UCLA

Electrical and Computer Department

ECE 100

First Midterm

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Problems	Points
1	10 /10
2	8 /10
3	0 /10
4	10 /10
5	7 /20
6	19 /20
7	8 /10
8	9 /10
Total	71 /100

1. **Find $i_s, i_1,$ and i_2 in the circuit Fig. 1.**

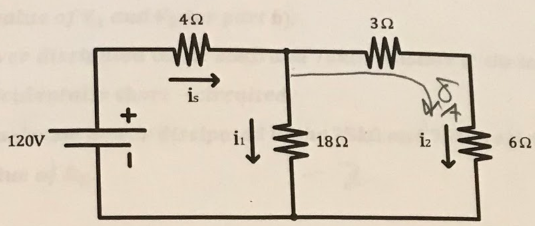
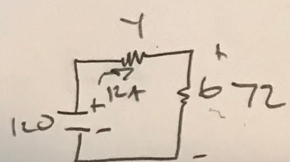
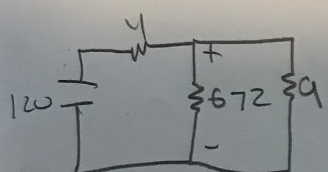


Figure 1



$i_s = \frac{V_s}{R_{eq}}$ $\boxed{i_s = 12A}$



$V_9 = I_2 R_{3+6}$

$\frac{72}{9} = 8$ $\boxed{I_2 = 8A}$

$I_s = i_1 + i_2$

$\boxed{12 - 8 = i_1 = 4A}$

2. a) *Find no load value of V_o in the circuit Fig. 2.*

b) *Find V_o when $R_L = 150\ k\Omega$.*

c) *What are the value of V_1 and V_2 for part b).*

d) *How much power dissipated in the $25k\Omega$ and $75k\Omega$ resistors if the load terminals are accidentally short – circuited.*

e) *What is the maximum power dissipated in the $25k\Omega$ and $75k\Omega$ resistors, and for what value of R_L.*

-2

$P=VI$

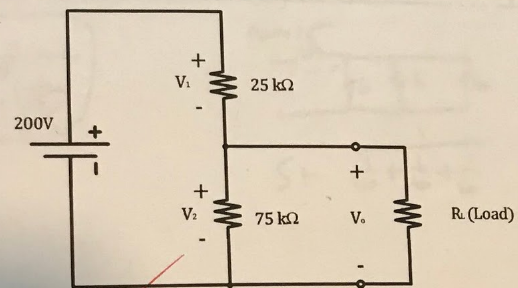


Figure 2

(a) $V=IR_{eq}$

$V=I100$

$\frac{200}{100{,}000} = 2\times10^{-3}A$

$V_o = 2\times10^{-3}\cdot 75\times10^{3}$

$V_o = \boxed{150V}$

(B) $R_{2L} = \frac{1}{75}+\frac{1}{150}$

$= \frac{2}{150}+\frac{1}{150} = \frac{3}{150} = \frac{150}{3}$

$= 50\Omega$

$V=IR$ ∴ $\frac{200}{75\times10^{3}} = 2.667\times10^{-3} = I$

$V_L = \boxed{133V}$

(c) $V_1 = 200-133$

$= \boxed{67V}$

$V_L = V_2 = \boxed{133V}$

(d) No Power in $75k\Omega$.

~~V~~ $P=VI=\boxed{1.6W}$

$I = \frac{200}{25\times10^{3}}$

3. *The ladder network has infinite number of resistors.*

a) Find R_{eq} of the circuit and I_s in terms of V_s and R.

b) If $V_s = 10V$ and $R = 1k\Omega$, what are I_1, I_2, I_3, and I_4.

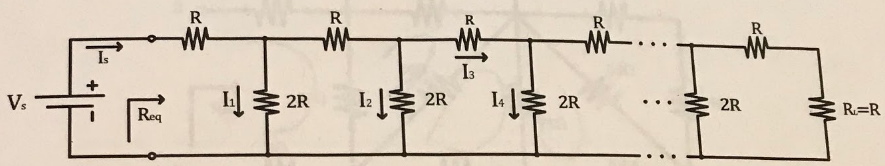
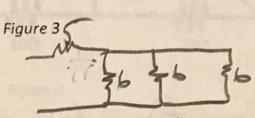


Figure 3



$$5 + \frac{1}{\frac{1}{6}+\frac{1}{6}+\frac{1}{6}}$$

a) $\boxed{R_{eq} = R + \frac{1}{\sum_{i=1}^{\infty} \cancel{\frac{1}{2R}}}}$

B)

-10

4. Find R_{ab} for the circuit.

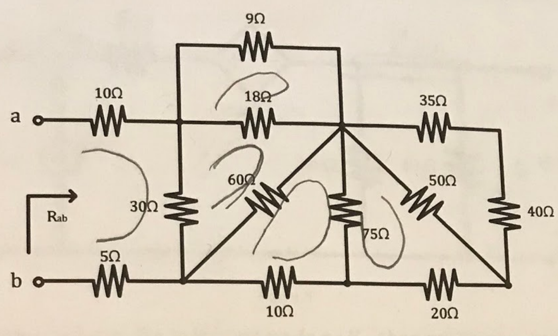
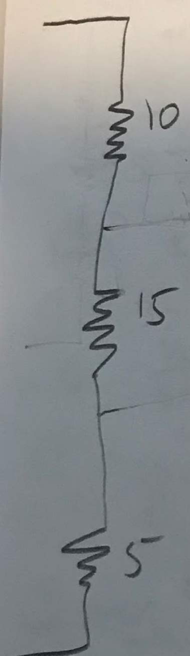


Figure 4

$\frac{1}{75} + \frac{1}{50} = \frac{2}{150} + \frac{3}{150} = \frac{5}{150} = \frac{150}{5} = 30$



$10 + 15 + 5 = 30$

$\frac{1}{50} + \frac{1}{75} = 30$

$\frac{1}{40} + \frac{1}{60} =$

$\frac{6}{240} + \frac{4}{240} = \frac{10}{240} = \frac{240}{10} = 24$

$\frac{1}{9} + \frac{1}{18} =$

$\frac{3}{18} = 6$

$\frac{1}{30} + \frac{1}{30} = 15$

$\boxed{30\Omega}$

I redraw circuit, then erased as went along

5. ***Find the THEVENIN equivalent circuit with respsect to the terminals a, b.***

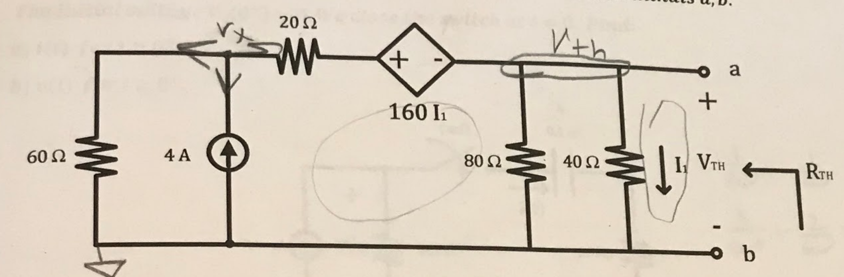


Figure 5

(Hint: define the voltage at the left most node as V_x, then write two nodal equations as V_x and V_{TH}, and then find V_{TH} and R_{TH}.)

$V_{th} = \cancel{4R}$

$= 40I_1$

V_x: $\frac{V_x}{60} - 4 + \frac{V_x - 160I_1}{20} = 0$

V_{th}: $\frac{V_{th}}{80} + \frac{V_{th}}{40} - \cancel{\frac{V_x - 160I_1}{20}} = 0$

(1) $\frac{V_x}{60} + \frac{V_x - 160I_1}{20} = 4$

$\frac{V_x}{60} + \frac{V_x}{20} - \frac{160I_1}{20} = 4$; $V_x + 3V_x - 480I_1 = 240$

(2) $\frac{V_{th}}{80} + \frac{V_{th}}{40} + \frac{160I_1 - V_x}{20} = 0$

$4V_x - 480I_1 = 240$

$-4V_x + 600I_1 = 0$

$I_1 = 120A$

(1) $= 4V_x - 480I_1 = 240$

$\cancel{4V_x = 576000 = 2400}$

(2) $\frac{40I_1}{80} - \frac{40I_1}{40} + \frac{160I_1}{20} - \frac{V_x}{20} = 0$

$40I_1 - 80I_1 + 640I_1 - 4V_x = 0$

$600I_1 - 4V_x = 0$

$V_{th} = 120 \cdot 40$

$= \boxed{4800V}$

-13

$R_{th} = \frac{V_{th}}{I_{sc}}$

6. ***The switch in the circuit shown has been open for a long time. The initial voltage $V_c(0^-) = 0$. We close the switch at $t = 0$. Find:***

a) $i(t)$ ***for*** $t \geq 0^+$.

b) $v(t)$ ***for*** $t \geq 0^+$.

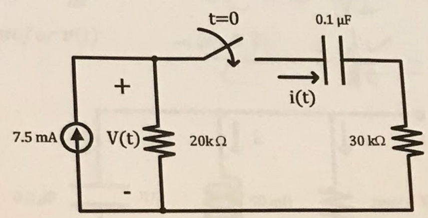
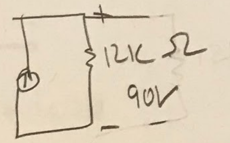


Figure 6

$\frac{1}{20} + \frac{1}{30}$

$\frac{3}{60} + \frac{2}{60} = \frac{5}{60} = \frac{60}{5}$

0^+ :



$V = IR$

$\frac{90}{30k} = I$

$I = 3 \times 10^{-3} A$

$= 3mA$

$i(0^-) = 0$

$i(0^+) = 3 \times 10^{-3} A$

$\tau = RC \quad R_{th} = 50 K\Omega$

$= 5 \times 10^{-3}$

$i(t) = i(\infty) + (i(0) - i(\infty)) e^{-t/\tau}$

$= 0 + (3 \times 10^{-3} A - 0) e^{-t/5 \times 10^{-3}}$

$i(t) = (3 \times 10^{-3}) e^{-t/5 \times 10^{-3}} A$

$V(\infty) = 150V$

$V(t) = V(\infty) + (V(0) - V(\infty)) e^{-t/\tau}$

$V(0^+) = 90V$

$150 + (90 - 150) e^{-t/5 \times 10^{-3}}$

$90 e^{-t \times 5 \times 10^{-3}} V$

-1

7. ***For the circuit in figure below,*** $v(0^+) = 12\,V$ ***and*** $i_L(0^+) = 30\,mA$.

$C = 0.2\,\mu F, L = 50\,mH,$ ***and*** $R = 200\Omega$.

a) ***Find the initial current in each branch of the circuit.***

b) ***Find the initial value of*** $\frac{dv}{dt}$.

c) ***Write an expression for*** $v(t)$.

$i_c = C\frac{dv}{dt}$

$\frac{-0.09}{C} = \frac{dv}{dt} = \frac{-0.09}{2\times10^{-7}} = -45000$

$i_c = -0.09A$

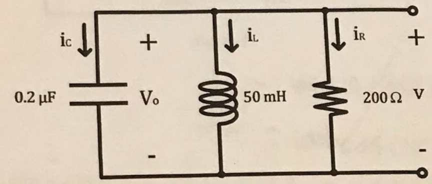


Figure 7

$v(0^+) = 12V$

$i_L(0^+) = 30mA$

$= 0.03A$

$i_R(0^+) = \frac{V}{R}$

$= \frac{12}{200}$

$= 0.06A$

$i_L + i_R + i_C = 0$

$i_L + i_R = -i_C$

$\alpha = \frac{1}{2RC} = 5\times10^{-5} = 12500$

$\omega_0 = \frac{1}{\sqrt{LC}} = 0.00632 = 158.11$

$\alpha^2 > \omega_0^2$; overdamped

$v(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$

$\frac{d^2v(t)}{dt^2} + \frac{1}{RC}\frac{dv(t)}{dt} + \frac{1}{LC}v(t) = 0$

$s_1, s_2 = -\alpha \pm \sqrt{\alpha^2 - \omega_0^2}$

$s_1 = -1.000$

$s_2 = -24995$

$v(t) = A_1 e^{-1.0t} + A_2 e^{-24999.0t}$

$12 = A_1 + A_2$

$45000 = -A_1 - 24999 A_2$

-2

8. ***For figure below,*** $L_1 = 10\ mH, L_2 = 20\ mH$ ***and*** $M = 5\ mH$***. Find an expression for*** $v_1(t)$ ***and*** $v_2(t)$***.***

$$\frac{di_2}{dt} = -200\sin(200t)$$

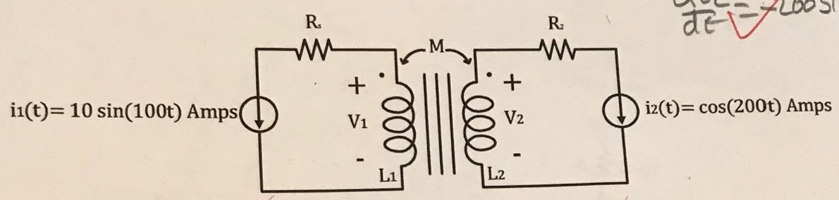


Figure 8

$$v_1 = L\frac{di_1}{dt} + M\frac{di_2}{dt}$$

$$\frac{di_1}{dt} = 100 \times 10\cos(100t) = 1000\cos(100t)$$

$$V_1 = (10\times10^{-3})(1000\cos(100t)) + (5\times10^{-3})(-200\sin(200t))$$

$$= \cos(100t) - 0.\cancel{2}\sin(200t)$$

-1

$$v_2 = M\frac{di_1}{dt} + L_2\frac{di_2}{dt}$$

$$= (5\times10^{-3})(1000\cos(100t)) + (20\times10^{-3})(-200\sin(200t))$$

$$= \boxed{5\cos(100t) - 4\sin(200t)}$$