Benha University
Benha Faculty of Engineering
Semester: Fall 2018
Final Examination
Examiners:
Dr. Abdullah Elgammal-Dr.Manar Hosny

1st year Electrical Eng. Dept.
Program: General
Time: 3Hr.
Total Points: 60
Electrical Engineering and Circuit Analysis(a) (E1101)

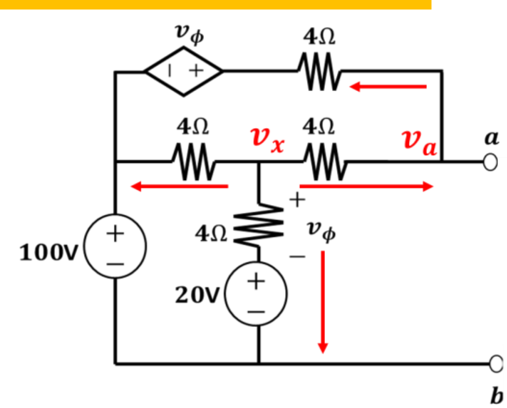
Model Answer

Question 1: (1X2→20 Points)

1) c → $v_6 = -16.7V$
2) d
3) b → 0.05 J
4) b → $v_a = 3.03V$
5) d → 1.28 J
6) d
7) a → 2Ω
8) c
9) c → $V_{out} = 3\,V_{in}$
10) b

Question 2: (12 Points)

Open circuit case to get Vth:



a)

$\frac{v_x-100}{4} + \frac{v_x-20}{4} + \frac{v_x-v_a}{4} = 0$(**1 point**)

$v_\phi = v_x - 20$(**1 point**)

$\frac{v_a-v_\phi-100}{4} = \frac{v_x-v_a}{4}$(**1 point**)

$v_x = 80\,V,\quad v_a = V_{th} = 120\,V$(**1 point**)

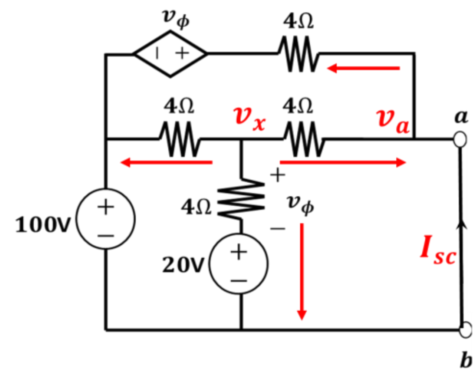
Short circuit case to get I_{sc}:

$\frac{v_x-100}{4} + \frac{v_x-20}{4} + \frac{v_x-v_a}{4} = 0$(**1 point**)

$\frac{v_a-v_x}{4} + \frac{v_a-v_\phi-100}{4} = I_{sc}$(**1 point**)

$v_a = zero$→ S.C, $v_x = 40V,\ v_\phi = 20V$

$I_{sc} = 40\ A$ (**1 point**)



$R_{th} = \frac{V_{th}}{I_{sc}} = 3\ \Omega$ (**1 point**)

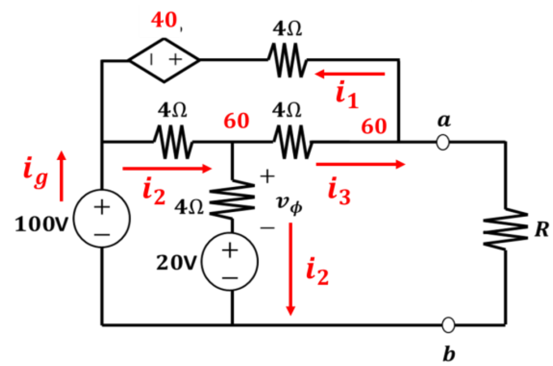
b) $P = \frac{V_{th}^2}{4R_{th}} = 1200W$ (**2 points**)

c) $i_1 = \frac{60-40-100}{4} = -20\ A$

$i_3 = zero.$

$i_2 = \frac{100-60}{4} = 10\ A$

$i_g = i_2 - i_1 = 10 - (-20) = 30\ A$



$P_{100V} = -i_g \times 100 = -3000\ W$ *developed*

$P_{20V} = +i_2 \times 20 = 200\ W$ *absorbed*

$P_{v_\phi} = i_1 \times v_\phi = -800\ W$ *developed*

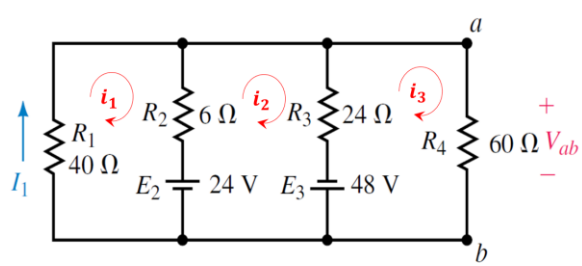
$\boldsymbol{\eta} = \frac{P_{max}}{P_{100V} + P_{v_\phi}} = \frac{1200}{3800} = \mathbf{31.5\%}$ (**2 points**)

Question 3: (8 Points)

$46i_1 - 6i_2 = -24$ (**2 point**)

$30i_2 - 6i_1 - 24i_3 = 72$ (**2 point**)

$84i_3 - 24i_2 = -48$ (**2 point**)



Solve for currents:

$i_1 = -0.2\ A,$ (**0.5 point**)

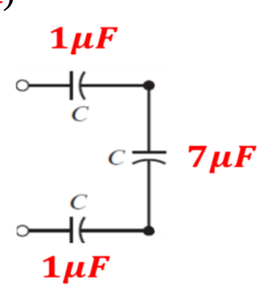
$i_2 = 2.46667\ A,$ (**0.5 point**)

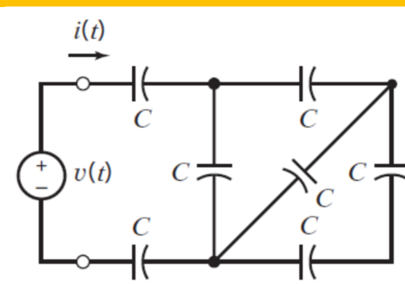
$i_3 = 0.1333A,$ (**0.5 point**)

$v_a = 8\ V$ (**0.5 point**)

Question 3)-a: (4 Points)

$C_{eq} = 0.38\ \mu F$ (**1 point**)





$v(t) = 4\cos(3t)\ \boldsymbol{V}$

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

$\frac{dv(t)}{dt} = -12\sin(3t)$ (**1 point**)

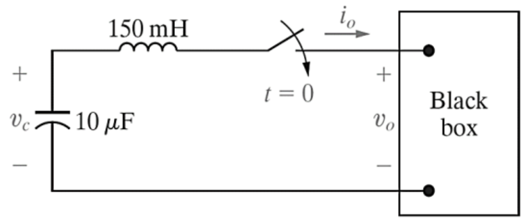
$i(t) = -4.57\sin(3t)\ [\mu A]$ (**2 point**)

Question 3)-b: (4 Points)

KVL at loop:

$-v_C + v_L + v_o = 0$ (**1 point**)

$v_o = v_c - v_L$



$$v_c = -\frac{1}{10\times10^{-6}}\left(\int_0^t 0.2e^{-800x}\,dx - \int_0^t 0.04e^{-200x}\,dx\right) + 5$$ (**1.5 points**)

$$= 25(e^{-800t} - 1) - 20(e^{-200t} - 1) + 5$$

$$= 25e^{-800t} - 20e^{-200t}\ \text{V}$$

$$v_L = 150\times10^{-3}\frac{di_o}{dt}$$ (**1 points**)

$$= 150\times10^{-3}(-160e^{-800t} + 8e^{-200t})$$

$$= -24e^{-800t} + 1.2e^{-200t}\ \text{V}$$

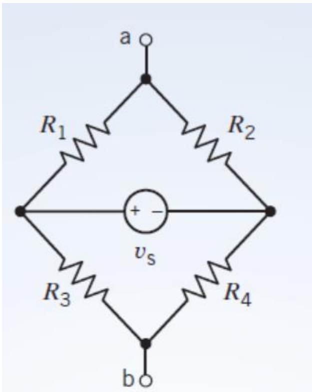
$$v_o = v_c - v_L$$

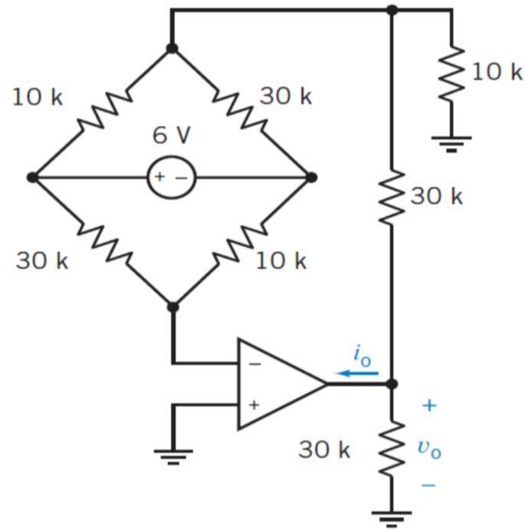
$$= (25e^{-800t} - 20e^{-200t}) - (-24e^{-800t} + 1.2e^{-200t})$$ (**0.5 points**)

$$= 49e^{-800t} - 21.2e^{-200t}\ \text{V},\ t > 0$$

Question 4: (12 Points)

Step 1:



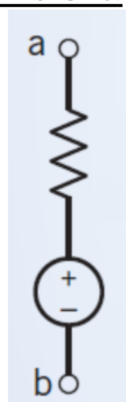


$V_{o.c} = V_{ab} = V_a - V_b$

$V_{o.c} = [\frac{R_2}{R_2+R_1} v_s - \frac{R_4}{R_4+R_3} v_s]$ (**2 points**)

$$R_t = \frac{R_1 R_2}{R_1 + R_2} + \frac{R_3 R_4}{R_3 + R_4}$$ (**2 points**)

Thévenin equivalent:



Apply KVL at node a:

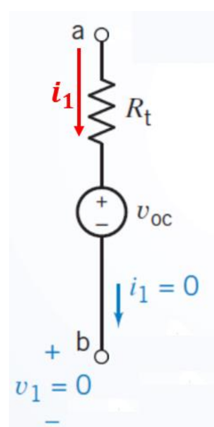
$v_a = i_1 R_t + v_{oc} + v_1$ (**2 points**)

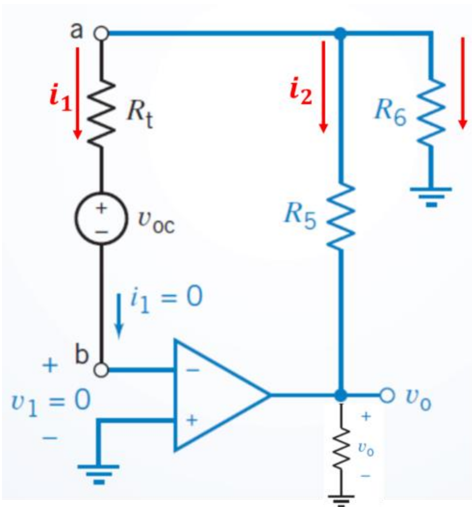
$v_1 = 0, \; i_1 R_t = 0$

$\boldsymbol{v_a = v_{oc}}$

Apply KCL at node a:

$\frac{v_a - v_{oc}}{R_t} + \frac{v_a - v_o}{R_5} + \frac{v_a}{R_6} = 0$ (**2 points**)





$$\frac{v_{oc} - v_o}{R_5} + \frac{v_{oc}}{R_6} = 0$$

$$v_o = \left[\frac{R_2}{R_2 + R_1} - \frac{R_4}{R_4 + R_3}\right]\left[1 + \frac{R_5}{R_6}\right] v_s$$

<u>Apply values to the above equation:</u>

$v_o = 12\ V$

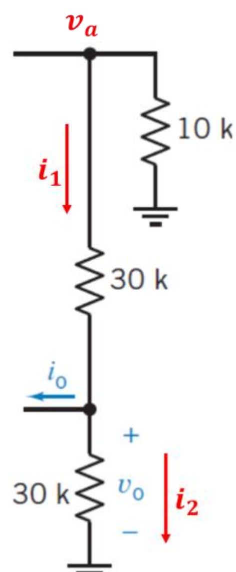
$v_{th} = v_a = 3V$ (**1 point**)

$i_1 = \frac{v_a - v_o}{30K} = -0.3\ mA,$ (**1 point**)

$i_2 = \frac{v_o}{30K} = 0.4\ mA,$ (**1 point**)

$i_1 = i_o + i_2,$

$i_o = -0.7mA.$ (**1 point**)



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Best wishes