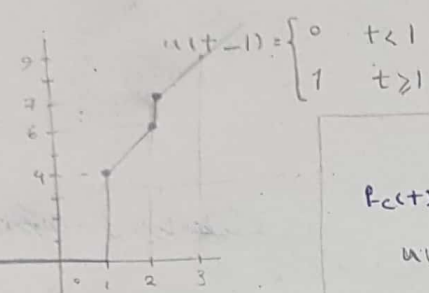


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2. شکل موج ها را رسم کنید.

$f_a(t) = u(t-2) + 2(t+1)u(t-1)$   
 $u(t-2) = \begin{cases} 0 & t < 2 \\ 1 & t \geq 2 \end{cases}$

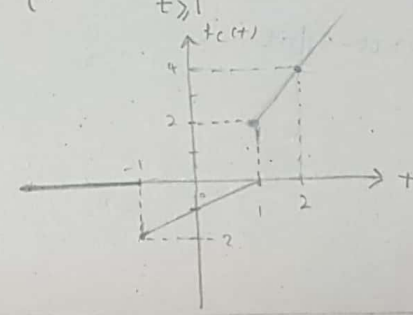
$r(t-k) = \begin{cases} t-k & t > k \\ 0 & t \leq k \end{cases}$   
 $\Rightarrow f_a(t) = \begin{cases} 0 & t < 1 \\ 0+2t+2 & 1 \leq t < 2 \\ 1+2t+2 & t \geq 2 \end{cases}$   
 $2(t+1)u(t-1) = \begin{cases} 0 & t < 1 \\ 2t+2 & t \geq 1 \end{cases}$



$(t+1-2)u(t+1) + (t-1+2)u(t-1) = r(t+1) - 2u(t+1) + r(t-1) + 2u(t-1)$   
 $f_c(t) = (t-1)u(t+1) + (t+1)u(t-1)$

$u(t+1) = \begin{cases} 0 & t < -1 \\ 1 & t \geq -1 \end{cases} \Rightarrow (t-1)u(t+1) = \begin{cases} 0 & t < -1 \\ t-1 & t \geq -1 \end{cases}$   
 $u(t-1) = \begin{cases} 0 & t < 1 \\ 1 & t \geq 1 \end{cases} \Rightarrow (t+1)u(t-1) = \begin{cases} 0 & t < 1 \\ t+1 & t \geq 1 \end{cases}$

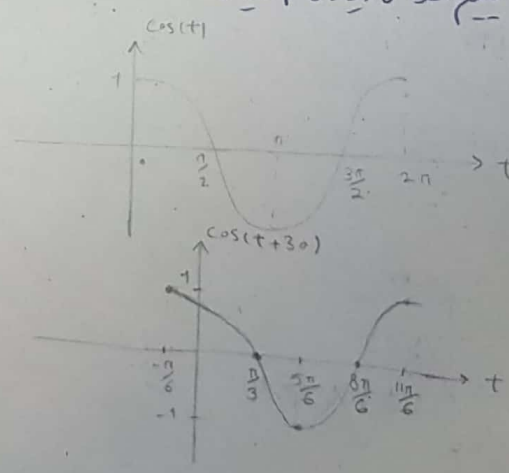
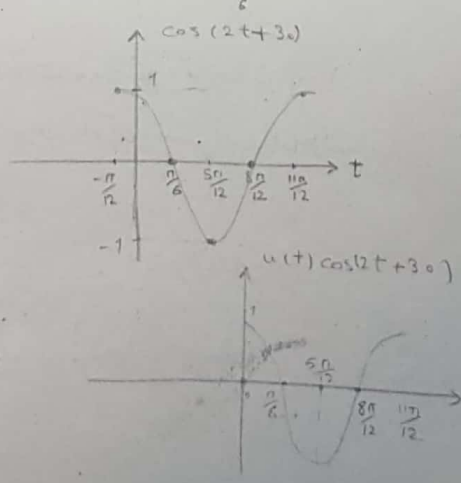
$f_c(t) = \begin{cases} 0 & t < -1 \\ \frac{t-1+0}{t-1} & -1 \leq t < 1 \\ \frac{t-1+t+1}{2t} & t \geq 1 \end{cases}$



3. شکل موج ها را تعیین کرده و زیر بار رسم کنید.

$u(t) \cos(2t+30^\circ) = \begin{cases} 0 & t < 0 \\ \cos(2t+30^\circ) & t \geq 0 \end{cases}$   
 ①  $f_1(t) = \cos(t + \frac{\pi}{6})$   
 $f(t) = f_1(2t)$

②  $f_1(t) = \cos(2t)$   
 $f(t) = f_1(t + \frac{\pi}{12})$

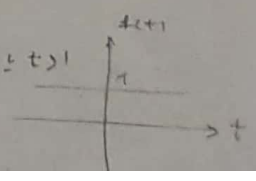


$u(1-t^2) + u(t^2-1)$   
 $1-t^2 > 0 \Rightarrow t^2 < 1 \Rightarrow -1 < t < 1$

$t^2-1 > 0 \Rightarrow t^2 > 1 \Rightarrow t > 1 \text{ or } t < -1$

$u(1-t^2) = \begin{cases} 0 & t > 1 \text{ or } t < -1 \\ 1 & -1 < t < 1 \end{cases}$   
 $u(t^2-1) = \begin{cases} 0 & -1 < t < 1 \\ 1 & t < -1 \text{ or } t > 1 \end{cases}$

$\Rightarrow \begin{cases} \frac{1}{1+t} & -1 < t < 1 \\ \frac{1}{1+t} & t < -1 \text{ or } t > 1 \end{cases}$



$$2u(t) - 4r(t-1) + 4r(t-2)$$

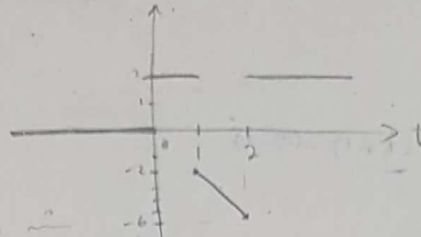
$\downarrow$   $\downarrow$   $\downarrow$   
 $t=0$   $t=1$   $t=2$

$$2u(t) = \begin{cases} 0 & t < 0 \\ 2 & t > 0 \end{cases}$$

$$-4r(t-1) = \begin{cases} 0 & t < 1 \\ -4t & t > 1 \end{cases}$$

$$4r(t-2) = \begin{cases} 0 & t < 2 \\ 4t & t > 2 \end{cases}$$

$$\Rightarrow \begin{cases} 0 & t < 0 \\ 2 & 0 < t < 1 \\ 2-4t & 1 < t < 2 \\ 2-4t+4t & t > 2 \end{cases}$$



$$f(t)\delta(t-k) = f(k)\delta(t-k)$$

5. حاصل انتگرال هار زیر را حساب کنید.

$$\text{مث) } \int_{-2}^4 (t^3+4)[\delta(t) + 4\delta(t-2)] dt = \int_{-2}^4 [(t^3+4)\delta(t) + 4(t^3+4)\delta(t-2)] dt = \int_{-2}^4 [4\delta(t) + 48\delta(t-2)] dt$$

$$= 4 \int_{-2}^4 \delta(t) dt + 48 \int_{-2}^4 \delta(t-2) dt = 4 + 48 = 52$$

$$\text{مث) } \int_{-3}^9 t^2 [\delta(t) + \delta(t+2.5) + \delta(t-5)] dt = \int_{-3}^9 [t^2\delta(t) + t^2\delta(t+2.5) + t^2\delta(t-5)] dt =$$

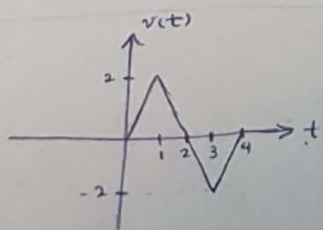
$$0 + (-2.5)^2 \int_{-3}^9 \delta(t+2.5) dt + 25 \int_{-3}^9 \delta(t-5) dt = 6.25$$

9. متق و متلازم تابع زیر را حساب کنید.

$$(1-te^{-t})u(t) \rightarrow (-e^{-t} + te^{-t})u(t) + (1-te^{-t})\delta(t)$$

$$\cos 2t u(t) \rightarrow -2\sin 2t u(t) + \cos 2t \delta(t)$$

$$e^{-t}u(t) \rightarrow -e^{-t}u(t) + e^{-t}\delta(t) = -e^{-t}u(t) + \delta(t)$$

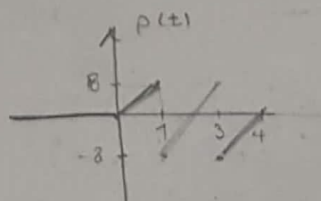


$$i = C \frac{dv(t)}{dt}$$

$$v_c(t) = 2r(t) - 4r(t-1) + 4r(t-3) - 2r(t-4)$$

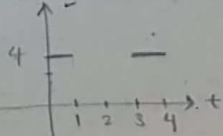
$$i_c(t) = 2[2u(t) - 4u(t-1) + 4u(t-3) - 2u(t-4)]$$

$$p(t) = v(t) \cdot i(t) = \begin{cases} 2t \times 4 & 0 < t < 1 \\ (-2t+4) \times 4 & 1 < t < 3 \\ (2t-8) \times 4 & 3 < t < 4 \\ 0 & t > 4 \end{cases}$$

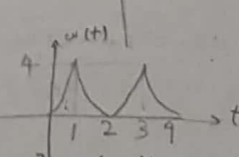
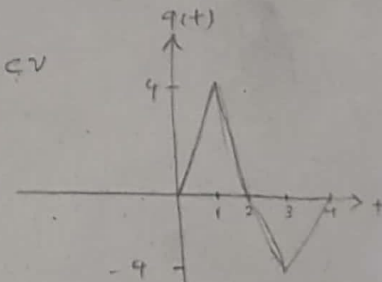


12. اگر شکل موج ولتژن داده شده در شکل زیر مشاهده کرد

اعمال شود، شکل موج جریا، بار، توان و انرژی بدست آورده را رسم کنید.



$$q = Cv$$



$$t < 0 \rightarrow w = 0, \quad 0 < t < 1 \rightarrow w(t) = \int_0^t 8t dt + w(0) = 4t^2 \Big|_0^t = 4t^2 \rightarrow w(1) = 4$$

$$1 < t < 3 \rightarrow w(t) = \int_1^t (8t-16) dt + w(1) = 4t^2 - 16t \Big|_1^t + 4 = 4t^2 - 16t - 4 + 16 + 4 = 4t^2 - 16t + 16 \rightarrow w(3) = 4$$

$$3 < t < 4 \rightarrow w(t) = \int_3^t (8t-32) dt + w(3) = 4t^2 - 32t + 4 \Big|_3^t = 4t^2 - 32t + 4 - 36 + 96 + 4 = 4t^2 - 32t + 69$$

$$t > 4 \rightarrow w(t) = 0$$

$$\Rightarrow -3 < i(t) < -2 \rightarrow \phi(t) = \frac{1}{4} i(t) - \frac{3}{2}$$

$$\Rightarrow \phi(t) = -\frac{3}{2}t + \frac{3}{2} - \frac{3}{2} = -\frac{3}{2}t \rightarrow v(t) = -\frac{3}{2}v$$

$$-6t + 6 = -3 \rightarrow t = \frac{3}{2} \Rightarrow \frac{4}{3} < t < \frac{3}{2}$$

$$-6t + 6 = -2 \rightarrow t = \frac{4}{3}$$

$$\Rightarrow -3 < i(t) < -2 \rightarrow \phi(t) = \frac{1}{4} i(t) - \frac{3}{2}$$

$$i(t) = 6t - 12$$

$$6t - 12 = -3 \rightarrow t = \frac{3}{2} = \frac{3}{2} \Rightarrow \frac{3}{2} < t < \frac{5}{3} \Rightarrow \phi(t) = \frac{3}{2}t - 3 - \frac{3}{2} = \frac{3}{2}t - \frac{9}{2} \rightarrow v(t) = \frac{3}{2}v$$

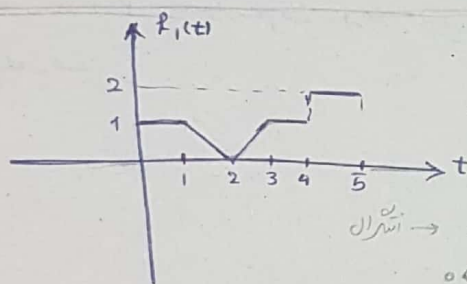
$$6t - 12 = -2 \rightarrow t = \frac{5}{3}$$

$$\Rightarrow -2 < i(t) < 0 \rightarrow \phi(t) = \frac{1}{4} i(t) - \frac{3}{2}$$

$$i(t) = 6t - 12$$

$$6t - 12 = -2 \rightarrow t = \frac{10}{6} = \frac{5}{3} \Rightarrow \frac{5}{3} < t < 2 \rightarrow \phi(t) = \frac{3}{2}t - \frac{9}{2} \rightarrow v(t) = \frac{3}{2}v$$

$$6t - 12 = 0 \rightarrow t = 2$$



6. شط معوج هار بر حسب توانع و سوره بایگ کنید. متق و استرکال آنها را یقین کنید.

$$f_1(t) = u(t) - r(t-1) + 2r(t-2) - r(t-3) + u(t-4) - 2u(t-5)$$

$$\frac{df_1(t)}{dt} = \delta(t) - u(t-1) + 2u(t-2) - u(t-3) + \delta(t-4) - 2\delta(t-5)$$

$$t < 0 \rightarrow F(t) = 0$$

$$0 < t < 1 \rightarrow \int_0^t 1 \times dt + F(0) = t \Big|_0^t = t, \quad 1 < t < 2 \rightarrow \int_1^t (1-t) dt + F(1) = t - \frac{1}{2}t^2 \Big|_1^t = t - \frac{1}{2}t^2 - 1 + \frac{1}{2} = t - \frac{1}{2}t^2 - \frac{1}{2}$$

$$2 < t < 3 \rightarrow \int_2^t (1-t+2t) dt + F(2) = t + \frac{1}{2}t^2 \Big|_2^t + \frac{1}{2} = t + \frac{1}{2}t^2 - 2 - 2 + \frac{1}{2} = \frac{1}{2}t^2 + t - \frac{7}{2}$$

$$F(3) = \frac{9}{2} + 3 - \frac{7}{2} = 4$$

$$F(2) = -2 + 2 + \frac{1}{2} = \frac{1}{2}$$

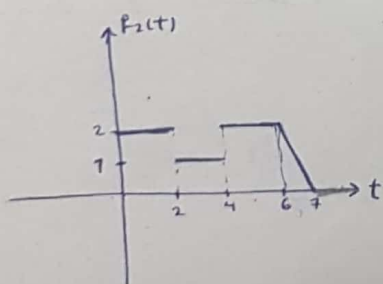
$$3 < t < 4 \rightarrow \int_3^t (1-t+2t-t) dt + F(3) = t \Big|_3^t + 4 = t - 3 + 4 = t + 1$$

$$F(4) = 5$$

$$4 < t < 5 \rightarrow \int_4^t (1-t+2t-t+1) dt + F(4) = 2t \Big|_4^t + 5 = 2t + 8 + 5 = 2t + 13$$

$$F(5) = 23$$

$$t > 5 \rightarrow \int_5^t (1-t+2t-t+1-2) dt + F(5) = 23$$



$$f_2(t) = 2u(t) - u(t-2) + u(t-4) - 2r(t-6) + 2r(t-7)$$

$$f_2'(t) = 2\delta(t) - \delta(t-2) + \delta(t-4) - 2u(t-6) + 2u(t-7)$$

$$t < 0 \rightarrow F(t) = 0$$

$$0 < t < 2 \rightarrow F(t) = \int_0^t 2 dt + F(0) = 2t \Big|_0^t = 2t \rightarrow F(2) = 4$$

$$2 < t < 4 \rightarrow F(t) = \int_2^t (2-1) dt + F(2) = t \Big|_2^t + 4 = t - 2 + 4 = t + 2 \rightarrow F(4) = 6$$

$$4 < t < 6 \rightarrow F(t) = \int_4^t (2-1+1) dt + F(4) = 2t \Big|_4^t + 6 = 2t - 8 + 6 = 2t - 2$$

$$\rightarrow F(6) = 10$$

$$6 < t < 7 \rightarrow F(t) = \int_6^t (2-1+1-2t) dt + F(6) = 2t - t^2 \Big|_6^t + 10 = 2t - t^2 - 12 + 36 + 10 = -t^2 + 2t + 34$$

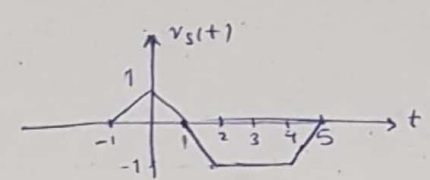
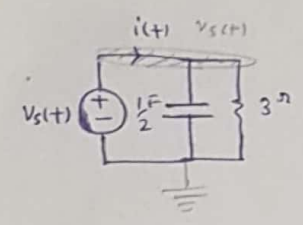
$$t > 7 \rightarrow F(t) = \int_7^t (2-1+1-2t+2t) dt + F(7) = -4t + 14 + 34 = -15$$

$$= 2t \Big|_7^t + (-1) = 2t - 14 - 1 = 2t - 15$$



and

در مدار معبر به نظر می آید، شکل موج  $i(t)$  را رسم کنید.



$$KCL @ v_s(t): -i(t) + \frac{1}{2} \frac{dv_s(t)}{dt} + \frac{v_s(t)}{3} = 0$$

$$\Rightarrow i(t) = \frac{1}{2} \frac{dv_s(t)}{dt} + \frac{v_s(t)}{3}$$

$$v_s(t) = \begin{cases} 0 & t < -1 \\ t+1 & -1 < t < 0 \\ -t+1 & 0 < t < 2 \\ -1 & 2 < t < 4 \\ t-5 & 4 < t < 5 \\ 0 & t > 5 \end{cases}$$

$$i(t) = \begin{cases} 0 & t < -1 \\ \frac{1}{2} + \frac{1}{3} + \frac{t}{3} & -1 < t < 0 \\ -\frac{1}{2} - \frac{t}{3} + \frac{1}{3} & 0 < t < 2 \\ 0 - \frac{1}{3} & 2 < t < 4 \\ \frac{1}{2} + \frac{t}{3} - \frac{5}{3} & 4 < t < 5 \\ 0 & t > 5 \end{cases}$$

27.  $i(t) = \begin{cases} 0 & t < 0 \\ 10te^{-5t} & t \geq 0 \end{cases}$  از یک سلف 100 اهمی هائی میگذرد.

سختی ها در  $i, P, V, w$  را رسم کنید. درجه های انرژی در سلف ذخیره می شود. درجه های انرژی از سلف خارج می شود؟ حداکثر انرژی ذخیره شده در سلف چیست؟

$$v_L = L \frac{di(t)}{dt} = \begin{cases} 0 & t < 0 \\ e^{-5t} - 5te^{-5t} & t \geq 0 \end{cases}$$

$$P = v_L(t) \cdot i(t) = \begin{cases} 0 & t < 0 \\ 10te^{-10t} - 50t^2e^{-10t} & t \geq 0 \end{cases}$$

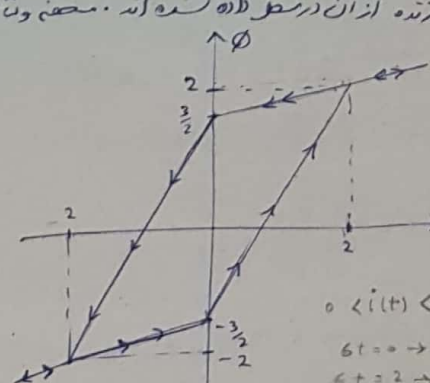
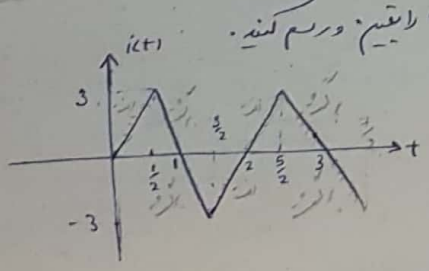
$$w = ? \quad t < 0 \rightarrow w = 0, \quad t \geq 0 \rightarrow w = \int_0^t (10te^{-10t} - 50t^2e^{-10t}) dt$$

$$u = t \rightarrow du = dt \\ dv = e^{-10t} dt \rightarrow v = -\frac{1}{10}e^{-10t} \\ \Rightarrow -0.1te^{-10t} - \int -0.1e^{-10t} dt = -0.1te^{-10t} - 0.01e^{-10t} - 0.01e^{-10t}$$

$$u = t^2 \rightarrow du = 2t dt \\ dv = e^{-10t} dt \rightarrow v = -0.1e^{-10t}$$

$$w = 10(-0.1te^{-10t} - 0.01e^{-10t}) - 50(-0.1t^2e^{-10t} - 0.01te^{-10t} - 0.001e^{-10t}) \\ = (-te^{-10t} - 0.1e^{-10t} + 5t^2e^{-10t} + 0.5te^{-10t} + 0.05e^{-10t}) = -0.5te^{-10t} - 0.05e^{-10t} + 5t^2e^{-10t}$$

28.  $i(t)$  یک سلف  $\phi(t)$  را گذرنده از آن در شکل داده شده اند. معده و تار  $v(t)$  را تعیین و رسم کنید.



$$i(t) = \begin{cases} 6t & 0 < t < \frac{1}{2} \\ -6t+6 & \frac{1}{2} < t < \frac{3}{2} \\ 6t-12 & \frac{3}{2} < t < \frac{5}{2} \\ -6t+18 & \frac{5}{2} < t < \frac{7}{2} \end{cases}$$

$$0 < i(t) < 2 \Rightarrow 0 < t < \frac{1}{3} \Rightarrow \phi(t) = \frac{7}{4}i(t) - \frac{3}{2} \\ 6t = 0 \rightarrow t = 0 \quad i(t) = 6t \Rightarrow \frac{2(1t) - 3}{2} \Rightarrow v(t) = \frac{2}{1}v \\ 6t = 2 \rightarrow t = \frac{1}{3}$$

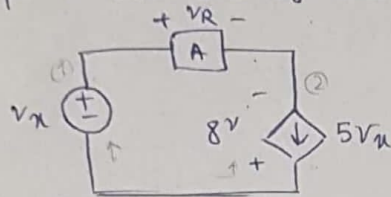
$$2 < i(t) < 3 \Rightarrow 6t + 2 \rightarrow t = \frac{1}{3} \\ 6t = 3 \rightarrow t = \frac{1}{2}$$

$$\Rightarrow \frac{1}{3} < t < \frac{1}{2} \Rightarrow \phi(t) = \frac{1}{4}i(t) + \frac{3}{2} \Rightarrow \phi(t) = \frac{3}{2}t + \frac{3}{2} \\ i(t) = 6t \quad \Rightarrow v(t) = \frac{3}{2}$$

$$\text{برگشت} \Rightarrow 3 < i(t) < 2 \Rightarrow \frac{1}{2} < t < \frac{3}{2} \Rightarrow \phi(t) = \frac{1}{4}i(t) + \frac{3}{2} \\ -6t+6 = 3 \rightarrow t = \frac{1}{2} \quad i(t) = -6t+6 \\ -6t+6 = 2 \rightarrow t = \frac{2}{3} \quad \Rightarrow \phi(t) = -\frac{3}{2}t + 3$$

$$\text{برگشت} \Rightarrow -2 < i(t) < 0 \Rightarrow -6t+6 < 0 \Rightarrow t > 1 \\ -6t+6 = -2 \Rightarrow t = \frac{4}{3} \quad i(t) = -6t+6 \\ -6t+6 = 0 \Rightarrow t = 1 \quad \Rightarrow \phi(t) = \frac{3}{2}t + \frac{1}{2} \Rightarrow v(t) = \frac{3}{2}$$

33. Refer to the circuit represented in Fig. 2.33 while noting that the same current  $i_x$  flows through each element. The voltage-controlled dependent source provides a current which is 5 times as large as the voltage  $v_R$ . (a) For  $v_R = 1.0\text{V}$  and  $v_x = 2\text{V}$ , determine the power absorbed by each element. (b) Is element A likely a passive or active source? Explain.



$$v_x = 2\text{V}$$

$$v_R = 1.0\text{V}$$

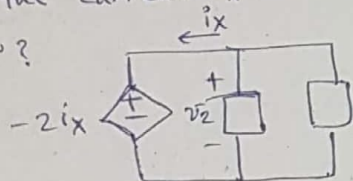
$$\rightarrow i = 5v_R = 1.0\text{A}$$

$$P_A = 1.0\text{V} \times 1.0\text{A} = 1.0\text{W} > 0 \text{ passive}$$

$$P_1 = 2\text{V} \times (1.0\text{A}) = 2.0\text{W} < 0 \text{ active}$$

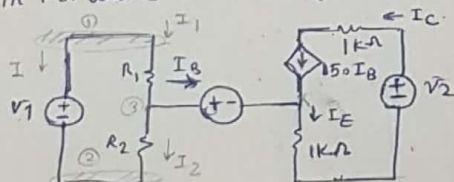
$$P_2 = 8\text{V} \times (-1.0\text{A}) = -8.0\text{W} < 0 \text{ active}$$

37. The dependent source in the circuit of Fig. 2.35 provides a voltage whose value depends on the current  $i_x$ , what value of  $i_x$  is required for the dependent source to be supplying  $1\text{W}$ ?



$$p = v \cdot i(t) \rightarrow -1\text{W} = i_x \times (-2i_x) \rightarrow 1 = 2i_x^2 \rightarrow i_x^2 = \frac{1}{2} \rightarrow i_x = \pm \frac{1}{\sqrt{2}}$$

12. For the circuit of Fig. 3.54 (which is a model for the dc operation of a bipolar junction transistor biased in forward active region),  $I_B$  is measured to be  $100\mu\text{A}$ . Determine  $I_C$  and  $I_E$ .



$$\text{KCL} \text{ @ } I: I + I_1 = 0 \rightarrow I = -I_1$$

$$\text{KCL} \text{ @ } I_2: -I - I_2 = 0 \rightarrow I = -I_2$$

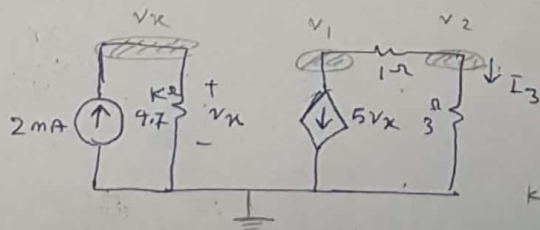
$$\text{KCL} \text{ @ } I_3: -I_1 + I_2 + I_B = 0 \rightarrow I_B = 0$$

$$I_C = I_E = 15 \cdot I_B$$

$$\text{KCL: } -I_C - I_B + I_E = 0 \Rightarrow I_E = I_C + I_B = 15I_B + I_B = 16I_B = 16 \times 100\mu\text{A} = 1.6\text{mA}$$

$$I_C = I_E = 1.6\text{mA}$$

13. Determine the current labeled  $I_3$  in the circuit of Fig. 3.55.



$$\text{KCL @ } v_x: -2\text{mA} + \frac{v_x}{4.7\text{k}\Omega} = 0$$

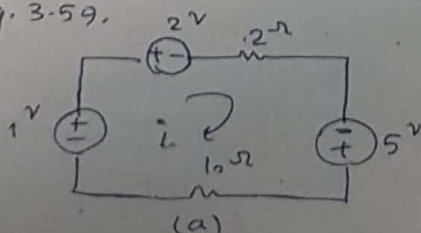
$$\Rightarrow v_x = 2\text{mA} \times 4.7\text{k}\Omega = 9.4\text{V}$$

$$\text{KCL @ } v_1: +5v_x + \frac{v_1 - v_2}{1} + I_3 = 0$$

$$\text{KCL @ } v_2: I_3 + \frac{v_2 - v_1}{1} = 0 \rightarrow \frac{v_1 - v_2}{1} = I_3$$

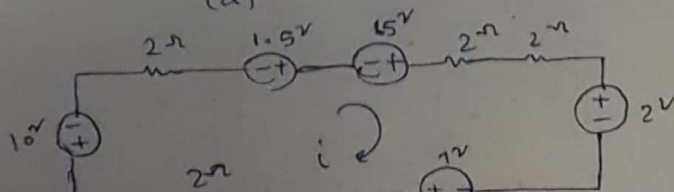
$$\Rightarrow 2I_3 = -5v_x \rightarrow I_3 = -\frac{5}{2} \times 9.4 = -23.5\text{A}$$

18. Use KVL to obtain a numerical value for the current labeled  $i$  in each circuit depicted in Fig. 3.59.



$$\text{KVL: } -1\text{V} + 2\text{V} + 2i - 5\text{V} + 10i = 0$$

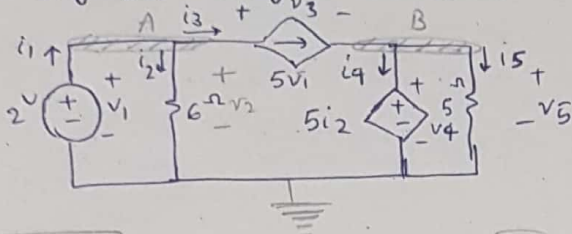
$$12i = 4 \rightarrow i = \frac{1}{3}\text{A}$$



$$+10\text{V} + 2i - 1.5\text{V} - 5\text{V} + 2i + 2i + 2\text{V} - 7\text{V} + 2i = 0$$

$$8i = -8 \rightarrow i = -1\text{A}$$

23. (a) Determine a numerical value for each current and voltage ( $i_1, v_1$ , etc) the circuit of Fig. 3.63. (b) calculate the power absorbed by each element and verify that they sum to zero.



$$\text{KCL @ A: } -i_1 + i_2 + i_3 = 0$$

$$\frac{i_3 = 5v_1 = 10}{v_1 = 2V} \rightarrow -i_1 + i_2 + 10 = 0 \rightarrow i_1 - i_2 = 10$$

$$\text{KCL @ B: } -i_3 + i_4 + i_5 = 0$$

$$i_4 + i_5 = 10$$

$$\rightarrow i_1 = 10 + \frac{1}{3} = \frac{31}{3} \text{ A}$$

$$v_1 = 2V$$

$$v_1 = v_2 = 2V$$

$$v_4 = 5i_2 = \frac{5}{3}V$$

$$v_5 = v_4 = 5i_2 = \frac{5}{3}V$$

$$v_3 = v_1 - v_4 = 2 - \frac{5}{3} = \frac{1}{3}V$$

$$P = v \cdot i$$

$$P_1 = 2 \times \frac{31}{3} = -\frac{62}{3} \rightarrow -\frac{124}{6}$$

$$P_2 = 2 \times \frac{1}{3} = \frac{2}{3}$$

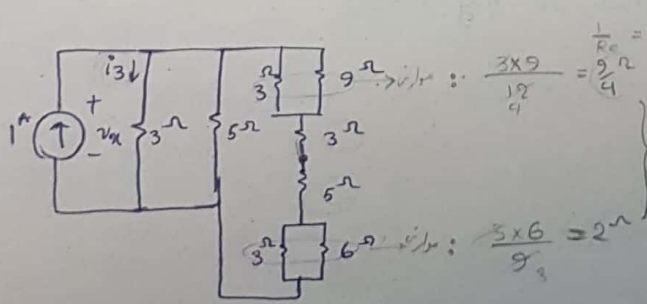
$$P_3 = \frac{1}{3} \times 10 = \frac{10}{3}$$

$$P_4 = \frac{5}{3} \times \frac{29}{3} = \frac{145}{9}$$

$$P_5 = \frac{5}{3} \times \frac{1}{3} = \frac{5}{9}$$

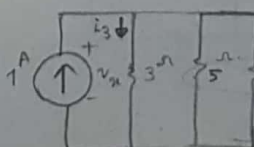
$$\Rightarrow \sum_{n=1}^5 P_n = 0$$

46. making appropriate use of resistor combination techniques, calculate  $i_3$  in the circuit of Fig. 3.84 and the power provided to the circuit by the single current source.

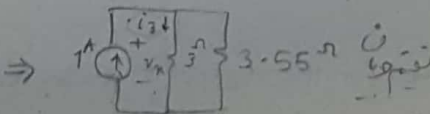


$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} \rightarrow R_e = \frac{R_1 R_2}{R_1 + R_2}$$

$$R_e = \frac{9 \times 3}{9 + 3} = \frac{27}{12} = \frac{9}{4} \Omega$$



$$i_3 = \frac{3.55}{3.55 + 3} \times 1A = 0.54A$$



$$i_3 = \frac{3.55}{3.55 + 3} \times 1A = 0.54A$$

$$P = (-1A) \times 1.62V = -1.62W < 0$$