ELEN2008 Electric Circuits:
EXAMINATION June 2015

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External Examiner:	Prof HE Hanrahan

TOTAL MARKS: 100
TIME: 3 hours

Instructions

Answer **ALL** questions. There are 110 possible marks, but the paper will be marked out of 100.

Knowledge Area 1: Basic Concepts [40 marks]

Question 1 [40 marks]

Note: Where indicated, solutions to this question must be entered on the sheet supplied. The final answer only is to be shown. Do not include any working on the sheet.
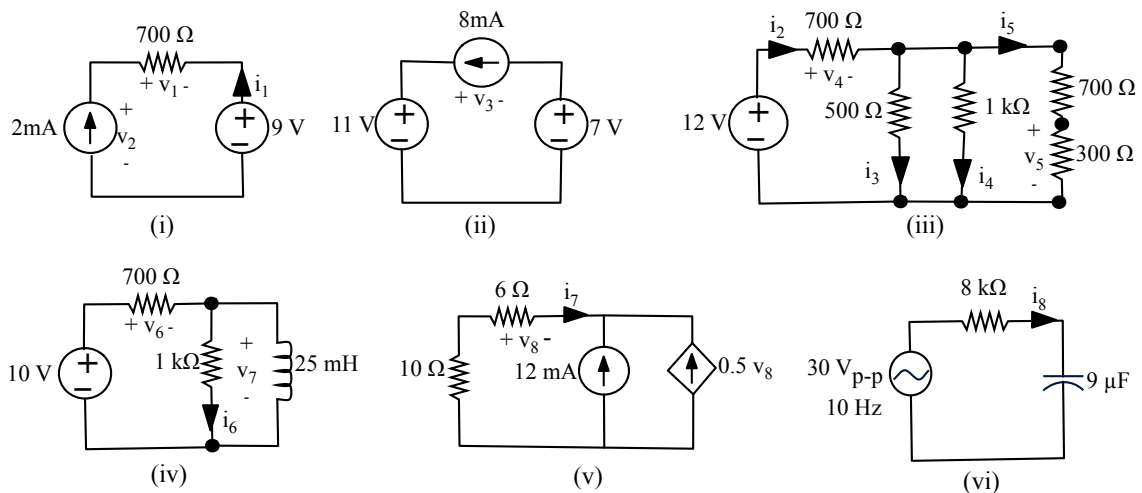

Figure 1: Six circuits containing various configurations of sources, resistors, capacitors and inductors

a) Enter the values on the sheet supplied for v_1 and v_2 for the circuit shown in Figure 1 (i). Indicate whether each source is supplying or absorbing power and how much power is being supplied/absorbed. Do not show any working on the sheet.   (6 marks)

b) For the circuit shown in Figure 1 (ii) enter the value for v_3 on the sheet supplied. Indicate whether each source is supplying or absorbing power and how much power is being supplied/absorbed. Do not show any working on the sheet. (7 marks)

c) For the circuit shown in Figure 1 (iii) calculate and enter the values for i_2, i_3, i_4 and v_5 on the sheet supplied. (Hint: to calculate i_2 you will have to reduce the circuit to a source and a single resistor.) Do not show any working on the sheet. (7 marks)

d) On the answer sheet provided, calculate and enter the impedances of the inductor and calculate and enter the values of voltages v_6 and v_7 and current i_6 for the circuit shown in Figure 1 (iv). (6 marks)

e) For the circuit shown in Figure 1 (v) calculate and enter the values for i_2 and v_4 on the sheet supplied. Indicate whether each source is supplying or absorbing power and how much power is being supplied/absorbed. Do not show any working on the sheet. (7 marks)

f) Answer this question in your exam script and **not** on the sheet provided. For the circuit shown in Figure 1 (vi):

- Determine the impedance of the capacitor. (2 marks)

- Determine the current i_8 using vectors and a phasor diagram (no complex mathematics) (5 marks)

Knowledge Area 2: Analysis techniques [30 marks]

Question 2 (15 marks)

i. Consider the circuit shown in Figure 2. Use **mesh** analysis to set up simultaneous equations and solve your equations to find values for the mesh currents. (6 marks)

ii. Consider the circuit shown in Figure 2. Use **superposition** to find the voltage across terminals a and b, v_{ab}. (9 marks)
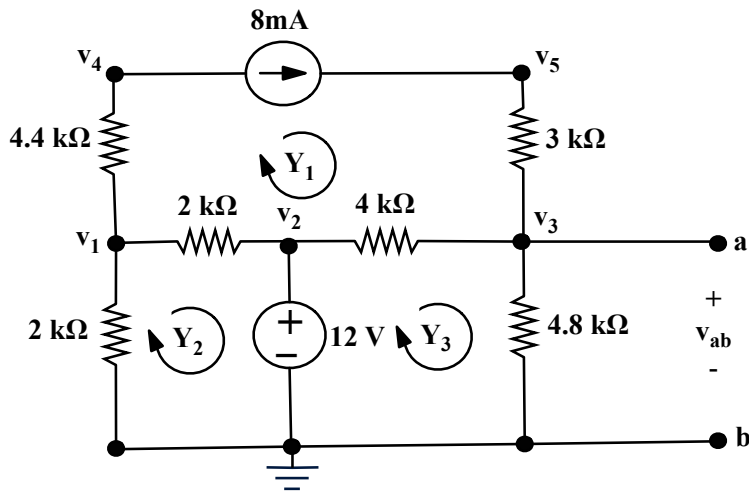
Figure 2: Circuit containing resistors and sources

Question 3 (15 marks)
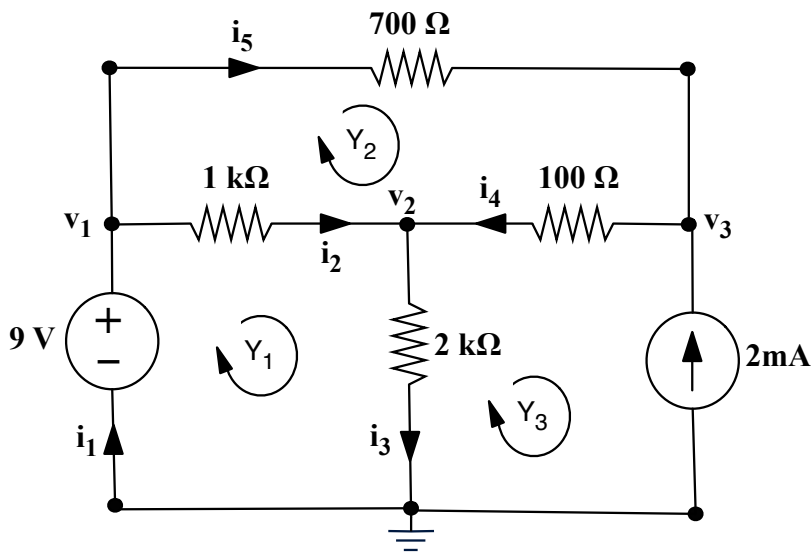

Figure 3: Resistive circuit with a voltage and a current source

a) Consider the circuit shown in Figure 3. Use **nodal** analysis and solve for all the node voltages.

(10 marks)

b) Consider the different circuit analysis techniques that you know (mesh and nodal analysis, superposition and Thévenin's and Norton's theorems, which one would you regards as most suitable for analyzing the circuit in Figure 3? Explain why you consider the technique that you chose as the most suitable one.

(6 marks)

Knowledge Area 3: Laboratory concepts and techniques [20 marks]

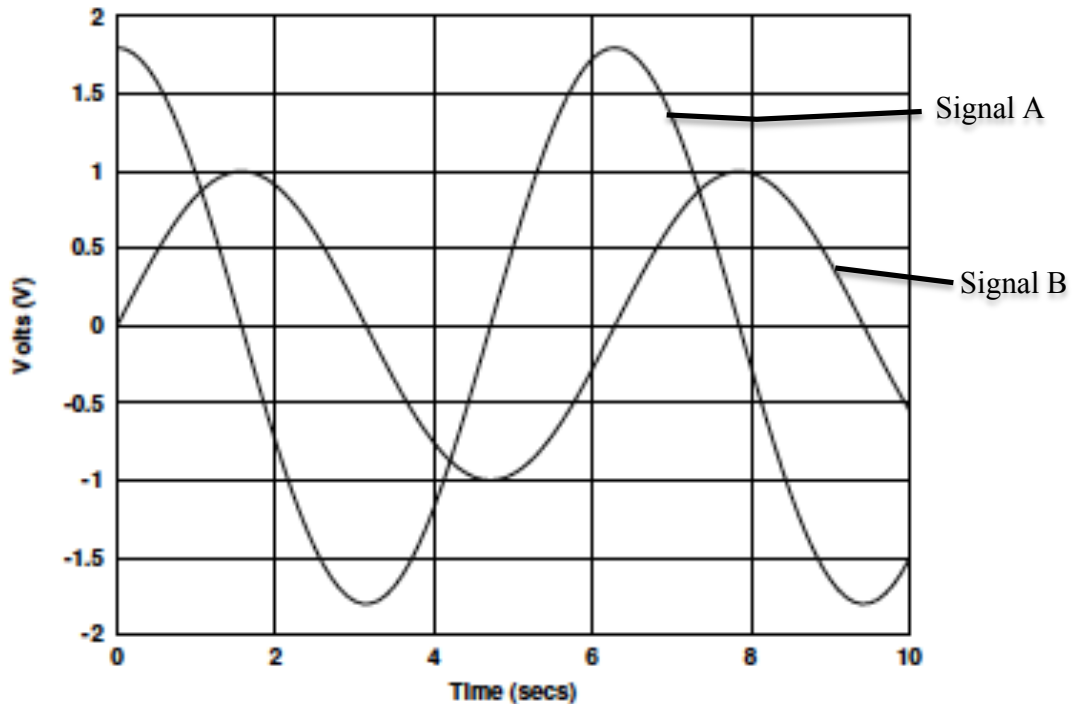## Question 4 (10 marks)

Figure 4: Two sinusoidal signals

Referring to Figure 4, determine the following:

a) Measure the phase shift between the two signals and give it in degrees and in radians;
b) The peak to peak voltage of each of the signals;
c) The period of each of the signals signals;
d) The frequency of each of the signals.

Question 5 (10 marks)

Table 1: Resistor values and voltage measurements

Resistor (Ω)	Voltage (V)	Current (mA)
200	2	
375	3	
500	3.5	
3000	6	

Four different load resistors were placed in turn across the output of a circuit and, in each case, the voltage across the resistor was measured, as shown in Table 1.

a) Redraw Table 1, calculate the current in the load resistor in mA and enter the values in your table.

(2 marks)

b) Draw a graph of the variables in Table 1 and use the graph to estimate the Thévenin equivalent and the Norton equivalent circuit values of the circuit. Draw the Thévenin and Norton equivalent circuits labeled with these values.

(8 marks)

Knowledge Area 4: Complex real circuits [20 marks]

Question 6

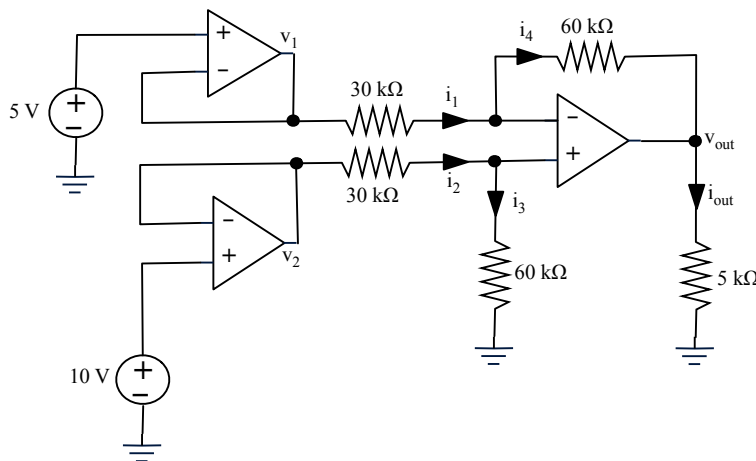a) Analyse the circuit in Figure 5 and calculate v_{out} and i_{out}.   (10 marks)

Figure 5: Circuit containing 3 operational amplifiers and two voltage sources

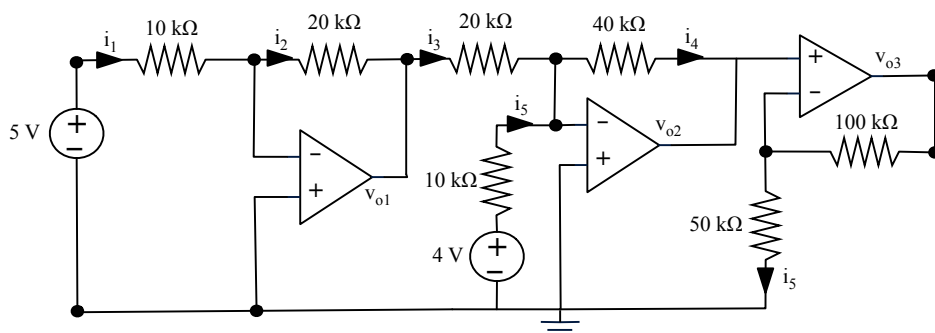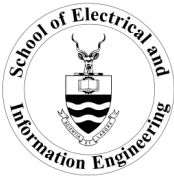b) Analyse the circuit in Figure 6 and calculate v_{o1}, v_{o2} and v_{o3}.   (10 marks)

Figure 6: Circuit containing three cascaded operational amplifiers

Examination June 2015: Answer sheet

Student number: _____ **Row:** _____ **Seat:** _____

Question 1(a) (6 marks)

v_1 = _____

v_2 = _____

Is the 2mA source supplying or absorbing power? _____

How much power is the 2mA source supplying or absorbing? _____ mW

Is the 9V source supplying or absorbing power? _____

How much power is the 9V source supplying or absorbing? _____ mW

Question 1(b) (7 marks)

v_3 = _____

Is the 8mA source supplying or absorbing power? _____

How much power is the 8mA source supplying or absorbing? _____ mW

Is the 11V source supplying or absorbing power? _____

How much power is the 11V source supplying or absorbing? _____mW

Is the 7V source supplying or absorbing power? _____

How much power is the 7V source supplying or absorbing? _____ mW

Question 1(c) (7 marks)

Current i_2 in Figure 1 (iii) is _____

Current i_3 in Figure 1 (iii) is _____

Current i_4 in Figure 1 (iii) is _____

Voltage v_5 in Figure 1 (iii) is _____

Question 1(d) (6 marks)

Impedance of the inductor in Figure 1 (iv) is: _____

Current i_6 in Figure 1 (iv) is _____

Voltage v_6 in Figure 1 (iv) is _____

Voltage v_7 in Figure 1 (iv) is _____

Question 1(e) (7 marks)

Current i_7 in Figure 1 (v) is _____

The voltage $v_8 =$ _____

Is the 12mA source supplying or absorbing power? _____

How much power is the 12mA source supplying or absorbing? _____W

Is the dependant current source supplying or absorbing power? _____

How much power is the dependant current source supplying or absorbing? _____W

Question 1(f) (7 marks)

Answer in your exam script, not on the sheet.