# University of Jordan

**Department of Electrical Engineering**

**Circuits I Second Exam**

**Fall 2012**

**Time : 75 Min.** **Date: Dec. 18, 2012**

**Name (in Arabic):** **Student # :** 0119203 **Section # :** Dr. Iyad Jafar

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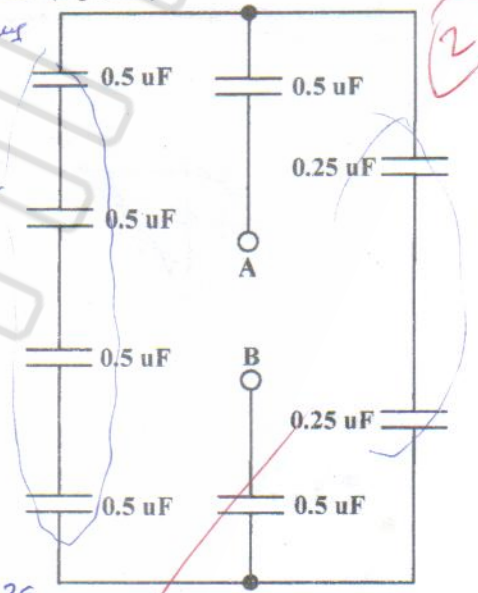
**Show the details of your solution**

**Problem 1:** Determine the equivalent capacitance seen through terminals A and B. (2 points)




2

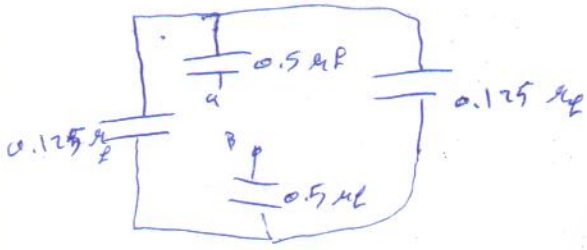
0.5, 0.5, 0.5, 0.5 series

$C = \frac{1}{\frac{1}{0.5}+\frac{1}{0.5}+\frac{1}{0.5}+\frac{1}{0.5}} = 0.125\ \mu F$

0.25 μF series 0.25 μF

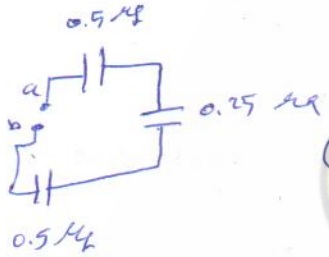
$\frac{1}{C_{eq}} = \frac{1}{0.25}+\frac{1}{0.25}$

$C_{eq_1} = 0.125\ \mu F$ series




0.125 // 0.125

$C_{eq} = 0.25$




$C_{eq} = \frac{1}{\frac{1}{0.5}+\frac{1}{0.5}+\frac{1}{0.25}} = 0.125$

$C_{AB} =$ 0.125 μF

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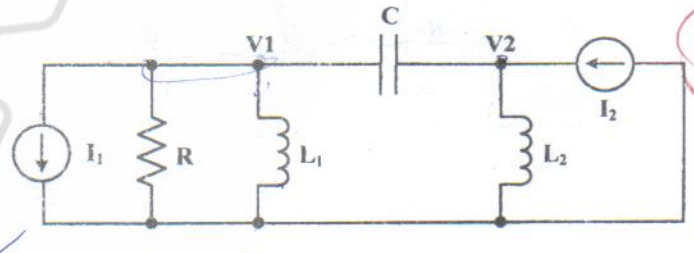
**Problem 2:** Write the nodal equations for the following circuit in terms of the nodal voltages V1 and V2. (4 points)




3

Node ①

$I_1 + \frac{V_1}{R} + L\frac{dI}{dt} + \frac{1}{C}\int (V_1 - V_2)\,dt = 0$

$I = \frac{dv}{dt}$

$\frac{1}{L}\int V\,dt$

Node ②

$\frac{1}{C}\int (V_2 - V_1)\,dt + L\frac{dI}{dt}$

Node ①

$I_1 + \frac{V_1}{R} + C\frac{d(V_1 - V_2)}{dt} + \frac{1}{L_1}\int V_1\,dt = 0$

I0

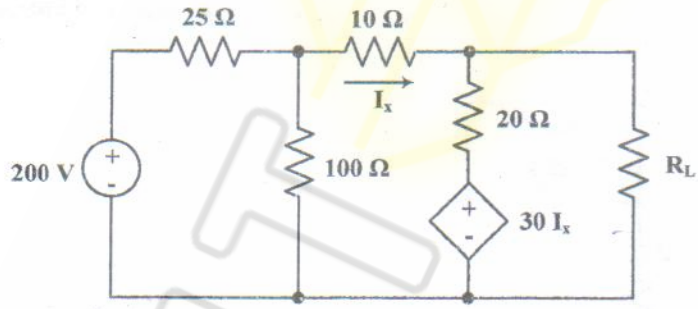
Node ②

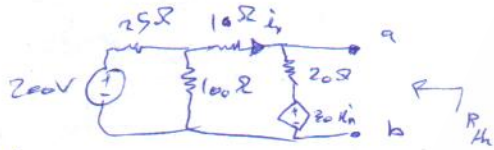
$C\frac{d(V_2 - V_1)}{dt} + \frac{1}{L_2}\int V_2\,dt = I_2$

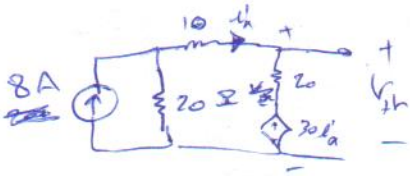
4.0

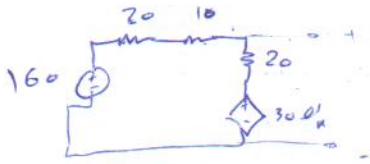
**em 3:** For the following circuit, determine the value of $R_L$ that absorbs the maximum power. Also, compute the e of the this maximum power. (7 points)

$R_{L\,(max\ power)} = R_{th}$




$-160 + 20i_x' + 10i_x' + 20i_x' + 30i_x' = 0$

$160 = 80i_x'$

$i_x = 2A$

$V_{th} = 100\ V$


$i_N' = i_x' =$

$-160 + 20i_x' + 10i_x' = 0$

$\frac{160}{30} = i_x'$

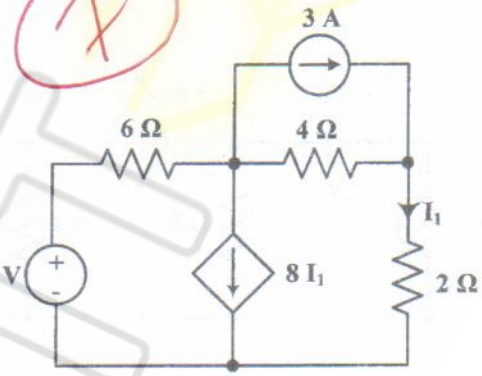
$i_x' = i_N = 5.33\ A$

$R_L = R_{th} = \frac{V_{th}}{I_N} = 18.75\ \Omega$

$P_{max} = \frac{V^2}{R} = 533.33\ J$

**$R_L$ =** 18.75 Ω **$P_{max}$ =** 533.33 J

**Problem 4:** In the following circuit, use superposition to find $I_1$. (7 points)




$$I_1 = I_{1(30V)} + I_{1(3A)}$$

Kill 3A


$$\frac{V-30}{6} + \frac{V}{6} + 8I_1 = 0 \qquad I_1 = \frac{V}{6}$$

$$\frac{V}{6} - \frac{30}{6} + \frac{V}{6} + \frac{8V}{6} = 0$$

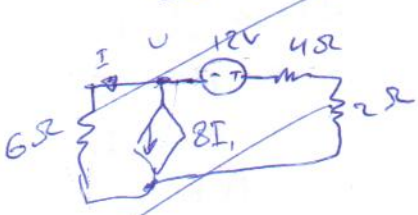
$$10V = 30$$

$$V = 3$$

$$I_1 = \frac{V}{6} = \frac{3}{6} = 0.5$$

(30 V)

Kill 30 V


$$\frac{V}{6} + \frac{V+12}{6} + 8I_1 = 0$$

$$8I_1 + I_1 = I$$

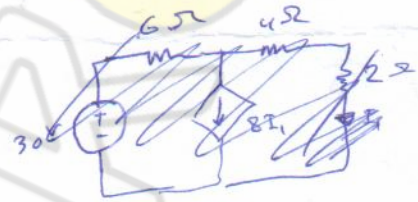
$$9I_1 = I$$

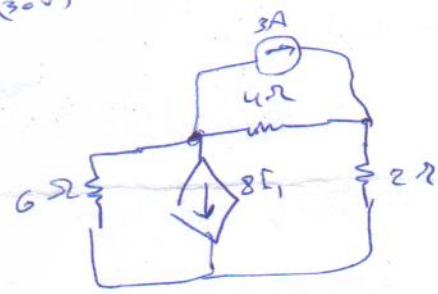
$$I = \frac{V}{6}$$

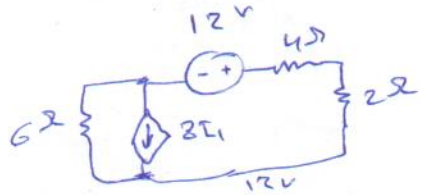
$$9I_1 = \frac{V}{6}$$

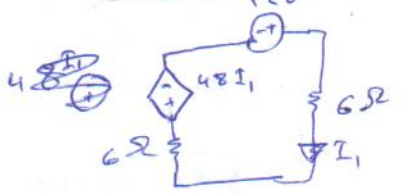
$$54I_1 + V + 12 + 48I_1 = 0$$

$$156I_1 = -12$$


$$4.8I_1 - 12 + 56I_1 + 6I_1$$

$$60I_1 = 12$$

$$I_1 = \frac{12}{60}$$

$$I_{1(3A)} = 0.2\ A$$

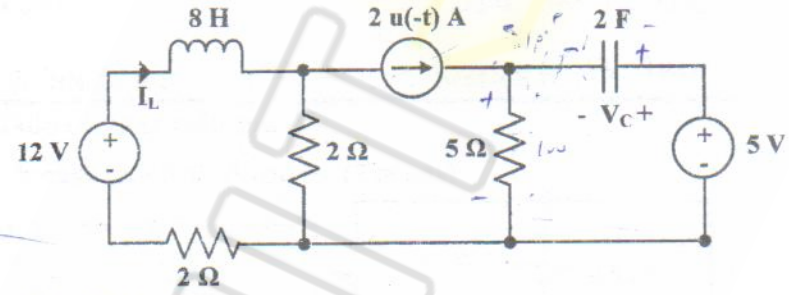
$$I_{1(30V)} + I_{1(3A)}$$

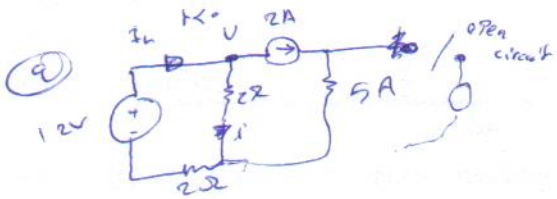
$$= 0.7\ A$$

$I_1 =$ 0.7 A

**Problem 5:** Study the following circuit then determnine the following, (10 points)

(a) $I_L(0-)$ (b) $V_C(0-)$ (c) $I_L(t)$, $t>0$ (d) $V_C(t)$, $t>0$




$-12V + 2i + 2I_L = 0$

$I_L - 2 = i$

$-12 + 2I_L - 4 + 2I_L = 0$

$-12 + 4I_L - 4 = 0$

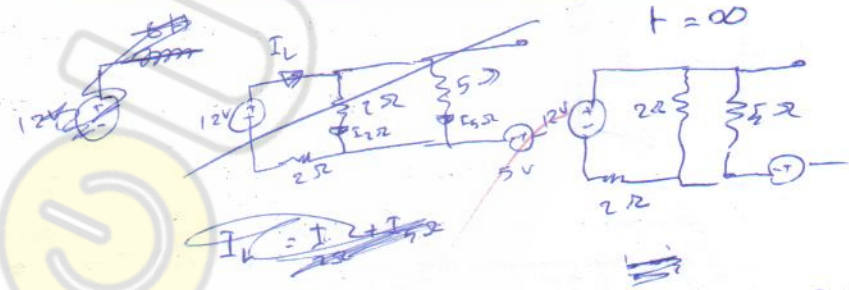
$4I_L = 16$

$I_L = 4\ A$

(b) $V_C(0^-)$

$V_C(0^-) = -V_{5\Omega} = -(2A * 5\Omega)$

$= -(2*5) = -10\ V$




(c) $I_L(t) = I_F + I_N$

$I_L(t) = 3.5 + Ae^{-t/\tau}$

$I_L(t) = 3.5 + Ae^{-t/2.33}$

$I_L(0^-) = I_L(0^+) = 4\ A$

$4 = 3.5 + A$

$A = 0.5\ A$

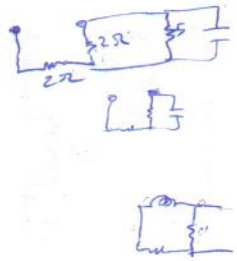
$I_L(t) = 3.5 + 0.5e^{-t/2.33}$

$I_L = \frac{12}{(2\|5)+2} = 3.5\ A$

$\tau = \frac{L}{R}$

$= \frac{8}{3.42}$

$= 2.33$










(d) $V_C(t) = V_F + V_N$

$= 3.57 + Ae^{-t/\tau}$

$= 3.57 + Ae^{-t/0.833}$

$V_C(0) = -10 = 3.57 + A$

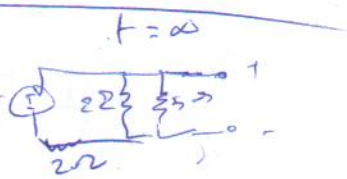
$= -13.57\ V$

$V_C(t) = 3.57 - 13.57e^{-t/0.833}$

$\tau = RC$

$= 2*(2\|2\|2)$

$= 0.833$




$V_C = 2.5 * (2\|5)$

$= 3.57\ V$

| | | | |
|---|---|---|---|
| $I_L(0-) =$ | 4 A | $V_C(0-) =$ | +10 V |
| $I_L(t) =$ | $3.5 + 0.5e^{-t/2.33}$ A | $V_C(t) =$ | $3.57 - 13.57e^{-t/0.833}$ V |