FALL 22

(1) for the node with v_1 voltage:

$$\frac{80-v_1}{20} = \frac{v_1-v_2}{30} + \frac{v_1-v_x}{30} = \frac{2v_1-v_2-v_x}{30}$$

$$\Rightarrow 2400 - 30v_1 = 40v_1 - 20v_2 - 20v_x$$

$$\Rightarrow 70v_1 - 20v_2 - 20v_x = 2400 \quad \text{——— (I)}$$

for the node with v_2 voltage:

$$\frac{v_x-v_2}{30} + \frac{v_1-v_2}{30} = \frac{v_2-(-80)}{20}$$

$$\Rightarrow \frac{v_1-2v_2+v_x}{30} = \frac{v_2+80}{20}$$

$$\Rightarrow 20v_1 - 40v_2 + 20v_x = 30v_2 + 2400$$

$$\Rightarrow 20v_1 - 70v_2 + 20v_x = 2400 \quad \text{——— (II)}$$

for the node x:

$$\frac{v_1-v_x}{30} = \frac{v_x}{20} + \frac{v_x-v_2}{30} = \frac{3v_x+2v_x-2v_2}{60} = \frac{5v_x-2v_2}{60}$$

$$\Rightarrow 2v_1 - 2v_x = 5v_x - 2v_2$$

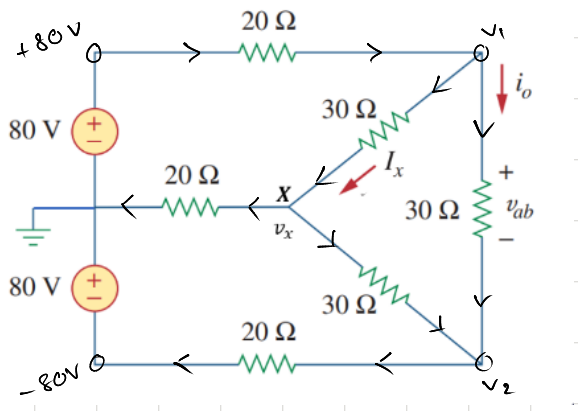
$$\Rightarrow 2v_1 + 2v_2 - 7v_x = 0$$

solving (I), (II) and (III)

$$v_1 = 26.67$$

$$v_2 = -26.67$$

$$v_x = 0$$



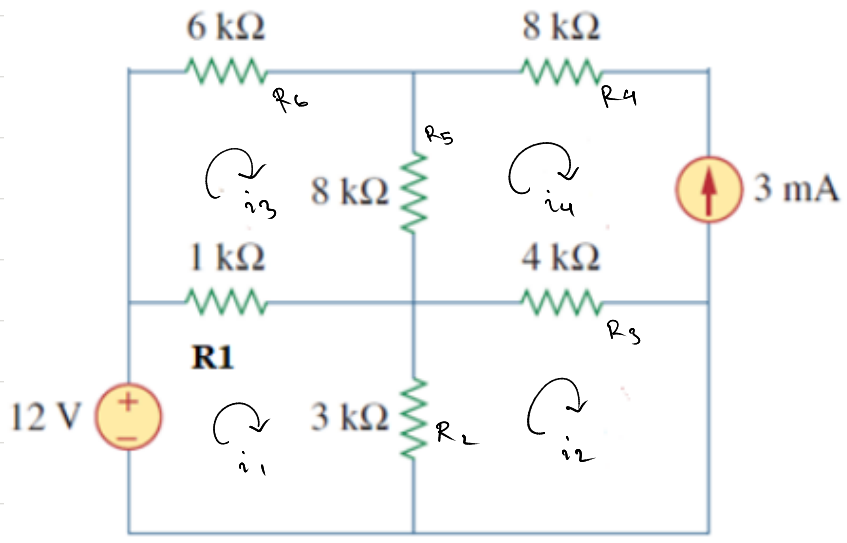
$$v_{ab} = v_1 - v_2 = 26.67 + 26.67 = 53.34\ V$$

$$i_o = \frac{v_{ab}}{30} = 1.78\ A$$

$$I_x = \frac{v_1-v_x}{30} = \frac{26.67-0}{30} = 0.89\ A$$

$$v_x = 0$$

(2) a)



loop 1

$$(i_1 - i_3) + 3(i_1 - i_2) - 12 = 0$$

$$\Rightarrow i_1 - i_3 + 3i_1 - 3i_2 - 12 = 0$$

$$\Rightarrow 4i_1 - 3i_2 - i_3 - 12 = 0 \quad \text{— (i)}$$

loop 2

$$3(i_2 - i_1) + 4(i_2 - i_4) = 0$$

$$\Rightarrow 3i_2 - 3i_1 + 4i_2 - 4i_4 = 0$$

$$\Rightarrow -3i_1 + 7i_2 + 12 = 0 \quad \text{— (ii)}$$

loop 3

$$6i_3 + 8(i_3 - i_4) + (i_3 - i_1) = 0$$

$$\Rightarrow 6i_3 + 8i_3 - 8i_4 + i_3 - i_1 = 0$$

$$\Rightarrow -i_1 + 15i_3 + 24 = 0 \quad \text{— (iii)}$$

loop 4

$$i_4 = -3 \text{ mA}$$

solving (i), (ii) and (iii)

$i_1 = 1.9856$ mA

$i_2 = -0.86$ mA

$i_3 = -1.467$ mA

current through $R_1 = i_1 - i_3 = 3.45$ mA

" " $R_2 = i_1 - i_2 = 2.84$ mA

" " $R_3 = i_2 - i_4 = 2.14$ mA

" " $R_4 = 3$ mA

" " $R_5 = i_4 - i_3 = -1.533$ mA

" " $R_6 = i_3 = -1.467$ mA

b) $P = i^2 R = (3.45 \text{ mA})^2 \times 1 \text{ k}\Omega$

$= 3.45^2 \times 10^{-6} \times 10^3$ W

$= 0.0119$ W

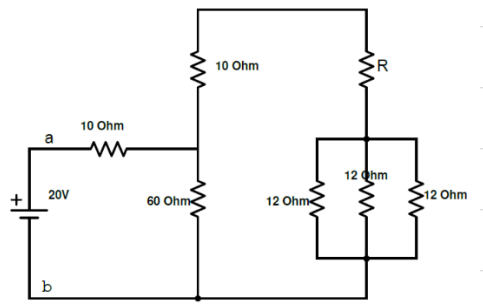
(3) a) $10 + 60 \| (R+14) = 50$

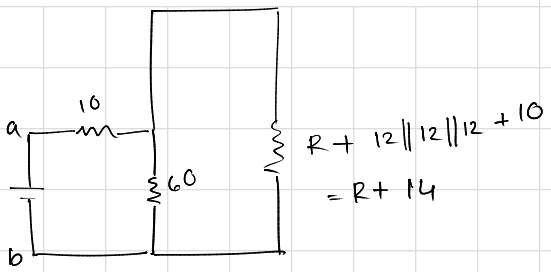
$\Rightarrow \left(60^{-1} + (R+14)^{-1}\right)^{-1} = 40$

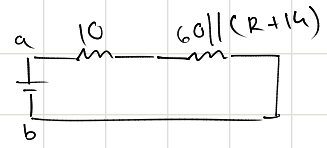
$\Rightarrow 60^{-1} + (R+14)^{-1} = 40^{-1}$

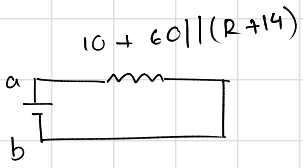
$\Rightarrow R + 14 = \left(40^{-1} - 60^{-1}\right)^{-1}$

$\Rightarrow R = \left(40^{-1} - 60^{-1}\right)^{-1} - 14 = 106\ \Omega$

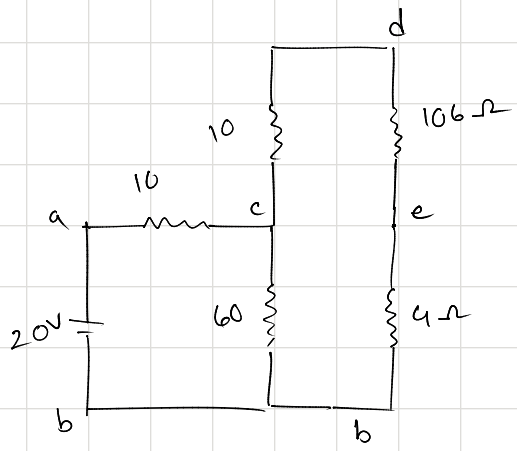








b)



$$v_{cb} = 20 \times \frac{60 \| (106+10+4)}{10 + 60 \| (106+10+4)} = 16\text{V}$$

$$v_{eb} = 16 \times \frac{4}{10+106+4} = 0.533\ \text{V}$$

$$i_{ab} = \frac{20}{50} = \frac{2}{5}\ A = i_{cb}$$

$$i_{cdeb} = \frac{2}{5} \times \frac{60}{60+120} = 0.133\ A$$

$$i_{eb} = 0.133\ A$$

$$i\ (12\ \Omega) = 0.133 \times \frac{12 \| 12}{12 + 12 \| 12} = 0.0443\ A$$

Summer 23

(1) i) $slope_{0,1} = \frac{-5}{1} = -5$

$slope_{1,2} = \frac{5}{1} = 5$

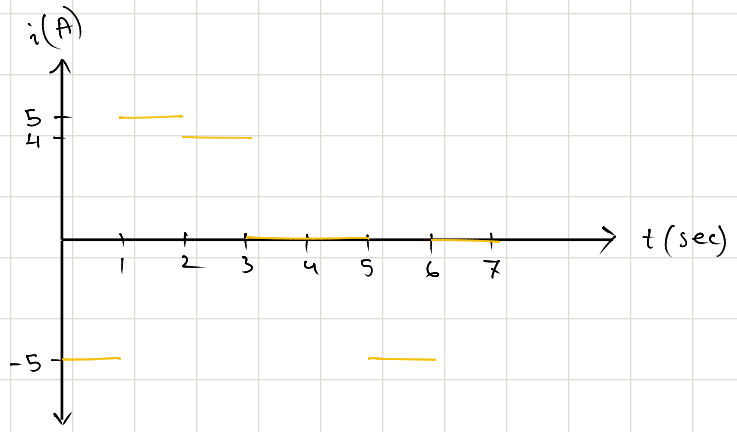
$slope_{2,3} = \frac{4}{1} = 4$

$slope_{3,4} = 0$

$slope_{4,5} = 0$

$slope_{5,6} = \frac{-5}{1} = -5$

$slope_{6,7} = 0$



$i(2.5) = 4\ A$

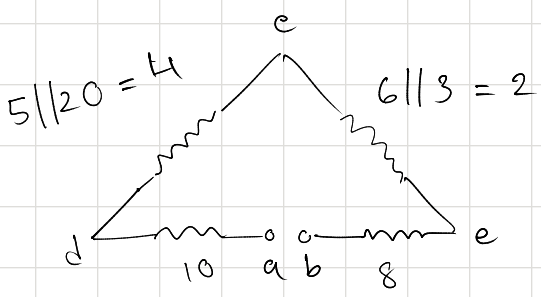
$i(5.5) = -5\ A$

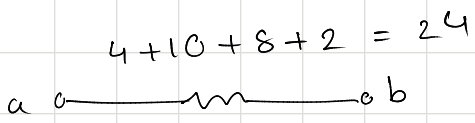
ii) $P = i^2R$ therefore p is maximum when i is maximum

In the graph $i_{max} = 5\ A$ from $t = 1s$ to $t = 2s$

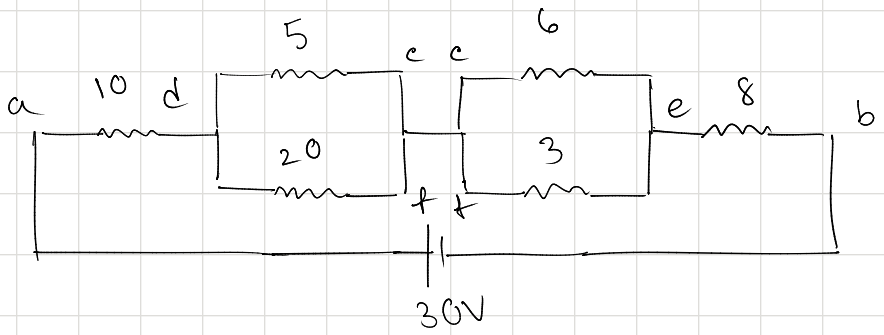
$\therefore p_{max} = 5^2 \times 20 = 500\ W$

(2) i) $eqv_{ab} = 24\ \Omega$





ii)

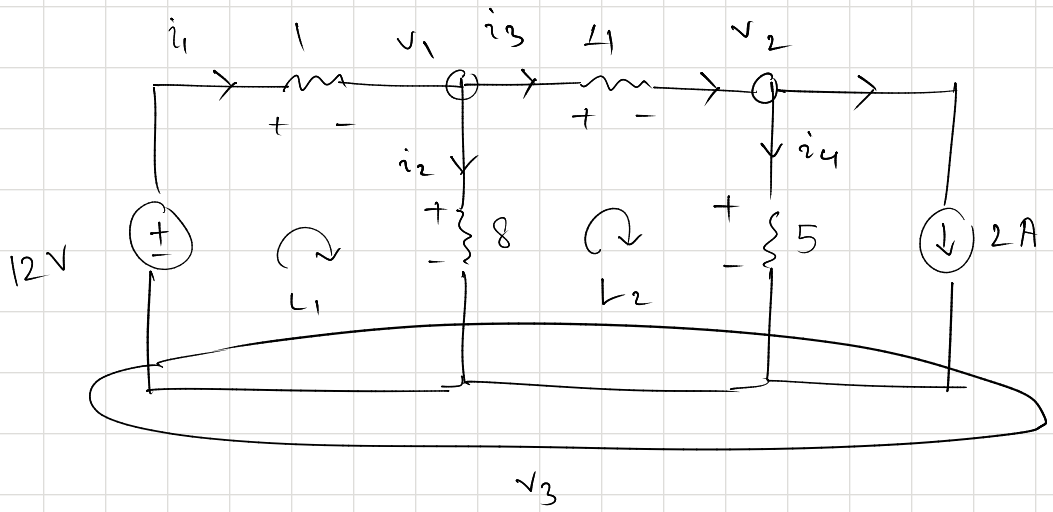


$i_{ab} = \frac{30}{24} = 1.25\ A$

$\therefore i_{eb} = 1.25A$

$i_{ce} = 1.25 \times \frac{3}{3+6} = 0.4167$

(3)



loop 1

$$i_1 + 8i_2 - 12 = 0$$

$$\Rightarrow i_2 + i_3 + 8i_2 - 12 = 0$$

$$\Rightarrow 9i_2 + i_3 - 12 = 0$$

loop 2

$$4i_3 + 5i_4 - 8i_2 = 0$$

$$\Rightarrow 4i_3 + 5i_3 - 10 - 8i_2 = 0 \quad [i_4 = i_3 - 2]$$

$$\Rightarrow -8i_2 + 9i_3 - 10 = 0$$

$i_2 = 1.1$ A $\quad i_3 = 2.09$ A

$i_1 = 1.1 + 2.09 = 3.19$ A

$i_4 = 2.09 - 2 = 0.09$ A

$$i_1 = \frac{12 - v_1}{1} \Rightarrow v_1 = 12 - 3.19 = 8.81 \text{ V}$$

$$i_2 = \frac{v_1 - v_3}{8} \Rightarrow v_3 = v_1 - 8i_2$$

$$= 8.81 - 8 \times 1.1$$

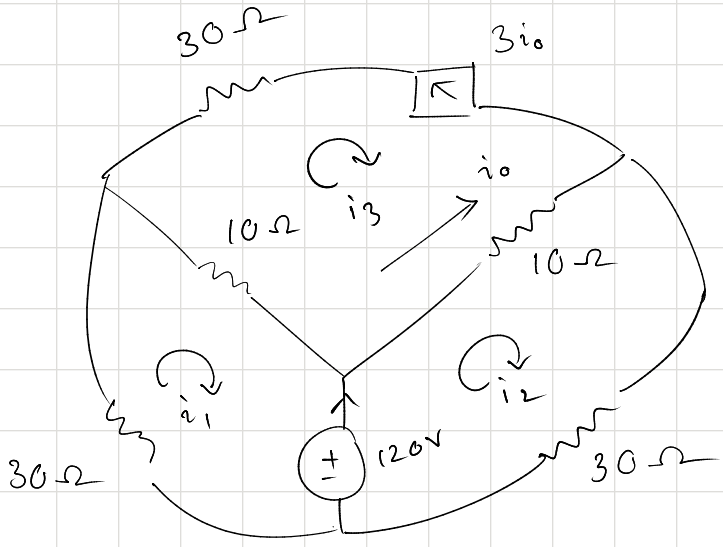
$$= 0 \text{ V}$$

$$i_3 = \frac{v_1 - v_2}{4} \Rightarrow v_2 = v_1 - 4i_3$$

$$= 8.81 - 4 \times 2.09$$

$$= 0.45 \text{ V}$$

(4)



loop 1:

$$120 + 30i_1 + 10(i_1 - i_3) = 0$$

$$\Rightarrow 120 + 30i_1 + 10(i_1 + 3i_0) = 0$$

$$\Rightarrow 120 + 30i_1 + 10i_1 - 15i_2 = 0$$

$$\Rightarrow 40i_1 - 15i_2 = -120$$

loop 2:

$$-120 + 10(i_2 - i_3) + 30i_2 = 0$$

$$\Rightarrow 10(i_2 + 3i_0) + 30i_2 = 120$$

$$\Rightarrow 10\left(i_2 - \frac{3}{2}i_2\right) + 30i_2 = 120$$

$$\Rightarrow 10i_2 - 15i_2 + 30i_2 = 120$$

$$\Rightarrow i_2 = \frac{120}{25} = 4.8\ A$$

$$i_0 = i_2 - i_3 = i_2 + 3i_0$$

$$\Rightarrow 2i_0 = -i_2$$

$$\Rightarrow i_0 = -\frac{i_2}{2}$$

$$i_0 = -2.4\ A$$

$$\therefore i_1 = \frac{-120 + 15i_2}{40}$$

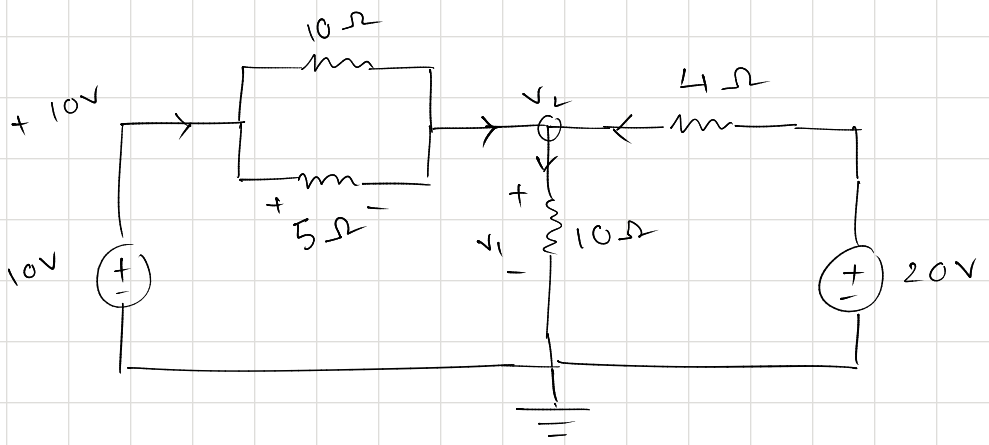
$$= \frac{-120 + 72}{40}$$

$$= -1.2\ A$$

current through the battery

$$i_2 - i_1 = 4.8 + 1.2 = 6\ A$$

(5) i) at the node with v_2 voltage



$$\frac{10 - v_2}{10||15} + \frac{20 - v_2}{4} = \frac{v_2}{10}$$

$$\Rightarrow \frac{3}{10}(10 - v_2) + \frac{20 - v_2}{4} = \frac{v_2}{10}$$

$$\Rightarrow 6(10 - v_2) + 5(20 - v_2) = 2v_2$$

$$\Rightarrow 60 - 6v_2 + 100 - 5v_2 = 2v_2$$

$$\Rightarrow 13v_2 = 160$$

$$\Rightarrow v_2 = 12.308$$

$$v_1 = v_2 - 0 = 12.308\ V$$

current in 5Ω, $i = \frac{10 - v_2}{5}$

$$= \frac{10 - 12.308}{5}$$

$$= -0.46\ A$$

ii) current through 4Ω resistor

$$i_1 = \frac{20 - v_2}{4}$$

$$= \frac{20 - 12.308}{4}$$

$$= 1.923\ A$$

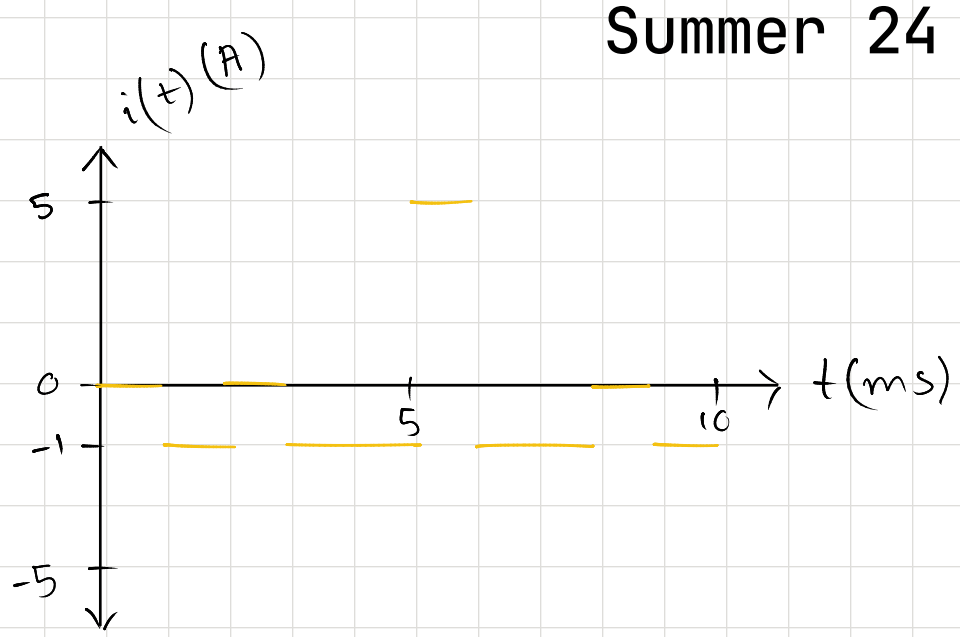
therefore 1.923 A current is flowing out of the positive terminal of 20v voltage source, meaning it is supplying power.

$$p = vi = 20 \times 1.923 = 38.46\ W$$

Summer 24

(1)

i)



slope (0,1) = 0

slope (1,2) = $\frac{-1}{1}$ = -1

slope (2,3) = 0

slope (3,5) = $\frac{-2}{2}$ = -1

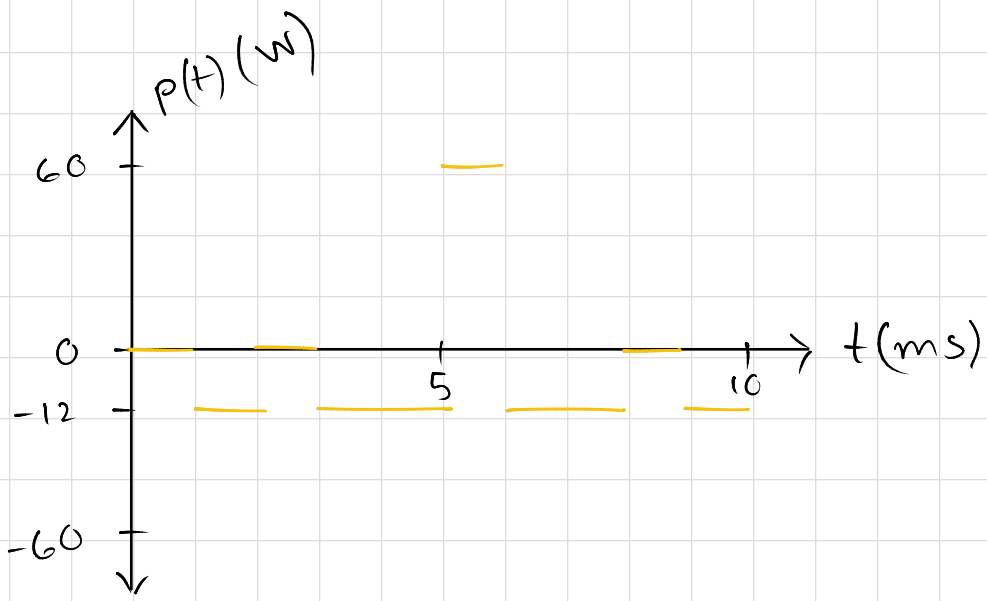
slope (5,6) = $\frac{5}{1}$ = 5

slope (6,8) = $\frac{-2}{2}$ = -1

slope (8,9) = 0

slope (9,10) = $\frac{-1}{1}$ = -1

ii) $p = vi$



p (0,1) = 12 x 0 = 0 W

p (1,2) = 12 x (-1) = -12 W

p (2,3) = 0

p (3,5) = 12 x (-1) = -12 W

p (5,6) = 12 x (5) = 60 W

p (6,8) = 12 x (-1) = -12 W

p (8,9) = 0

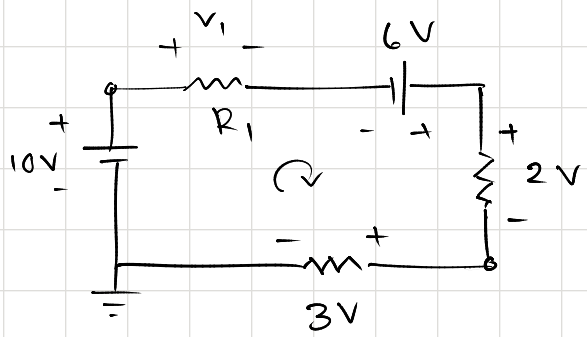
p (9,10) = 12 x (-1) = -12 W

power is absorbed in the interval [5, 6]

power is delivered in the following intervals

[1,2], [3,5], [6,8], [9,10]

(2) 1) Applying KVL in the loop

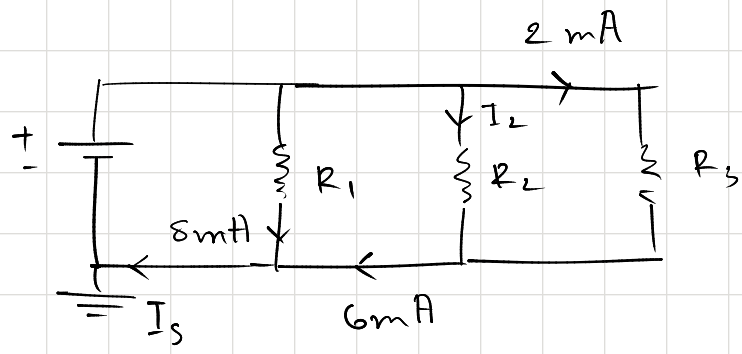


$$-10 + V_1 - 6 + 2 + 3 = 0$$

$$\Rightarrow V_1 = 11\ V$$

$$\therefore V_2 = V_1 - 6 + 2 = 7\ V$$

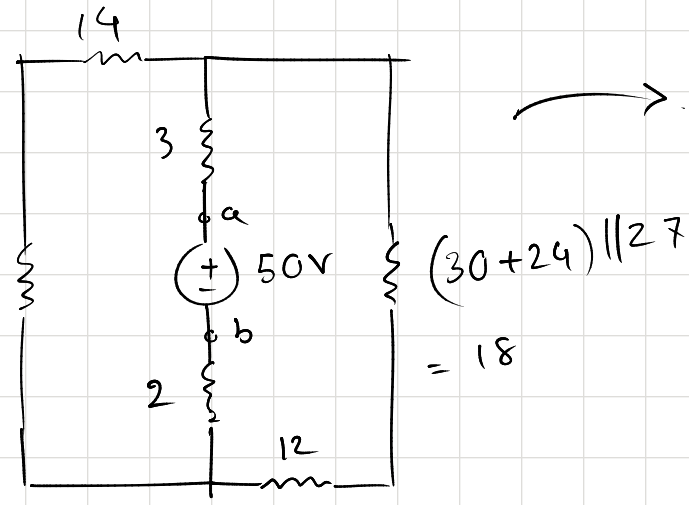
11) $I_s = 8 + 6 = 14\ mA$



$$I_s = 8 + I_2 + 2$$

$$\Rightarrow I_2 = 14 - 10 = 4\ mA$$

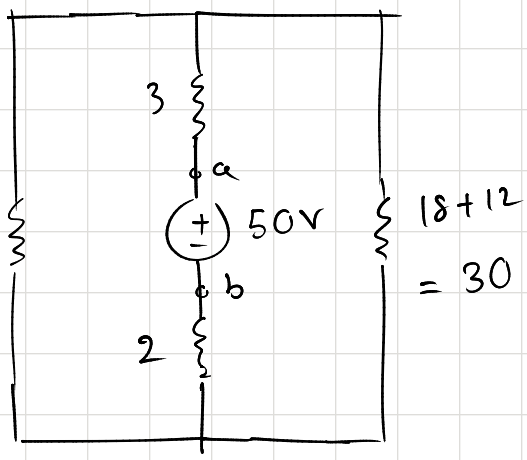
(3) 1)

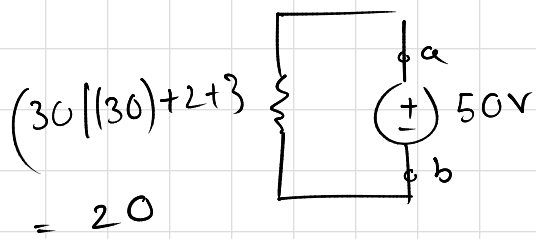


$(50+30) \| 20$
$= 16$

$(30+24) \| 27$
$= 18$

$16 + 14$
$= 30$





$R_{ab} = 20\ \Omega$

11) $I = \frac{50}{20} = 2.5\ A$

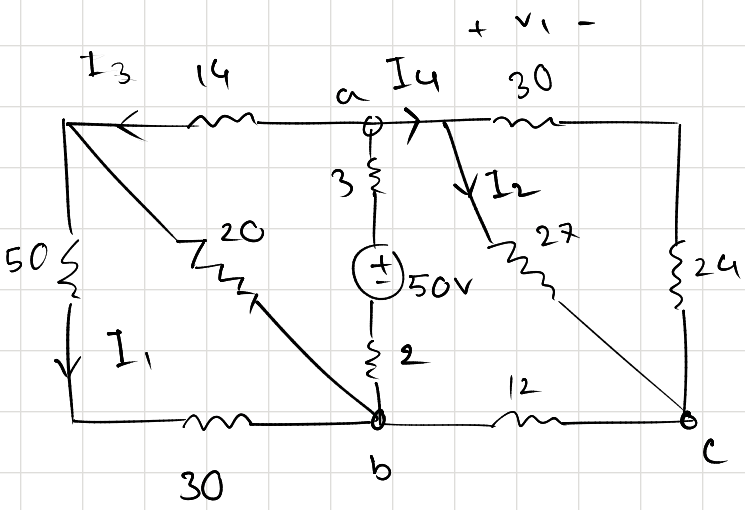
$$I_3 = 2.5 \times \frac{\left(12 + 27 \| (30+24)\right)}{\left(14 + 20 \| (50+30)\right) + \left(12 + 27 \| (30+24)\right)}$$

$$= 1.25\ A$$

$$\therefore I_1 = 1.25 \times \frac{20}{(50+30)+20} = 0.25\ A$$

$$I_4 = 2.5 - I_3 = 1.25\ A$$

$$I_2 = I_4 \times \frac{30+24}{27+(30+24)} = 0.833\ A$$



$$v_{ab} = 50 \times \frac{30 \| 30}{3 + 2 + (30 \| 30)}$$

$$= 37.5\ V$$

$$v_{ac} = 37.5 \times \frac{27 \| (30+24)}{12 + 27 \| (30+24)}$$

$$= 22.5\ V$$

$$v_1 = 22.5 \times \frac{30}{30+24}$$

$$= 12.5\ V$$

(4) i) loop 1:

$$-660 + 5i_1 + 15(i_1 - i_3) + 10(i_1 - i_2) = 0$$

$$\Rightarrow -660 + 5i_1 + 15i_1 - 15i_3 + 10i_1 - 10i_2 = 0$$

$$\Rightarrow 30i_1 - 10i_2 - 15i_3 = 660 \quad \text{——} (I)$$

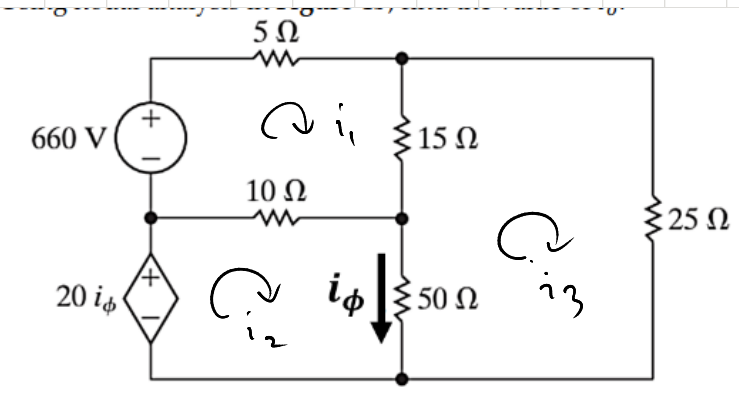


Figure 4a.

loop 2

$$-20 i_\phi + 10(i_2 - i_1) + 50(i_2 - i_3) = 0$$

$$\Rightarrow -20(i_2 - i_3) + 10i_2 - 10i_1 + 50i_2 - 50i_3 = 0$$

$$\Rightarrow -10i_1 + 40i_2 - 30i_3 = 0 \quad \text{——} (II)$$

loop 3

$$15(i_3 - i_1) + 25i_3 + 50(i_3 - i_2) = 0$$

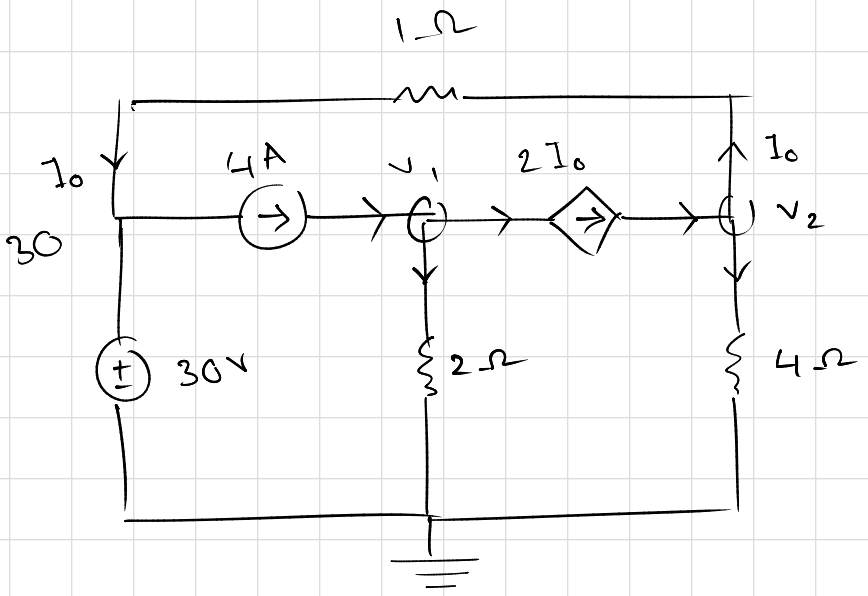
$$\Rightarrow -15i_1 - 50i_2 + 90i_3 = 0 \quad \text{——} (III)$$

solving (I), (II) and (III)

$i_1 = 42 \quad i_2 = 27 \quad i_3 = 22$

$\therefore i_\phi = i_2 - i_3 = 5\ A$

11) node 1:



$$4 = \frac{v_1}{2} + 2I_o$$

$$\Rightarrow 4 = \frac{v_1}{2} + 2\left(\frac{v_2 - 30}{1}\right)$$

$$\Rightarrow 4 = \frac{v_1}{2} + 2v_2 - 60$$

$$\Rightarrow \frac{1}{2}v_1 + 2v_2 = 64 \quad \text{——} (1)$$

node 2:

$$2I_o = I_o + \frac{v_2}{4}$$

$$\Rightarrow \frac{v_2}{4} = I_o = \frac{v_2 - 30}{1}$$

$$\Rightarrow v_2 = 4v_2 - 120$$

$$\Rightarrow v_2 = \frac{120}{3} = 40$$

$$\therefore I_o = \frac{v_2}{4} = \frac{40}{4} = 10\,A$$

Spring 24

1. i) $i_1 = 5 \quad i_2 = -5$

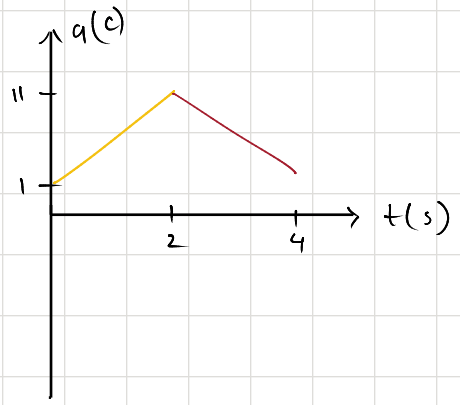
$q_1 = 5t + c = 5t + 1$ $\qquad q_2 = -5t + c = -5t + c = -5t + 21$

$q_1(0) = q(0) = 1$ $\qquad q_2(2) = q_1(2) = 5 \cdot 2 + 1 = 11$

$\Rightarrow e = 1$ $\qquad \Rightarrow -5 \cdot 2 + c = 11$

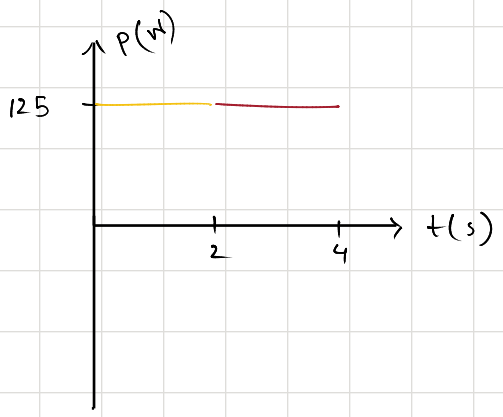
$\Rightarrow c = 21$

$q_2(4) = -20 + 21 = 1$



ii) $p = i^2 R \qquad p_1 = 5^2 \times 5 = 125\,W$

$p_2 = (-5)^2 \times 5 = 125\,W$

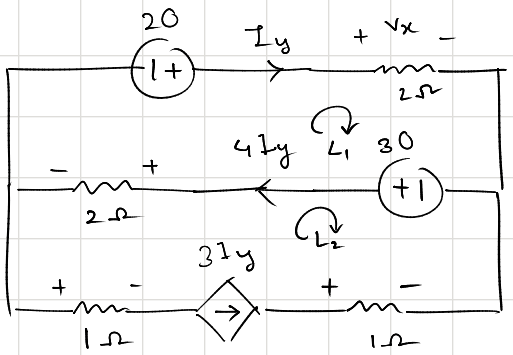


2. Loop 1

$-20 + 2I_y - 30 + 2 \cdot 4I_y = 0$

$\Rightarrow -20 + 10 I_y - 30 = 0$

$\Rightarrow I_y = \frac{50}{10} = 5$



Loop 2:

$-2 \cdot 4I_y + 30 - 3I_y + 4V_x - 3I_y = 0$

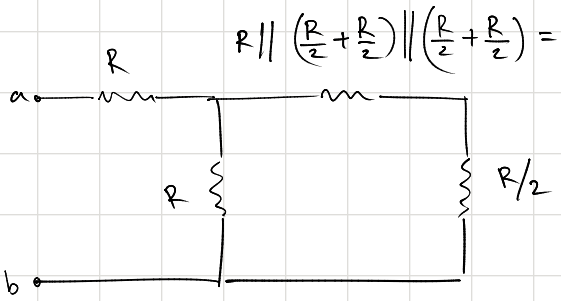
$\Rightarrow -8I_y + 30 - 3I_y + 4V_x - 3I_y = 0$

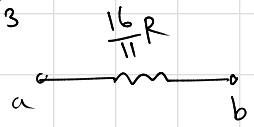
$\Rightarrow -14 I_y + 30 + 4V_x = 0$

$\Rightarrow 4V_x = 14 \cdot 5 - 30 = 40$

$\Rightarrow V_x = 10$

3. i) $R \,||\, \left(\frac{R}{2} + \frac{R}{2}\right) \,||\, \left(\frac{R}{2} + \frac{R}{2}\right) = R/3$





$R + R \,||\, (R/3 + R/2)$

$= R + \left(\frac{1}{R} + \frac{6}{5R}\right)^{-1}$

$= R + \left(\frac{5+6}{5R}\right)^{-1}$

$= R + \frac{5R}{11}$

$= \frac{16}{11} R$

$R_{eq} = 10$

$\Rightarrow \frac{16}{11} R = 10$

$\Rightarrow R = 6.875\,\Omega$

11) $v_{ac} = 30 \times 5 \| 20 \| 4$

$= 30 \times 2$

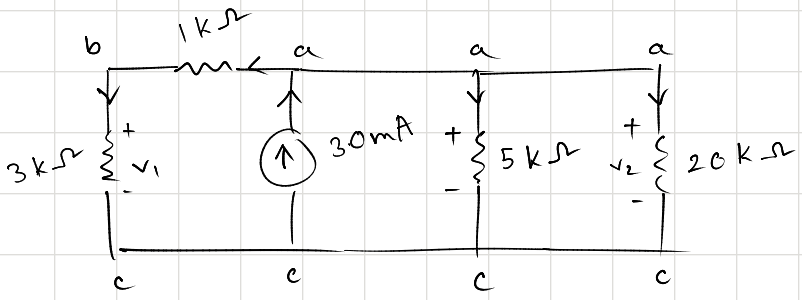
$= 60\,V$

$v_2 = 60\,V$

$v_{bc} = 60 \times \frac{3}{3+1}$

$= 45\,V$

$v_1 = 45\,V$



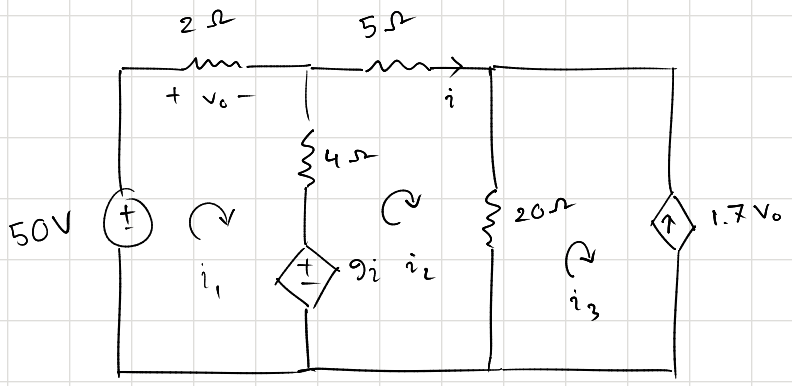
4. i) loop 1

$-50 + 2i_1 + 4(i_1 - i_2) + 9i = 0$

$\Rightarrow 2i_1 + 4i_1 - 4i_2 + 9i_2 - 50 = 0$

$\Rightarrow 6i_1 + 5i_2 = 50$

$\Rightarrow 3v_o + 5i_2 = 50$



loop 2

$-9i + 4(i_2 - i_1) + 5i_2 + 20(i_2 - i_3) = 0$

$\Rightarrow -9i_2 + 4i_2 - 4i_1 + 5i_2 + 20i_2 - 20i_3 = 0$

$\Rightarrow -4i_1 + 20i_2 - 20i_3 = 0$

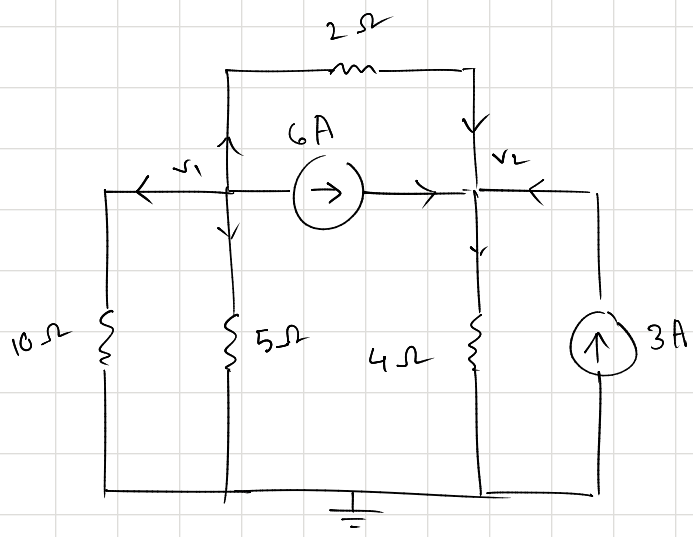
$\Rightarrow -2v_o + 20i_2 - 20 \times 1.7 v_o = 0$

$v_o = 4.167\,V \quad i_2 = 7.5\,A = i$

11) node 1

$\frac{v_1}{10} + \frac{v_1 - v_2}{2} + 6 + \frac{v_1}{5} = 0$

$\Rightarrow \frac{4}{5} v_1 - \frac{1}{2} v_2 + 6 = 0$ —— (1)



node 2

$6 + \frac{v_1 - v_2}{2} + 3 = \frac{v_2}{4}$

$\Rightarrow \frac{v_1}{2} - \frac{v_2}{2} - \frac{v_2}{4} = -9$

$\Rightarrow \frac{1}{2} v_1 - \frac{3}{4} v_2 = -9$ —— (11)

solve (1) and (11)

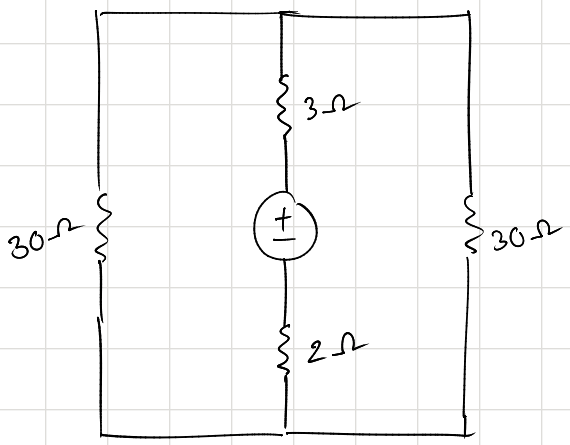
$v_1 = 0 \quad v_2 = 12$

Spring 23

1. a)

$14 + 20 \| (50+30)$

$= 30$

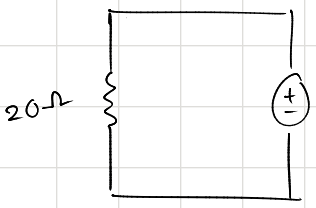


$12 + 27 \| (30+24)$

$= 30\Omega$

$2+3+30\|30$

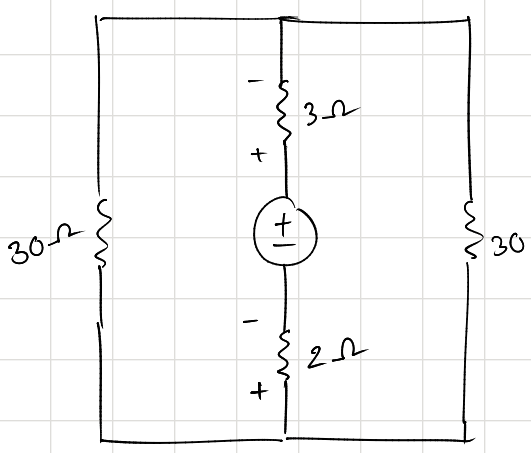
$= 20$



$Req = 20\Omega$

b) voltage across $3\Omega = 10 \times \frac{3}{2+3+30\|30} = 1.5\ V$

" " $2\Omega = 10 \times \frac{2}{2+3+30\|30} = 1\ V$

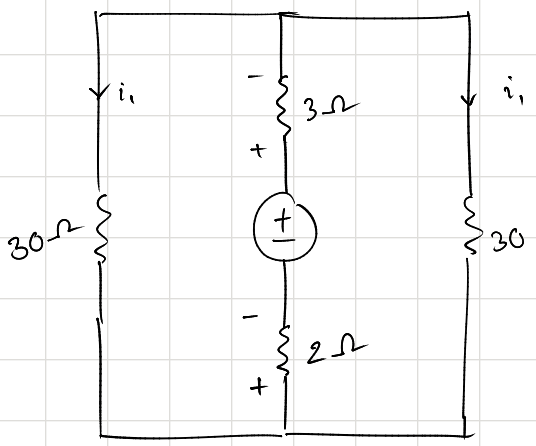


c) Current through the whole circuit

$i = \frac{10}{20} = 0.5\ A$

$i_1 = 0.5 \times \frac{30}{30+30} = 0.25A$

$\therefore$ current through $12\Omega = 0.25\ A$

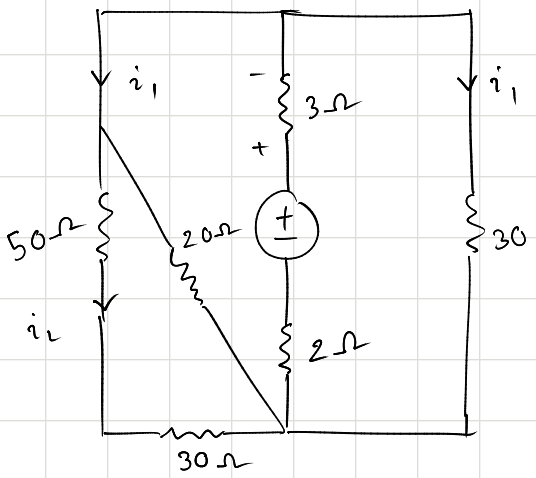


$i_2 = i_1 \times \frac{20}{20+(50+30)}$

$= 0.25 \times 0.2$

$= 0.05\ A$

$\therefore$ current through $50\Omega = 0.05A$



2. a)

$q_1 = 20t \quad \{0 \le t \le 1\}$

$q_2 = 20 \quad \{1 \le t < 3\}$

$q_3 = -\frac{40}{2}t + c = -20t + c = -20t + 80 \quad \{3 \le t \le 5\}$

$q_3(3) = q_2(3)$

$\Rightarrow -60 + c = 20$

$\Rightarrow c = 80$

$q_4 = \frac{40}{2}t + c = 20t + c = 20t - 120 \quad \{5 \le t \le 7\}$

$q_4(5) = q_3(5)$

$\Rightarrow 100 + c = -20$

$\Rightarrow c = -120$

$q_5 = 20 \quad \{7 \le t\}$

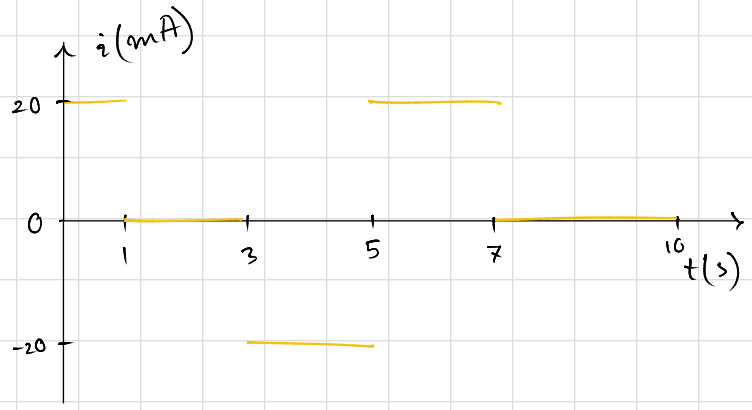
$i_1 = 20$

$i_2 = 0$

$i_3 = -20$

$i_4 = 20$

$i_5 = 0$



b)

$p = i^2R$

for $0 \le t \le 1$

$p = 20^2 \times 10 = 4$ mW

for $1 \le t \le 3$

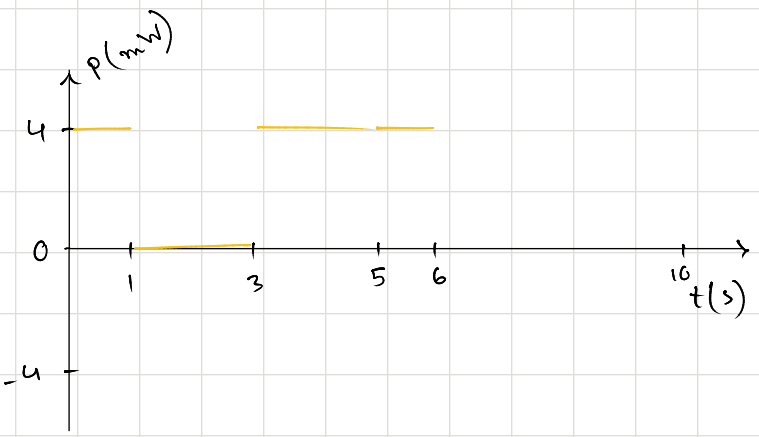
$p = 0^2 \times 10 = 0$

for $3 \le t \le 5$

$p = (-20)^2 \times 10 = 4$ mW

for $5 \le t \le 6$

$p = 20^2 \times 10 = 4$ mW

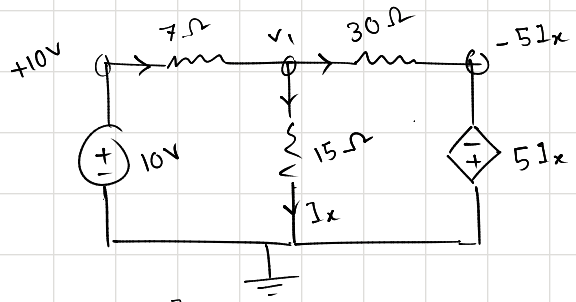


total energy delivered from 0 to 6 sec

$E = 4 \times 1 + 0 + 4 \times 3$

$= 16$ mJ

3. a)



node v_1:

$\frac{10 - v_1}{7} = \frac{v_1 + 5I_x}{30} + \frac{v_1}{15}$

$\Rightarrow \frac{10 - v_1}{7} = \frac{v_1 + \frac{v_1}{3}}{30} + \frac{v_1}{15} \quad [I_x = \frac{v_1}{15}]$

$\Rightarrow v_1 = 5.625$ V $\quad \therefore I_x = 0.375$ A

current through $7\Omega = \frac{10 - v_1}{7} = 0.625$ A

current through $30\Omega = \frac{v_1 + 5I_x}{30} = 0.25$A

" " $15\Omega = I_x = 0.375$ A

current through 10V = 0.625 A

" " $5I_x = 0.25$ A

b) power supplied by 10V = $10 \times 0.625 = 6.25$ W

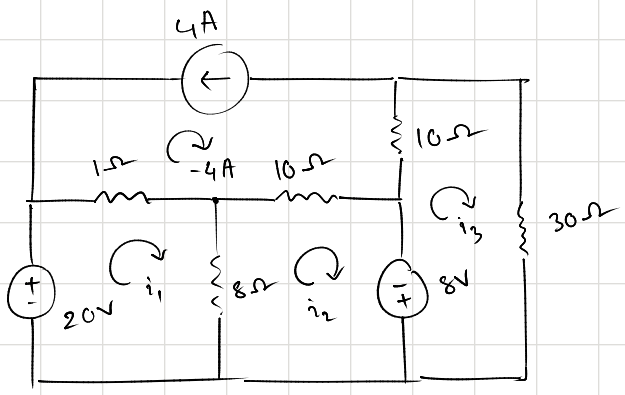
power absorbed by 7Ω = $7 \times 0.625^2 = 2.734$ W

power absorbed by 15Ω = $0.375^2 \times 15 = 2.109$ W

power absorbed by 30Ω = $0.25^2 \times 30 = 1.875$ W

power supplied by 51_x = $5 \times 0.375 \times 0.25 = 0.469$ W

4. a)



loop 1:

$1(i_1 + 4) + 8(i_1 - i_2) - 20 = 0$

$\Rightarrow i_1 + 4 + 8i_1 - 8i_2 - 20 = 0$

$\Rightarrow 9i_1 - 8i_2 = 16$

loop 2:

$8(i_2 - i_1) + 10(i_2 + 4) - 8 = 0$

$\Rightarrow 8i_2 - 8i_1 + 10i_2 + 40 - 8 = 0$

$\Rightarrow -8i_1 + 18i_2 = -32$

loop 3:

$10(i_3 + 4) + 30i_3 + 8 = 0$

$\Rightarrow 10i_3 + 40 + 30i_3 + 8 = 0$

$\Rightarrow 40i_3 = -48$

$\Rightarrow i_3 = -1.2$

$i_1 = 0.326$ A

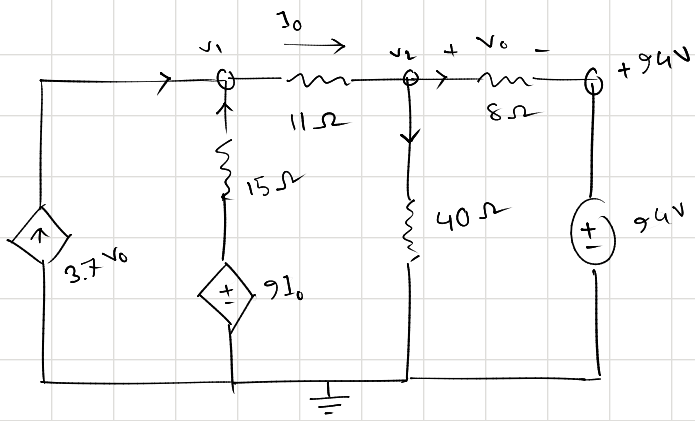
$i_2 = -1.63$ A

$i_3 = -1.2$ A

b) $p = i^2R = (i_1 + 4)^2 \times 1$

$= 18.714$ W

5. a)



node v_1

$3.7v_o + \frac{91_o - v_1}{15} = 1_o$

$\Rightarrow 3.7(v_2 - 94) + \frac{1}{15}\left(9\frac{v_1 - v_2}{11} - v_1\right) = \frac{v_1 - v_2}{11}$

$\Rightarrow 3.7v_2 - 347.8 + \frac{1}{15}\left(\frac{9}{11}v_1 - \frac{9}{11}v_2 - v_1\right)$

$= \frac{1}{11}v_1 - \frac{1}{11}v_2$

$\Rightarrow 3.7v_2 - 347.8 + \frac{3}{55}v_1 - \frac{3}{55}v_2 - \frac{1}{15}v_1 = \frac{1}{11}v_1 - \frac{1}{11}v_2$

$\Rightarrow \left(\frac{3}{55} - \frac{1}{15} - \frac{1}{11}\right)v_1 + \left(3.7 - \frac{3}{55} + \frac{1}{11}\right)v_2 = 347.8$

$\Rightarrow -\frac{17}{165}v_1 + \frac{411}{110}v_2 = 347.8$ —— (1)

node v_2:

$$\frac{v_1 - v_2}{11} = \frac{v_2 - 94}{11} + \frac{v_2}{40}$$

$$\Rightarrow \frac{1}{11}v_1 - \frac{1}{11}v_2 = \frac{1}{11}v_2 - \frac{94}{11} + \frac{v_2}{40}$$

$$\Rightarrow \frac{1}{11}v_1 + \left(-\frac{1}{11} - \frac{1}{11} - \frac{1}{40}\right)v_2 = -\frac{94}{11} \quad \text{—— (11)}$$

$$\Rightarrow \frac{1}{11}v_1 - \frac{91}{440}v_2 = -\frac{94}{11}$$

solve (1) and (11)

$v_1 = 125.65$

$v_2 = 96.55$

b) $v_o = v_2 - 94 = 2.55\ V$

$i_o = \frac{v_1 - v_2}{11} = 2.65\ A$