Family Name ....

Given Name ....

Student No. ....

Signature ....

THE UNIVERSITY OF NEW SOUTH WALES

School of Electrical Engineering & Telecommunications

MID-TERM EXAMINATION

Term 1, 2019

ELEC1111
Electrical and Telecommunications Engineering

TIME ALLOWED:	**75 min**
TOTAL MARKS:	**100**
TOTAL NUMBER OF QUESTIONS:	**5**

THIS EXAM CONTRIBUTES 25% TO THE TOTAL COURSE ASSESSMENT

Reading Time: 5 minutes.

This paper contains 5 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. **(6 marks)** Apply mesh analysis and write down the mesh equations using the labels provided. Note: Simplify the equations, but DO NOT solve them.

ii. **(4 marks)** Given the values of mesh currents as $i_1 = 5.95\,A$, $i_2 = 4.65\,A$ and $i_3 = 0.95\,A$, find the power in the 5 A current source.

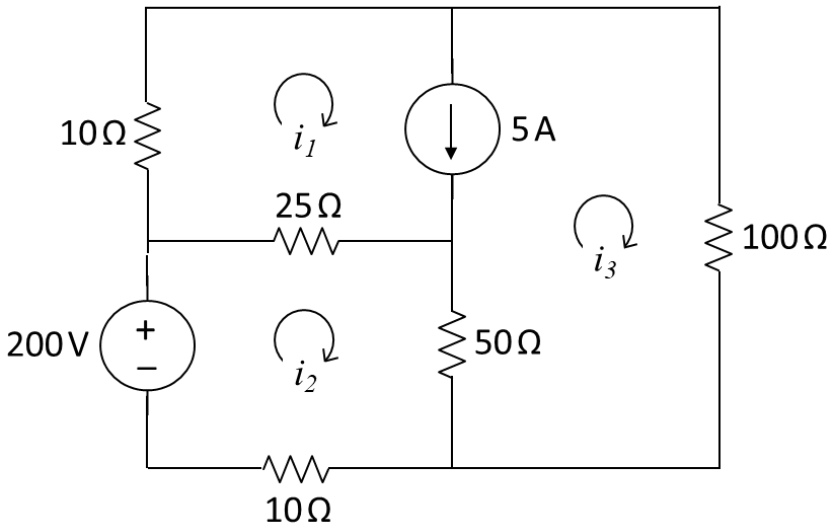

Figure 1

b. **(10 marks)** Bipolar transistors can serve as amplifiers, producing both current gain and voltage gain. Such amplifiers can be used to furnish a considerable amount of power to devices that convert energy from one form to another, such as loudspeakers or control motors. For the simplified transistor circuit shown in Figure 2,

i. **(6 marks)** Use nodal analysis to find the nodal voltage v_1.

ii. **(4 marks)** Use the result of part (i) to calculate the output current i_0 and output voltage v_0.

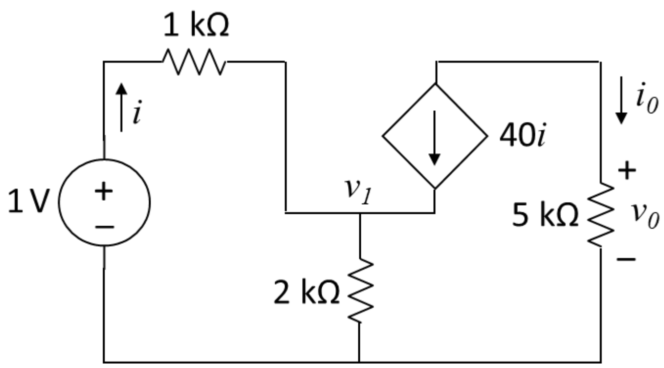

Figure 2

QUESTION 2 [15 marks]

For the circuit shown in Figure 3,

a. **(6 marks)** Calculate the equivalent resistance R_{eq} as seen from terminals *a*-*b*.

b. **(3 marks)** Find current i_g using the result of part (a).

c. **(6 marks)** Find the power dissipated in the 8 Ω resistor.

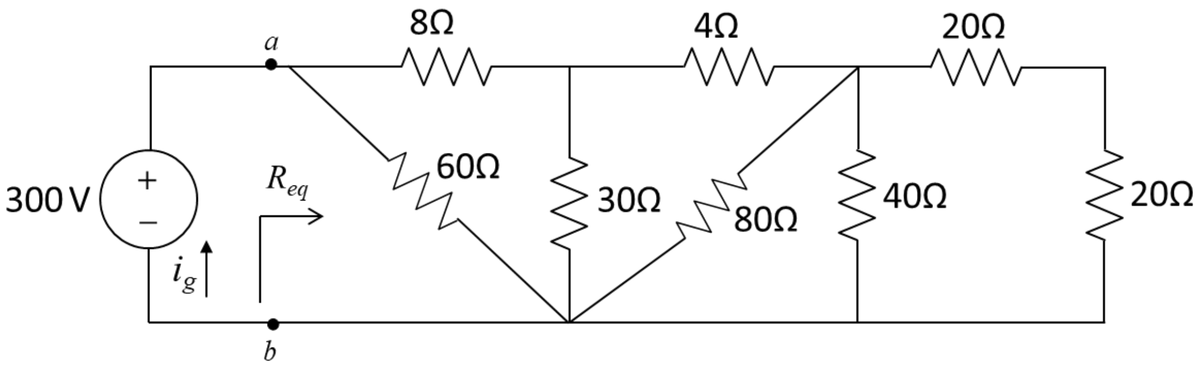

Figure 3

QUESTION 3 [15 marks]

For the circuit shown in Figure 4, use a succession of <u>source transformations</u> (<u>only</u> source transformations) to find an equivalent circuit consisting of a single voltage source and a single resistor.

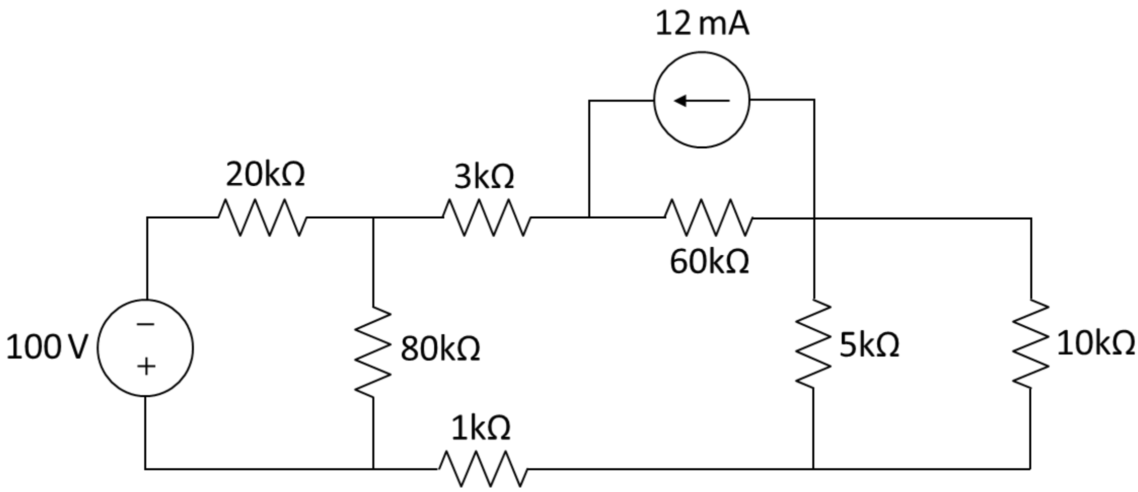

Figure 4

QUESTION 4 [20 marks]

The circuit shown in Figure 5 is being used to illuminate a mine. Generator 1 is at the entrance of the mine, with 50 metres of cabling connecting the generator to the lighting system. Generator 2 is at a campsite 75 metres away and is connected to Generator 1 to boost the power that can be supplied to the lighting system. The cables have a resistance of 0.01Ω per metre. The lighting system is made of light bulbs in parallel and can be modelled as a single resistor.

- **a. (10 marks)** Use the <u>superposition</u> principle to find the Thevenin voltage at the lighting system terminals (terminals *a*-*b*).
- **b. (5 marks)** Calculate the lighting system resistance that will ensure the maximum transfer of power from the circuit to the lighting system.
- **c. (5 marks)** Find the maximum power that can be delivered to the lighting system.

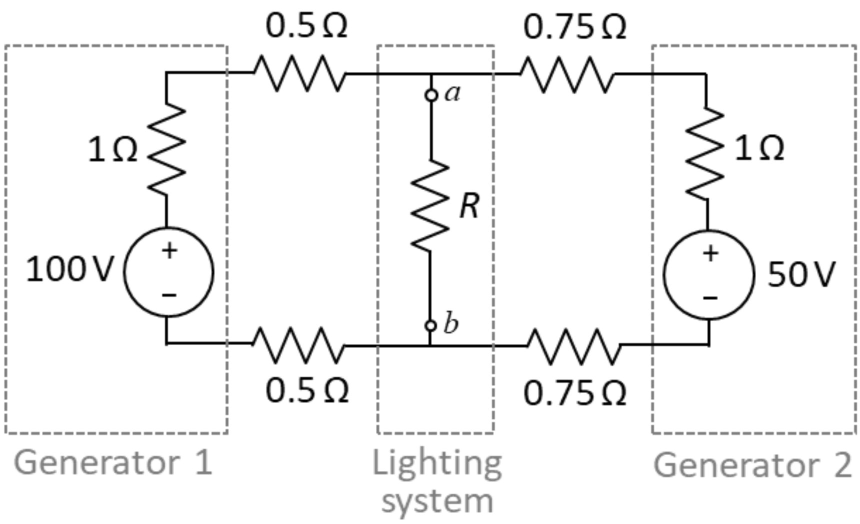

Figure 5

QUESTION 5 [30 marks]

a. **(15 marks)** Find the voltage across the capacitors in the circuit of Figure 6 under DC steady state conditions.

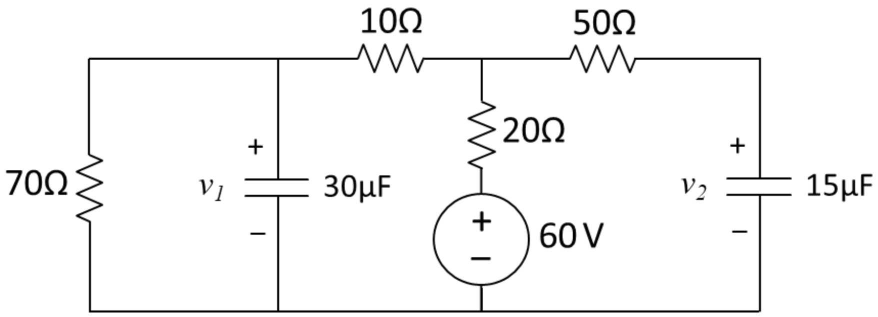

Figure 6

b. **(15 marks)** The circuit shown in Figure 7 is used to estimate the speed of a horse running a 4 km racetrack. The switch closes when the horse begins and opens when the horse crosses the finish line at $t = t_1$ s.

- **i.** **(8 marks)** Calculate the voltage $v_c(t)$ in the capacitor for $t < t_1$ s. Assume that the capacitor was initially discharged.
- **ii.** **(5 marks)** If the capacitor is charged to 85.6 V when the horse crosses the finish line, calculate the time instant t_1.
- **iii.** **(2 marks)** Calculate the speed of the horse in m/s.

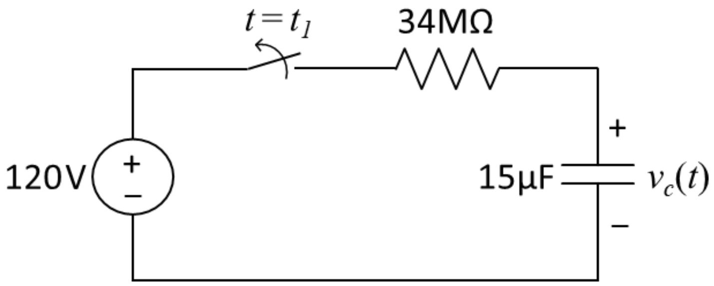

Figure 7

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