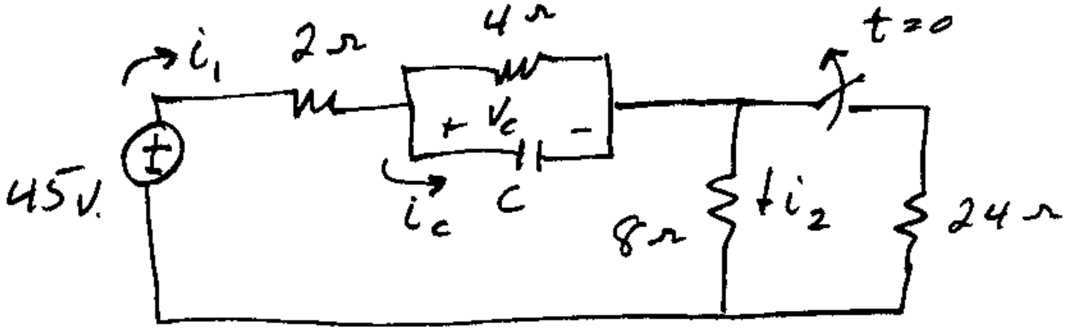
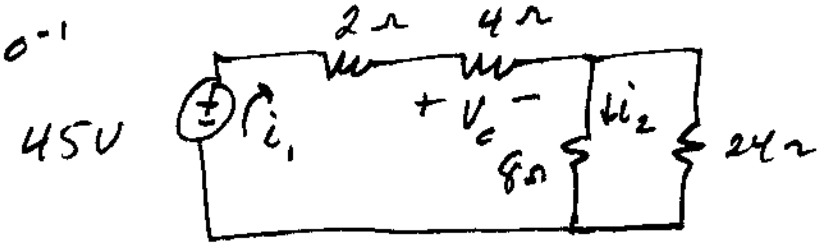
1. If $i_1(0^-) = \frac{15}{4}A$ Find i_1, i_2, i_c and V_c at $t=0^+$



Verify the $t=0^-$ condition

$t \le 0^-$



$$R_1 = \frac{8(24)}{32} = 6\,\Omega$$

$$i_1 = \frac{45}{12} = \frac{15}{4}A$$

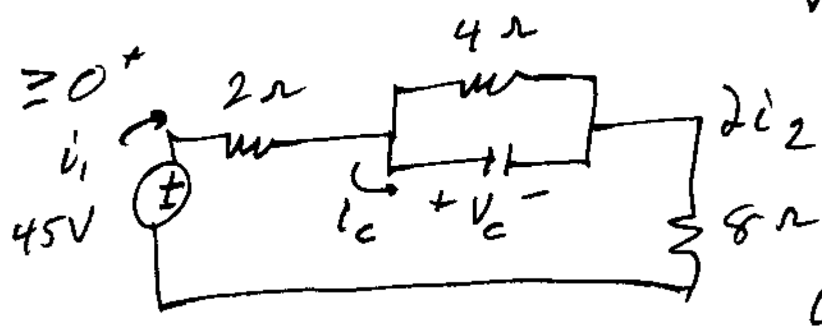
$$i_2(0^-) = \frac{24}{32}\left[\frac{15}{4}\right]$$

$$i_2(0^-) = 2.8125\,A$$

$$V_c(0^-) = 4\left(\frac{15}{4}\right)$$

$$V_c(0^-) = 15\,V$$

$t \ge 0^+$



$$V_c(0^+) = 15\,V$$

$$i_{4\Omega}(0^+) = \frac{15}{4}A$$

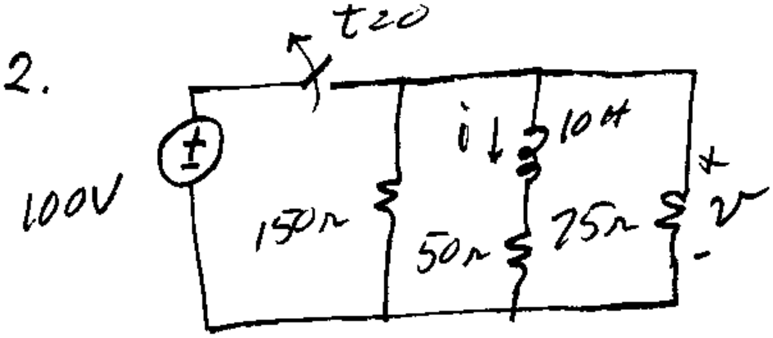
$$-45 + 2i_1 + V_c + 8i_1 = 0$$

$$10i_1 = 45 - 15$$

$$i_1(0^+) = 3A = i_2(0^+)$$

$$i_c(0^+) = 3 - 15/4 = -3/4\,A$$

2.

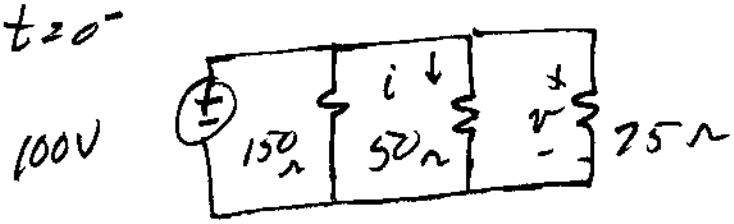


DC steady state at $t=0^-$

Verify that $i(0^-)=2A$

Find the complete response for v, $t>0$.

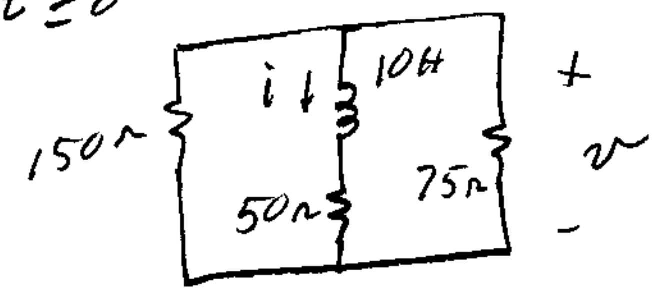
$t=0^-$



$i(0^-) = \frac{100}{50} = 2A$

$i(0^-) = i(0^+) = 2A$

$t \geq 0$



Req as seen by the 10 H inductor.

$$R_{eq} = 50 + \frac{75(150)}{75+150} = 100\,\Omega$$

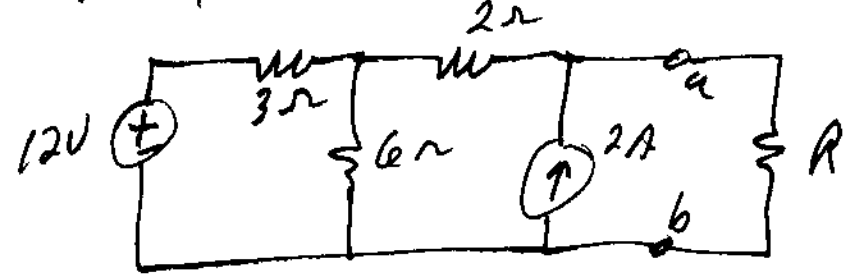
$$\tau = \frac{L}{R_{eq}} = .1\text{ s}$$

$$i(t) = 2e^{-10t}\text{ A}$$

$$v(t) = 10\frac{di}{dt} + 50i = 10\left[-20e^{-10t}\right] + 100e^{-10t}$$

$$v(t) = -100e^{-10t}\text{ V.}$$

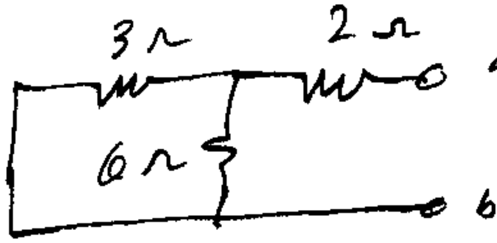
3.(a) Find the value of R that yields the max Power Transfer.



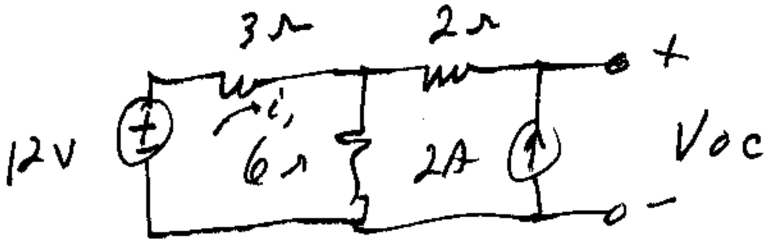
a) Find Thevenin & Norton Equivalent circuit.

Rth :

why is this True?



$R_{th} = 2 + \frac{3(6)}{3+6} = 4\,\Omega$



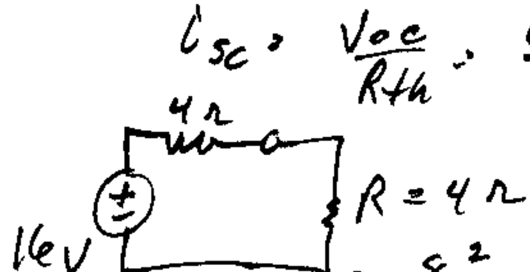
$-12 + 9i_1 + 6(2) = 0$

$9i_1 = 12 - 12 = 0 \Rightarrow i_1 = 0\,A$

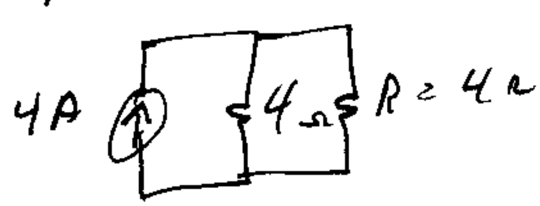
$0 \cdot 6 + 8(2) - V_{oc} = 0$

$V_{oc} = 16$ VOLTS

$i_{sc} = \frac{V_{oc}}{R_{th}} = \frac{16}{4} = 4\,A$

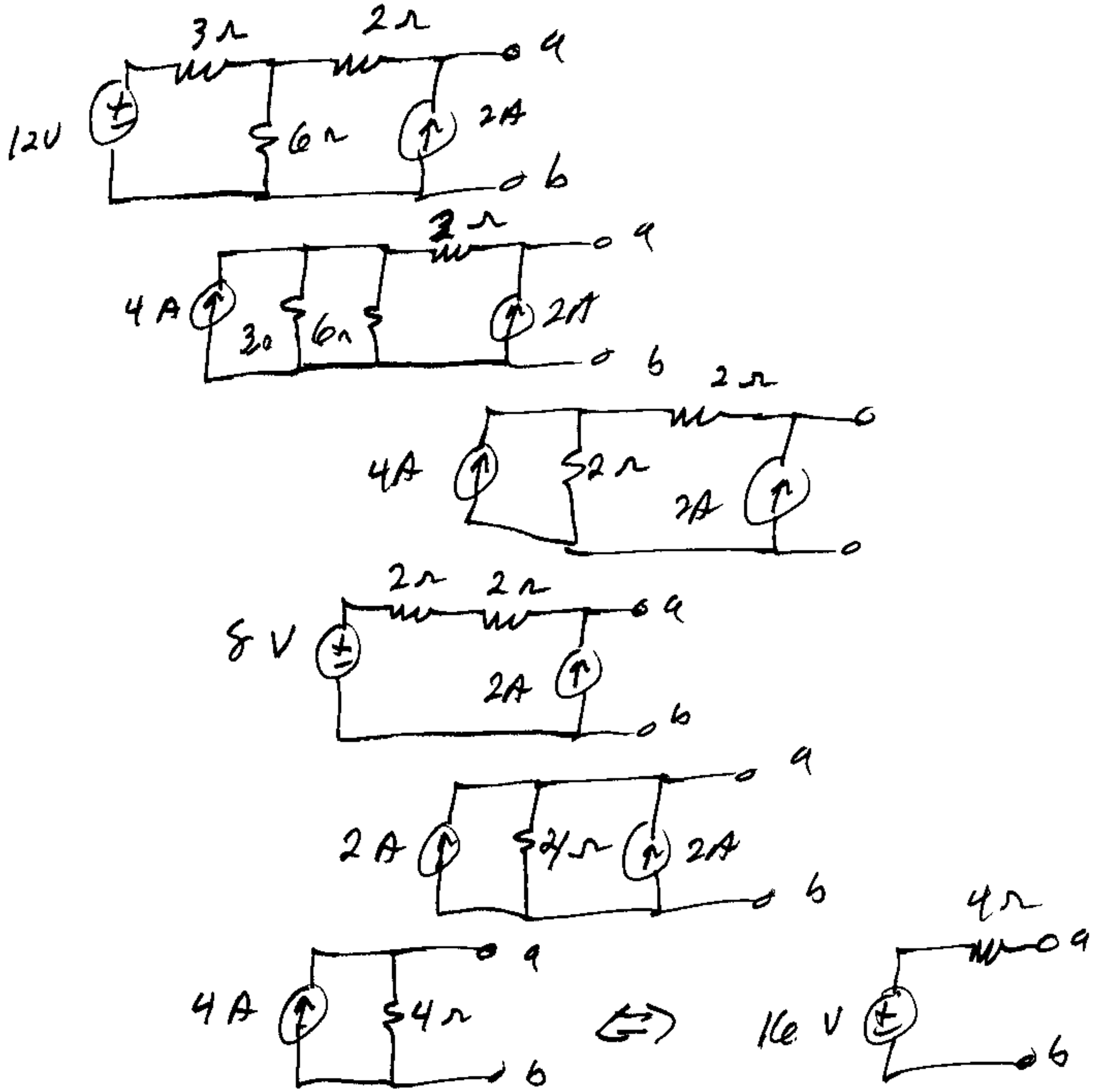


$P = \frac{8^2}{4} = 16\,W$



$P = (2)^2 4 = 16\,W$

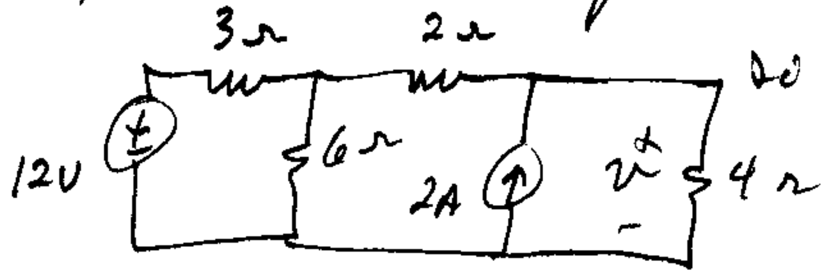
3 cont (b) Find Thevinin & Norton equivalent using Source Trans.

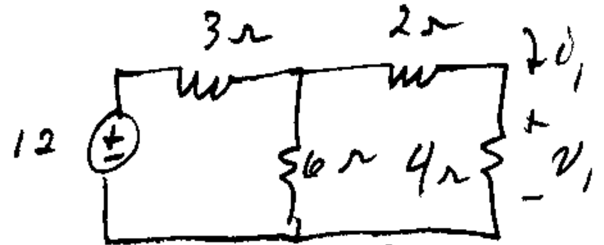


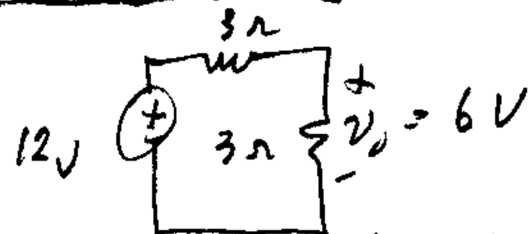
NORTON

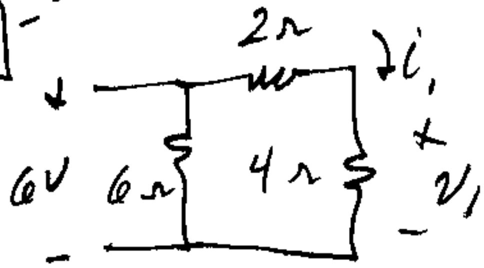
3 cont Let $R = 4\Omega$ Use superposition to find i and v

c)



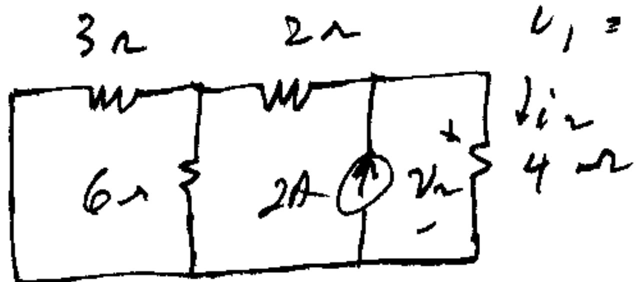


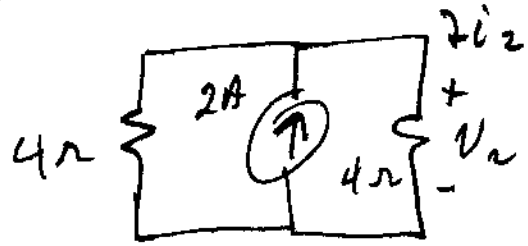




$$\Rightarrow v_1 = \frac{4}{6}(6) = 4V.$$

$$i_1 = \frac{4}{4} = 1A$$





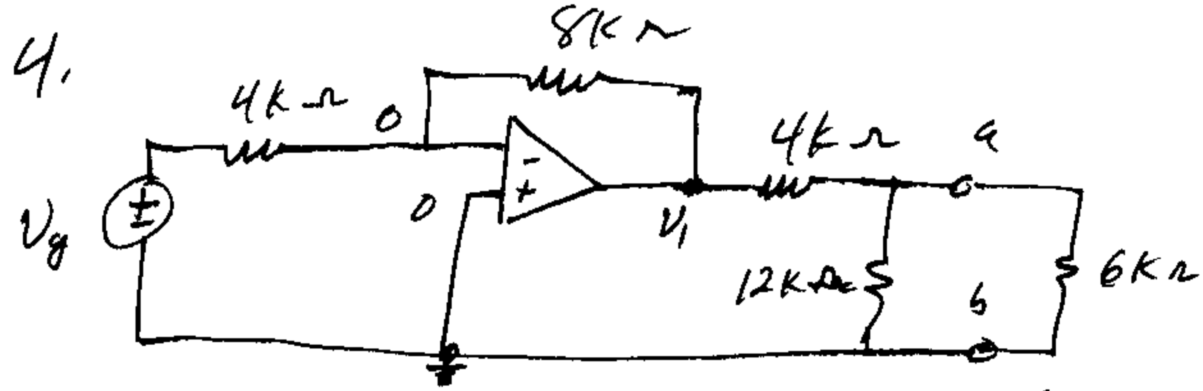
$i_2 = 1A$

$v_2 = 4V$

$i = i_1 + i_2 = 1 + 1 = 2A$

$v = 4 + 4 = 8V.$

4.



$V_g = 6\cos 2t$ V

Find the Norton eq ckt to the left of Ports a, b

Use the results to find the Power delivered to the 6K Ω resistor.

$$\frac{0-V_g}{4K} + \frac{0-V_1}{8K} = 0 \Rightarrow \frac{V_1}{8} = \frac{-V_g}{4}$$

$$V_1 = -2V_g$$

$$V_{oc} = \frac{12}{16}V_1 = \frac{3}{4}\left[-2V_g\right] = -\frac{3}{2}V_g$$

$$V_{oc} = -9\cos 2t \text{ V.}$$

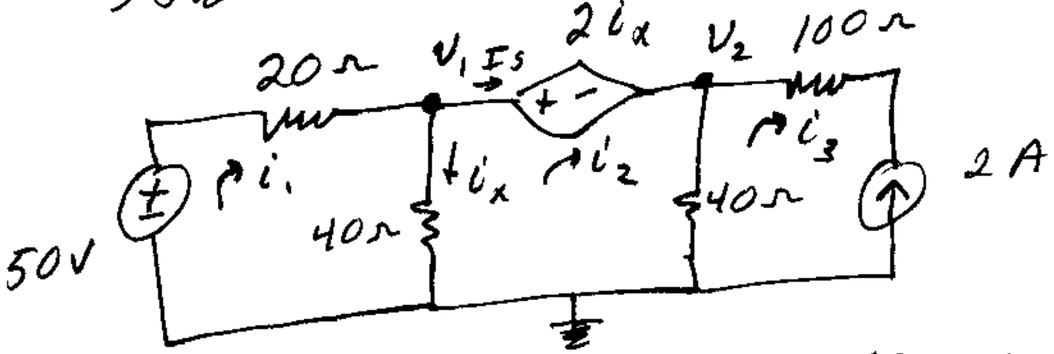
$$i_{sc} = \frac{V_1}{4K} = -\frac{1}{2}V_g \text{ mA} = -3\cos 2t \text{ mA}$$

$$R_{th} = \frac{V_{oc}}{i_{sc}} = \frac{-9\cos 2t \text{ V}}{-3\cos 2t \text{ mA}} = 3K\,\Omega$$

$$P = (6000)\left(\frac{3K}{3K+6K}i_{sc}\right)^2 = 6\left[\frac{3}{9}(-3\cos 2t)\right]^2 \times 10^{-3}$$

$$\underline{P = 6\cos^2 2t \text{ mW}}$$

5. Given



a) use Nodal analysis to find v_1, v_2
i) "Super Node - eliminate I_s"
ii) Include I_s

Dependency eq
$$i_x = \frac{V_1}{40}$$

① $$\frac{V_1 - 50}{20} + \frac{V_1}{40} + I_s = 0$$

② $$-I_s + \frac{V_2}{40} - 2 = 0$$

add these eliminate I_s "super node"

$$\frac{V_1 - 50}{20} + \frac{V_1}{40} + \frac{V_2}{40} - 2 = 0$$

$$3V_1 + V_2 = 180$$

CONSTRAINT EQUATION:

$$-V_1 + 2i_x + V_2 = 0$$

$$-V_1 + 2\left(\frac{V_1}{40}\right) + V_2 = 0$$

$$-19V_1 + 20V_2 = 0$$

5a cont

2 equations 2 unknowns.

$$3V_1 + V_2 = 180$$
$$-19V_1 + 20V_2 = 0$$

$$\begin{bmatrix} 3 & 1 \\ -19 & 20 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 180 \\ 0 \end{bmatrix}$$

$$\Rightarrow V_1 = 45.57\ V$$
$$V_2 = +43.29\ V$$

$$i_x = \frac{45.57}{40} = 1.14\ A$$

$$-I_s + \frac{43.24}{40} - 2 = 0 \Rightarrow I_s = -.9178\ A$$

5a cont Nodal Analysis with I_S

① $$\frac{v_1 - 50}{20} + \frac{v_1}{40} + I_S = 0$$

$$3v_1 + 40 I_S = 100$$

② $$-I_S + \frac{V_2}{40} - 2 = 0$$

$$V_2 - 40 I_S = 80$$

③ const eq $$-19V_1 + 20V_2 = 0$$

$$\begin{bmatrix} 3 & 0 & 40 \\ 0 & 1 & -40 \\ -19 & 20 & 0 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ I_S \end{bmatrix} = \begin{bmatrix} 100 \\ 80 \\ 0 \end{bmatrix}$$

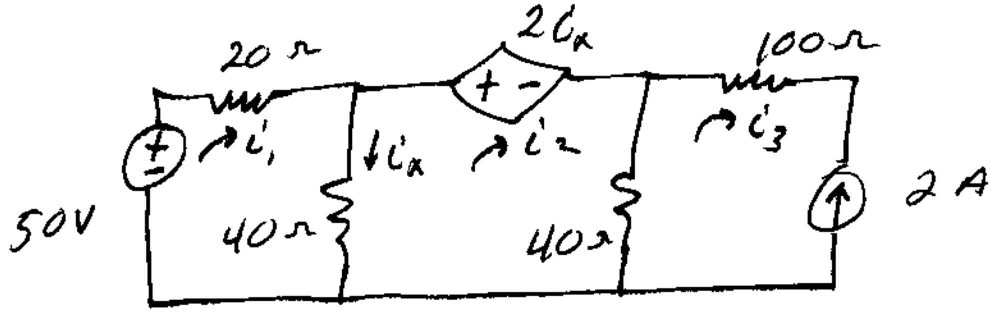
$$V_1 = 45.57\,V$$

$$V_2 = 43.29\,V.$$

$$I_S = -.1978$$

5b cont

MESH ANALYSIS



$i_3 = -2A$

Dependency eq: $i_x = i_1 - i_2$

① $-50 + 60i_1 - 40i_2 = 0$

$60i_1 - 40i_2 = 50$

② $-40i_1 + 2[i_1 - i_2] + 80i_2 = -80$ NOTE $[i_1 - i_2] = i_x$

$-38i_1 + 78i_2 = -80$

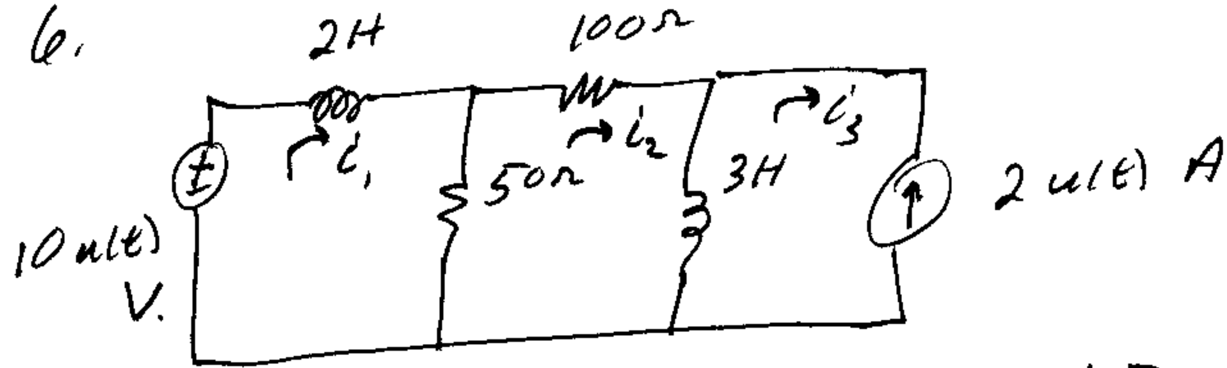
$$\begin{bmatrix} 60 & -40 \\ -38 & 78 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 50 \\ -80 \end{bmatrix}$$

$i_1 = .222\ A$

$i_2 = -.918\ A$

$i_x = i_1 - i_2 = 1.14$

6.



$i_3 = -2A \quad t \geq 0$

Find $i_1(t)$, $t \geq 0$ complete sol.

Need to determine:

a) $i_1(0)$

b) FORM of THE NATURAL RESPONSE $s_1, s_2 \Rightarrow$? [TWO CONSTANTS A_1, A_2]

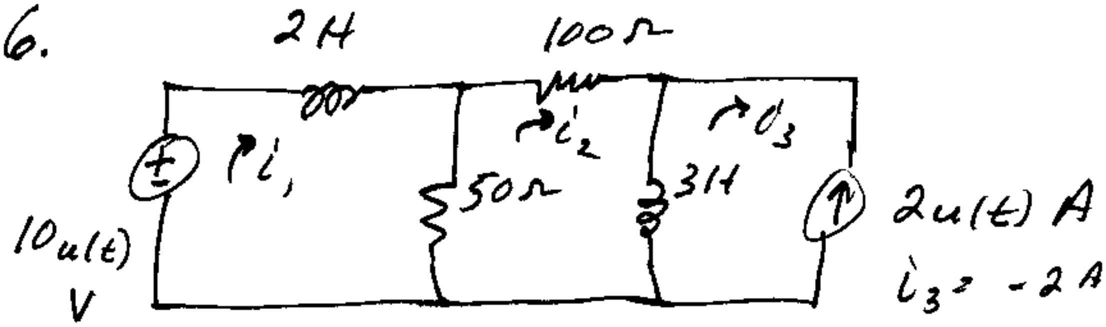
c) Forced Response

d) $\dfrac{di_1(0+)}{dt}$

e) Then SOLVE FOR A_1, A_2

f) Then you have the complete solution.

6.



$i_3 = -2A \quad t \geq 0$

Find $i_1(t)$, $t \geq 0$ complete solution

Use Mesh analysis all i.c are zero

① $-10 + 2\frac{di_1}{dt} + 50(i_1 - i_2) = 0$

$$2\frac{di_1}{dt} + 50i_1 - 50i_2 = 0$$

② $-50i_1 + 150i_2 + 3\frac{d(i_2 - (-2))}{dt} = 0$

$$3\frac{di_2}{dt} + 150i_2 - 50i_1 = 0$$

$$s \equiv \frac{d}{dt}$$

① $2si_1 + 50i_1 - 50i_2 = 10$

$$(2s + 50)i_1 - 50i_2 = 10$$

②

$$3si_2 - 150i_2 - 50i_1 = 0$$

$$-50i_1 + (3s + 150)i_2 = 0$$

6 cont

$$i_1 = \frac{\begin{vmatrix} 10 & -50 \\ 0 & (3s+150) \end{vmatrix}}{\begin{vmatrix} (25+50) & -50 \\ -50 & (3s+150) \end{vmatrix}}$$

$$= \frac{10(3s+150)}{(2s+50)(3s+150) - (-50)(-50)}$$

$$= \frac{10(3s+150)}{6s^2 + 300s + 150s + 7500 - 2500}$$

$$= \frac{10(3s+150)}{6s^2 + 450s + 5000} = \frac{10(3s+150)}{s^2 + 75s + 833.3}$$

$$s_{1,2} = \frac{-75 \pm \sqrt{75^2 - 4(833.3)}}{2}$$

$$s_1 = -85.37 \qquad s_2 = -10.37$$

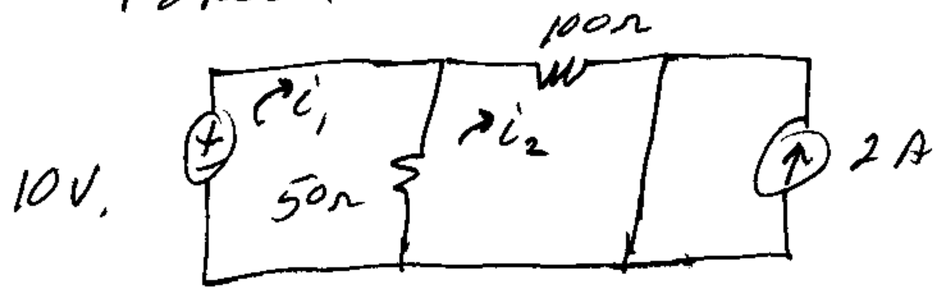
$$i_1(t) = A_1 e^{-85.37t} + A_2 e^{-10.37t} + i_f$$

overdamped

6 cont The initial condition were all zero

$i_1(0) = 0$

Forced Response:



① $-10 + 50 i_1 - 50 i_2 = 0$

$50 i_1 - 50 i_2 = 10$

② $-50 i_1 + 150 i_2 = 0$ — why?

$\Rightarrow \quad 100 i_2 = 10$

$i_2 = \frac{10}{100} = .1 A$

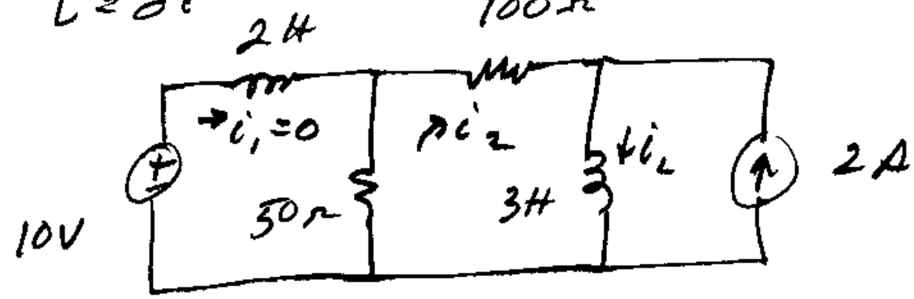
$50 i_1 = 10 + 50(.1)$

$i_1 = 15/50 = .3 A$

$\Rightarrow$

$i_1(t) = A_1 e^{-85.37t} + A_2 e^{-10.37t} + .3 \quad A \quad t \geq 0$

6) $t=0^+$



$$i_1(0^-) = i_1(0^+) = 0 \qquad i_L(0^-) = i_L(0^+) = 0$$

$$0 = i_2 + 2$$

$$\Rightarrow i_2 = -2\text{ A}$$

$$-10 + 2\frac{di_1(0^+)}{dt} + 50\left(0-(-2)\right) = 0$$

$$2\frac{di_1(0^+)}{dt} = 10 - 50\left(0-(-2)\right) = 10 - 50(2)$$

$$= 10 - 100 = -90$$

$$\frac{di_1(0^+)}{dt} = -45 \text{ A/s}$$

6 cont

$$\frac{di_1}{dt} = -85.37A_1e^{-85.37t} - 10.37A_2e^{-10.37t} + 0$$

since Forced Response A CONSTANT

$$\frac{di_1(0^+)}{dt} = -45 = -85.37A_1 - 10.37A_2$$

$$i_1(0) = 0 = A_1 + A_2 + .3$$

$$\begin{bmatrix} -85.37 & -10.37 \\ 1 & 1 \end{bmatrix}\begin{bmatrix} A_1 \\ A_2 \end{bmatrix} = \begin{bmatrix} -45 \\ -.3 \end{bmatrix}$$

$A_1 = .6415$
$A_2 = -.9418$

$$i_1(t) = .6415e^{-85.37t} - .9418e^{-10.37t} + .3 \quad u(t)\ A$$