Family Name ....

Given Name ....

Student No. ....

Signature ....

THE UNIVERSITY OF NEW SOUTH WALES

School of Electrical Engineering & Telecommunications

FINAL EXAMINATION

Semester 2, 2018

ELEC1111
Electrical and Telecommunications Engineering

TIME ALLOWED:	**2 hours**
TOTAL MARKS:	**100**
TOTAL NUMBER OF QUESTIONS:	**5**

THIS EXAM CONTRIBUTES 50% TO THE TOTAL COURSE ASSESSMENT

Reading Time: 10 minutes.

This paper contains 6 pages.

Candidates must **ATTEMPT ALL** questions.

Answer each question in a **separate answer booklet**.

Marks for each question are indicated beside the question.

This paper **MAY NOT** be retained by the candidate.

Print your name, student ID and question number on the front page of each answer book.

Authorised examination materials:

Candidates should use their own UNSW-approved electronic calculators.

This is a closed book examination.

Assumptions made in answering the questions should be stated explicitly.

All answers must be written in ink. Except where they are expressly required, pencils **may only be used** for drawing, sketching or graphical work.

QUESTION 1 [20 marks]

a. **(10 marks)** For the circuit shown in Figure 1,

   i. **(8 marks)** Apply mesh analysis and write down the mesh equations using the labels provided. Note: DO NOT solve the equations.

   ii. **(2 marks)** Given the values of mesh currents as $i_1 = 64.8\ A, i_2 = 68.4\ A$ and $i_3 = 39\ A$, find the power dissipated in the 20Ω resistor.

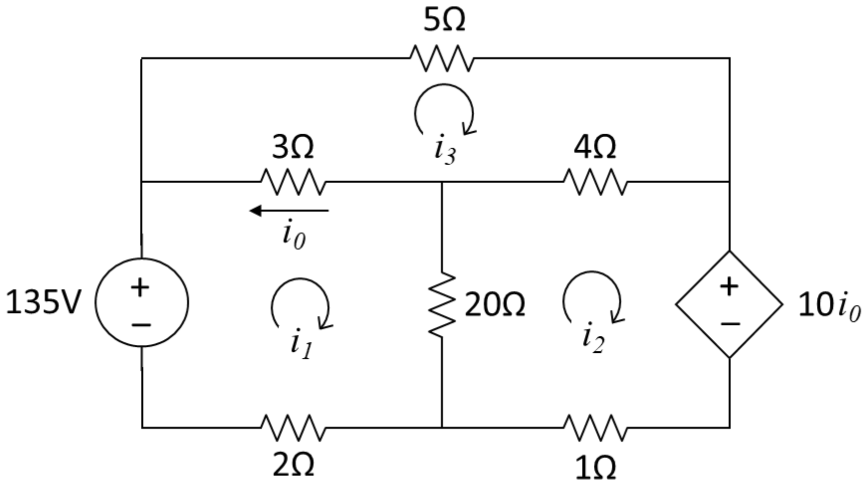

Figure 1

b. **(10 marks)** The variable resistor R_0 in the circuit shown in Figure 2 is adjusted for maximum power transfer.

   iii. **(2 marks)** Find the value of R_0.

   iv. **(8 marks)** Find the maximum power that can be delivered to R_0.

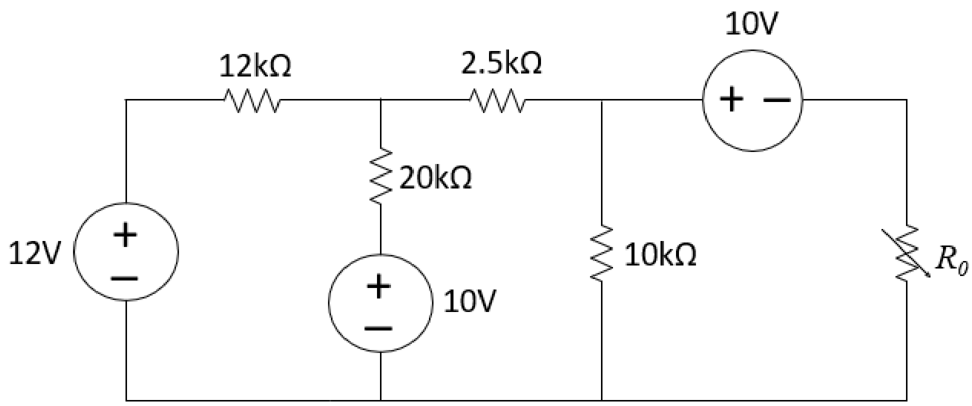

Figure 2

QUESTION 2 [20 marks]

The switch in the circuit shown in Figure 3 has been in position a for a long time. At $t = 0$, the switch moves instantaneously to position b.

a. **(4 marks)** Find the initial current $i(0^-)$ though the inductor under steady-state condition.

b. **(2 marks)** Calculate the initial energy $w_L(0)$ stored in the inductor.

c. **(4 marks)** Find the final current $i(\infty)$ through the inductor under steady-state condition.

d. **(5 marks)** Derive an expression for the current of the inductor $i(t)$ for all time (i.e., for both $t < 0$ and $t \geq 0$).

e. **(5 marks)** Derive an expression for the voltage $v(t)$ across the 40 Ω resistor for $t \geq 0$.

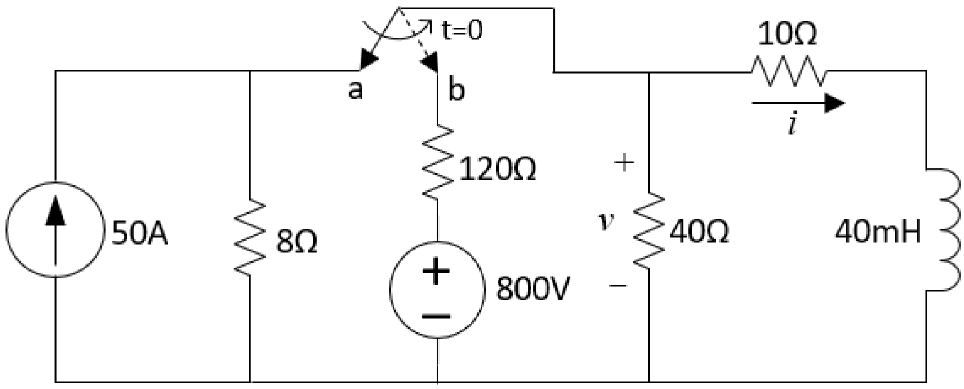

Figure 3

QUESTION 3 [18 marks]

The circuit shown in Figure 4 is a simple fire alarm system. When the alarm is triggered, 1 kHz sinusoidal "beeps" are sent to the speakers.

a. **(2 marks)** Express the voltage at the amplifier input v_{in} as a function of time and as a phasor.

b. **(10 marks)** Find the voltage v_{out} across each speaker as a phasor.

c. **(6 marks)** Find the average power consumed by each speaker.

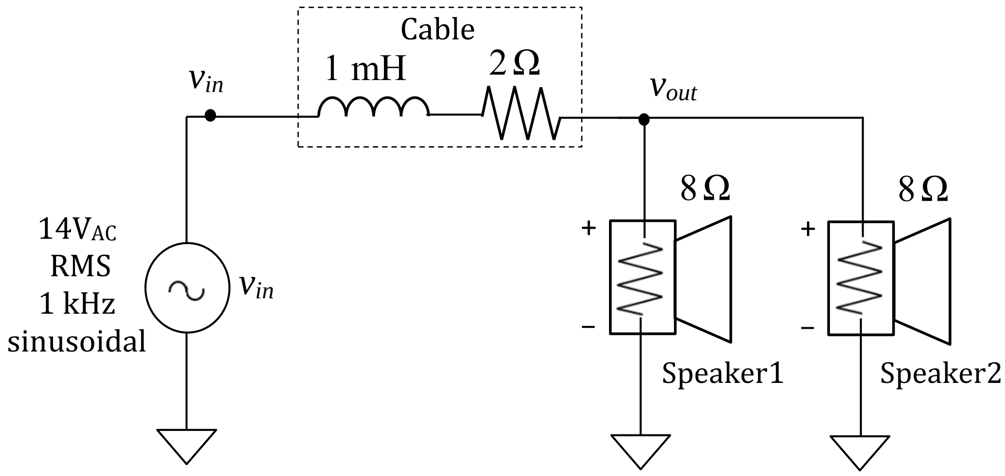

Figure 4

QUESTION 4 [30 marks]

a. (15 marks) A 120Ω strain gauge bridge consists of four identical 120Ω resistors arranged in a Wheatstone bridge. When the gauge experiences a positive strain of 0.5%, the resistances of the individual resistor elements change as shown in Figure 5. The op-amp circuit shown has been designed to amplify these small changes in resistance into a larger change in voltage for measurement.

- **i. (3 marks)** Calculate the voltages v_a and v_b at the output of the strain gauge.
- **ii. (10 marks)** Derive an expression for the op-amp output voltage v_{out} in terms of the input voltages v_a and v_b to demonstrate that it is a difference amplifier. Note: DO NOT substitute the values of v_a and v_b from part (i) so that you can find a general expression rather than a voltage value.
- **iii. (2 marks)** Substitute the values of v_a and v_b from part (i) to calculate the voltage value at the output of the op-amp.

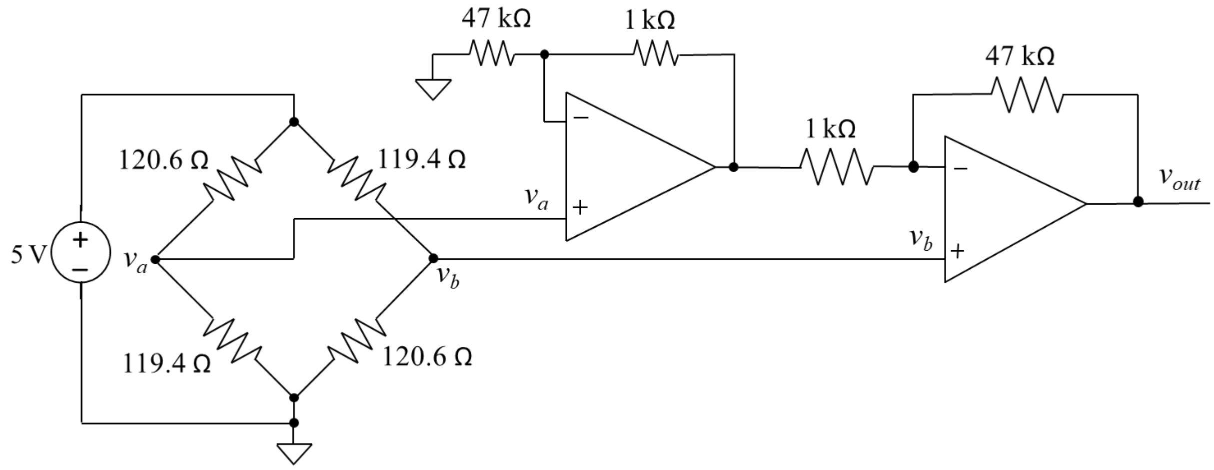

Figure 5

b. (15 marks) Calculate the steady-state value for v_{out} in the circuit shown in Figure 6 if $v_g = 25\cos 50000t\ V$.

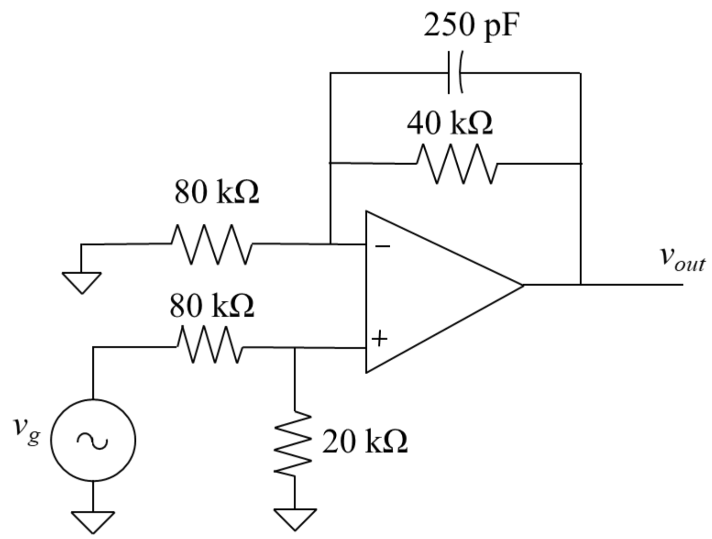

Figure 6

QUESTION 5 [12 marks]

a. **(6 marks)** Draw the logic diagram which represents the function of the following logic equation:

$$Z = (\bar{A} + \bar{B} + C)(A + B + \bar{C})(A + \bar{B} + C)$$

b. **(6 marks)** Consider the logical diagram in Figure 7.

i. **(3 marks)** Derive the logical expression for Z.

ii. **(3 marks)** Write the truth table of the circuit.

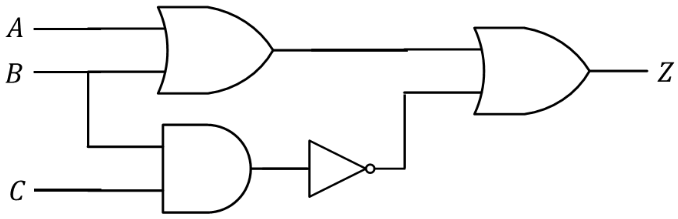

Figure 7

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