KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

ELECTRICAL ENGINEERING DEPARTMENT

EE 201_102

EXAM II

DATE: Saturday April 30, 2011

TIME: 7:00 PM-8:30 PM

SER#	**Key Solution**
ID#	
Name	
Section#	

Course Instructors:

- Dr. Jamil Bakhashwain
- Dr. Adil Balghonaim
- Dr. Zaki Al-Akhdhar
- Dr. Mohammad Sharawi
- Dr. Abdallah Al-Ahmari

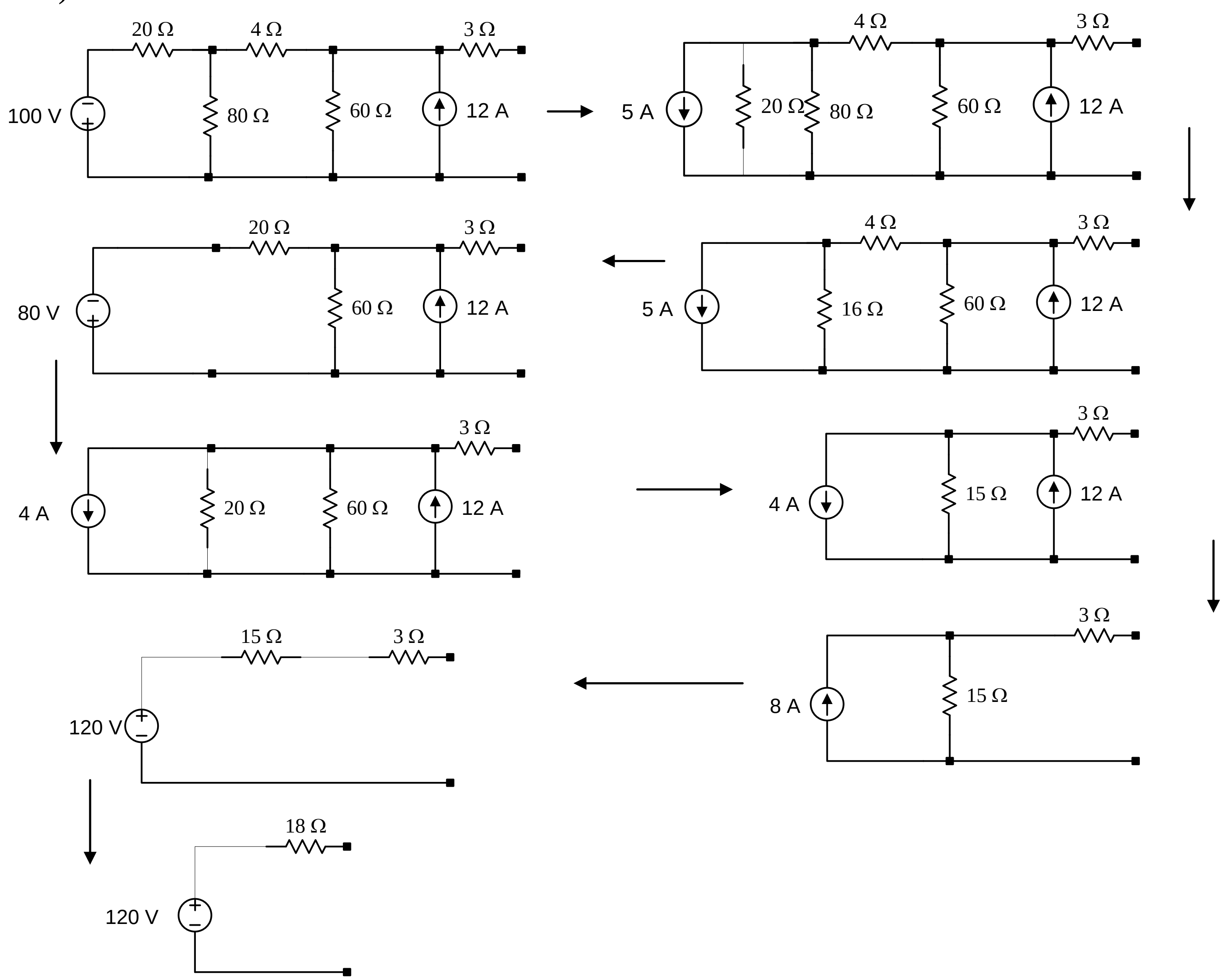
	Maximum Score	Score
Q1	25	
Q2	25	
Q3	25	
Q4	25	
TOTAL	100	

Q1

a) Apply as many as possible of ***<u>source transformations</u>*** to reduce the circuit connected between terminal *ab* to its equivalent Thevenin's.
b) Calculate the value of R_L that absorbs maximum power in the circuit when connected to terminals *ab*.
c) Calculate the power absorbed by R_L if it is selected to be 12 Ω.

<u>Solution:</u>

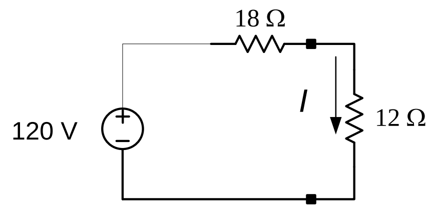
a)



b) For maximum power transfer RL = 18 Ω

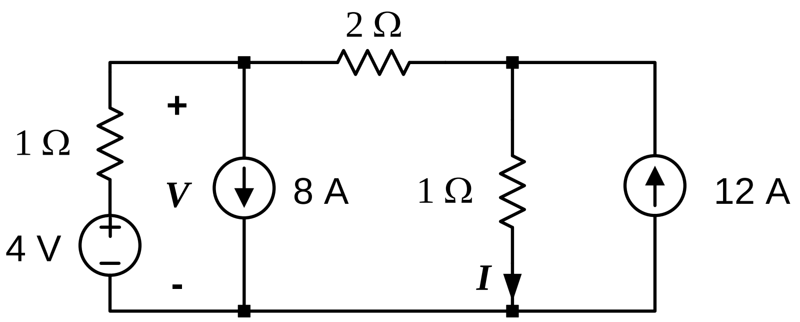
c) From the circuit $I = 120/(18+12) = 4$ A

$P_{12\Omega} = 12(4)^2 = 192$ watts

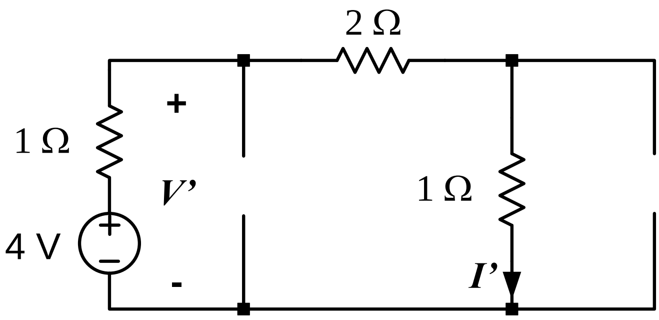


Q2

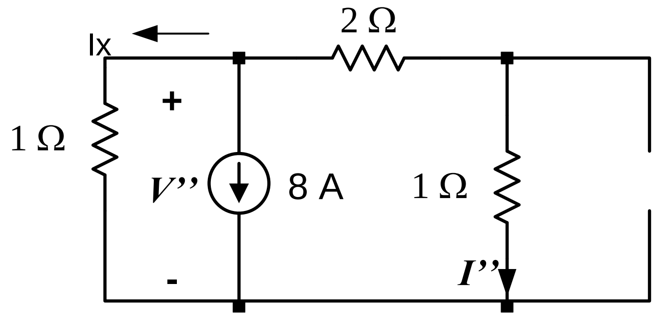
For the circuit shown use the superposition principle to calculate the current ***I*** and the voltage ***V***. (No points for using any other method)



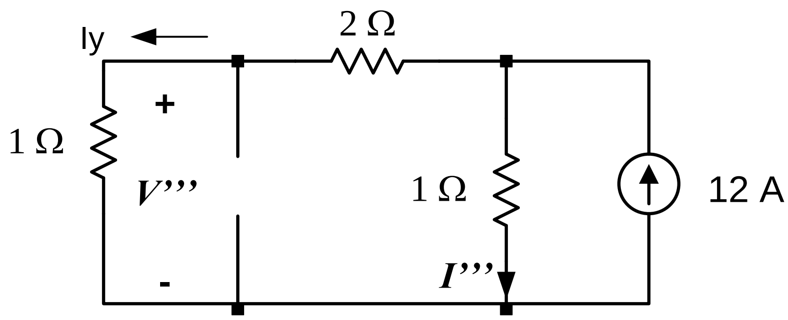
<u>Solution:</u>



I'= 4/4 = 1A
V' = 4-1(1)=3V



I''= -8(1)/4 = -2 A
Ix= -8(3)/4) = - 6 A
V''=-6(1) = -6 V



I''' = 12(3)/4 = 9 A
Iy = 12(1)/4 = 3 A
V''' = 3(1) = 3 V

I= 1- 2 + 9 = 8A
V= 3 – 6 +3 =0 V

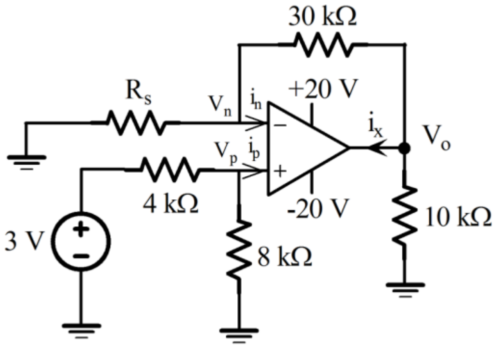
Q 3:

For the circuit shown below:

a) Derive the expression of the voltage V_o as a function of R_s.

b) If R_s = 5 kΩ, find the value of V_o and the current i_x.

c) Find the range of Rs to avoid the saturation region.



Solution:

a) Assuming ideal op-amp and linear region
The current ip = 0 & in = 0 A,

Also Vp – Vn = 0 ➔ Vn = Vp

Apply VDR in the 8 kΩ resistor or apply KVL at the loop of 3V, 4k Ohms, & 8 KOhms to get:
Vp = 8k/(8k+4k) * 3 = 2 V

Going back to our assumption Vp – Vn = 0 ➔ Vn = 2 V.

Applying KCL at node n:

$$\frac{Vn}{Rs}+\frac{Vn-Vo}{30k}=0$$

Multiply with 30k

$$Vo=Vn\left(\frac{30k}{Rs}+1\right)=2\left(\frac{30k}{Rs}+1\right)=2+\frac{60k}{Rs}$$

b) If Rs = 5 kΩ then

$$Vo=2\left(\frac{30k}{5k}+1\right)=2(6+1)=14 \text{ V}$$

$$ix+\frac{Vo}{10k}+\frac{Vo-Vn}{30k}=0$$

$$ix=-\left(\frac{Vo}{10k}+\frac{Vo-Vn}{30k}\right)=-\left(\frac{14}{10k}+\frac{14-2}{30k}\right)=-1.8 \text{ mA}$$

c) The range of Rs to avoid saturation region

$$-20\le Vo\le 20$$

$$-20\le\left(\frac{60k}{Rs}+2\right)\le 20$$

$$-22\le\left(\frac{60k}{Rs}\right)\le 18$$

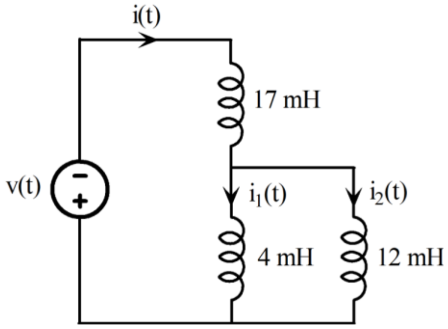
$$Rs\ge\frac{60k}{18}=\frac{10}{3} \text{ k}\Omega$$

Q 4:

For the circuit shown below it is given that, $i_1(0) = 5$ A, $i_2(0) = 15$ A, and $v(t) = 200e^{-500t}$ V, for $t > 0$.

a) Find the current $i(t)$ for $t \geq 0$.

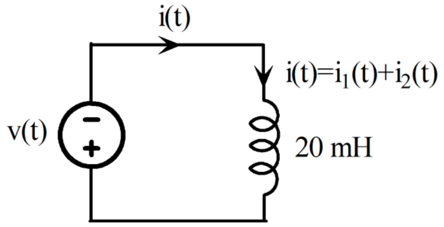
b) Sketch the current $i(t)$ for $t \geq 0$.



Solution:

a) First of all we combine the three inductors into one inductor in two steps:
   Step 1: (4mH//12mH) = 3mH
   Step 2: L_{eq} = 17mH + 3mH = 20 mH.

   We also use KCL to find i(0) = $i_1(0) + i_2(0)$ = 5 A + 15 A = 20 A.



Then we have:

$$i(t) = i(0) + \frac{1}{L_{eq}} \int_0^t \{-v(x)\}\, dx$$

$$i(t) = 20 + \frac{1}{20m} \int_0^t \{-200e^{-500x}\}\, dx$$

$$i(t) = 20 + \frac{200}{(20m)(500)} \left[e^{-500x}\right]_0^t$$

$$i(t) = 20e^{-500t}, \text{ for } t \geq 0$$

b) Sketching of i(t) for $t \geq 0$: