UNIVERSITY OF GHANA

BACHELOR OF SCIENCE IN ENGINEERING
SECOND SEMESTER EXAMINATIONS, 2012/2013
CPEN 206 : LINEAR CIRCUITS (3 Credits)

Answer **All** Questions; TIME : **3 Hours**

1. (a) When operated at a wavelength of $750nm$, a certain Ti:sapphire laser is capable of producing pulses as short as $50fs$, each with an energy content of $500\mu J$.

   i. calculate the instantaneous output power of the laser. [2 marks]

   ii. if the laser is capable of a pulse repetition rate of $80MHz$, calculate the maximum average output power that can be achieved. [3 marks]

   (b) An electric vehicle is driven by a single motor rated at $40hp$. If the motor is run continuously for $3h$ at maximum output, calculate the electrical energy consumed. Express your answer in SI units using engineering notation. [3 marks]

2. (a) Determine the current labelled I_3 in the circuit of Figure 1. [4 marks]

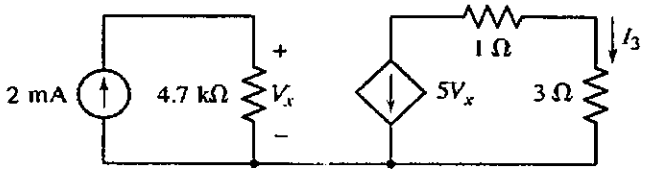

Figure 1: Circuit for question 2a

   (b) Determine a value for the voltage, v, as labelled in the circuit of Figure 2, and compute the power supplied by the two current sources. [6 marks]

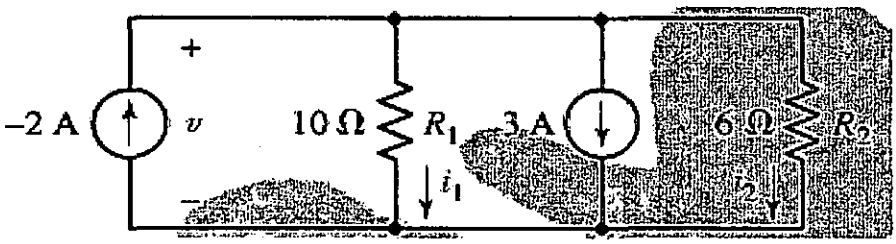

Figure 2: Circuit for question 2b

Examiner : **Steven Armoo**

A

3. For the circuit of Figure 3, calculate the nodal voltage, v_1, if the dependent current source, A, is

(a) $2i_1$ [5 marks]

(b) $2v_1$ [5 marks]

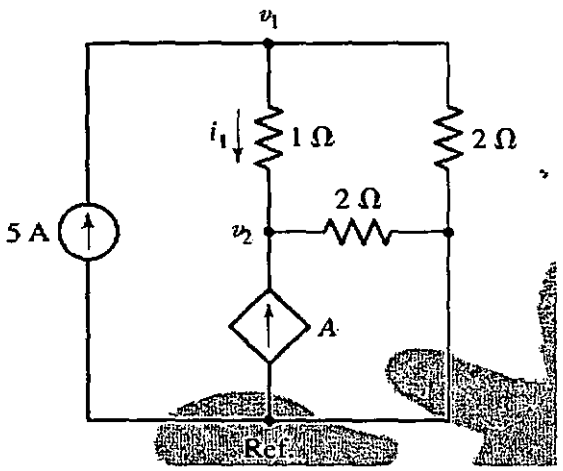

Figure 3: Circuit for question 3

4. For the circuit of Figure 4, using the principle of a supermesh, determine the mesh current i_1 and the power dissipated by the 1Ω resistor. [10 marks]

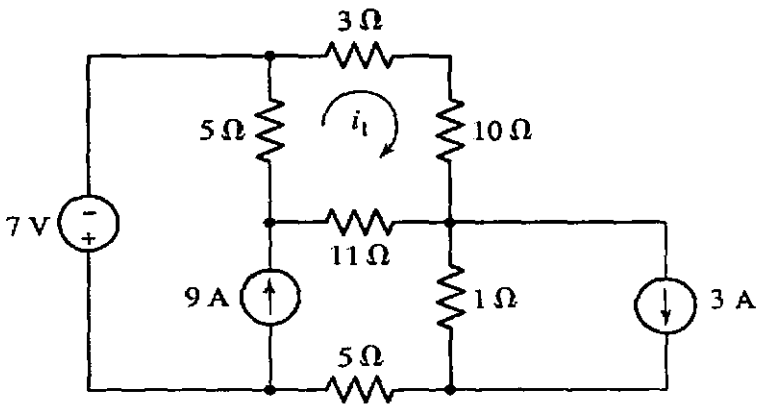

Figure 4: Circuit for question 4

5. (a) Briefly differentiate between a first order circuit and a second order circuit. [2 marks]

(b) Show, from first principles, that for a driven RL circuit, the response is given by

$$i = \frac{V_o}{R} - \frac{V_o}{R}e^{-Rt/L}$$

for all $t > 0$ and all symbols have their usual meaning [4 marks]

(c) We can safely assume the switch in the circuit of Figure 5 was closed a very long time prior to being thrown open at $t = 0$.

i. determine the circuit time constant [2 marks]

ii. obtain an expression for $i_1(t)$ which is valid for $t > 0$ [3 marks]

iii. determine the power dissipated by the 12Ω resistor at $t = 500ms$ [2 marks]

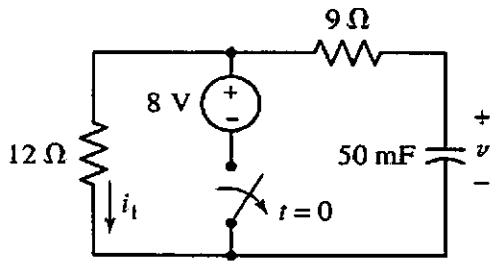

Figure 5: Circuit for question 5c

6. (a) Using repeated source transformations, reduce the circuit of Figure 6 to a voltage source in series with a resistor, both of which are in series with the $6M\Omega$ resistor. [7 marks]

(b) Calculate the power dissipated by the $6M\Omega$ resistor using your simplified circuit. [2 marks]

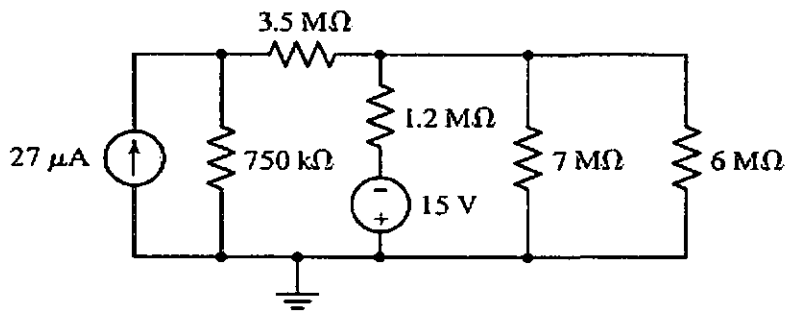

Figure 6: Circuit for question 6

7. For the circuit of Figure 7, what value of R_L will ensure it absorbs the maximum possible amount of power? [10 marks]

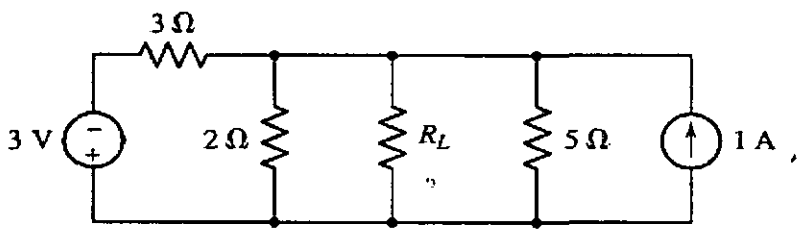

Figure 7: Circuit for question 7

8. (a) Assuming an ideal op amp, it is required to design the circuit shown in Figure 8 to implement a current amplifier with a gain of $i_L/i_I = 20A/A$.

   i. find the required value for R [5 marks]

   ii. if $R_L = 1k\Omega$ and the op amp operates in an ideal manner so long as v_o ranges from $+12V$ to $-12V$. What range of i_I is possible? [5 marks]

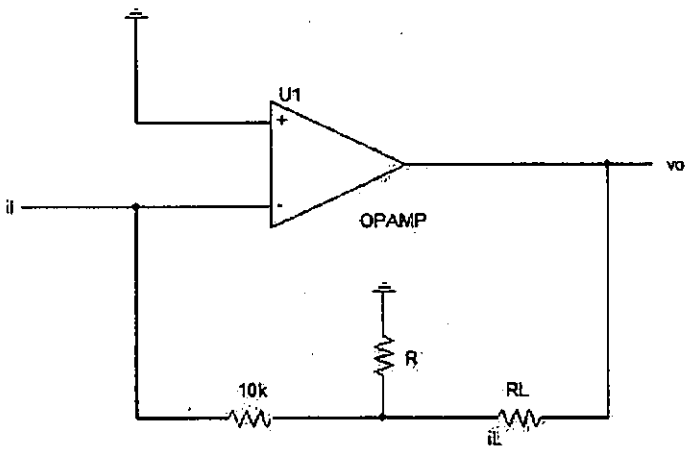

Figure 8: Circuit for question 8a

(b) In the circuit of Figure 9, use the principle of superposition to find the output voltage, v_o, in terms of v_1 and v_2. [10 marks]

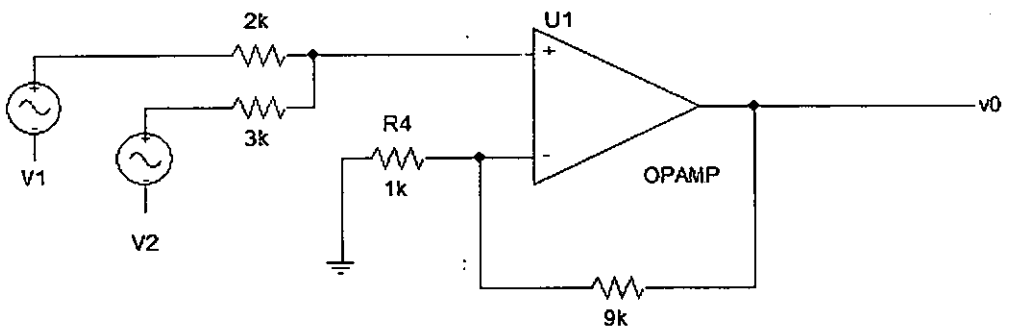

Figure 9: Circuit for question 8b

(c) Assuming in the circuit of Figure 9, the $1k\Omega$ resistor is disconnected from ground and connected to a third signal source, v_3, use the principle of superposition to determine v_o in terms of v_1, v_2 and v_3. [10 marks]