KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

ELECTRICAL ENGINEERING DEPARTMENT

EE 202

EXAM II

DATE: Sunday 17 Nov 2013

TIME: 6:00 PM-7:30 PM

SER #	**Solution – Ver 2**
ID#	
Name	
Section#	

	Maximum Score	**Score**
Question 1	**32**	
Question 2	**23**	
Question 3	**22**	
Question 4	**23**	
Total	**100**	

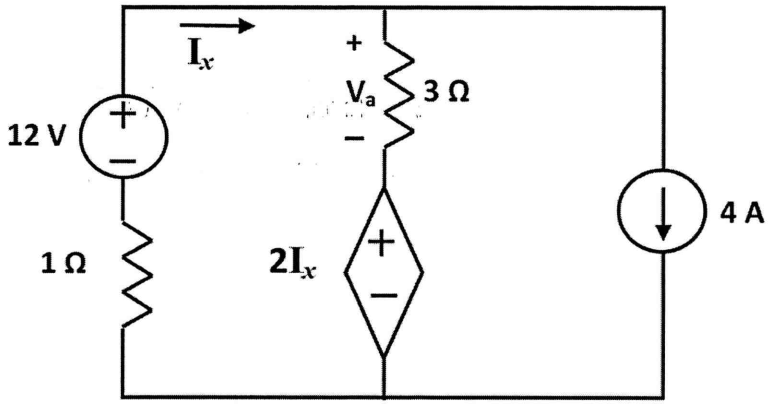
**** <u>Question 1</u>** is a Multiple Choice . You select one answer only.

**** <u>Question 3</u>** Put your answer in 3 X 3 Matrix form as indicated

Do not solve.

Question 1 [Parts (a) to (h) 28 points]:

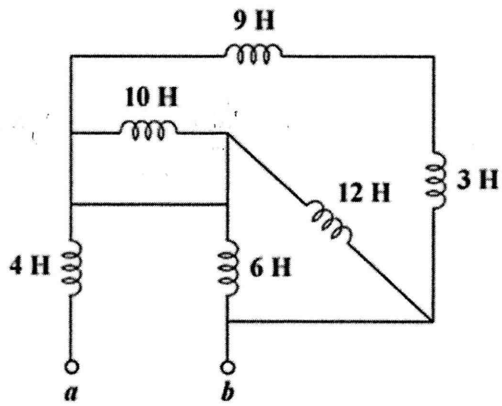
Part (a) [5 points]:



Determine the voltage V_a in the circuit above: (Hint: You may use the superposition principle)

i) −12 V, ii) 12 V, iii) 0 V, iv) −6 V, v) 6 V, .

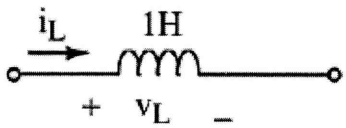
Part (b) [5 points]:

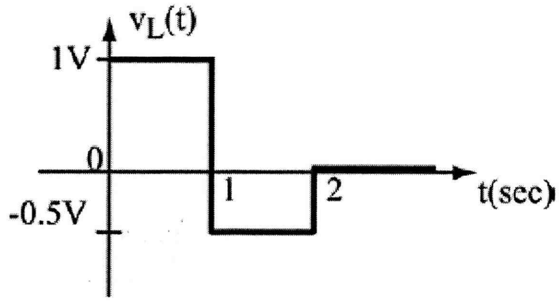


Find the equivalent inductance looking into the terminals a and b of the circuit:

i) 6.3 H, ii) 7 H, iii) 0 H, iv) 10.4 H, v) 20 H.

Part (c) [5 points]:

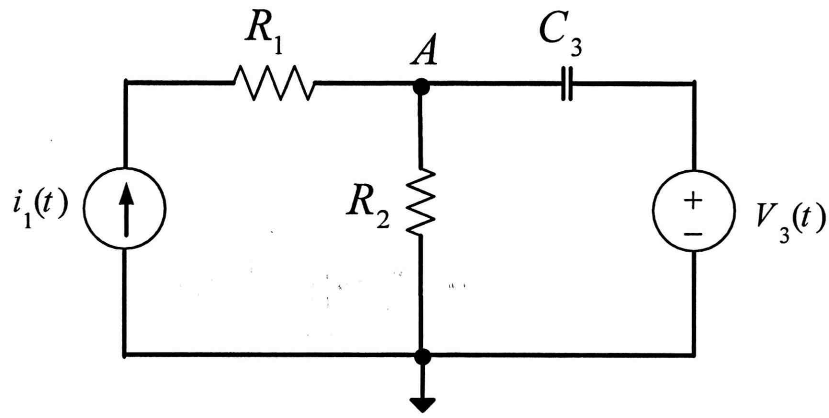




The inductor voltage $V_L(t)$ is as shown in the figure above. It is also known that $i_L(\infty)=0$. The initial condition $i_L(0^+)$ is :

i) -2.5, ii) 2.5, iii) -0.5, iv) 0.5, v) -1.5, ii) 1.5, vii) none of the previous answers.

Part (d) [5 points]:



In the circuit above, the Node Voltage Equations is:

i) $-i_1(t)+\frac{V_A(t)}{R_2}+C_3\frac{d}{dt}[V_3(t)-V_A(t)]=0,$

ii) $\frac{V_A(t)}{R_1}+\frac{V_A(t)}{R_2}+C_3\frac{d\,V_A(t)}{dt}=0,$

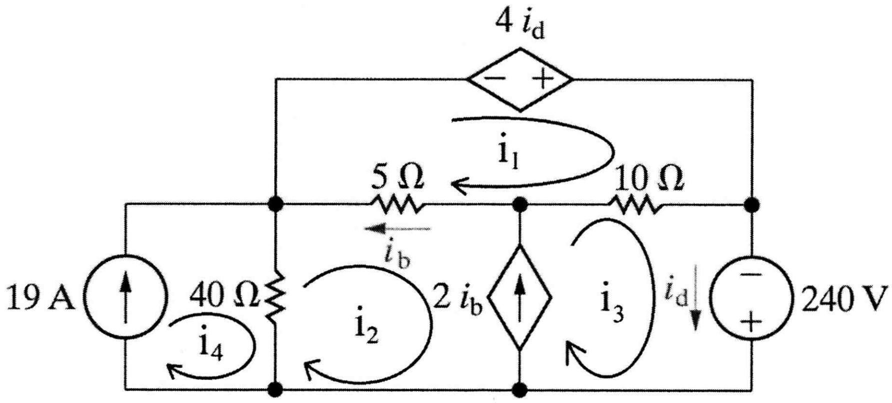
iii) $-i_1(t)+\frac{V_A(t)}{R_2}+C_3\frac{d}{dt}[V_A(t)-V_3(t)]=0,$

iv) $-i_1(t)+\frac{V_A(t)}{R_2}-C_3\frac{d\,V_A(t)}{dt}=0$

v) $i_1(t)+\frac{V_A(t)}{R_2}+C_3\frac{d\,V_A(t)}{dt}=0,$

vi) $i_1(t)-\frac{V_A(t)}{R_2}-C_3\frac{d\,V_3(t)}{dt}=0,$

Part (e), (f), (g), and (h):



The Mesh-Currents in the above circuit are i_1 = 18 A , i_2 = 26 A, and i_3 = 10 A, find the following:

Part (e) [3 points]: the power generated by dependent voltage source (4 i_d) is:

i) −720 W, ii) 720 W, iii) −480 W, iv) 480 W,
v) −640 W, vi) 640 W, vii) −180 W, viii) 180.

Part (f) [3 points]: the power generated by dependent current source (2 i_b) is:

i) −256 W, ii) 256 W, iii) −2560 W, iv) 2560 W,
v) −3600 W, vi) 3600 W, vii) −5120 W, viii) 5120 W,

Part (g) [3 points]: the power generated by independent current source (19 A) is:

i) −12920 W, ii) 12920 W, iii) −5320 W, iv) 5320 W,
v) −280 W, vi) 280 W, vii) −2520 W, viii) 2520 W,

Part (h) [3 points]: the power absorbed by all the resistors (5 Ω, 10 Ω , & 40 Ω) is:

i) −12280 W, ii) 12280 W, iii) −10120 W, iv) 10120 W,
v) −2920 W, vi) 2920W, vii) − 81960 W, viii) 81960 W,

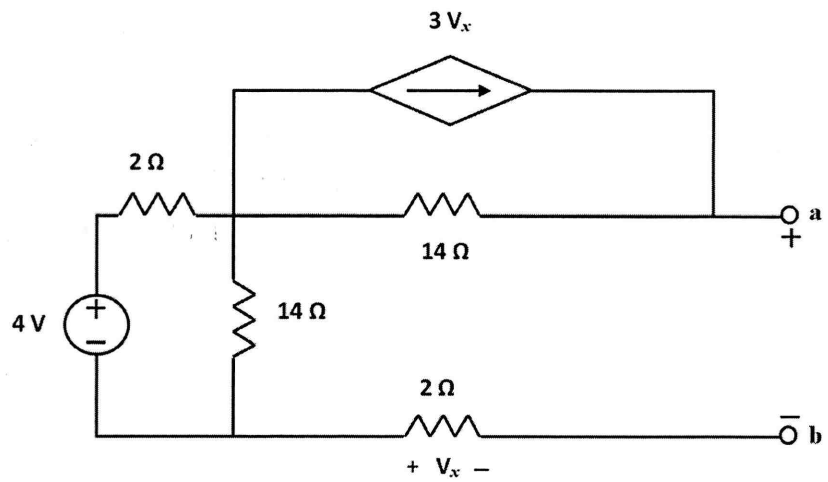
Question 2 [24 points]:

For the circuit shown below:

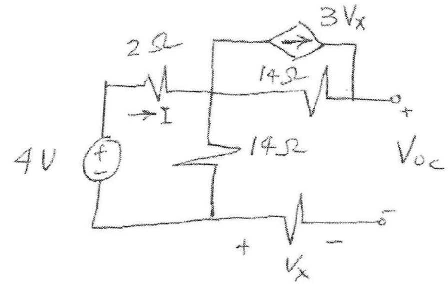
a) Find the open circuit voltage V_{OC} between the terminals **a** and **b** directly?
(Do not use source transformation)

b) Find the R_{th} using any method?

c) If a load resistor R_L is connected between terminals **a** and **b**, find the maximum power absorbed by this load resistor?



(a)



$$V_{oc} = 4\left(\frac{14}{14+2}\right) = 3.5\,V$$

OR

KVL in left loop

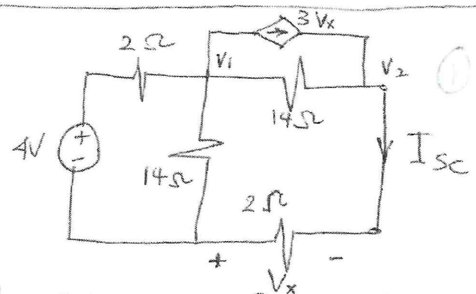
$$-4 + 16I = 0$$

$$I = 4/16 = 0.25\,A$$

$$V_{oc} = I(14) = (0.25)(14)$$

$$\boxed{V_{oc} = 3.5\,V}$$

(b) Using I_{sc}



node ①

$$\frac{V_1-4}{2} + \frac{V_1}{14} + \frac{V_1-V_2}{14} + 3V_x = 0 \quad \text{— I}$$

node ②

$$\frac{V_2-V_1}{14} + \frac{V_2}{2} - 3V_x = 0 \quad \text{— II}$$

→ Since $V_2 = -V_x$ [Substitute in (I) and (II)]

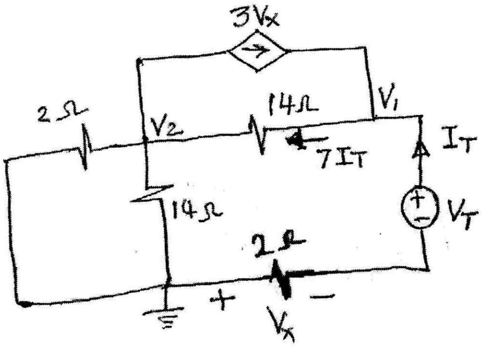
→ $\boxed{V_2 = 0.069\,V}$ $\quad \boxed{I_{sc} = \frac{V_2}{2} = 34.4\,mA}$ → (1 mark)

$R_{th} = \frac{V_{oc}}{I_{sc}} \Rightarrow \boxed{R_{th} = \frac{3.5}{34.4\times10^{-3}} = 101.75\,\Omega}$ → (1 mark)

Using Test Source

OR

(b)



$V_x = 2I_T \Rightarrow 3V_x = 6I_T \rightarrow$

$V_1 = V_T - V_x \Rightarrow V_1 = V_T - 2I_T \rightarrow$

node V_2

$$\frac{V_2 - V_1}{14} + \frac{V_2}{2} + \frac{V_2}{14} + 6I_T = 0 \quad \text{— (I)} \rightarrow$$

$$V_1 - 9V_2 = 84 I_T \quad \text{— (II)}$$

also $$\frac{V_1 - V_2}{14} = 7I_T \quad \text{— (III)} \rightarrow$$

solving (II) and (III)

$$814\, I_T = 8\, V_T \rightarrow$$

$$R_{th} = \frac{V_T}{I_T} = \frac{814}{8} \rightarrow$$

$$\boxed{R_{th} = 101.75\ \Omega} \rightarrow$$

(c)

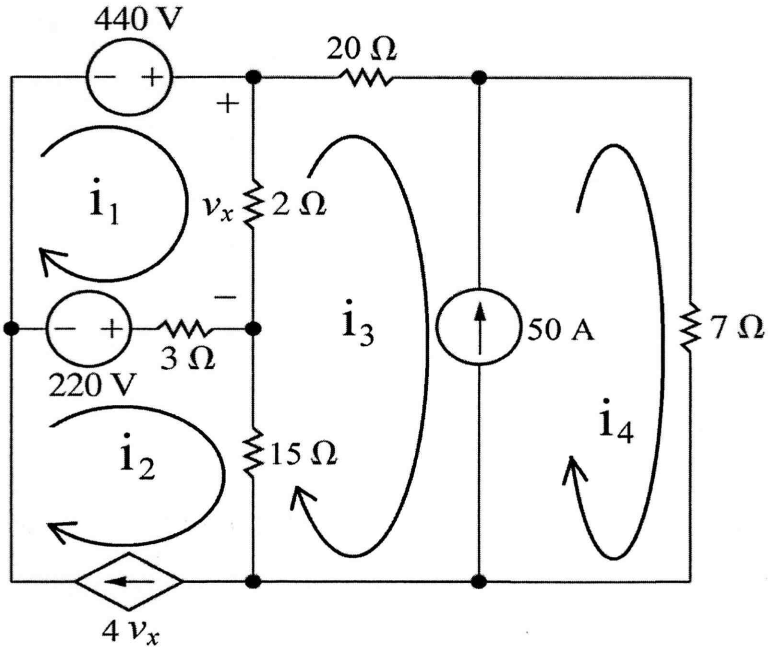
[illegible] mark

$$R_L = R_{th} = 101.75$$

$$P_{max} = \frac{V_{oc}^2}{4R_L}$$

$$P_{max} = \frac{(3.5)^2}{4(101.75)} = 30\,mW$$

Question 3 [22 points]:



For the circuit shown above find the Mesh-Current equations necessary to solve for the node voltages i_1, i_2, i_3, i_4, simplify the equations and put them in the matrix form as

$$\begin{bmatrix} & & & \\ & & & \\ & & & \\ & & & \end{bmatrix}\begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{bmatrix} = \begin{bmatrix} \\ \\ \\ \\ \end{bmatrix}$$

(DO NOT SOLVE THE SYTEM OF EQUATIONS)

[illegible], One Negative [illegible] Kvl in Mesh#1

$$-440+2(i_1-i_3)+3(i_1-i_2)+220=0 \quad \text{..............................} \quad (1)$$

[3 Marks, [illegible] or other, he [illegible]] Current Source 50 A:

$$i_4-i_3=50 \quad \text{..............................} \quad (2)$$

[illegible] mistake, [illegible] or other, he gets Zero] Current Source $4\,v_x$:

$$i_2=4\,v_x \quad \text{..............................} \quad (3)$$

[illegible], other Zero] Supermesh M3+M4 – kvl:

$$15(i_3-i_2)+2(i_3-i_1)+20i_3+7i_4=0 \quad \text{..............................} \quad (4)$$

[illegible] or other, he gets Zero] Help Equation for the dependent source:

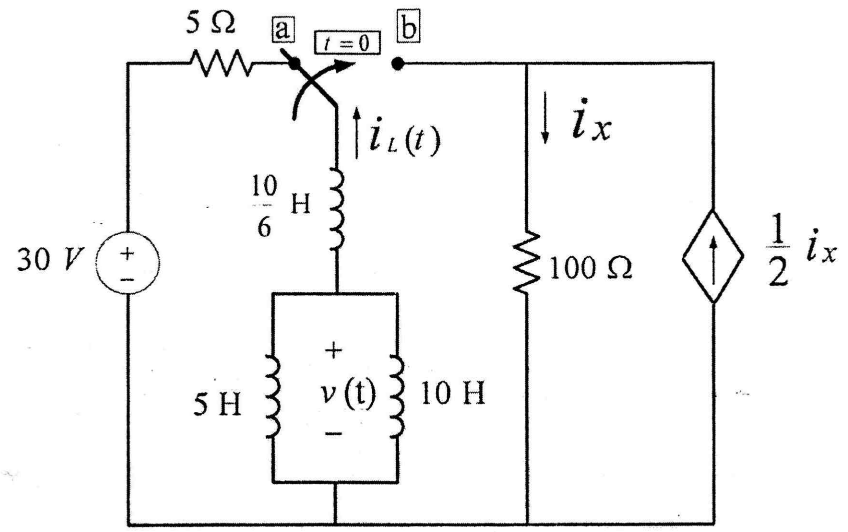
$$v_x=2(i_1-i_3) \quad \text{..............................} \quad (H)$$

[illegible] marks, one mark for the simplif[illegible] and 4, Zero if that row has a simplification error] simplify (1), Substitute (H) in (3), simplify (4) to get

$$\begin{bmatrix} 5 & -3 & -2 & 0 \\ 0 & 0 & -1 & 1 \\ 8 & -1 & -8 & 0 \\ -2 & -15 & 37 & 7 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{bmatrix} = \begin{bmatrix} 220 \\ 50 \\ 0 \\ 0 \end{bmatrix}$$

Question 4 [24 points]:

In the below circuit, the switch is moved from position "a" to position "b" at time $t = 0$. Solve the following questions and write the final answers in the box.



a) Find the initial value of i_L

$i_L(0^+) = -6$

b) Find the final value of i_L

$i_L(\infty) =$ Zero

c) Find the time constant τ for $t \geq 0$

$\tau = 25$ msec

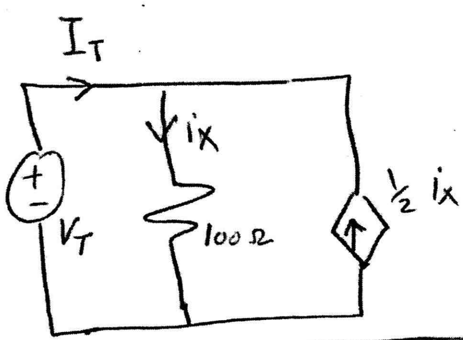
$$\tau = \frac{L_{eq}}{R_{eq}}$$

$$L_{eq} = \frac{10}{6} + \frac{(5)(10)}{5+10} = 5H$$

$$I_T = i_x - \frac{1}{2} i_x = \frac{1}{2} i_x$$

$$i_x = \frac{V_T}{100}$$

$$I_T = \frac{V_T}{200} \longrightarrow R_{eq} = \frac{V_T}{I_T} = 200\ \Omega$$



$$\tau = \frac{5}{200} = 25 \times 10^{-3} \text{ sec}$$

d) Find the expression of $i_L(t)$ for $t \geq 0$

$i_L(t) = -6\, e^{-t/25*10^{-3}}$

e) Find the expression of $v(t)$ across the 10 H inductor for $t \geq 0$

$v(t) = -800\, e^{-t/25*10^{-3}}$

$$V(t) = -L_{5\|10} \frac{d\, i_L(t)}{dt}$$

$$= -\frac{50}{15} \frac{d}{dt}\left[-6\, e^{-t/25*10^{-3}}\right]$$

$$= \frac{(50)(6)}{15}\left(-\frac{1}{25*10^{-3}}\right) e^{-t/25*10^{-3}}$$

$$= -\frac{20}{25} * 10^{3}\, e^{-t/25*10^{-3}}$$

$$= -800\, e^{-t/25*10^{-3}}$$