UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
SCHOOL OF ELECTRICAL AND INFORMATION ENGINEERING

ELEN2008 Electric Circuits: EXAMINATION 2013

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External Examiner: Dr Grant Grobbelaar

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: Concepts [30 marks]

Question 1 [12 marks]

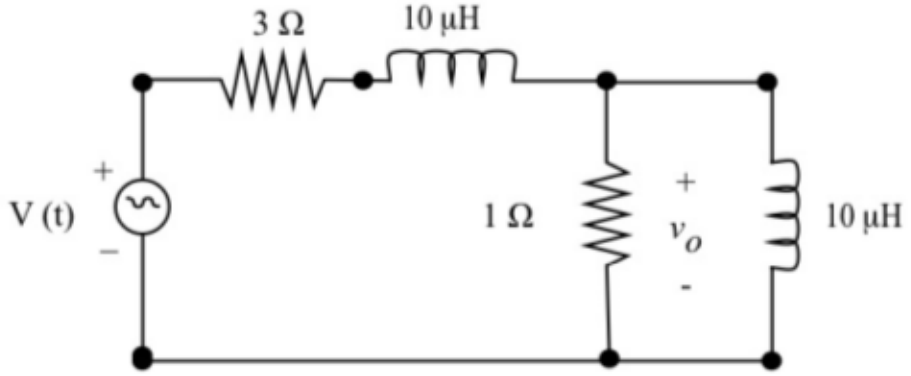

Figure 1: A circuit containing resistors and inductors

a) How many nodes does the circuit in Figure 1 contain?
b) How many meshes does the circuit in Figure 1 contain?
c) How many loops does the circuit in Figure 1 contain?
d) How many branches does the circuit in Figure 1 contain?
e) Using your own English words, and sketches if necessary, briefly explain the difference between an AC and a DC source.
f) Is the source in the circuit in Figure 1 an AC or a DC source?
g) Using your own English words, and sketches if necessary, briefly explain how an inductor behaves in a circuit with a DC power supply.
h) If the voltage source in Figure 1 was replaced by a 9V battery, what would v_o be?

Question 2 (18 marks)

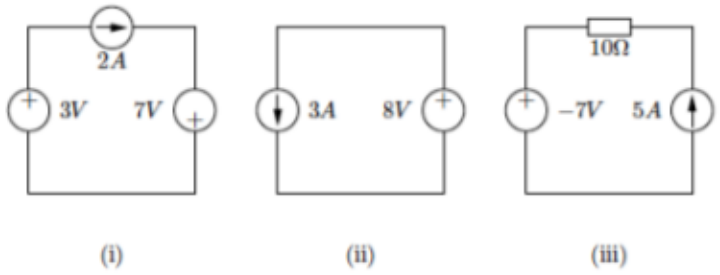

Figure 2: Three circuits with interconnected sources

a) Three circuits are shown in Figure 2. For each of the three circuits, show which source(s) is absorbing power and which source(s) is supplying power. In each case, determine how much power is being supplied/absorbed. (10 marks)

b) Describe and use a sketch to show an example of when the model of an ideal voltage source breaks down. (3 marks)

c) Simplify the circuit shown in Figure 3. (5 marks)

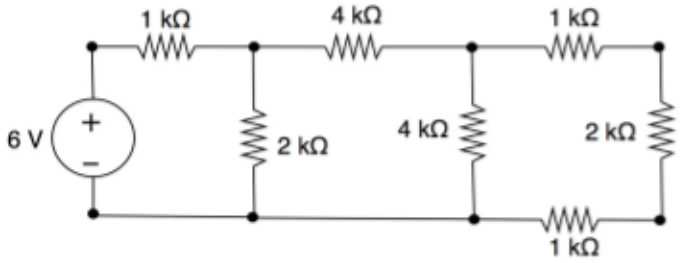

Figure 3: Circuit with resistors in series and in parallel

Knowledge Area 2: Analysis techniques [40 marks]

Question 3 (19 marks)

a) Consider the circuit shown in Figure 4. Use **nodal** analysis to find v_2 and i_6 in the circuit shown in Figure 4. (10 marks)

b) Consider the circuit shown in Figure 4. Use **mesh** analysis to find v_2 and i_6 in the circuit shown in Figure 4. Note: You should obtain the same values for v_2 and i_6 as in Question 3 (a) – use this as a check. (9 marks)

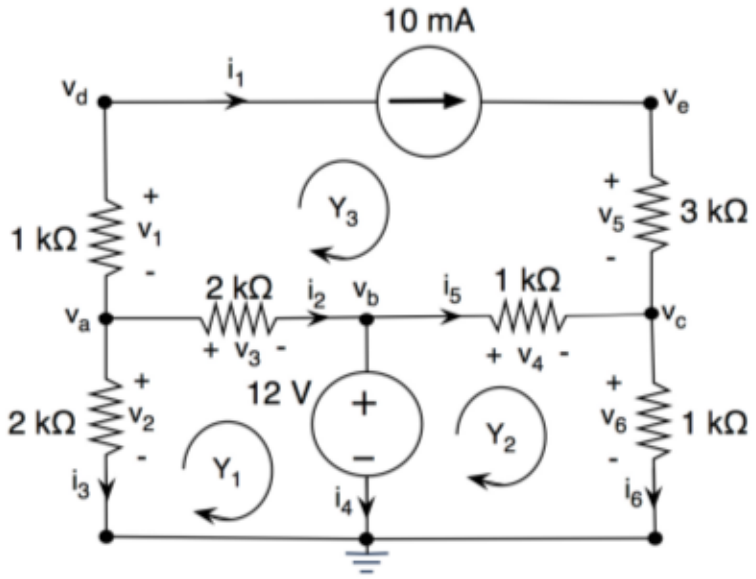

Figure 4: Circuit containing resistors and sources

Question 4 (21 marks)

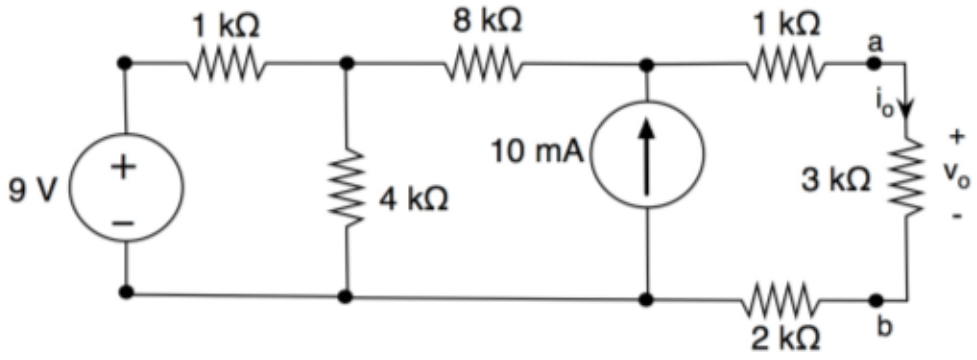

Figure 5: Resistive circuit with a voltage and a current source

a) Consider the circuit shown in Figure 5. Use superposition to determine the load voltage v_o and the load current i_o. (11 marks)

b) Consider the circuit shown in Figure 5. Find the Thévenin equivalent for the circuit to the left of nodes a and b in Figure 5. Use your Thévenin equivalent circuit to determine the load voltage v_o and the load current i_o in Figure 5. Note: You should obtain the same values for v_2 and i_6 as in Question 4 (a) – use this as a check. (10 marks)

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

Question 5 (8 marks)

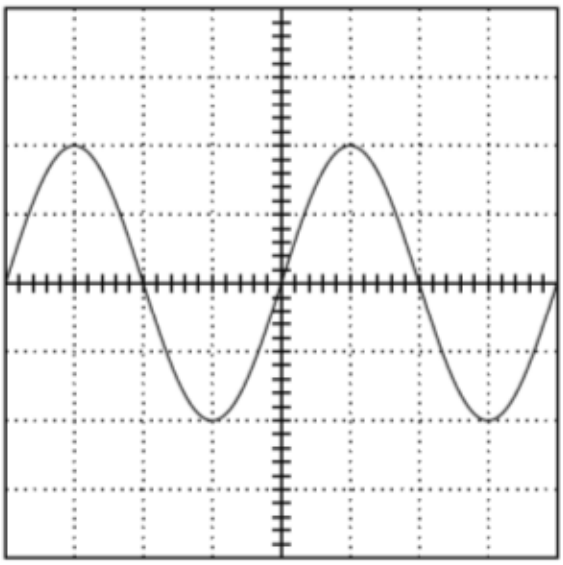

Figure 6: An oscilloscope trace

Figure 6 shows the trace of a sinusoidal voltage measured using a single channel oscilloscope. The channel gain is set to 0.5 V/div with a 1.5 V vertical offset. The time base is set to 5 ms/div. Referring to Figure 6, determine the following:

a) The peak to peak voltage;
b) The DC component;
c) The period of the signal;
d) The frequency of the signal.

Question 6 (12 marks)

Table 1: Resistor values and voltage measurements

Resistor (Ω)	Voltage (V)	Current (A)
2.5	9.2	
2.8	9.4	
3.6	9.7	
4.6	10.1	
7	10.5	

Five different load resistors were placed across the output of an amplifier and, in each case, the voltage across the resistor was measured, as shown in Table 1. Calculate the current and then use the data to draw a graph. Use your graph to estimate and draw the Thévenin equivalent circuit and the the Norton equivalent circuit of the amplifier.

Knowledge Area 4: Complex real circuits [20 marks]

Question 7 (20 marks)

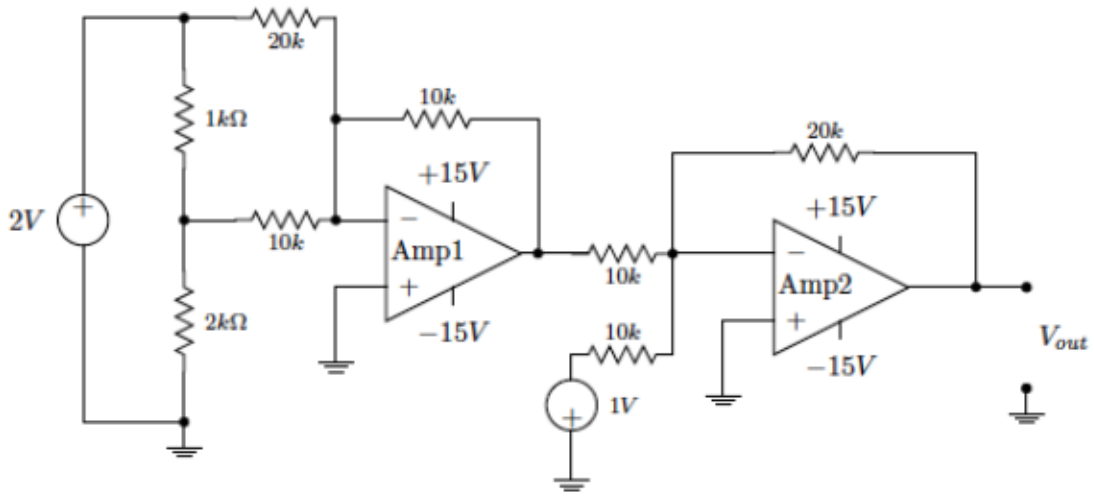

Figure 7: An operational amplifier circuit

Analyse the circuit in Figure 7 and then determine V_{out}.

END OF QUESTION PAPER