American University of Beirut
Department of Electrical and Computer Engineering

EECE 210 – Electric Circuits
Fall 2018 (November 9) – Quiz 2

Student Name: __________**SOLUTIONS**___________

Student ID: ____

Instructor Name: ____________________________________

Only work written on this set of question sheets will be graded.

DURATION: 90 MINUTES

APPLY TIME MANAGEMENT!

TOTAL OF 100 POINTS

NUMBER OF PAGES: 9

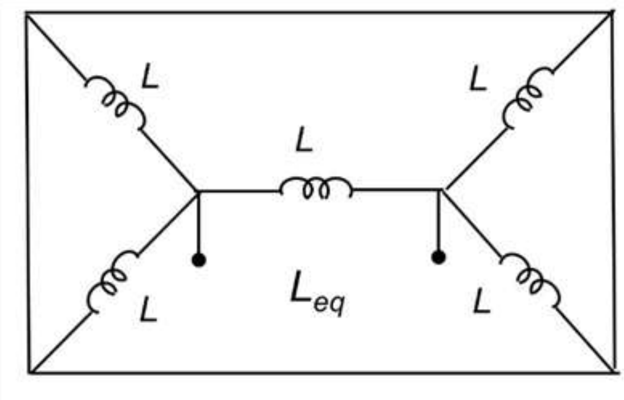
NUMBER OF PROBLEMS: 8

NO QUESTIONS ASKED DURING THE QUIZ, EXCEPT FOR SIMPLE LOGISTICS SUCH AS EXTRA SCRATCH PAPER

Problem 1 (5 pts)

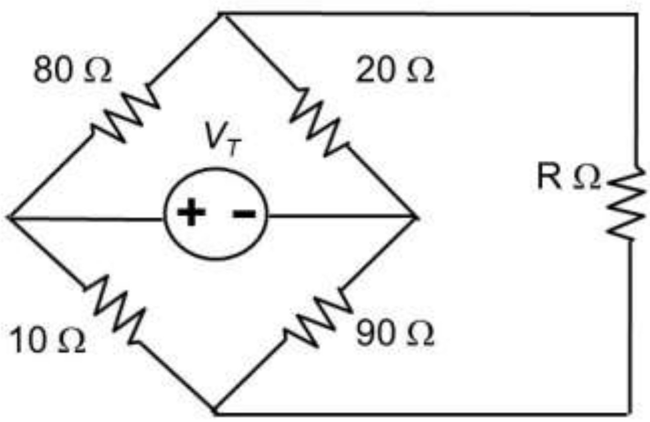
Find L_{eq} in the circuit below, if $L = \{6,8,12\}H$. Circle the best answer.

a) 3 HA
b) 4 HB
c) 6 HC
d) 1/3 H
e) 1/4 H
f) 1/6 H



Problem 2 (10 pts)

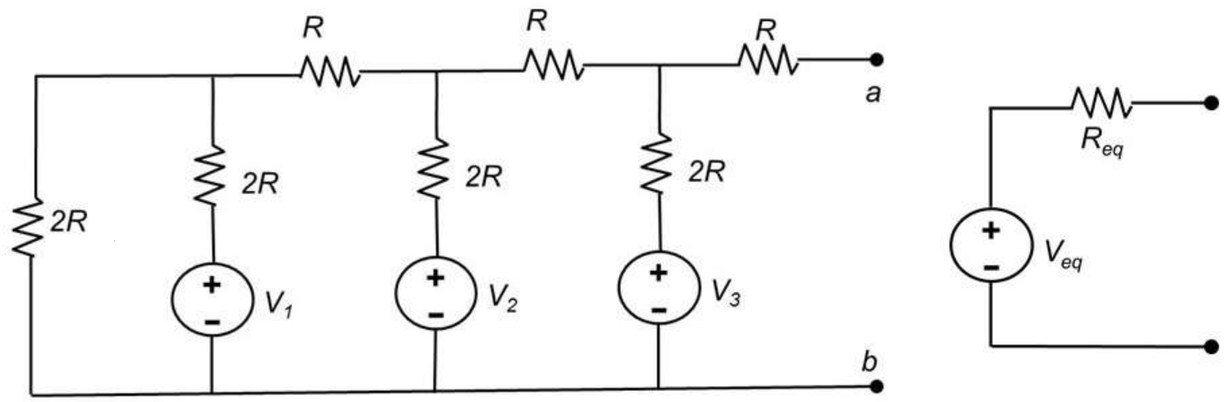
A. (6 pts) V_T={20,10,40}V, Find $|V_{Th}|$ in the circuit without R. Circle the best answer.



a) 1 V
b) 7 VB
c) 10 V
d) 14 VA
e) 20 V
f) 25 V
g) 28 VC
h) 40 V

B. (6 pts) Find the value of R for maximum power transfer.

a) 10 Ω
b) 20 Ω
c) 25 ΩABC
d) 30 Ω
e) 35 Ω
f) 40 Ω
g) 50 Ω
h) 75 Ω



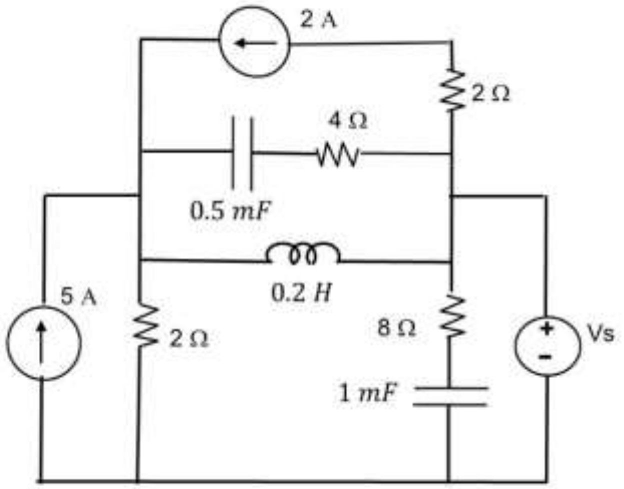
Problem 3 (5 pts)

The circuit on the left hand side is replaced by an equivalent circuit as shown on the right. Use multiple source transformations to find an expression for V_{eq} in terms of R, V_1, V_2, and V_3:

a) $V_1/2+ V_2/2+ V_3/2$
b) $V_1/2+ V_2/4+ V_3/8$
c) $V_1/8+ V_2/4+ V_3/2$ABC
d) $V_1/4+ V_2/2+ V_3$
e) $V_1+ V_2+ V_3$
f) $(V_1/8+ V_2/4+ V_3/2)/R$
g) $(V_1/2+ V_2/2+ V_3/2)/R$
h) $(V_1/2+ V_2/4+ V_3/8)/R$

Problem 4 (15 pts)

A. (5 pts) The circuit is in DC steady state. V_s={80,40, 60} V. Find the energy stored in the 1mF capacitance. Circle the best answer.



a) 0 J,
b) 0.8 J, B
c) 1.8 J, C
d) 3.2 J, A
e) 16.9 J,
f) 17.7 J,
g) 52.9 J,
h) 54.7 J,
i) 108.9 J,
j) 112.1 J

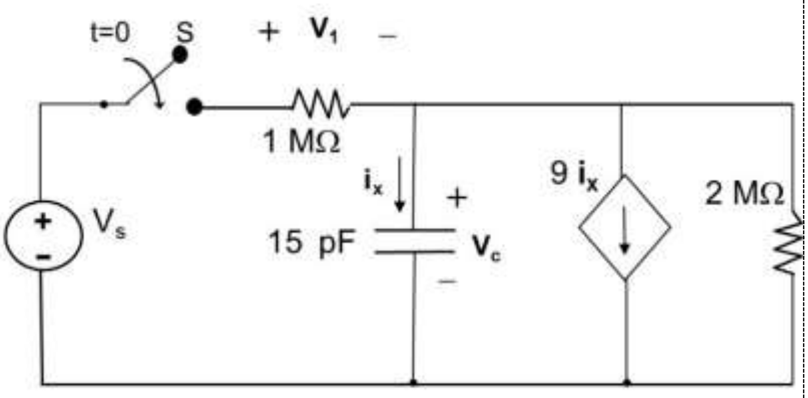
B. (5 pts) Find the energy stored in the 0.5mF capacitance. Circle the best answer.

a) 0 J, ABC
b) 0.8 J,
c) 1.8 J,
d) 3.2 J,
e) 16.9 J,
f) 17.7 J,
g) 52.9 J,
h) 54.7 J,
i) 108.9 J,
j) 112.1 J

C. (5 pts) Find the energy stored in the inductance. Circle the best answer.

a) 0 J,
b) 0.8 J,
c) 1.8 J,
d) 3.2 J,
e) 16.9 J, B
f) 17.7 J,
g) 52.9 J, C
h) 54.7 J,
i) 108.9 J, A
j) 112.1 J

Problem 5 (15 pts)



A. (5 pts) The switch has been open for a long time and closes at t=0. V_s={20,80,50}V. Find $v_1(0^+)$ (voltage over the 1 MΩ resistance). Circle the best answer.

a) 0 V
b) 6.7 V
c) 16.7 V
d) 20 VA
e) 26.7 V
f) 50 VC
g) 66.7 V
h) 80 VB

B. (5 pts) Find $i_x(0^+)$. Circle the best answer.

a) 0 A
b) 2.0 μAA
c) 5.0 μAC
d) 6.67 μA
e) 8.0 μAB
f) 16.67 μA
g) 20.0 μA
h) 26.67 μA
i) 50.0 μA
j) 80.0 μA

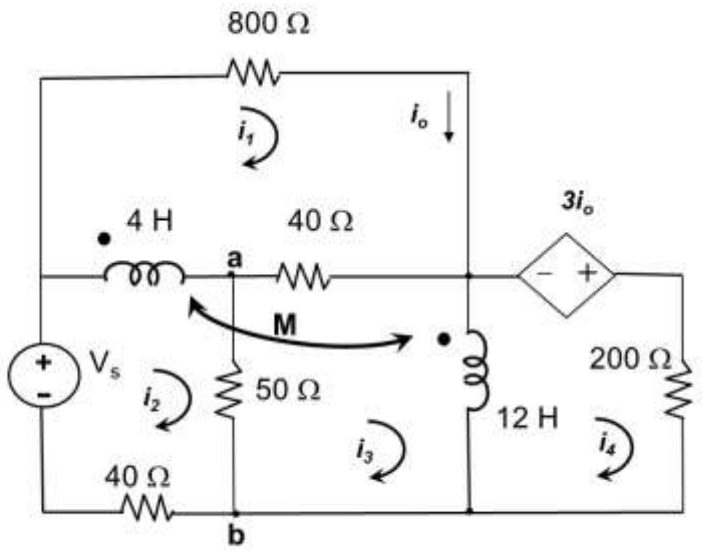
C.(5 pts) Find $v_1(\infty)$(voltage over the 1 MΩ resistance). Circle the best answer.

a) 0 V
b) 6.7 VA
c) 16.7 VC
d) 20 V
e) 26.7 VB
f) 50 V
g) 66.7 V
h) 80 V

Problem 6 (17 pts)

For the circuit below, $V_s = 10V$.

a) (8 pts) Write expressions for each mesh in the circuit in terms of the mesh currents, M and V_s (i.e. 4 expressions). Note to simplify each expression (group like variables).



Mesh i_1:

$$800i_1 + 40(i_1 - i_3) + \frac{4\,d(i_1 - i_2)}{dt} - M\frac{d(i_3 - i_4)}{dt} = 0$$

$$840i_1 - 40i_3 + \frac{4\,d(i_1 - i_2)}{dt} - M\frac{d(i_3 - i_4)}{dt} = 0$$

Mesh i_2:

$$40i_2 - v_s + \frac{4\,d(i_2 - i_1)}{dt} + M\frac{d(i_3 - i_4)}{dt} + 50(i_2 - i_3) = 0$$

$$90i_2 - 50i_3 + \frac{4\,d(i_2 - i_1)}{dt} + M\frac{d(i_3 - i_4)}{dt} = v_s$$

Mesh i_3:

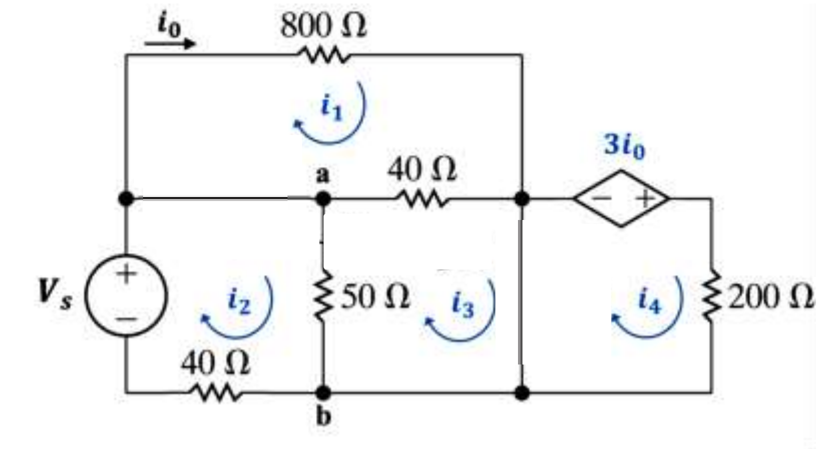
$$50(i_3 - i_2) + 40(i_3 - i_1) + \frac{12\,d(i_3 - i_4)}{dt} - M\frac{d(i_1 - i_2)}{dt} = 0$$

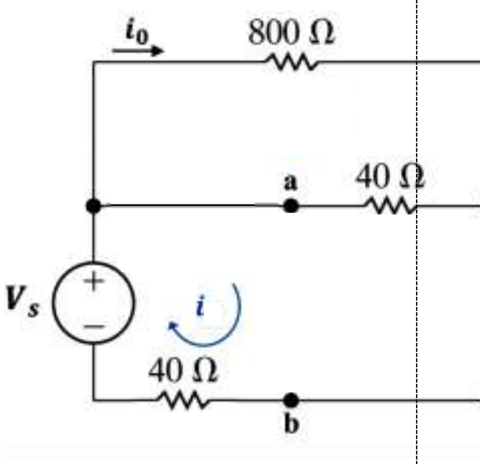
$$-40i_1 - 50i_2 + 90i_3 - M\frac{d(i_1 - i_2)}{dt} + 12\frac{d(i_3 - i_4)}{dt} = 0$$

Mesh i_4:

$$-3i_1 + 200i_4 + \frac{12\,d(i_4 - i_3)}{dt} + M\frac{d(i_1 - i_2)}{dt} = 0$$

a) and c) As t→∞.
The inductors are short circuited, and a-b becomes open circuit in order to find Vth and Rth.





(Note right hand side of circuit with dependent source and 200 ohm resistor has no effect on left hand side, so can be removed for our purposes)

$800||40 = 38.095\ \Omega$

$38.095i + 40i - 10 = 0$

$i = \dfrac{10}{78.095} = 0.128\ \text{A}$

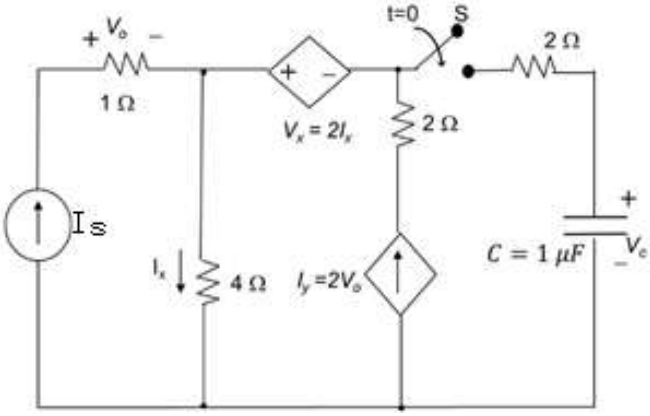
$v_{ab} = v_s + v_{40}$ but $v_{40} = -40i = -5.122\ \text{V}$

$v_{ab} = V_{Th} = 10 + (-5.122) = 4.878\ \text{V}$

$R_{Th} = 800||40||40 = 19.512\ \Omega$

Problem 7 (17 pts)

I_s= 5A. Find the voltage $V_c(t)$ if the capacitor was uncharged before the switch is closed. (Hint: find the Thevenin or Norton equivalent circuit connected to the capacitance.)



find V_{Th}:

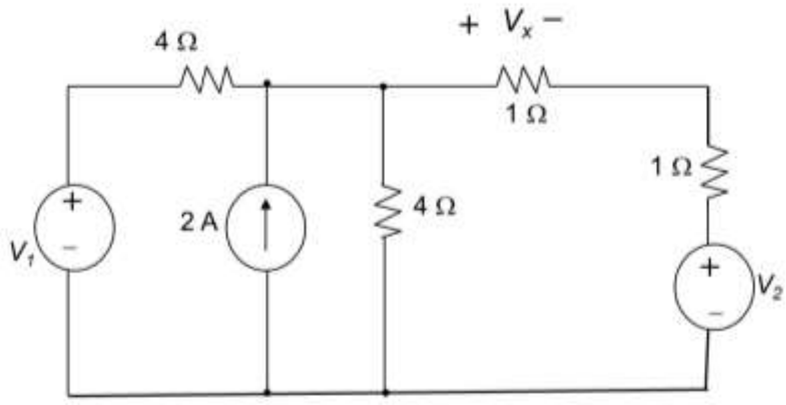
V_o=1 Is=5,
I_y=2 V_o=10,
I_x=I_y+Is=15,
V_{oc}=V_{Th}=-2I_x+4I_x=2I_x=30

find I_N: 2 I_N=2 I_x,
KCL: 2 I_x=15, I_N=15,

R_{Th}= 4Ω.
$V_c(t)$= 30(1-$e^{t/4}$), t in μs

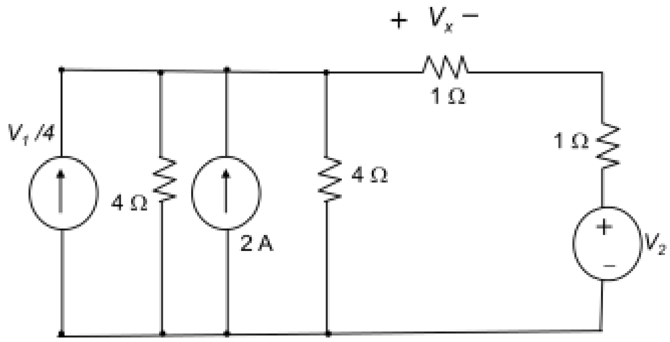
Problem 8 (16 pts)

Let V_1=8 Volts. If you are told that for some value of V_2=M volts, the output voltage V_x= 1 Volts, Find V_x if the voltage V_2 is doubled to 2M volts.

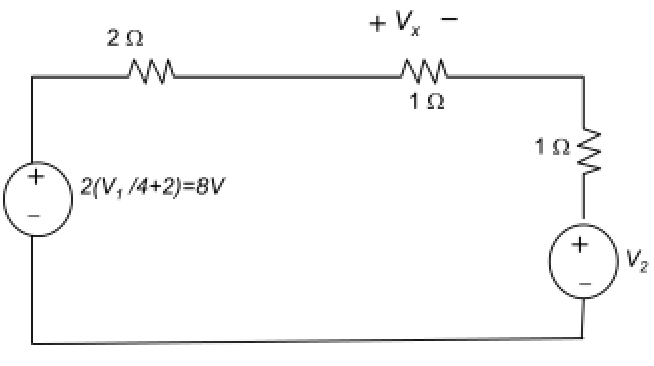


The key point in this problem is to consider the contribution of V_2 separately using superposition. The rest can be solved many ways.

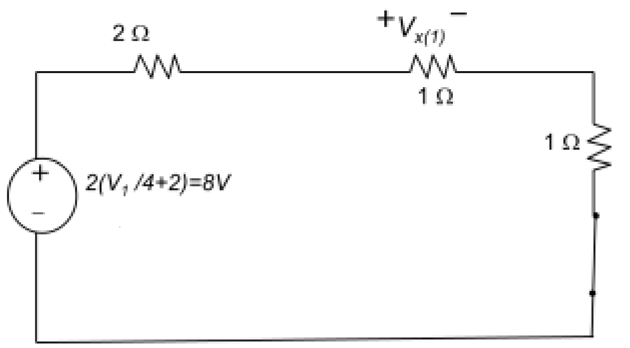
For example, note that the circuit can be slightly simplified by combining the voltage source V_1 and the 2A source (not needed, but helpful) as follows



Or

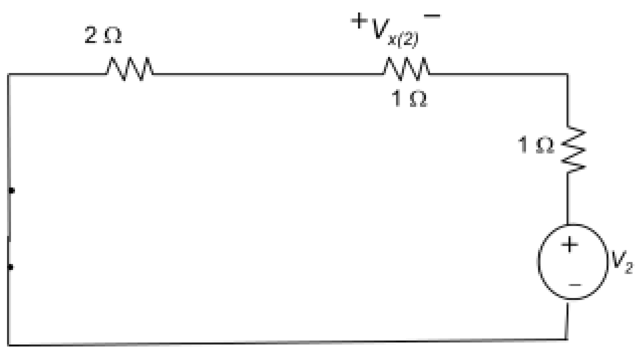


Now applying superposition, the contribution of the 8V source is (setting V_2 to zero)



$$V_{x(1)} = \frac{1}{1+1+2} 8 = 2\ V$$

Now that of V_2 (notice polarity)



$$V_{x(2)} = -\frac{1}{1+1+2} V_2 = -\frac{1}{4} V_2$$

So V_x is the sum of both :

$V_x = 2-0.25V_2$

For V_x=1 Volts, V_2=4 Volts. Therefore, when V_2 is doubled to 8 Volts, V_x=2-8/4=0 Volts.