1. (15%) Find the charge q flowing through a device if the current i is:

a. $i(t) = 5\ (A), q(0) = 0$

$$q(t) = \int i(t)dt + q(0) = 5t\ (C)$$

b. $i(t) = (2t + 1)\ (\mu A), q(0) = 1\ (mC)$

$$q(t) = t^2 + t + 1000\ (\mu C)$$

c. $i(t) = 10 \cdot \cos(10t + \pi/6)\ (\mu A)\ , q(0) = 1\ (\mu C)$

$$q(t) = \sin(10t + \pi/6) + 0.5\ \ (\mu C)$$

2. (15%) Find the current i flowing through a device if the charge q is:

a. $q(t) = (3t + 8)$ (mC)

b. $q(t) = (e^{-3t} - 5e^{-5t})$ (nC)

c. $q(t) = 8 \cdot \sin(60\pi t)$ (pC)

a. $i = \frac{dq}{dt} = \frac{d(3t+8)}{dt} = 3\ (mA)$

b. $i = \frac{dq}{dt} = \frac{d(e^{-3t}-5e^{-5t})}{dt} = -3e^{-3t} + 25e^{-5t}(nA)$

b. $i = \frac{dq}{dt} = \frac{d\ 8\cdot\sin(60\pi t)}{dt} = 480\pi \cdot \cos(60\pi t)(pA)$

3. (10%) The charge q flowing in a wire is plotted in Fig 2. **Sketch** the corresponding current.

$$i = \frac{dq}{dt} = \begin{cases} 25\text{A}, & 0 < t < 2 \\ -25\text{A}, & 2 < t < 6 \\ 25\text{A}, & 6 < t < 8 \end{cases}$$

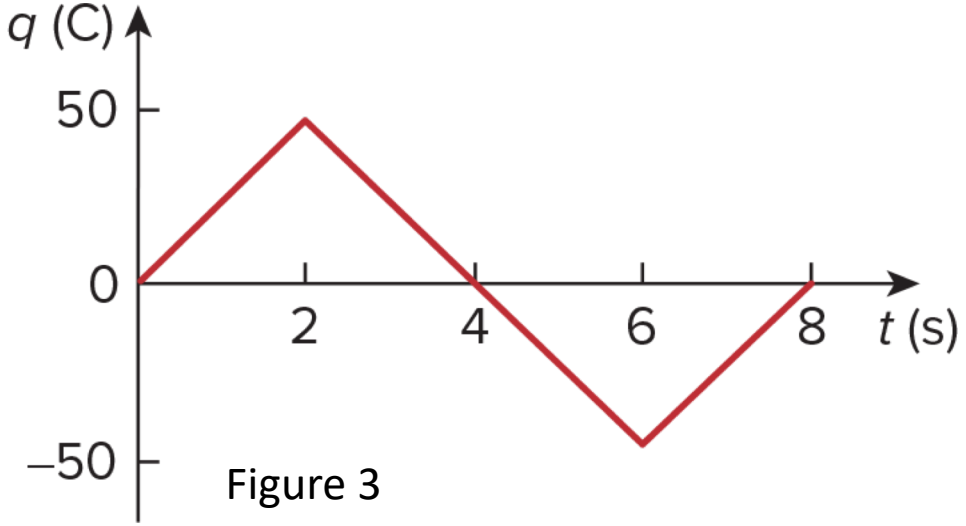
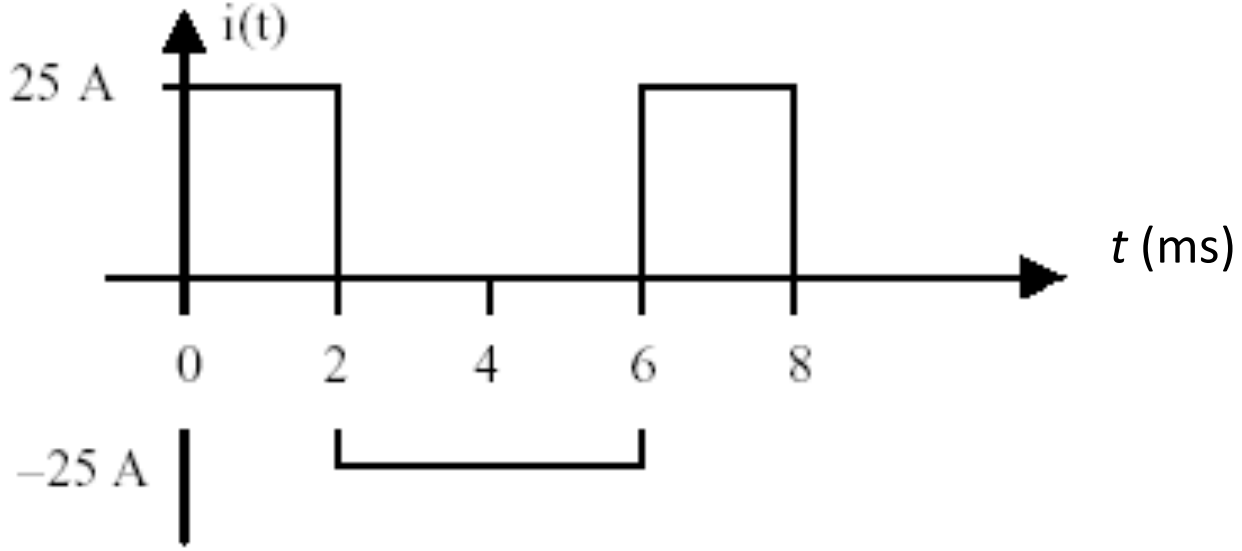


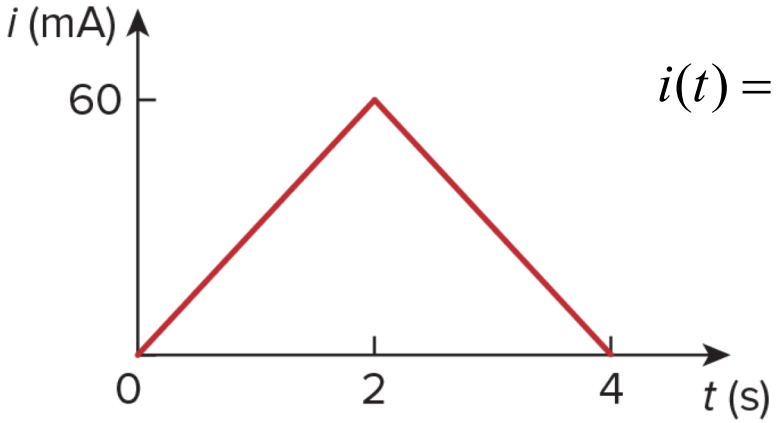
Figure 3



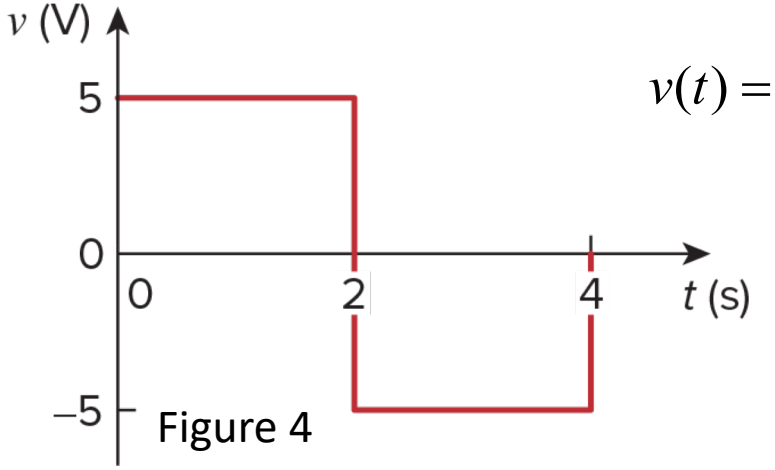
4. (25%) Figure 3 shows the current through and the voltage across an element.

(a) **(15%)** Derive the current ***i***(t), voltage ***v***(t), and power delivered to the element ***p***(t) as a function of time (t) in the interval of $0 < t < 4$ (s)

(b) **(10%)** Sketch the power ***p***(t) delivered to the element for $t > 0$.



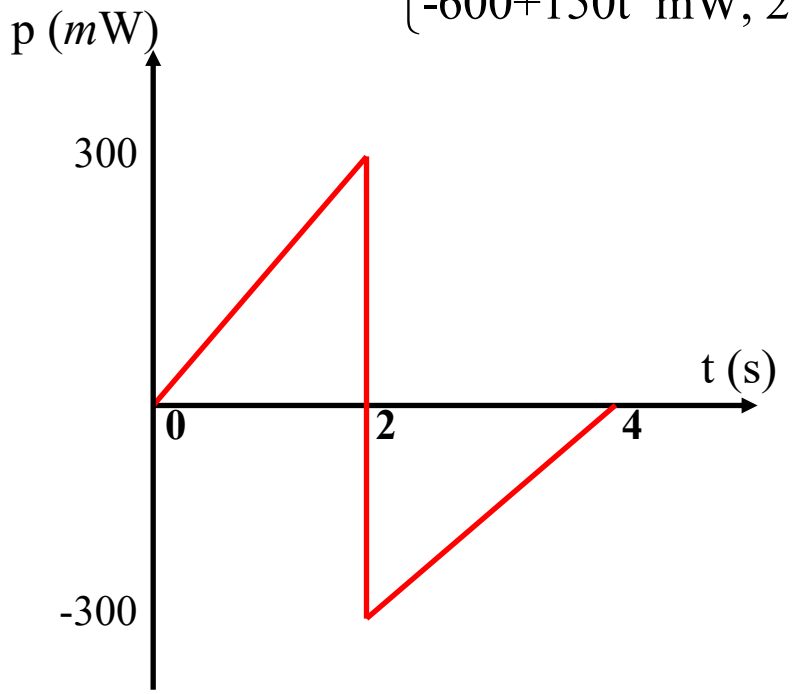
$$i(t) = \begin{cases} 30t \text{ mA}, & 0 < t < 2 \text{ (s)} \\ 120\text{-}30t \text{ mA}, & 2 < t < 4 \text{ (s)} \end{cases}$$



$$v(t) = \begin{cases} 5 \text{ V}, & 0 < t < 2 \text{ (s)} \\ -5 \text{ V}, & 2 < t < 4 \text{ (s)} \end{cases}$$

Figure 4

$$p(t) = \begin{cases} 150t \text{ mW}, & 0 < t < 2 \text{ (s)} \\ -600+150t \text{ mW}, & 2 < t < 4 \text{ (s)} \end{cases}$$



5. The current through an element is shown in Fig. 5. Determine the total charge that passed through the element at: (a) t =1 s ; (b) t = 3 s ; (c) t = 5 s

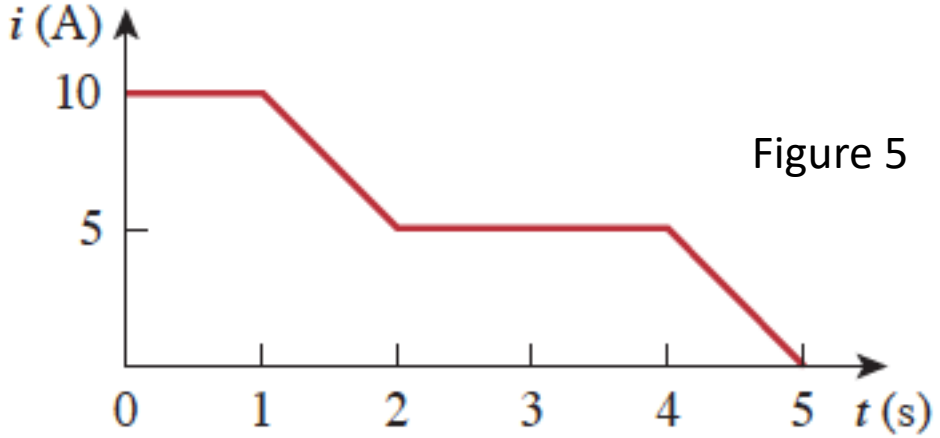


Figure 5

(a) t =1 s

$$\mathbf{q = \int idt = \int_0^1 10\,dt = \underline{10\ C}}$$

(b) t = 3 s

$$q = \int_0^3 idt = 10\times 1 + \left(10 - \frac{5\times 1}{2}\right) + 5\times 1$$

$$= 15 + 7.5 + 5 = \underline{22.5C}$$

(c) t = 5 s

$$\mathbf{q = \int_0^5 idt = 10 + 10 + 10 = \underline{30\ C}}$$

6. (25%) Find the power absorbed by each of the elements in Fig. 6.

$p_1 = 30\times(-10) =$ **-300 (W)**

$p_2 = 10\times(10) =$ **100 (W)**

$p_3 = 20\times(14) =$ **280 (W)**

$p_4 = 8\times(-4) =$ **-32 (W)**

$p_5 = 12\times(-4) =$ **-48 (W)**

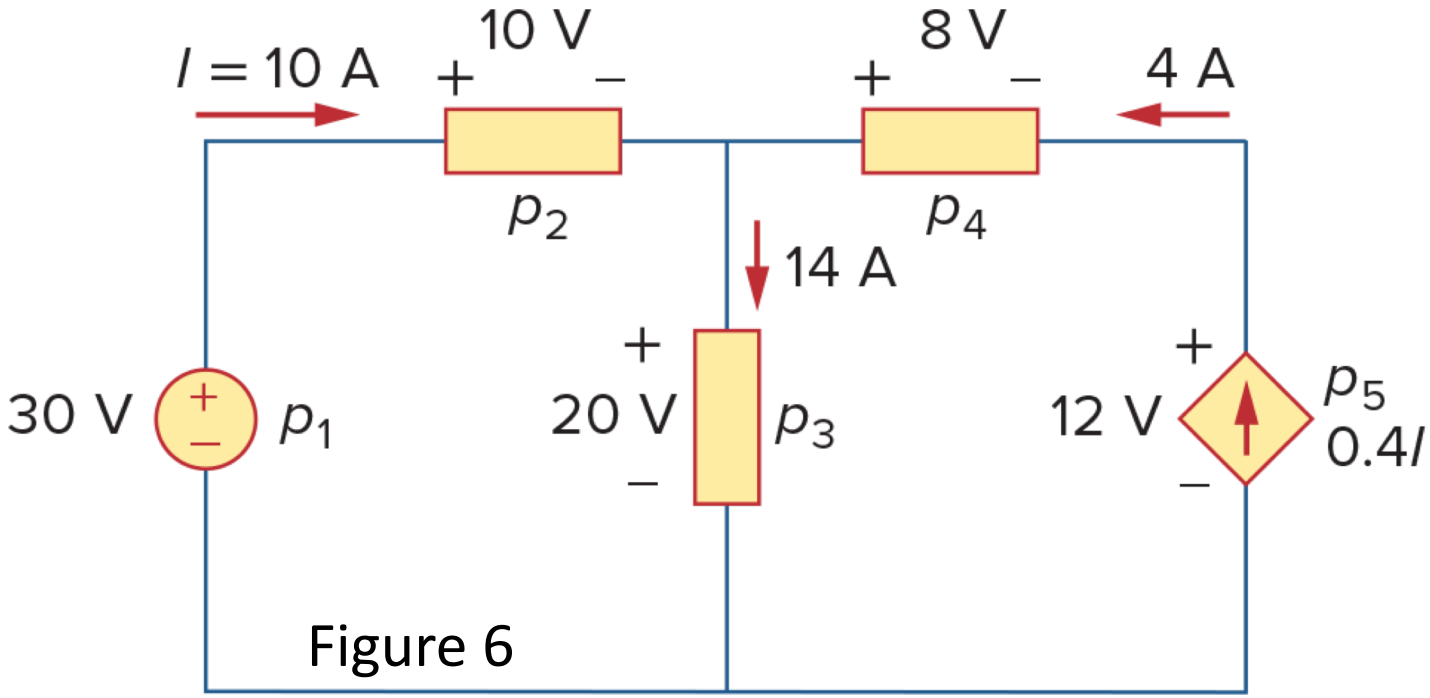


Figure 6

7. Find Vo and the power absorbed by each element in the circuit of Fig. 7.

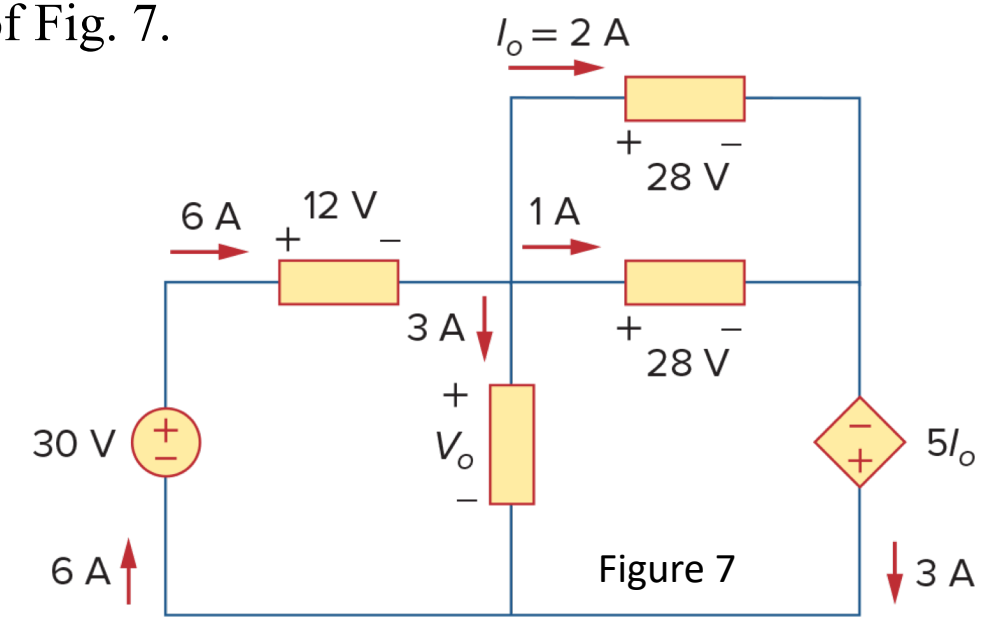


Figure 7

$p_{30 \text{ volt source}} = 30x(-6) = \mathbf{-180\ W}$

$p_{12 \text{ volt element}} = 12x6 = \mathbf{72\ W}$

$p_{28 \text{ volt e.ement with 2 amps flowing through it}} = 28x2 = \mathbf{56\ W}$

$p_{28 \text{ volt element with 1 amp flowing through it}} = 28x1 = \mathbf{28\ W}$

$p_{\text{the 5Io dependent source}} = 5x2x(-3) = \mathbf{-30\ W}$

Since the total power absorbed by all the elements in the circuit must equal zero,
or $0 = -180 + 72 + 56 + 28 - 30 + p_{\text{into the element with Vo}}$ or

$p_{\text{into the element with Vo}} = 180-72-56-28+30 = \mathbf{54\ W}$

Since $p_{\text{into the element with Vo}} = V_o x3 = 54$ W or $V_o = \mathbf{18\ V}$.