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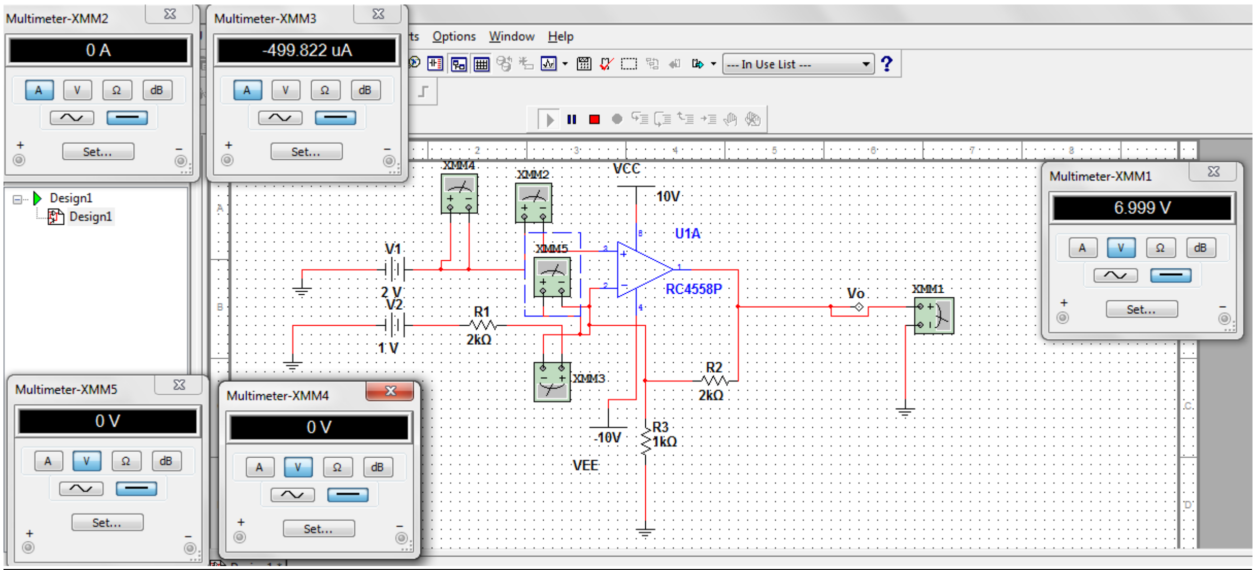
Exam 2 Redo

Question 1




Let the node connecting $R_1$, R2 and $R_3$ be V

For an ideal op-amp, I- = I+ = 0 and $V_1 = V$

KCL @ Node V (Nodal analysis)

$V/1 + (V-V_0)/2 + (V-V_2)/2 + I_2 = 0$

$V_1/1 + (V_1-V_0)/2 + (V_1-V_2)/2 = 0$

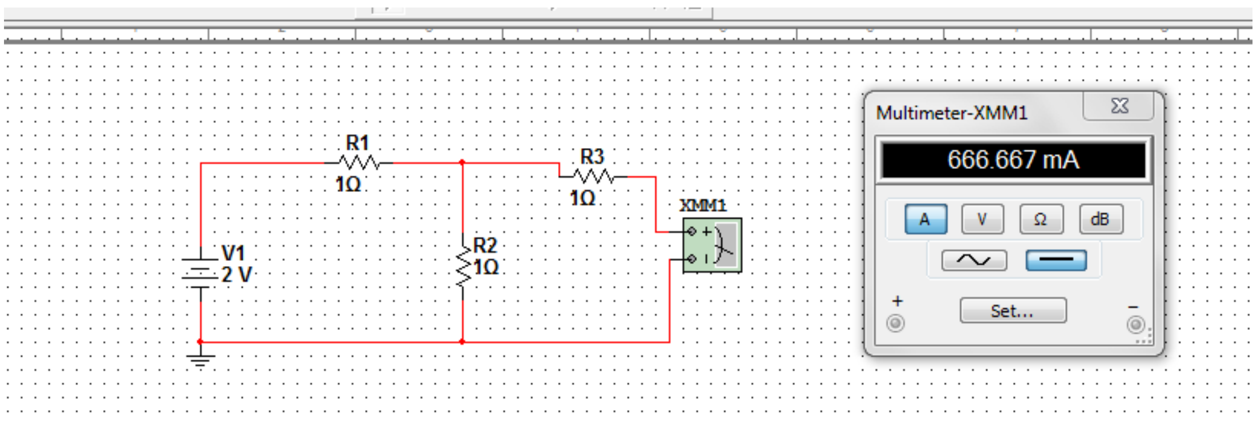
$2V_1 + V_1 – V_0 + V_1 – V_2 = 0$

$V_0 = 4V_1-V_2$

As a test, I set $V_1$ and $V_2$ to be 2V and 1V respectively on multisim. As shown in the above, I obtained $V_0$ as 7V, justifying the equation $V_0 = 4V_1-V_2$

Question 2

For the first part, open current source.




Let $I_o$ be the total current.

$R_{total} = 1 + ( 1 \| 1) = 1.5$ohms

$I_o = V_s/R_{total}$

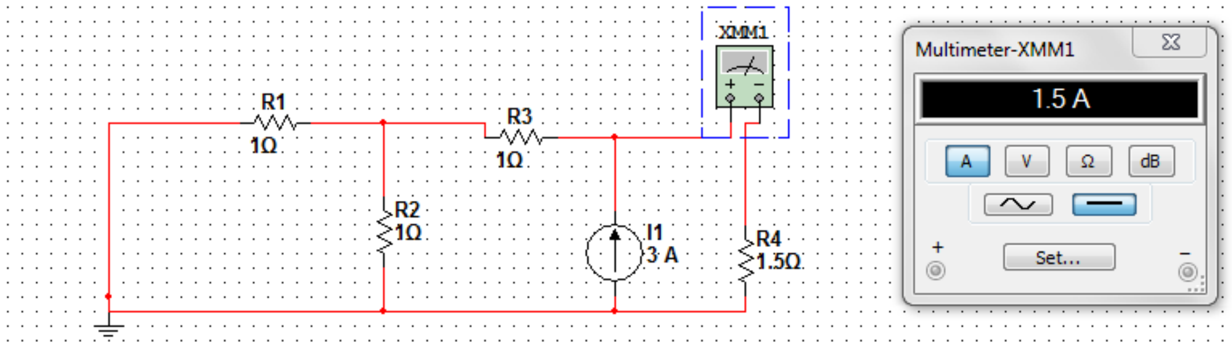
$I_o = 2/(1.5) = 2/3$A

$R_L = R_{th} = 1.5$ohms

$P'_L = (2/3)^2 * (3/2) = 2/3$W

For the second part,

Short the voltage source, circuit becomes




$R_L = R_{th} = 1.5$ohms

Let $I_{sc}$ be the current flowing through the branch on the furthest right.

Since the resistance on the left and right side of the current source is equal, therefore the current is equally split between both the branches.

$I_{sc} = 3/2 = 1.5$A

$P''_L = (3/2)^2 * (3/2)$

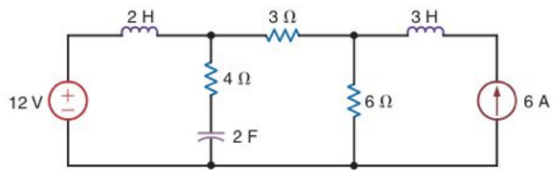
$P''_L = 27/8$ W

Therefore, total power is

$P_o = P'_L + P''_L = 2/3 + 27/8$

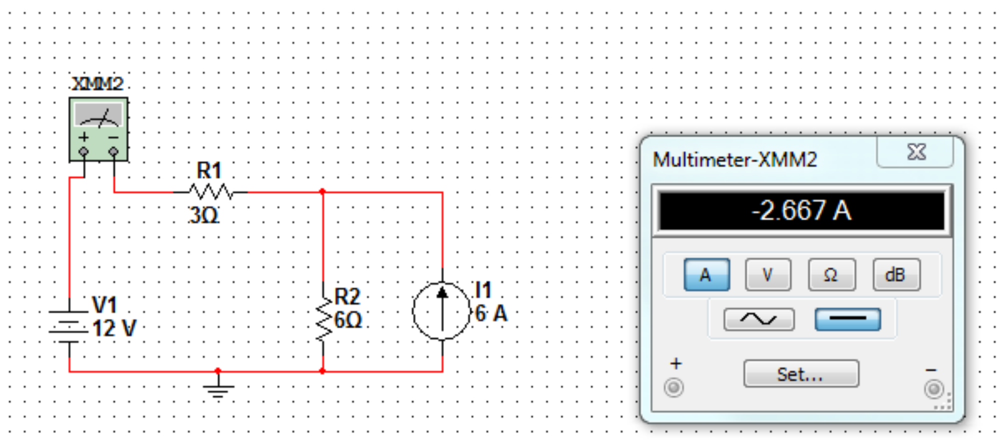
$P_o = 97/24$ W

Question 3




The first step to this problem is to have the inductors be short circuit and capacitors to be open circuit.

The circuit should turn out like below.




There are two methods to calculate the current across the 3ohms resistor, the mesh and nodal analysis.

Mesh Analysis

Let $I_1$ = the current flowing in the left loop

$I_2$= 6A

KVL @ left loop

$-12+3I_1 +6(I_1+I_2) = 0$

$3 I_1+6 I_1+36 =12$

$I_1 = -8/3 = -2.667A$

Since P = I^2R,

Therefore, Power across 3ohms: $P_{3ohms}$ = (-8/3)^2 * (3)  = 64/9 W

Nodal Analysis

Let $V_2$ be the middle node and $V_1$ be at the left node.

Note that $V_1 = 12V$

$(V_2-V_1)/3 - 6 + V_2/6 = 0$

$(V_2-V_1)/3 + V_2/6 = 6$

$2(V_2-V_1) + V_2 = 36$

$3V_2 - 2V_1 = 36$

$V_2 = 20$

$V_o = V_1 - V_2 = -8V$ (Current flowing from right to left across the 3ohms resistor)

$I_{3ohms} = V_0/R_1 = 8/3A$

Since P = I^2R,

Therefore, Power across 3ohms: $P_{3ohms} = (8/3)^2 * (3) = 64/9$ W

**(The above set of workings function as a prove that I am able to find Power and Current across each device)**

For 3H inductor

We know that a current of 6A is flowing through the inductor.

The formula of energy dissipation of an inductor is given as

E = 1/2L(I^2)

E = ½(3)(36) = 54W

For 2F Capacitor

We know that the Voltage across the branch with capacitor is parallel to the $V_{source}$ on the left.

$V_c = V_{source} = 12V$

Dissipation of energy of a capacitor is 1/2CV^2

E = ½(2)(144) = 144W