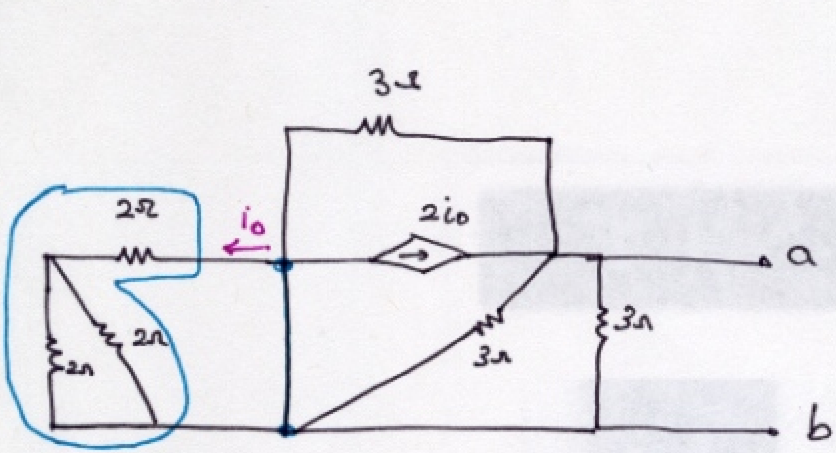
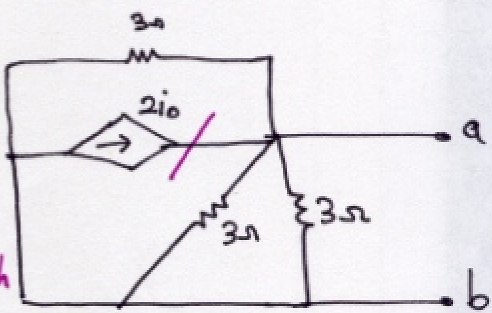
Problem 1)

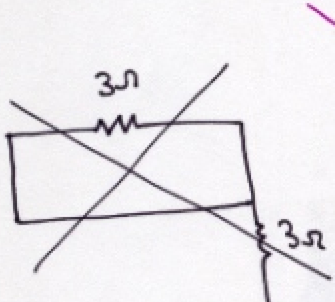
To find R_{th}, turn off all independent sources:

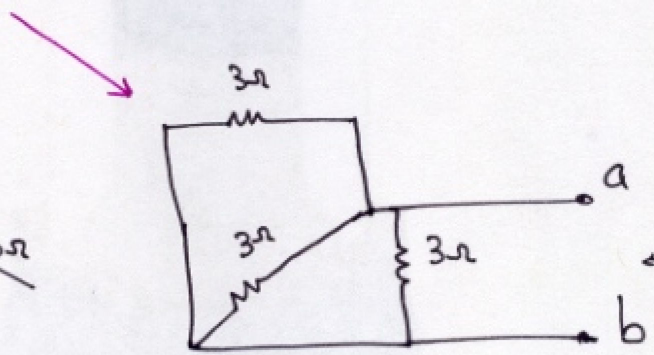


Shorted $\Rightarrow i_o = 0$

$i_o = 0 \Rightarrow 2i_o = 0$
$\Rightarrow$ no current in this branch
$\Rightarrow$ open





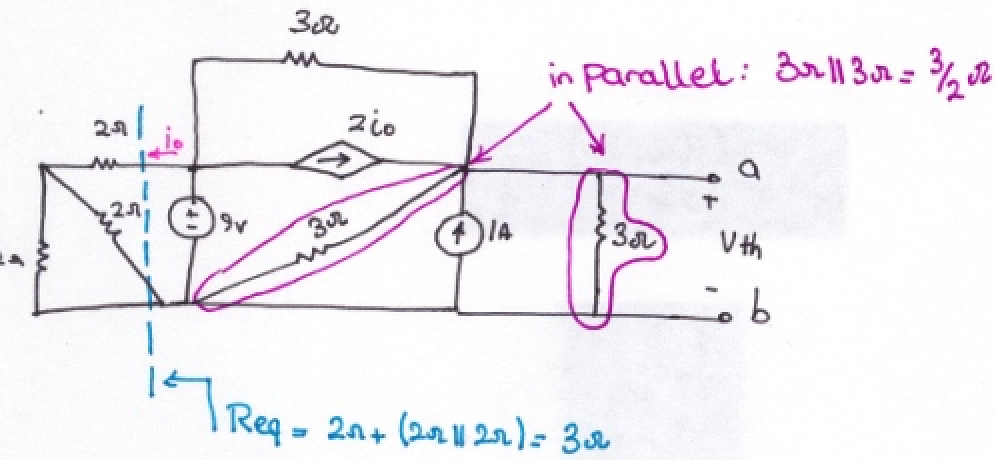


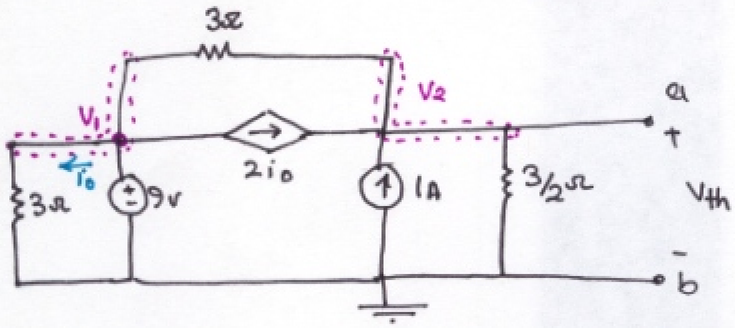
$R_{th} = 3\Omega \parallel 3\Omega \parallel$

$\boxed{R_{th} = 1\,\Omega}$

(problem 1)

to find V_{th}, find the <u>open-circuit</u> voltage between terminals a-b.
to make analysis easier, you can first simplify the circuit as much as possible.





nodal analysis:

$V_{th} = V_{ab} = V_2$

@ node 1: $V_1 = 9_v$ (eq. 1)

@ node 2: $\frac{V_2 - V_1}{3\Omega} + (-2i_o) + (-1A) + \frac{V_2 - 0}{\frac{3}{2}\Omega} = 0$ (eq. 2)

to find i_o : $i_o = \frac{V_1}{3\Omega} = \frac{9v}{3\Omega} = 3A$

Replace i_o and V_1 with (3A) and (9_v) in equation 2:

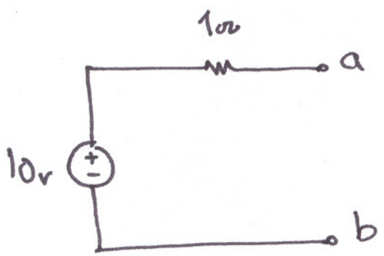
$\frac{V_2 - 9}{3} + (-2 \times 3) - 1 + V_2/_{3/2} = 0$

(Prob.1)

$$\frac{V_2}{3} - 3 - 6 - 1 + \frac{2V_2}{3} = 0 \Rightarrow V_2 = 10\,v$$

$$V_{th} = 10\,v$$

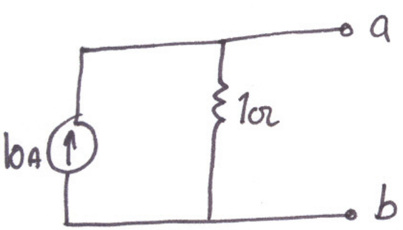
Therenin equivalent



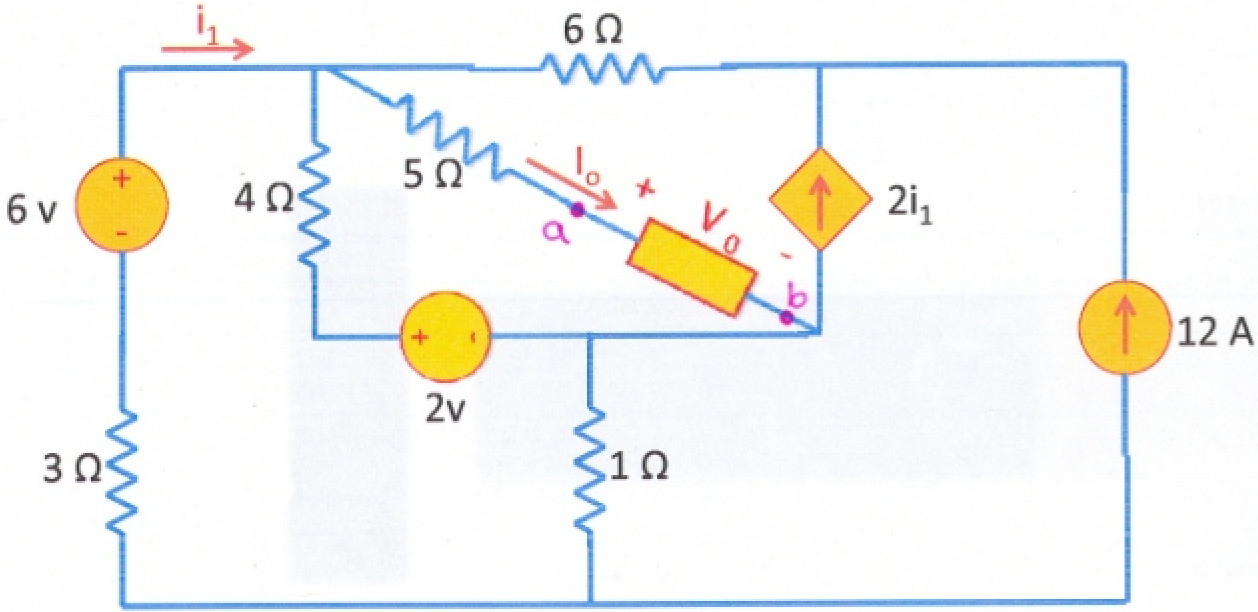
Norton equivalent :

$$R_n = R_{th} = 1\,\Omega$$

$$I_n = \frac{V_{th}}{R_{th}} = \frac{10\,v}{1\,\Omega} = 10\,A$$



Problem2) Determine the relationship between V_o and I_o.



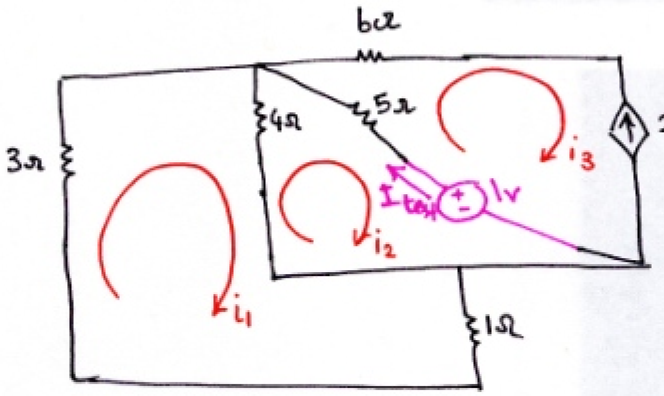
Problem 2)

To find the relationship between V_o and I_o, first find the equivalent circuit seen by the unknown element; ie the terminals a-b:

to find R_{th}, turn off the independent sources and apply a test source between a and b:

if we add a voltage source as the test source

$$R_{th} = \frac{V_{test}}{I_{test}} = \frac{1v}{I_{test}}$$



mesh analysis:

KVL @ mesh 1: $3i_1 + 4(i_1 - i_2) + i_1 = 0$

$2i_1 - i_2 = 0$ (eq. 1)

KVL @ mesh 2: $4(i_2 - i_1) + 5(i_2 - i_3) + 1 = 0$

$-4i_1 + 9i_2 - 5i_3 = -1$ (eq. 2)

mesh 3: $i_3 = -2i_1$ (eq. 3)

$\left.\begin{array}{l}\text{eq. 2}\\ \text{eq. 3}\end{array}\right\} \Rightarrow -4i_1 + 9i_2 - 5(-2i_1) = -1$

$6i_1 + 9i_2 = -1 \longrightarrow \begin{cases} 6i_1 + 9i_2 = -1 \\ 2i_1 - i_2 = 0 \end{cases}$ (eq.1 →) $\Rightarrow \begin{cases} i_2 = -1/12 \text{ A} \\ i_1 = \frac{-1}{24} \text{ A} \end{cases}$

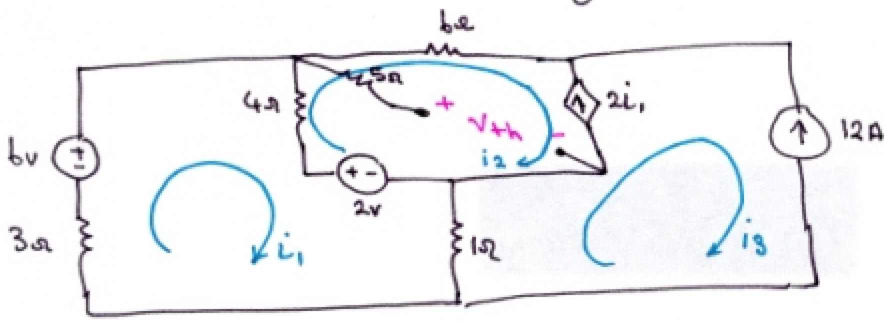
$i_3 = -2i_1 = \frac{1}{12}$ A

$I_{test} = i_3 - i_2 = \frac{1}{12} - (-\frac{1}{12}) = \frac{1}{6}$ A ,

$R_{th} = \frac{1v}{I_{test}} = \frac{1}{1/6} = 6\Omega$

(Prob. 2)

V_{th} : go back to the original circuit and find the open circuit voltage between a and b:



note that for the 5Ω resistor, since terminals a–b are open, there is no current flowing in the 5Ω resistor → can be neglected.
and has no voltage drop

mesh analysis:

mesh 3: $i_3 = -12\,A$ (eq. 1)

KVL @ mesh 1: $3i_1 - 6 + 4(i_1 - i_2) + 2 + 1(i_1 - i_3) = 0$

$8i_1 - 4i_2 - i_3 = 4$

$8i_1 - 4i_2 - (-12) = 4$

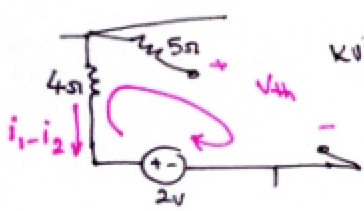
$8i_1 - 4i_2 = -8$

$2i_1 - i_2 = -2$ (eq. 2)

@ mesh 2: $i_2 = -2i_1$ (eq. 3)

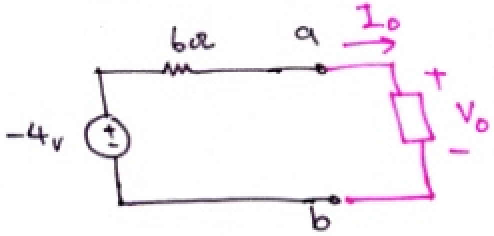
replace $i_2 = -2i_1$ (eq. 3) in eq. 2: $2i_1 - (-2i_1) = -2 \Rightarrow i_1 = -\frac{1}{2}\,A$

$i_2 = -2i_1 = 1\,A$



KVL: $-4(i_1 - i_2) - 0 + V_{th} - 2 = 0$

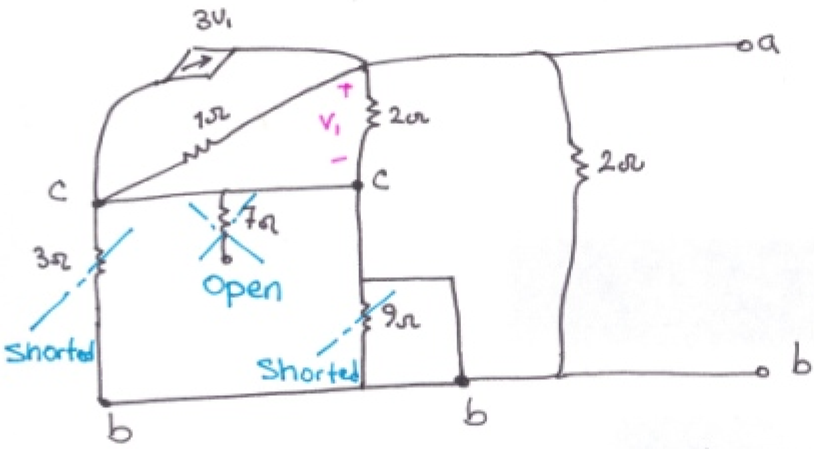
$-4(-\frac{1}{2} + 1) + V_{th} - 2 = 0 \Rightarrow V_{th} = -4\,v$



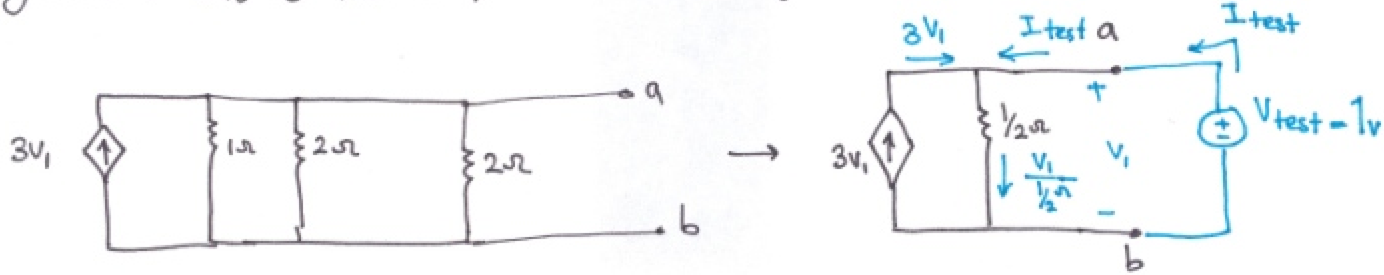
$\Rightarrow I_o = \dfrac{-4 - V_o}{6\Omega}$

Problem 3)

- R_{th} : Turn off all independent sources, this is how the circuit looks:



As you can see, when the 10_v voltage source is turned off, ~~terminal~~ nodes (b) and (c) are shorted, so the 9Ω and the 3Ω resistors can be ignored (they are shorted), the 7Ω resistor is open and can be ignored, this is the simplified circuit diagram:



KCL: $3V_1 + I_{test} = \frac{V_1}{\frac{1}{2}\Omega}$

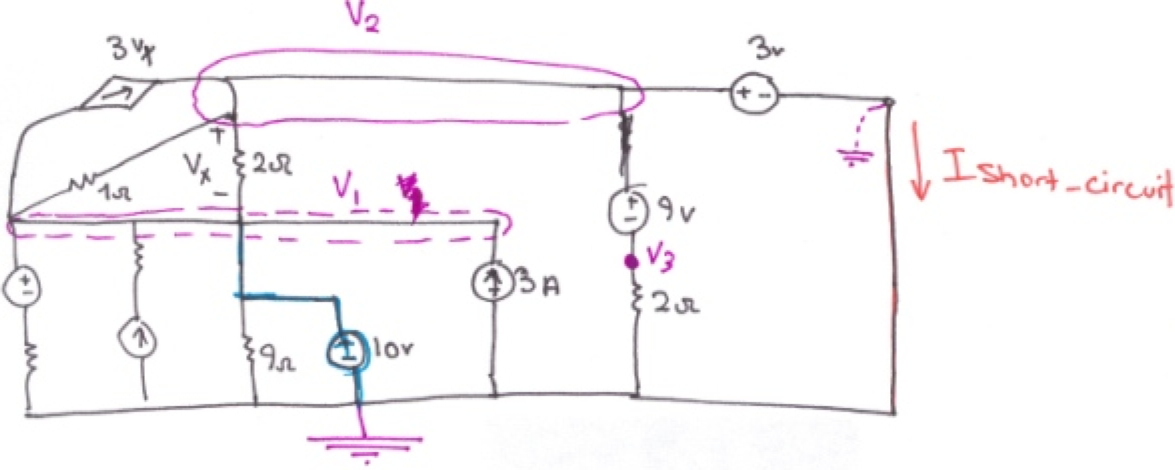
$V_1 = V_{test} = 1_v$

$3 + I_{test} = 2 \Rightarrow I_{test} = -1\,A$, $R_{th} = \frac{V_{test}}{I_{test}} = \frac{1_v}{-1\,A} = -1\,\Omega$

- I_n: short a to b and find the short circuit current.

It is easier to do nodal analysis.

Since we are only interested in the short-circuit current, we can simplify the rest of the circuit as much as possible; all the elements in parallel with the 10_v voltage source have no effect on $I_{short\_circuit}$.

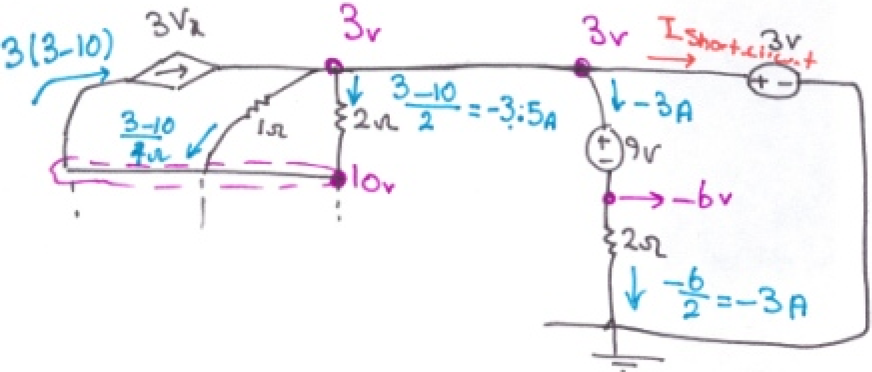


node 1: $V_1 = 10v$ (because of the voltage source)

node 2: $V_2 = 3v$

node 3: $V_3 = V_2 - 9v = 3 - 9 = -6v$

We must write a KCL to find I short-circuit:

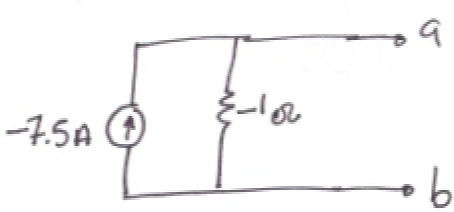


$$3(3-10)v - \frac{(3-10)v}{2\Omega} - \frac{(3-10)v}{1\Omega} - \left(\frac{-6v}{2\Omega}\right) - I_{short\text{-}circuit} = 0$$

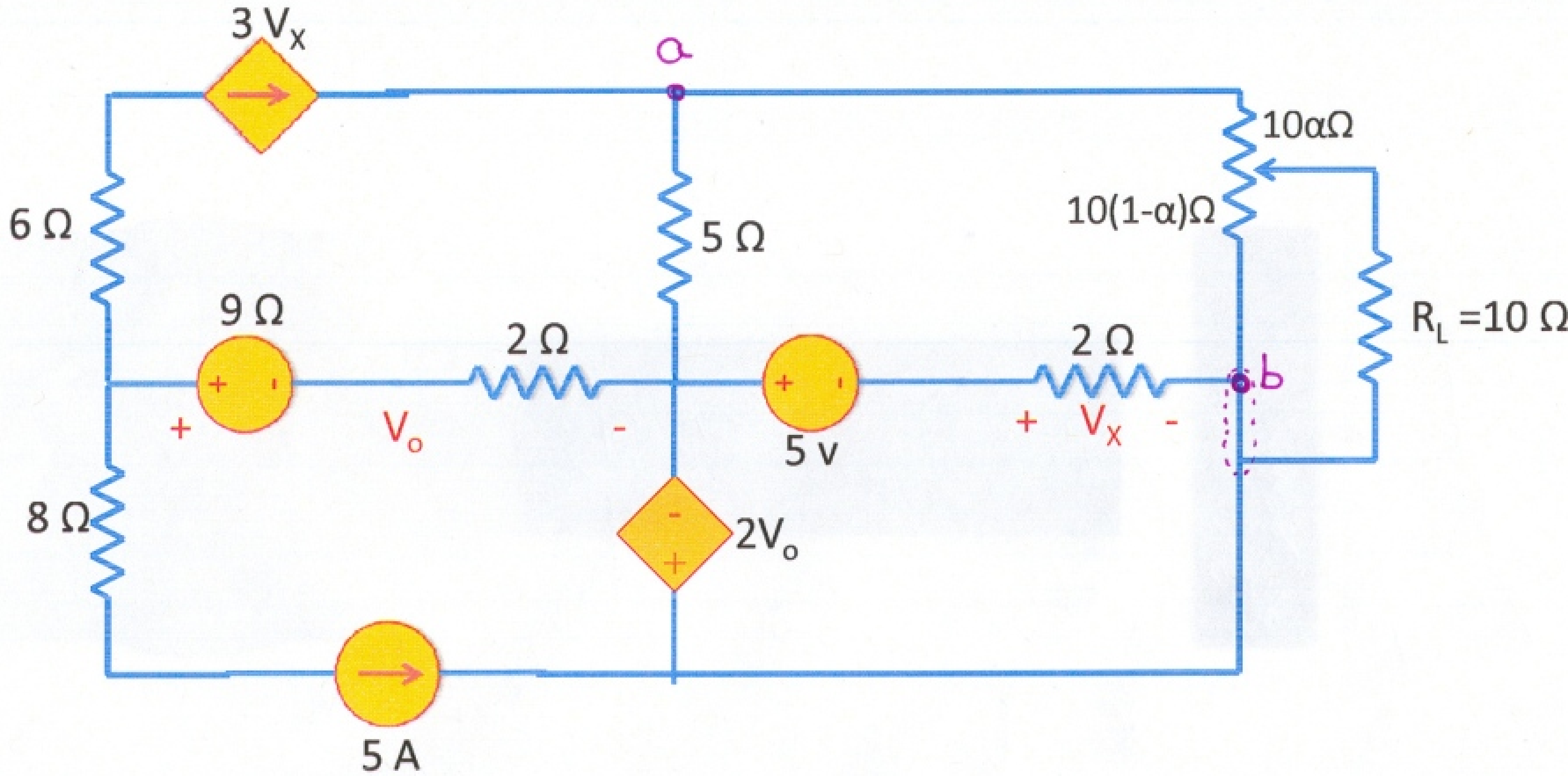
$$-21 + 3.5 + 7 + 3 = I_{short\text{-}circuit}$$

$$I_n = I_{short\text{-}circuit} = -21 + 13.5 = -7.5A$$

Norton equivalent:



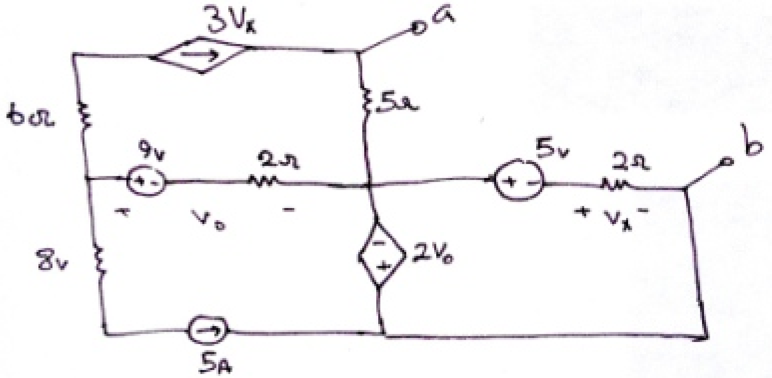
Problem4) Find the value for α, such that the power transferred to R_L is maximum. What is the value for the maximum power.



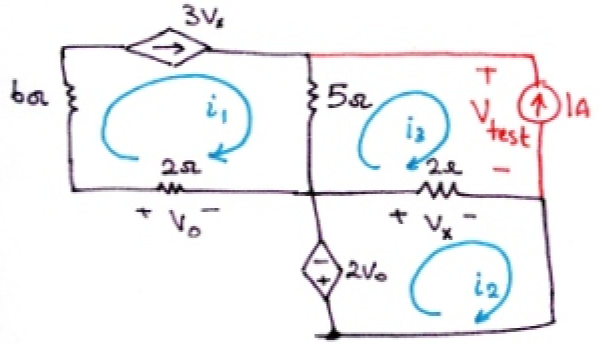
Problem 4)

To find the optimum value for α, let's first find the equivalent circuit seen by R_L; to make analysis easier, we can find the equivalent circuit in two steps.

First leave out the potentiometer and find the equivalent circuit from terminals a-b (shown on the diagram)



• to find R_{th}: turn off all independent sources, and add the test source:



we can use nodal or mesh analysis to find V_{test}.

@ mesh 3: $i_3 = -1\,A$ (eq. 1)

@ mesh 1: $\left.\begin{array}{l} i_1 = 3V_x \\ V_x = 2(i_2 - i_3) \end{array}\right\} \Rightarrow \left.\begin{array}{l} i_1 = 6(i_2 - i_3) \\ i_3 = -1\,A \end{array}\right\} \Rightarrow i_1 = 6(i_2 + 1)$ (eq. 2)

KVL @ mesh 2: $\left.\begin{array}{l} 2V_0 + 2(i_2 - i_3) = 0 \\ V_0 = -2i_1 \end{array}\right\} \Rightarrow (-2i_1) + (i_2 - i_3) = 0$

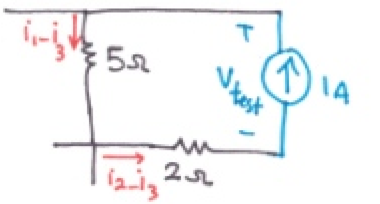
$-2i_1 + i_2 = -1$ (eq. 3)

(problem 4)

$$\begin{aligned} eq.2 &\longrightarrow \quad i_1 - 6i_2 = 6 \\ eq.3 &\longrightarrow \quad -2i_1 + i_2 = -1 \end{aligned} \Bigg\} \xrightarrow{\times 2} \begin{cases} 2i_1 - 12i_2 = 12 \\ -2i_1 + i_2 = -1 \end{cases}$$

$$-11 i_2 = 11 \Rightarrow i_2 = -1\,A$$

$$i_1 = 6 + 6i_2 = 0\,A$$



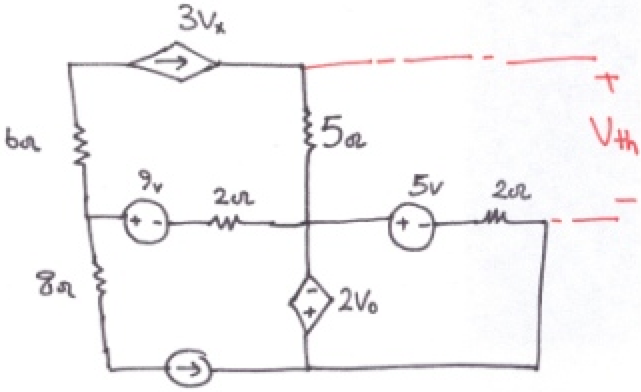
$$V_{test} = 5\Omega \times (i_1 - i_3) + 2\Omega(i_2 - i_3)$$

$$= 5\Omega \, (0 - (-1)) + 2\Omega(-1 - (-1))$$

$$= 5 \times 1 = 5v$$

$$R_{th_1} = \frac{V_{test}}{I_{test}} = \frac{5v}{1A} = 5\Omega$$

• V_{th}



at mesh 1: $\left.\begin{aligned} i_1 &= 3V_x \\ V_x &= 2\Omega \times i_3 \end{aligned}\right\} \Rightarrow i_1 = 6i_3 \quad (eq.1)$

@ mesh 2: $i_2 = -5A \quad (eq.2)$

@ mesh 3: $\left.\begin{aligned} 2V_0 + 5 + 2i_3 &= 0 \\ V_0 &= 9 + 2\Omega(i_2 - i_1) \end{aligned}\right\} \Rightarrow 2(9 + 2i_2 - 2i_1) + 5 + 2i_3 = 0$

$$18 + 4\underbrace{i_2}_{-5A} - 4i_1 + 5 + 2i_3 = 0$$

$$18 - 20 - 4i_1 + 5 + 2i_3 = 0$$

$$-4i_1 + 2i_3 = -3 \quad (eq.3)$$

(Prob. 4)

~~replace i_1 by $6i_3$ (eq.1)~~

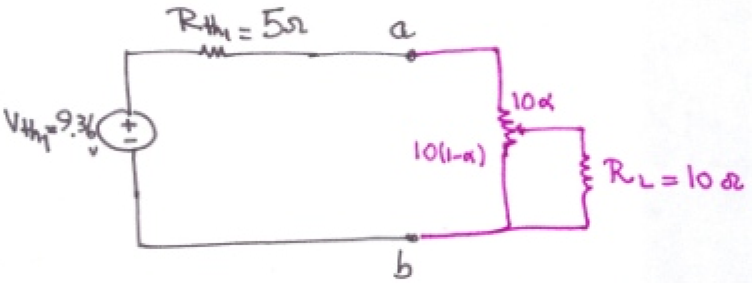
$$\left.\begin{array}{l} \text{eq. 1} \rightarrow i_1 = 6i_3 \\ \text{eq. 3} \rightarrow -4i_1 + 2i_3 = -3 \end{array}\right\} \Rightarrow -4(6i_3) + 2i_3 = -3$$

$$-22i_3 = -3 \rightarrow i_3 = 3/22 \text{ A}$$

$$i_1 = 6i_3 = \frac{18}{22} \text{ A}$$

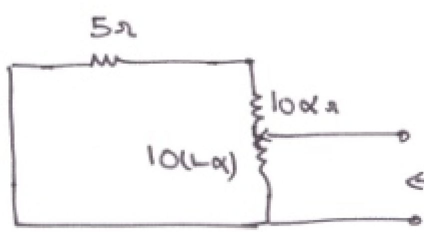
$$V_{th_1} = 5i_1 + 5 + 2i_3 = 5 \times \frac{18}{22} + 5 + 2 \times \frac{3}{22} = 9.36 \text{ v}$$

This is the equivalent circuit from a-b:



Step 2. Now we should find the equivalent circuit seen by R_L, we could have found this from the begining, but it is easier to do it in two steps:

· R_{th}



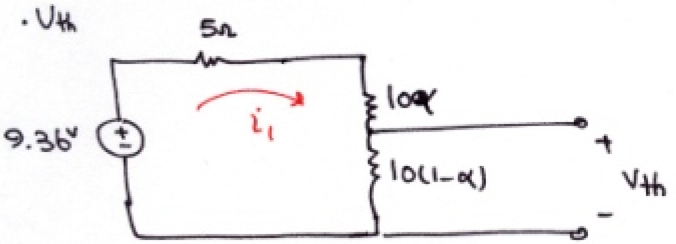
$$R_{th} = (5\Omega + 10\alpha\Omega) \parallel 10(1-\alpha)\Omega$$

$$= \frac{(5+10\alpha)\cdot(10(1-\alpha))}{5+10\alpha+10(1-\alpha)}$$

$$= \frac{(5+10\alpha)10(1-\alpha)}{15} = \frac{10(1+2\alpha)(1-\alpha)}{3}\Omega$$

(Prob. 4)

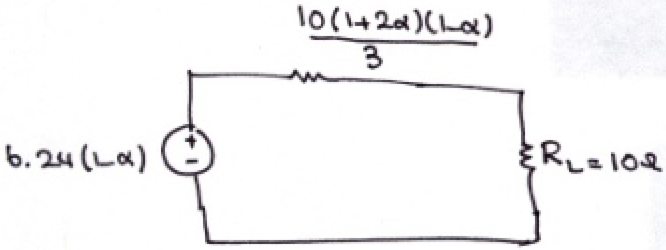
· V_{th}



$$i_1 = \frac{9.36\,v}{5\Omega + 10\alpha + 10(1-\alpha)} = \frac{9.36}{15}\ A$$

$$V_{th} = i_1 \times 10(1-\alpha)\Omega = \frac{9.36}{15} \times 10(1-\alpha) = 6.24(1-\alpha)$$

Therefore the total equivalent circuit seen by R_L is:



$$P_L = i_L^2 \cdot R_L$$

$$P_L = i_L^2 \cdot 10\Omega$$

To maximize P_L, we have to maximize i_L:

$$i_L = \frac{6.24(1-\alpha)^v}{\frac{10(1+2\alpha)(1-\alpha)}{3}\Omega + 10\Omega} = \frac{6.24 \times 3}{10} \cdot \frac{(1-\alpha)}{(1+2\alpha)(1-\alpha)+3} = \frac{6.24 \times 3}{10} \cdot \frac{1-\alpha}{(-2\alpha^2+\alpha+4)}$$

$$\frac{di_L}{dt} = \frac{6.24 \times 3}{10} \cdot \frac{-1(-2\alpha^2+\alpha+4) - (1-\alpha)(-4\alpha+1)}{(-2\alpha^2+\alpha+4)^2} = \frac{6.24 \times 3}{10} \cdot \frac{-2\alpha^2+4\alpha-4}{(-2\alpha^2+\alpha+4)^2}$$

$$\frac{di_L}{dt} = \underbrace{\boxed{\frac{6.24 \times 3}{10}}}_{>0} \cdot \frac{\boxed{(-2\alpha^2+4\alpha-4)} \rightarrow <0}{\boxed{(-2\alpha^2+\alpha+4)^2} \rightarrow >0}$$

$\Rightarrow \frac{di_L}{dt} < 0 \Rightarrow$ as α increases, i_L decreas

$\Rightarrow$ to get maximum i_L, α should be minimum

$\Rightarrow \alpha = 0$ optimum

$$\lim_{\alpha \to \infty} -2\alpha^2 + 4\alpha - 4 = -\infty$$

$$-4\alpha + 4 = 0 \Rightarrow \alpha = 1$$

$$-2(1)^2 + 4 \times 1 - 4 = -2 < 0$$

$$\Rightarrow -2\alpha^2 + 4\alpha - 4 < 0$$

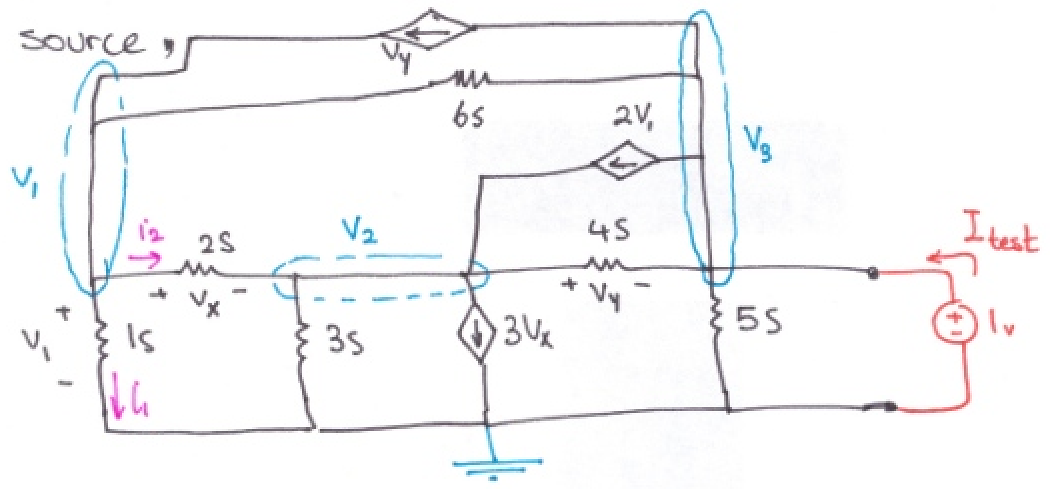
$$i_L\Big|_{\alpha=0} = \frac{6.24\,v}{10\Omega + \frac{10}{3}\Omega} = 0.468\ A$$

$$P_{L_{max}} = (0.468)^2 \times 10 = 2.19\ W$$

(Problem 5)

First we must find the equivalent circuit seen by R_L:

• R_{th}: turn off all independent sources and add a 1v test voltage source,



* S is the unit for conductance (G). So for example, the current flowing in the 1s conductance:

$i_1 = \frac{V_1}{R} = G.V_1 \Rightarrow i_1 = (1S).V_1$

for the 2s conductance: $i_2 = \frac{V_1 - V_2}{R} = G(V_1 - V_2) = (2S)(V_1 - V_2)$

at node 1: $V_1 + 2(V_1 - V_2) + 6(V_1 - V_3) - V_y = 0$

$V_y = V_2 - V_3$ $\qquad V_2 - V_3$

$V_1 + 2V_1 - 2V_2 + 6V_1 - 6V_3 - V_2 + V_3 = 0$

$9V_1 - 3V_2 - 5V_3 = 0$ (eq.1)

@ node 2: $2(V_2 - V_1) + 3V_2 + 3V_x + 4(V_2 - V_3) - 2V_1 = 0$

$V_x = V_1 - V_2$

$V_1(-2+3-2) + V_2(2-3+3+4) - 4V_3 = 0 \Rightarrow -V_1 + 6V_2 - 4V_3 = 0$ (eq.2

(Problem 5)

@node 3: $V_3 = 1v$

eq.1 $\longrightarrow 9V_1 - 3V_2 - 5(1) = 0 \longrightarrow 9V_1 - 3V_2 = 5 \xrightarrow{\times 2}$

eq.2 $\longrightarrow -V_1 + 6V_2 - 4(1) = 0 \Rightarrow -V_1 + 6V_2 = 4$

$$\begin{cases} 18V_1 - 6V_2 = 10 \\ -V_1 + 6V_2 = 4 \end{cases}$$

$17V_1 = 14$

$V_1 = 0.82\ v$

$V_2 = \frac{4 + V_1}{6} = 0.8v$

To find I_{test} write a KCL @ node 3:

$V_y + 6(V_3 - V_1) + 2V_1 + 4(V_3 - V_2) + 5V_3 = I_{test}$

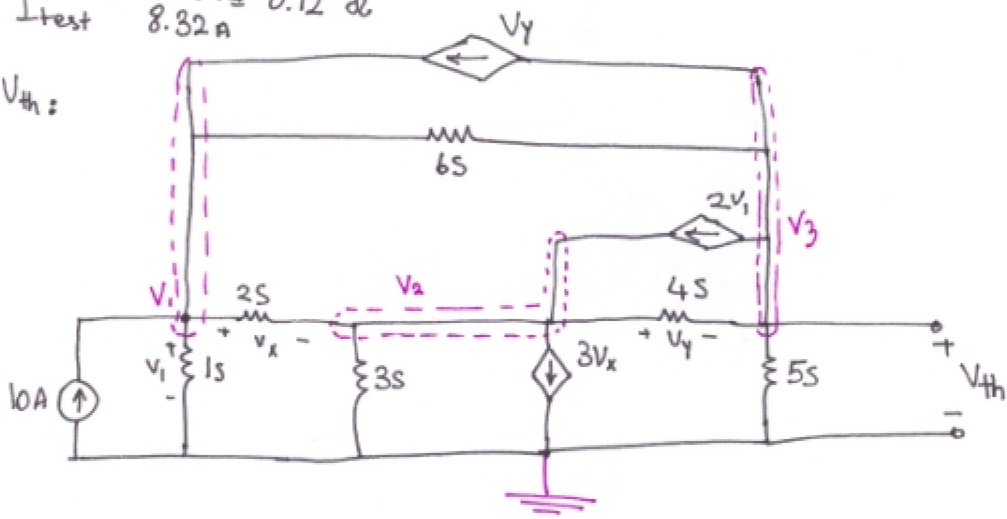
$V_2 - V_3 + 6V_3 - 6V_1 + 2V_1 + 4V_3 - 4V_2 + 5V_3 = I_{test}$

$I_{test} = (-6+2)V_1 + (1-4)V_2 + (-1+6+4+5)V_3$

$= -4 \times 0.82 - 3 \times 0.8 + 14 \times 1 = -3.28 - 2.4 + 14 = 8.32\ A$

$R_{th} = \frac{V_{test}}{I_{test}} = \frac{1v}{8.32A} = 0.12\ \Omega$

to find V_{th}:



node 1: $1 \times V_1 + 2(V_1 - V_2) + 6(V_1 - V_3) - V_Y = 10\ A$

$9V_1 - 3V_2 - 5V_3 = 10.$ (eq. 1)

(Problem 5)

@ node 2:

$$3V_2 + 2(V_2 - V_1) + 3\underbrace{V_x}_{V_1 - V_2} + 4(V_2 - V_3) - 2V_1 = 0$$

$$-V_1 + 6V_2 - 4V_3 = 0 \qquad \text{(eq. 2)}$$

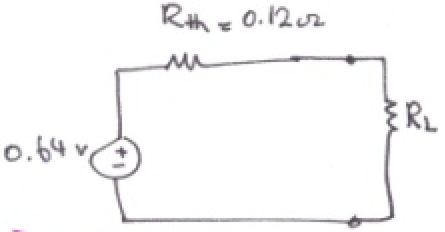
@ node 3:

$$5V_3 + 4(V_3 - V_2) + 2V_1 + 6(V_3 - V_1) + \underbrace{V_y}_{V_2 - V_3} = 0$$

$$-4V_1 - 3V_2 + 14V_3 = 0 \qquad \text{(eq. 3)}$$

$$\begin{bmatrix} 9 & -3 & -5 \\ -1 & 6 & -4 \\ 4 & -3 & 14 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix} \qquad V_{th} = V_3 = \frac{\Delta_3}{\Delta} = \frac{\begin{vmatrix} 9 & -3 & 10 \\ -1 & 6 & 0 \\ 4 & -3 & 0 \end{vmatrix}}{\begin{vmatrix} 9 & -3 & -5 \\ -1 & 6 & -4 \\ 4 & -3 & 14 \end{vmatrix}}$$

$$V_{th} = \frac{270}{423} = 0.64\ \text{v}$$



to get the maximum power transfer,

$$R_{th} = R_L \Rightarrow R_L = 0.12\Omega$$

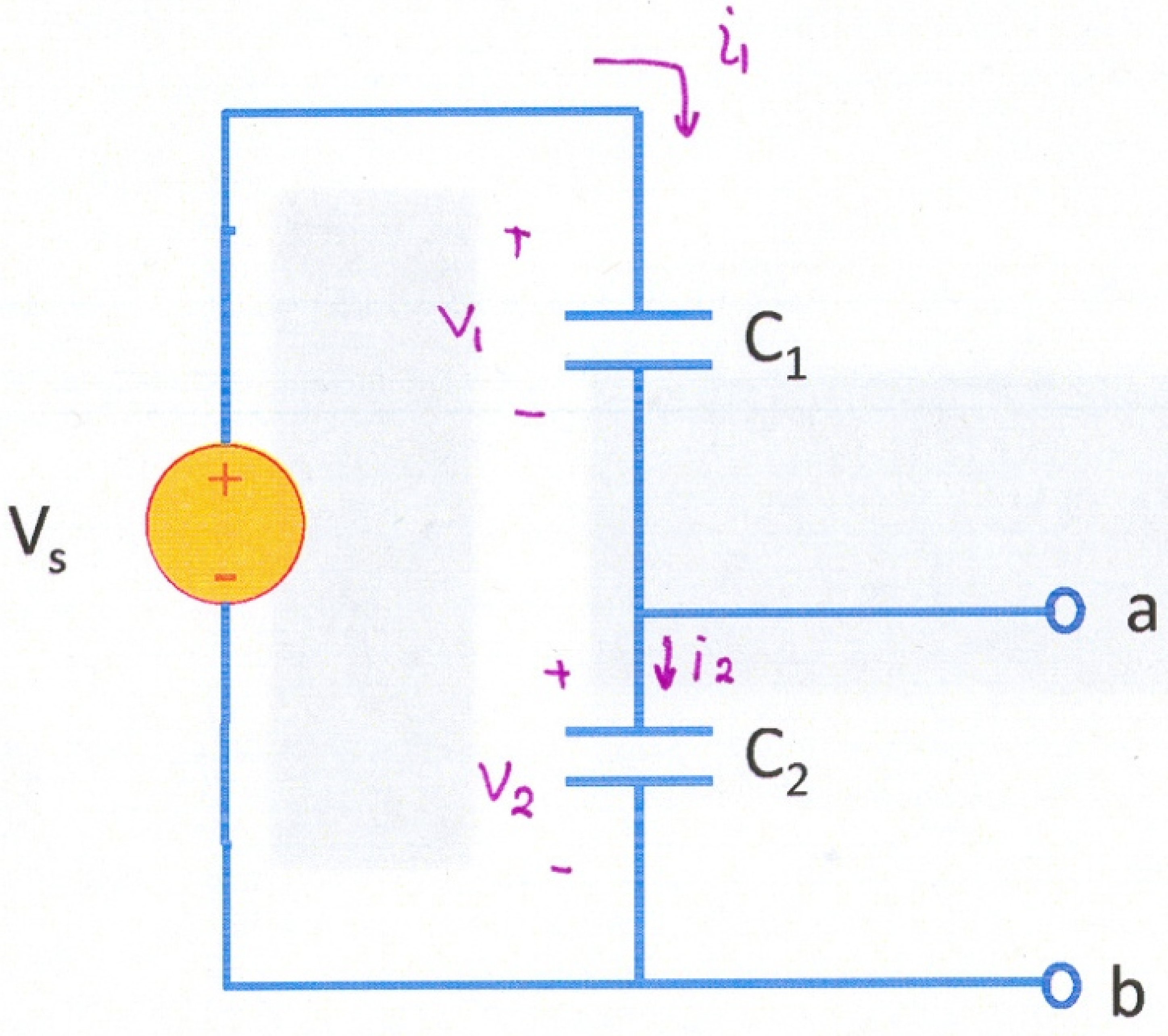
$$P_L = \frac{V_{th}^2}{4R} = \frac{(0.64)^2}{4 \times 0.12} = 0.85\ \text{w}$$

$$P_L = i_L^2 \cdot R_L$$

$$P_L = \left(\frac{V_{th}}{R_{th} + R_L}\right)^2 \cdot R_L$$

$$R_L = R_{th} = R \Rightarrow P_L = \left(\frac{V_{th}}{R + R}\right)^2 \cdot R = \frac{V_{th}^2}{4R}$$

Problem6) Find the voltage across C_2.



(Problem 6)

C_1 is in series with $C_2 \Rightarrow i_1 = i_2 = i$

$$q = \int_0^t i(t)\,dt$$

charge stored in the capacitor

$$\left.\begin{aligned} q_1 &= \int i_1(t)\,dt = \int i(t)\,dt \\ q_2 &= \int i_2(t)\,dt = \int i(t)\,dt \end{aligned}\right\} \Rightarrow q_1 = q_2 = q$$

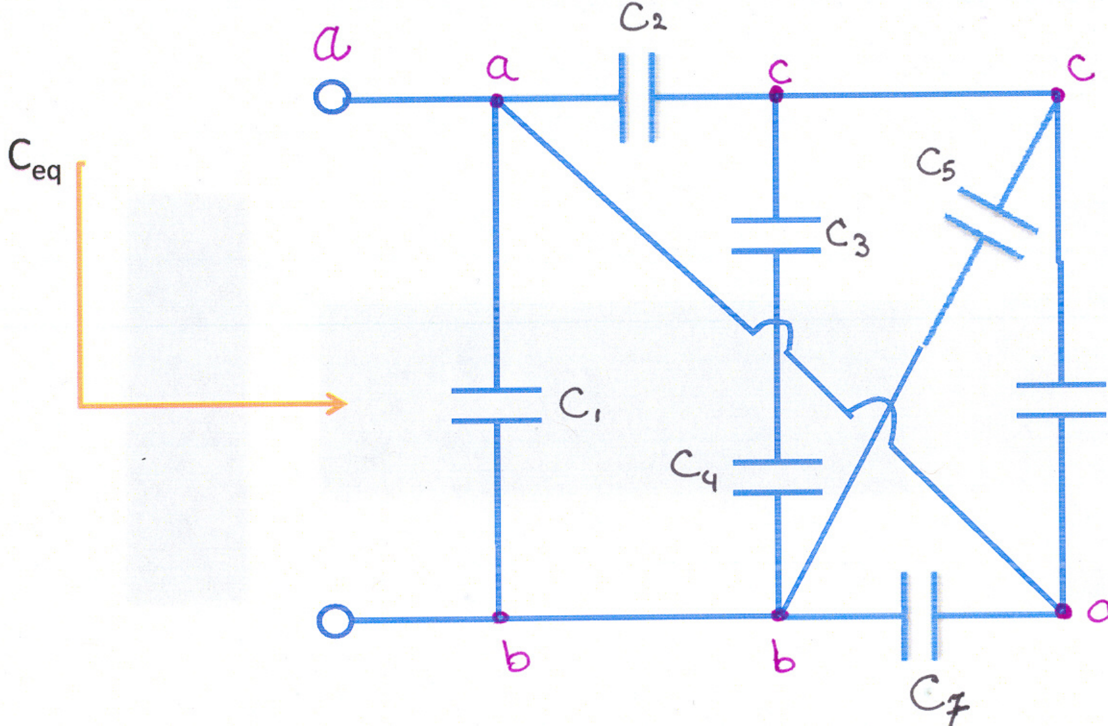
$$\left.\begin{aligned} q_1 &= C_1 V_1 \\ q_2 &= C_2 V_2 \end{aligned}\right\} \Rightarrow C_1 V_1 = C_2 V_2$$

$$\left.\begin{aligned} &C_1 V_1 = C_2 V_2 \\ &\text{KVL} \rightarrow V_S = V_1 + V_2 \end{aligned}\right\} \Rightarrow C_1 (V_S - V_2) = C_2 V_2$$

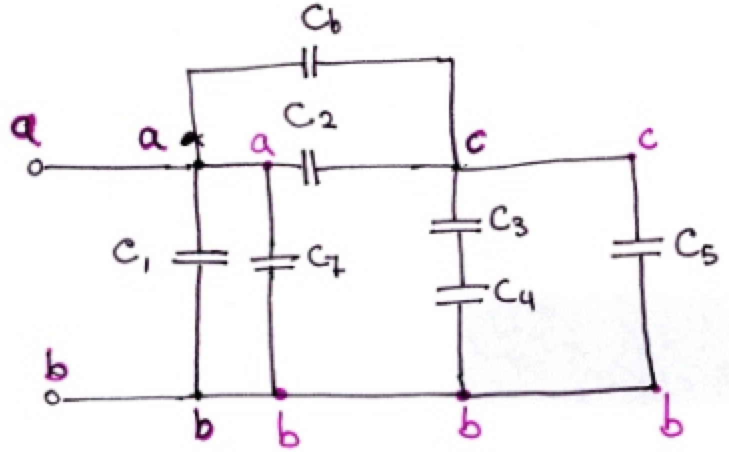
$$C_1 V_S = (C_1 + C_2) V_2$$

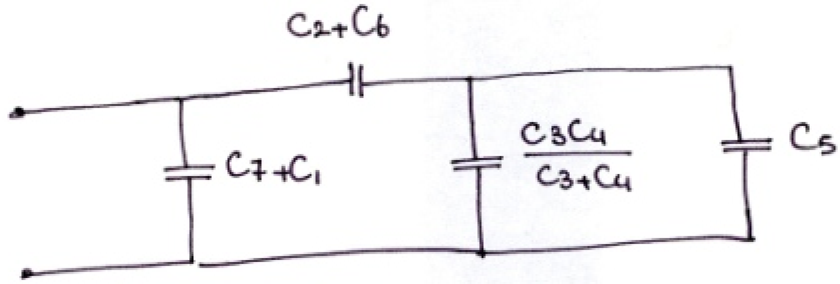
$$V_2 = \frac{C_1}{C_1 + C_2} V_S$$

Problem 7) Find the equivalent capacitance. All Capacitors have the value of 1mF.

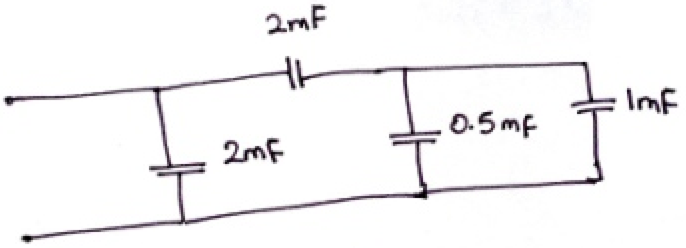


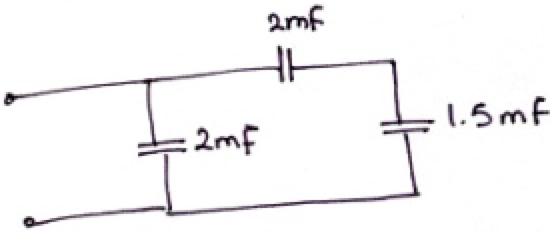
(Problem 7)

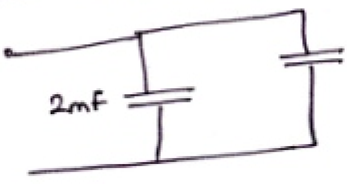




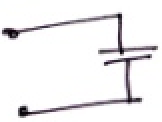
$C_1 = C_2 = C_3 = C_4 = C_5 = C_6 = C_7 = 1\,mF$





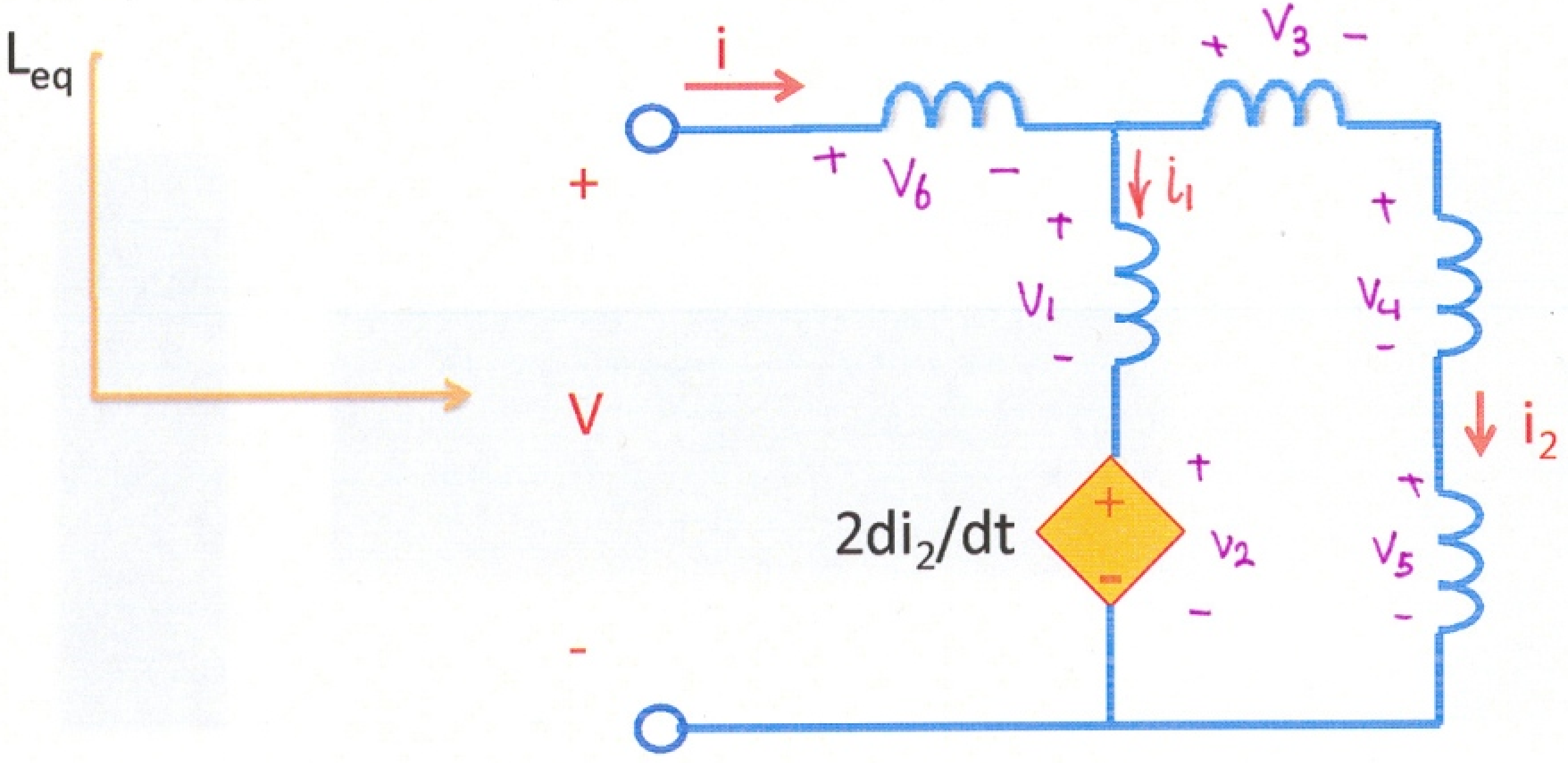


$\frac{2mF \times 1.5mF}{2mF + 1.5mF} = \frac{6}{7}\,mF$



$2mF + \frac{6}{7}mF = \frac{20}{7}\,mF \Rightarrow C_{eq} = \frac{20}{7}\,mF$

Problem8) Find the equivalent inductance. All inductors are 1H



Hint: $V=L_{eq}\ di/dt$

(Problem 8)

$$V = V_6 + V_1 + V_2 = L\frac{di}{dt} + L\frac{di_1}{dt} + 2\frac{di_2}{dt} \qquad (*)$$

$$V = \frac{di}{dt} + \frac{di_1}{dt} + 2\frac{di_2}{dt}$$

KVL : $V_1 + V_2 = V_3 + V_4 + V_5$

$$\frac{di_1}{dt} + 2\frac{di_2}{dt} = \frac{di_2}{dt} + \frac{di_2}{dt} + \frac{di_2}{dt} \Rightarrow \frac{di_1}{dt} = \frac{di_2}{dt}$$

$$i_1 + i_2 = i \Rightarrow \left.\begin{array}{l} \dfrac{di_1}{dt} + \dfrac{di_2}{dt} = \dfrac{di}{dt} \\ \\ \dfrac{di_1}{dt} = \dfrac{di_2}{dt} \end{array}\right\} \Rightarrow \frac{di_1}{dt} = \frac{di_2}{dt} = \frac{1}{2}\frac{di}{dt}$$

$\Rightarrow$ replace in $(*)$ $\rightarrow$ $V = \dfrac{di}{dt} + \dfrac{1}{2}\dfrac{di}{dt} + 2 \times \dfrac{1}{2}\dfrac{di}{dt}$

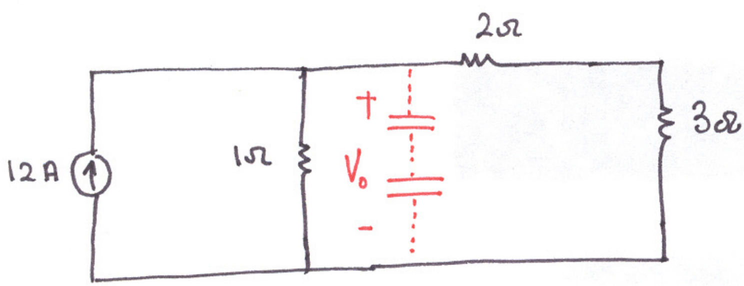
$$V = \frac{5}{2}\frac{di}{dt} = L_{eq}\frac{di}{dt}$$

$$\Rightarrow L_{eq} = \frac{5}{2}\ H$$

Problem 9)

$$V(t) = V_0 e^{-t/RC}$$

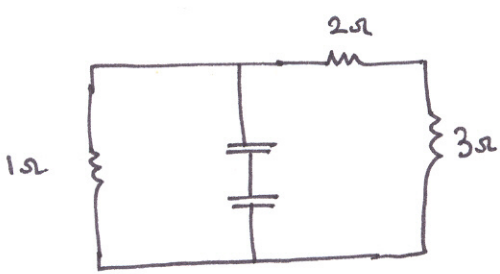
before the switch opens: (Capacitors behave like open circuits)



$$V_0 = 12 \times R_{eq} = 12 \times (1\Omega \parallel (2\Omega + 3\Omega))$$

$$= 12 \times (1 \parallel 5) = 12 \times \frac{1 \times 5}{1+5} = 10\,v$$

after the switch opens:



$$R_{eq} = 1\Omega \parallel (2\Omega + 3\Omega) = 5/6\,\Omega$$

$$C_{eq} = \frac{C_1 C_2}{C_1 + C_2} = \frac{3 \times 7}{3+7}\,F = 2.1\,F$$

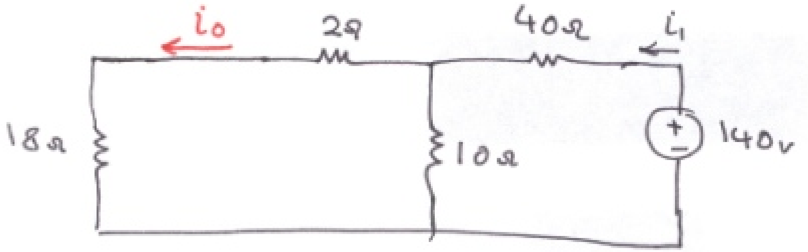
$$\tau = R_{eq} . C_{eq} = 5/6 \times 2.1 = 1.75\ s$$

$$V(t) = 10\, e^{-t/1.75}\ v \qquad (t>0)$$

(Problem 10)

$$i_L(t) = i_0 \, e^{-R/L\, t}$$

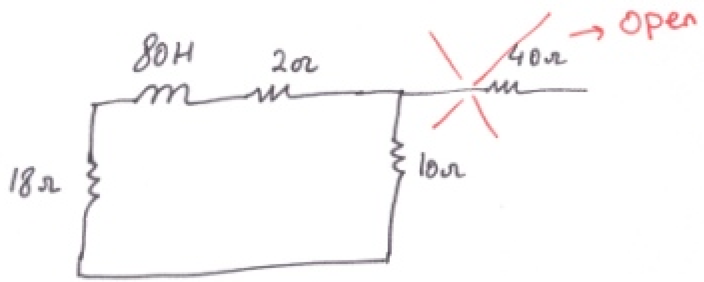
before switch opens : (Inductor behaves like a short circuit)



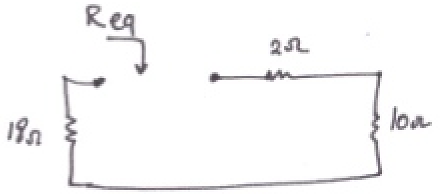
$$i_1 = \frac{140\text{v}}{40\Omega + (10 \parallel (2+18))\Omega} = \frac{140\text{v}}{(40 + 10 \parallel 20)\Omega} = 3\text{ A}$$

$$i_0 = i_1 \times \frac{10\Omega}{10\Omega + 2\Omega + 18\Omega} = i_1 \times \frac{10}{30} = 1 \times \frac{1}{3} = 1\text{ A}$$

after the switch opens :



$$L_{eq} = 80\text{ H}$$



$$R_{eq} = 2\Omega + 8\Omega + 10\Omega = 20\Omega$$

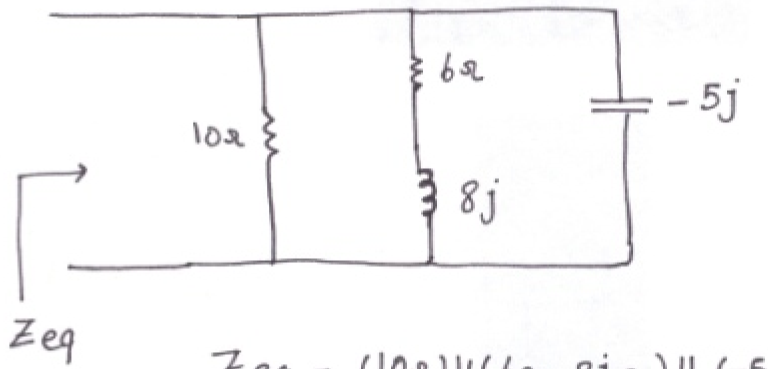
$$i_L(t) = i_0 \, e^{-R/L\, t} = 1 \times e^{-\frac{20}{80}t} = e^{-t/4} \quad \text{A} \quad (t > 0$$

(Problem 11)

First we should find all impedances:

For the capacitor: $Z_C = \frac{1}{j\omega C} = \frac{1}{j \times 10^5 \times 2 \times 10^{-6}} = -5j\ \Omega$

" " Inductor: $Z_L = j\omega L = j \times 10^5 \times 80 \times 10^{-6} = 8j\ \Omega$

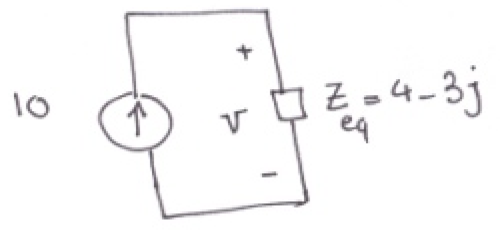


$$Z_{eq} = (10\Omega) \| (6\Omega + 8j\Omega) \| (-5j\Omega)$$

$$\frac{1}{Z_{eq}} = \frac{1}{10\Omega} + \frac{1}{(6+8j)\Omega} + \frac{-1}{5j\Omega}$$

$$\frac{1}{Z_{eq}} = \frac{(j-2)(3+4j)+5j}{10j\,(3+4j)} = \frac{-10}{30j-40} = \frac{-1}{3j-4}$$

$$\Rightarrow Z_{eq} = 4 - 3j\ \Omega$$



$V = I . Z_{eq} = 10\,(4-3j) = 10 \times 5 \angle -0.6$

$= 50 \angle -0.64$

$v(t) = 50 \cos(\omega t - 0.64)$ v