KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

ELECTRICAL ENGINEERING DEPARTMENT

EE 202

EXAM II

DATE: Sunday 13 April 2014

TIME: 6:30 PM - 8:00 PM *

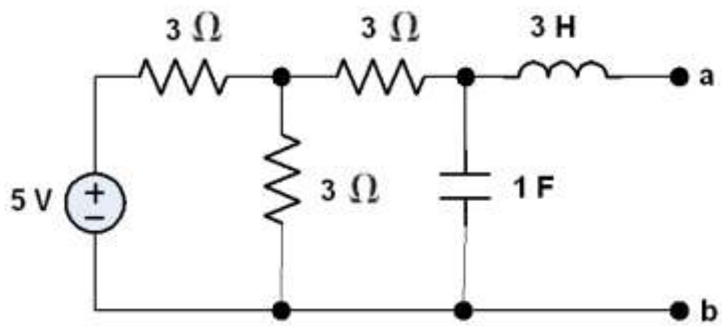
SER #	
ID#	Solution - Updated
Name	
Section#	

	Maximum Score	Score
Problem No 1	**24**	
Problem No 2	**26**	
Problem No 3	**20**	
Problem No 4	**30**	
Total	**100**	

<u>Problem No 1</u>:

<u>Part (a)</u>:

For the circuit shown below, under DC conditions, the voltage between terminals a-b is:

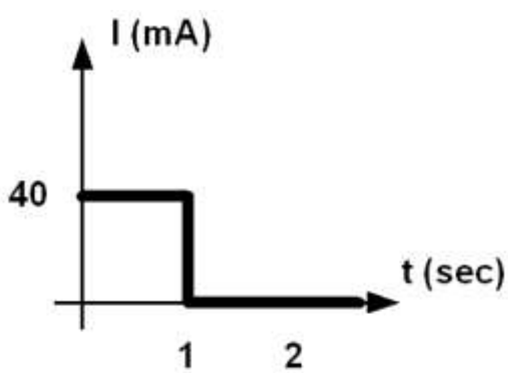


(i) 0 V, (ii) 5 V, (iii) 1.667 V, (iv) 2.5 V,

(v) 0.833 V, (vi) 7.5 V, (vii) 2 V, (viii) 0.556 V.

<u>Part (b)</u>:

The current through an initially uncharged 4 μF capacitor is shown in Figure 3. The voltage across the capacitor terminals at t=1.5 seconds is:

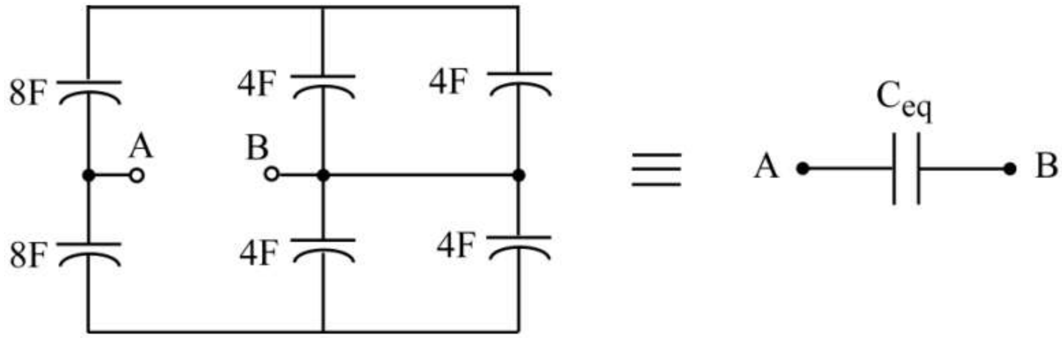


(i) 10 V, (ii) 0 V, (iii) 10 mV, (iv) 15 KV,

(v) 10 KV, (vi) 15 mV, (vii) 15 V, (viii) 30 V.

Part (c):

Compute the equivalent capacitance (C_{eq}) of the capacitor network shown below.

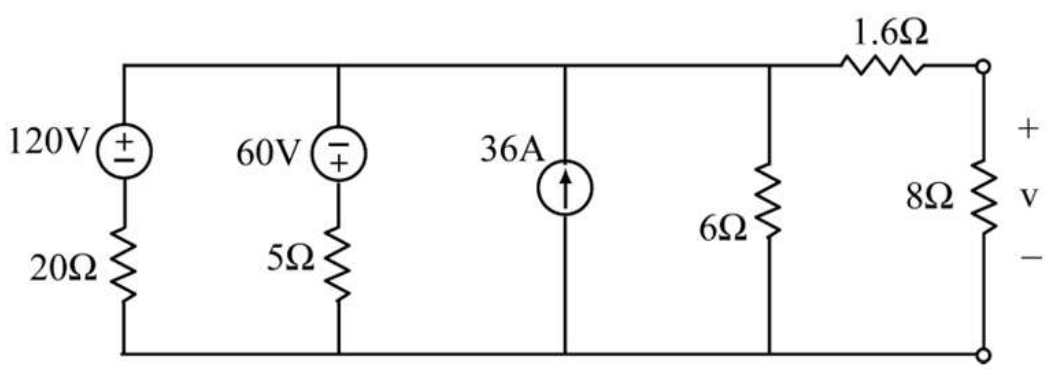


(i) 2 F, (ii) 4 F, (iii) 6 F, (iv) 8 F,

(v) 10 F, (vi) 12 F, (vii) 14 F, (viii) 16 F.

Part (d):

Using source transformations, find the voltage "v" (in V):

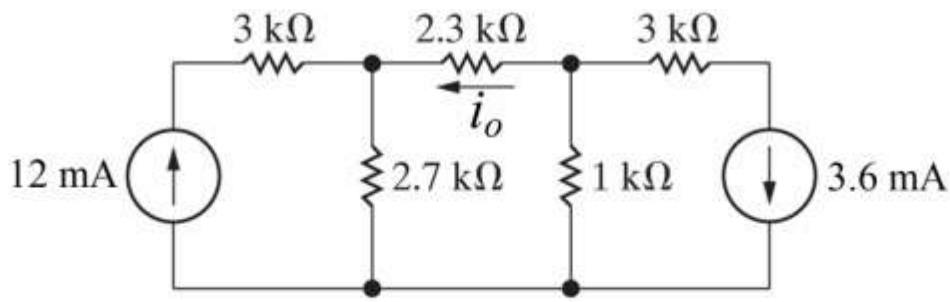


(i) 12, (ii) 24, (iii) 36, (iv) 48,

(v) 56, (vi) 60, (vii) 72, (viii) 84.

Part (e):

For the circuit shown below, find the current i_o:

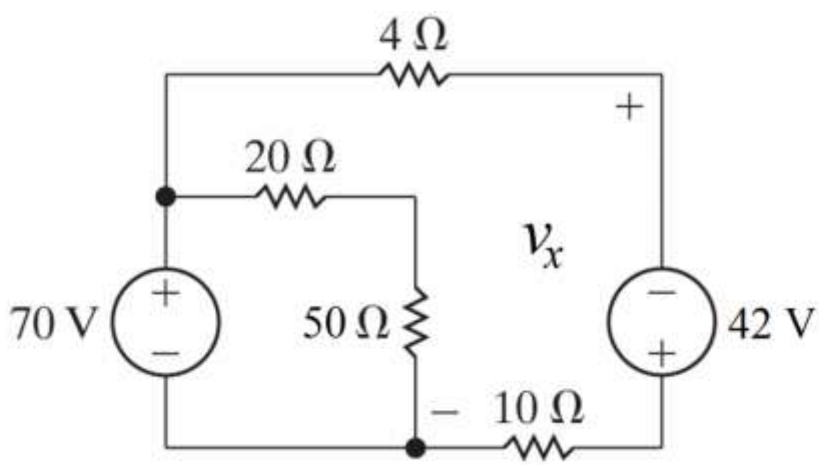


(i) 6 mA, (ii) -6 mA, (iii) 4.8 mA, (iv) -4.8 mA,

(v) 3 mA, (vi) -3 mA, (vii) 2.4 mA, (viii) -2.4 mA.

Part (f):

Find the voltage v_x in the following circuit (Hint: Use the principal of superposition)

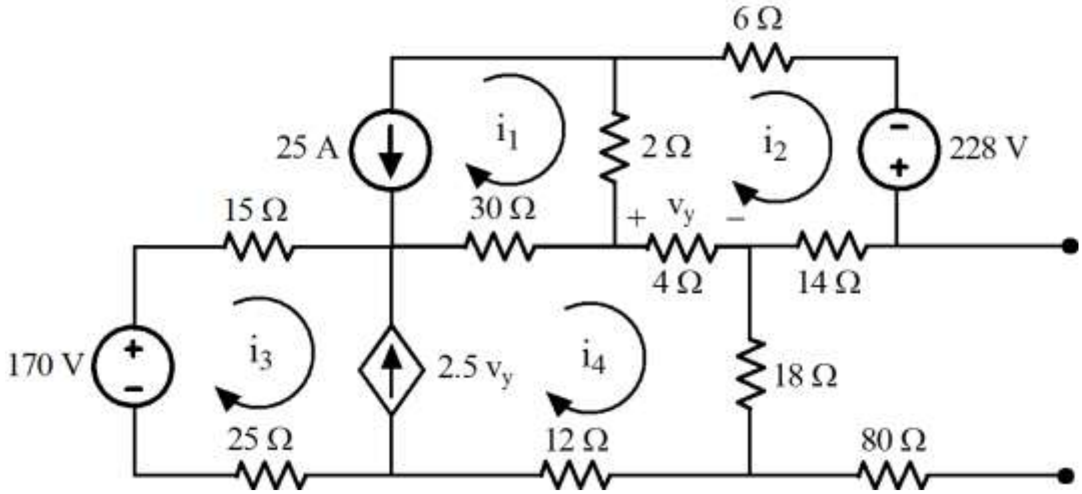


(i) 80 V, (ii) -80 V, (iii) 62 V, (iv) -62 V,

(v) 13 V, (vi) -13 V, (vii) 38 V, (viii) -38 V.

<u>Problem No 2</u>:

Given the following circuit:



a) Find all the necessary equations to solve for the mesh currents i_1, i_2, i_3, and i_4. [**Note: In this part do not simplify or solve any system of equations**]

Solution:

Current Source 25A:

$$i_1 = -25$$

Current Source $2.5v_y$:

$$i_4 - i_3 = 2.5\,v_y$$

KVL in mesh 2:

$$2(i_2 + 25) + 6i_2 - 228 + 14i_2 + 4(i_2 - i_4) = 0$$

Super Mesh m3+m4:

$$-170 + 15i_3 + 30(i_4 + 25) + 4(i_4 - i_2) + 18i_4 + 12i_4 + 25i_3 = 0$$

Help Equation for dependent source:

$$v_y = 4(i_4 - i_2)$$

b) Simplify the equations in part(a) and calculate the values of the mesh currents i_1, i_2, i_3, and i_4.

Solution:

Simplify the above equation into a matrix form, then solve for the mesh currents

$$\begin{bmatrix} 26 & 0 & -4 \\ -10 & 1 & 9 \\ -4 & 40 & 64 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 178 \\ 0 \\ -580 \end{bmatrix}$$

$i_1 = -25 \text{ A}, \qquad i_2 = 9 \text{ A},$

$i_3 = -36 \text{ A}, \qquad i_4 = 14 \text{ A}.$

c) Find the expressions and the values of the power delivered by the two current sources. The expressions will be as functions of the mesh currents (i_1, i_2, i_3, and i_4).

Solution:

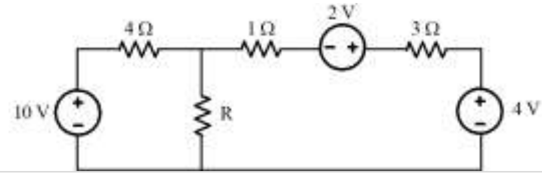
$$\begin{aligned} P_{\text{delivered by the 25 A Current Source}} &= [v][i] \\ &= -\left[2(i_2 - i_1) + 30(i_4 - i_1)\right][i_1] \\ &= -[-32i_1 + 2i_2 + 30i_4][i_1] \\ &= \left[2(i_2 + 25) + 30(i_4 + 25)\right][25] \\ &= 30.95 \text{ kW} \end{aligned}$$

$$\begin{aligned} P_{\text{delivered by the 2.5 v}_y\text{ Current Source}} &= [v][i] \\ &= \left[30(i_4 - i_1) + 4(i_4 - i_2) + 30i_4\right]\left[2.5(4)(i_4 - i_2)\right] \\ &= [-30i_1 - 4i_2 + 64i_4][10i_4 - 10i_2] \\ &= \left[30(i_4 + 25) + 4(i_4 - i_2) + 30i_4\right]\left[2.5(4)(i_4 - i_2)\right] \\ &= 80.5 \text{ kW} \end{aligned}$$

<u>Problem No 3</u>:

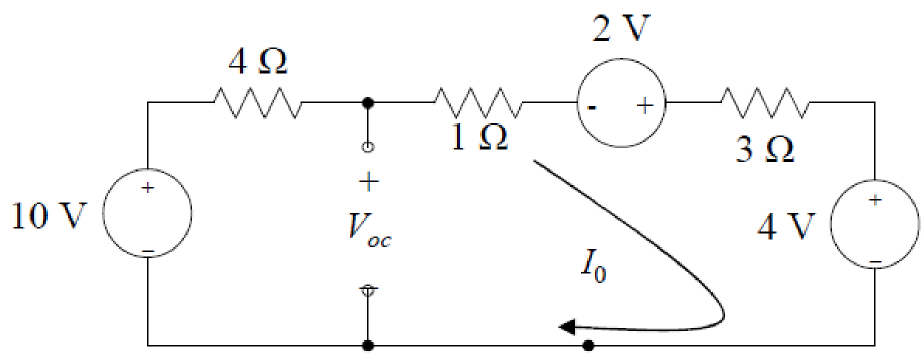
For the circuit shown below:

a) Find the value of the resistor R so that maximum power is transferred to it.
b) Find the value of maximum power that is transferred to the resistance R.



Solution

(a) Thevenin's equivalent at the terminals of R must be found.



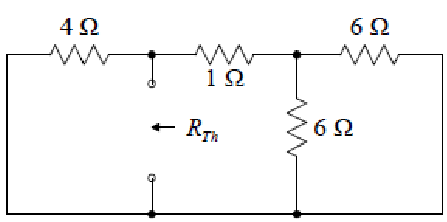
KVL:

$$-10-2+4+8I_0=0$$

$$\Rightarrow \quad I_0 = 1 \text{ A}$$

$$\Rightarrow \quad V_{oc} = 10-4I_0 = 6 \text{ V}$$

R R_{Th}:



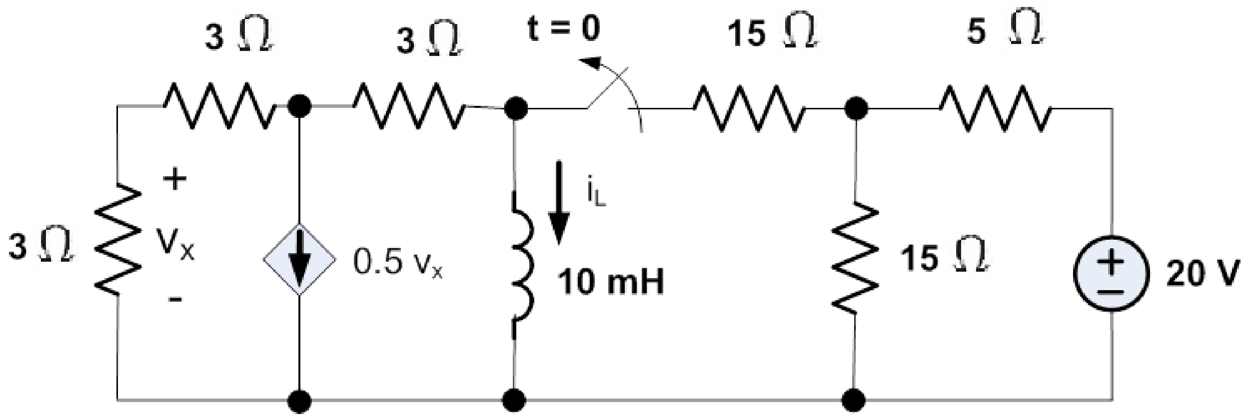
$$R_{Th} = 4\Omega \,||\, (1+6\,||\,6)\Omega = 4\Omega \,||\, 4\Omega = 2\Omega$$

$\therefore$ For maximum power transfer $\quad R = R_{Th} = 2\ \Omega$

(b) Maximum power transferred: $P_{max} = \dfrac{V_{Th}^2}{4R_{Th}} = 4.5 \text{ W}$

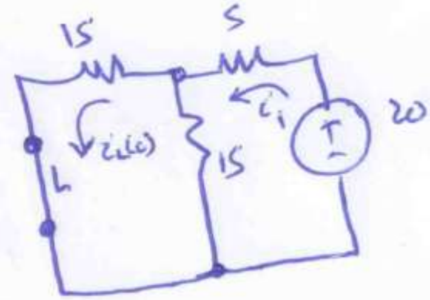
Problem No 4:

In the circuit shown in the Figure, the switch was closed for a long time. At time t=0, the switch was open. Find an expression for the current $i_L(t)$ inside the inductor for $t \geq 0$.



Sol.

before opening the switch,

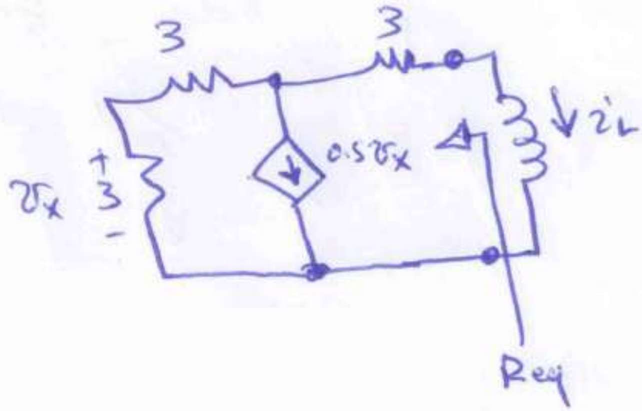


$i_1 = \frac{20}{5+7.5} = 1.6\text{ A}$

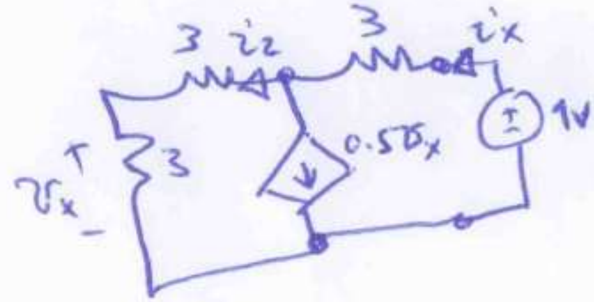
$i_L(0) = \frac{i_1}{2} = 0.8\text{ A}$

after opening the switch

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



to find R_{eq};



$$1 = 3i_x + 6i_2$$

$$i_x = 0.5v_x + i_2$$

$$v_x = 3i_2$$

$$\Rightarrow i_x = 1.5i_2 + i_2 = 2.5i_2$$

$$\Rightarrow 1 = 7.5i_2 + 6i_2 \Rightarrow i_2 = \frac{2}{27}\ A$$

$$i_x = \frac{5}{27}\ A$$

$$R_{eq} = \frac{1}{i_x} = \frac{27}{5} = \underline{\underline{5.4\ \Omega}}$$

$$\Rightarrow \tau = \frac{L}{R_{eq}} = \frac{10m}{5.4} = \underline{\underline{1.852\ m\ Sec.}}$$

$$\Rightarrow \quad i_L(t) = i_L(0)\ e^{-\frac{t}{\tau}}\ A,\ t \geq 0$$

$$i_L(t) = 0.8\ e^{-539.96t}\ A,\ t \geq 0$$

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