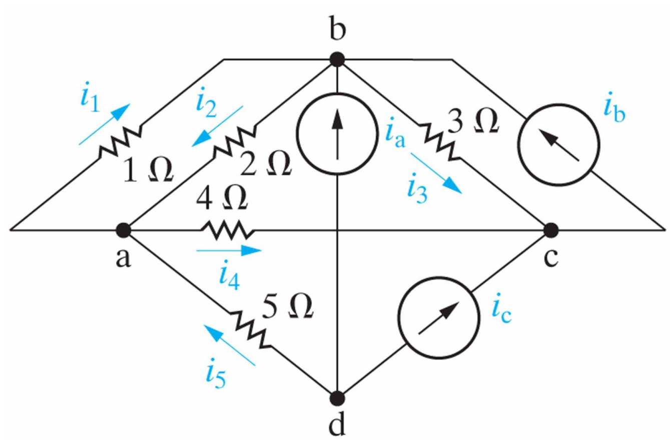
(c) $v_c = iR = -1*20 = -20V$

(d) $i_d = V/R = -50/25 = -2A$



Activity 4

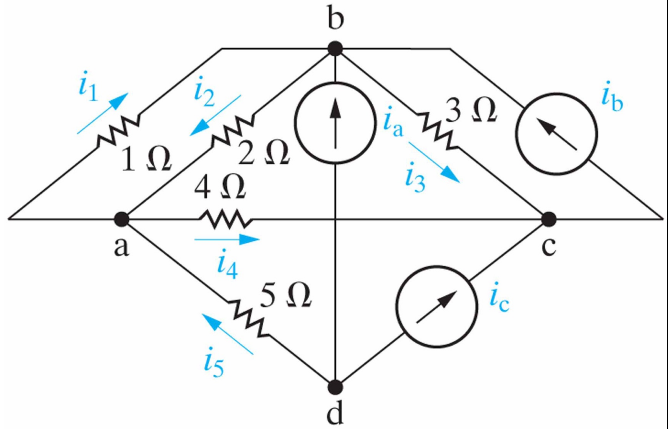
Sum the currents at each node in the circuit.



Solution

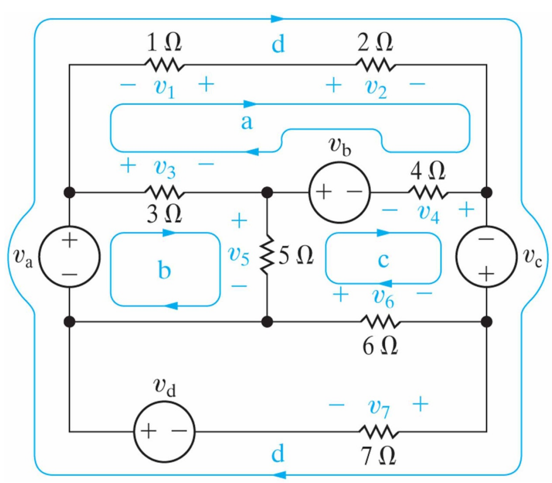
a: $-i_2-i_5+i_1+i_4=0$
b: $i_2+i_3-i_1-i_a-i_b=0$
c: $i_b-i_3-i_c-i_4=0$
d: $i_5+i_a+i_c=0$

leaving = positive



Activity 5

Sum the voltage around each designated path in the circuit.



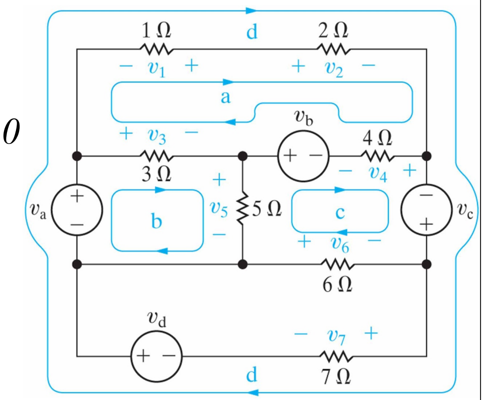
Solution

a: $-v_1 + v_2 + v_4 - v_b - v_3 = 0$

b: $v_3 + v_5 - v_a = 0$

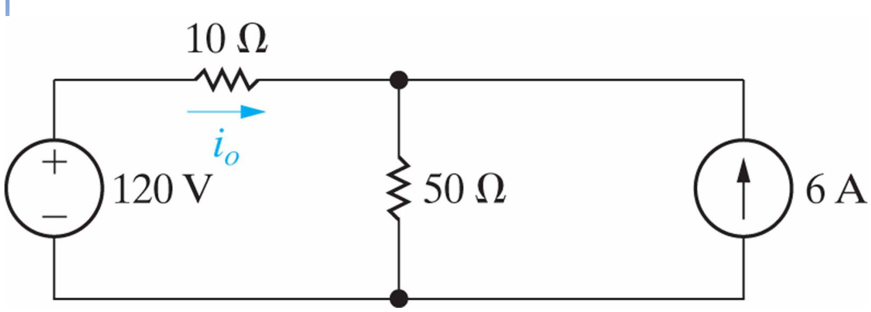
c: $v_b - v_4 - v_c - v_6 - v_5 = 0$

d: $-v_a - v_1 + v_2 - v_c + v_7 - v_d = 0$



Activity 6

Use Kirchhoff's Law and Ohm's Law to find i_0 in the circuit.



Solution

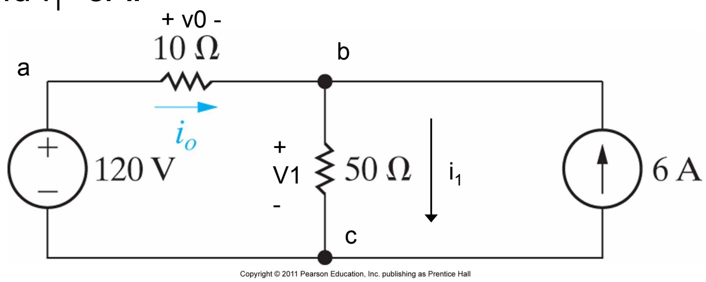
Applying KCL to node b: i_1-i_0-6=0 → $\boxed{-i_0+i_1=6}$

Applying KVL to loop "abca",

v_0+v_1-120=0 → $\boxed{10i_0+50i_1=120}$

Based on two equations, we can solve i_0 and i_1

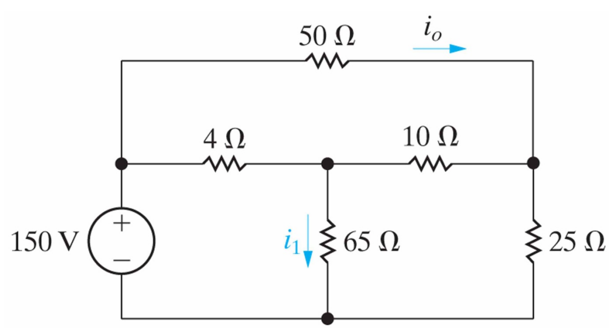
i_0=-3A and i_1=3A.



Activity 7

(1) If i_0=1A, find i_1

(2) Find the power dissipated in every register



Solution

(1) Given i_0=1A, we have:

v_2=150-50*1=100V (KVL, acda)

$i_2=v_2/25$=4A (Ohm's Law, OL)

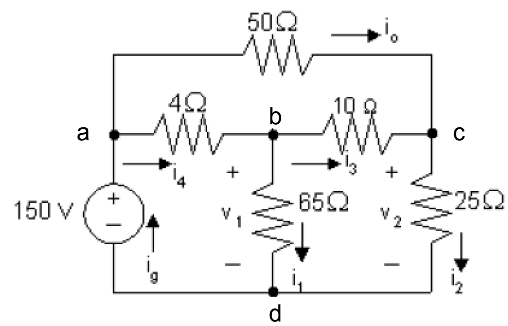
$i_3+1=i_2$, i_3=3A (KCL, c)

$v_1=10*i_3+25*i_2$=130V (KVL, bcdb)

$i_1=v_1/65$=2A (OL)

$i_4=i_1+i_3$=5A (KCL, b)

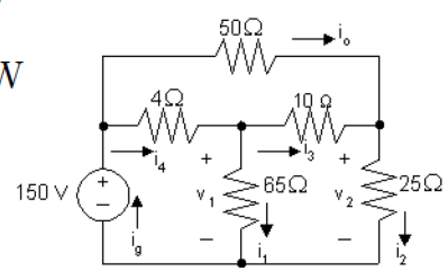
$i_g=i_4+i_0$=6A (KCL, a)



Solution

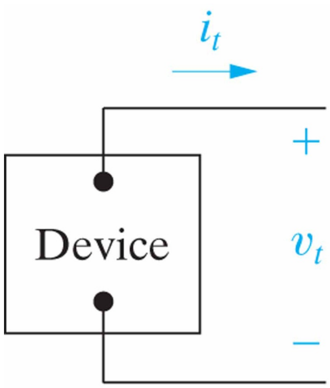
(2) i_0=1A, i_1=2A, i_2=4A, i_3=3A, i_4=5A

$$
\begin{aligned}
p_{4\Omega} &= 5^2(4) = 100 \text{ W} \\
p_{50\Omega} &= 1^2(50) = 50 \text{ W} \\
p_{65\Omega} &= 2^2(65) = 260 \text{ W} \\
p_{10\Omega} &= 3^2(10) = 90 \text{ W} \\
p_{25\Omega} &= 4^2(25) = 400 \text{ W}
\end{aligned}
$$



Activity 8

Construct a circuit model for a device



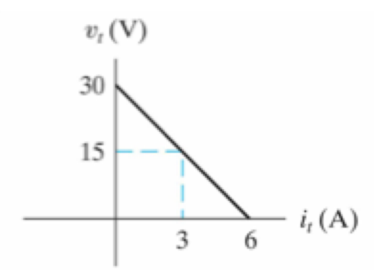
(a)

v_t (V)	i_t (A)
30	0
15	3
0	6

(b)

Solution

Based on the V-I relation in Table, we can plot the voltage as a function of the current.



v_t (V)	i_t (A)
30	0
15	3
0	6

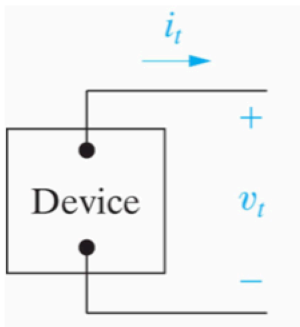
From the plot, we have: v_t=30-5i_t

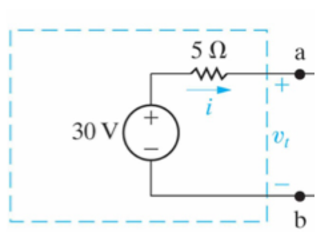
Solution

Given: v_t=30-5i_t → a KVL equation in a loop

30 → independent voltage source

5i_t → a current passes through a 5Ω resistor

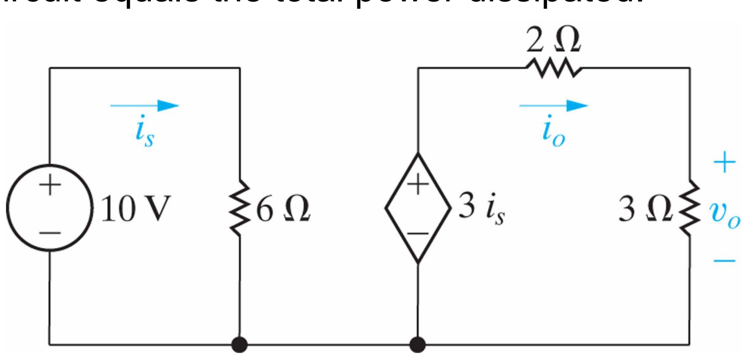




Activity 9

(a) Use Kirchhoff's Law and Ohm's Law to find the voltage v_0.

(b) Show that the solution is consistent with the constraint that the total power developed in the circuit equals the total power dissipated.



Solution

(a) There are two loops in the circuit.

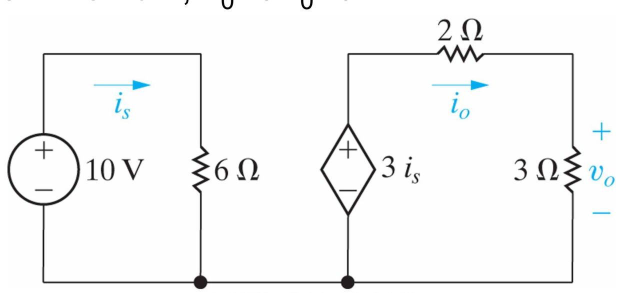
KVL for left part: $10=6i_s$

KVL for right part: $3i_s=2i_0+3i_0$

Solve two equations, we have:

$i_s=1.67$ and $i_0=1A$

Applying Ohm's Law, $v_0=3*i_0=3V$



Solution

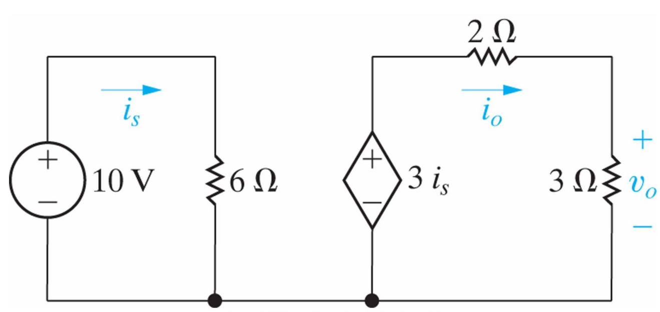
(b) $p_{10V}=-10*1.67=-16.7W$

$p_{ds}=3i_s*(-i_0)=-5W$

$p_6=1.67^2*6=16.7W$, $p_2=1^2*2=2W$, $p_3=1^2*3=3W$

$P_{total}=-16.7-5+16.7+2+3=0W$

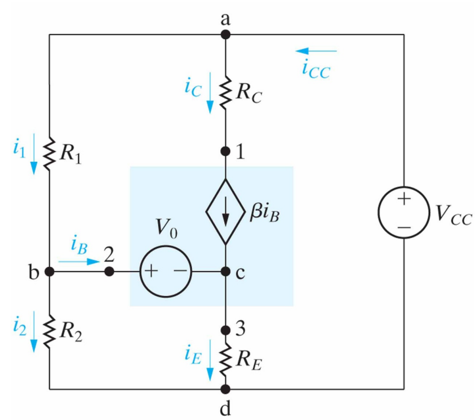
So the power is balanced.



Activity 10

The circuit represents a common configuration encountered in the analysis and design of transistor amplifiers. Assume that the values of R_1, R_2, R_C, R_E, V_{cc} and V_0 are known.

Find i_B in terms of the circuit element values.



Solution

Apply KCL to nodes a, b, c, and 1, we have:

(1) $i_1 + i_C - i_{CC} = 0$

(2) $i_B + i_2 - i_1 = 0$

(3) $i_E - i_B - i_C = 0$

(4) $i_C = \beta i_B$

Apply KVL to 2 loops bcdb and badb, we have:

(5) $V_0 + i_E R_E - i_2 R_2 = 0$

(6) $-i_1 R_1 + V_{CC} - i_2 R_2 = 0$

Solution

Solve Eq.(6) for i_1 and substitute i_1 into Eq. (2)

$$i_1 = \frac{V_{CC} - i_2 R_2}{R_1}$$

$$\frac{V_{CC} - i_2 R_2}{R_1} = i_B + i_2 \Rightarrow i_2 = \frac{V_{CC} - i_B R_1}{R_1 + R_2}$$

Substitute i_2 to Eq.(5), solve for i_E

$$\frac{V_0 + i_E R_E}{R_2} = \frac{V_{CC} - i_B R_1}{R_1 + R_2} \Rightarrow i_E = \left(\frac{\left(V_{CC} - i_B R_1\right) R_2}{\left(R_1 + R_2\right) R_E} - \frac{V_0}{R_E} \right)$$

Solution

Substitute i_E into Eq. (3), and use Eq.(4) to eliminate i_c in Eq.(3), we have:

$$\frac{\left(V_{CC} - i_B R_1\right) R_2}{\left(R_1 + R_2\right) R_E} - \frac{V_0}{R_E} = i_B (1 + \beta)$$

$$\therefore i_B = \frac{V_{CC} R_2 / \left(R_1 + R_2\right) - V_0}{R_1 R_2 / \left(R_1 + R_2\right) + \left(1 + \beta\right) R_E}$$