Family Name ....

Given Name ....

Student No. ....

Signature ....

THE UNIVERSITY OF NEW SOUTH WALES

School of Electrical Engineering & Telecommunications

FINAL EXAMINATION

Semester 2, 2017

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.

Students must achieve **a minimum of 40 marks** to pass the course.

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.

For the **numerical solutions**, you can use either **fraction** form or floating-point form (maximum **2 digits** after decimal point is enough)

QUESTION 1 [20 marks]

(i) **[10 marks]** For the circuit shown in Figure 1,

a. **(8 marks)** Apply mesh analysis and show that the mesh equation are given as below,

$$\begin{cases} i_1 + 3i_2 - 2i_3 = 8 \\ i_1 + i_2 - 4i_3 = -1 \\ i_1 - i_2 = -4 \end{cases}$$

b. **(2 marks)** Given the values of mesh currents as $i_1 = -0.5$ A, $i_2 = 3.5$ A, and $i_3 = 1$ A, find the voltage v across 4-A current source.

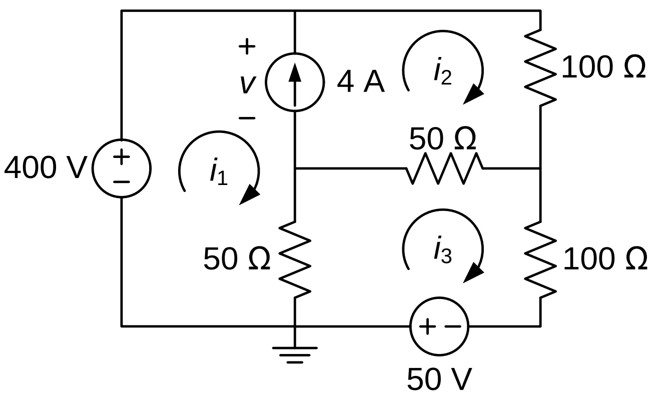

Figure 1

(ii) **[10 marks]** For the circuit shown in Figure 2,

a. **(8 marks)** Apply nodal analysis and show that the nodal equations are given as below,

$$\begin{cases} 11v_1 - 6v_2 = 108 \\ 4v_1 - 3v_2 = -54 \end{cases}$$

b. **(2 marks)** Given the values of node voltages as $v_1 = 72$ V and $v_2 = 114$ V, Calculate the power of the dependent current source.

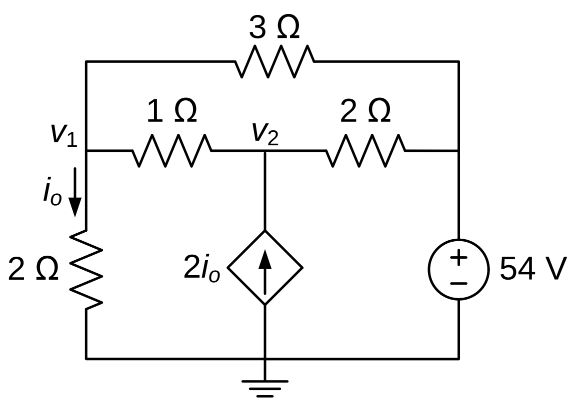

Figure 2

QUESTION 2 [20 marks]

(i) **[10 marks]** For the circuit shown in Figure 3,

a. **(4 marks)** Calculate the open-circuit voltage v_{oc} and short-circuit current i_{sc} at the terminals *a-b.*
b. **(4 marks)** Obtain the Norton equivalent circuit with respect to the terminals *a-b* and draw the equivalent circuit.
c. **(2 marks)** Determine the value of the load resistance R_L for maximum power transfer, and then calculate the maximum power that can be delivered to R_L.

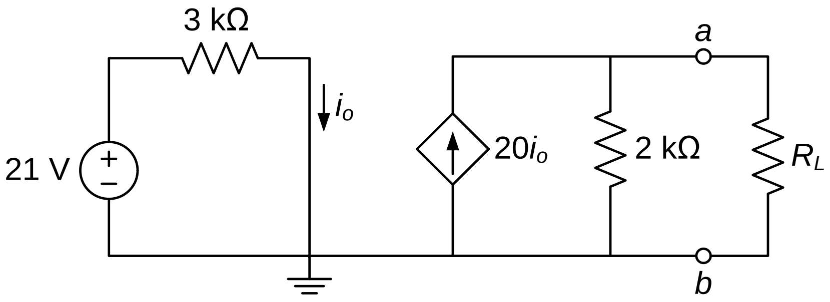

Figure 3

(ii) **[10 marks]** In circuit shown in Figure 4, the switch has been in position *A* for a long time. At $t = 0$, the switch moves to position *B*.

a. **(4 marks)** Find the voltage $v(t)$ across the capacitor immediately after the switch changes to position *B*, $v(0^+)$, and its final voltage when $t \to \infty$, $v(\infty)$.

b. **(4 marks)** Derive an expression for the capacitor voltage $v(t)$ for all time (i.e., for both $t < 0$ and $t > 0$).

c. **(2 marks)** Find the current $i(t)$ through $3\text{-k}\Omega$ resistor for $t > 0$.

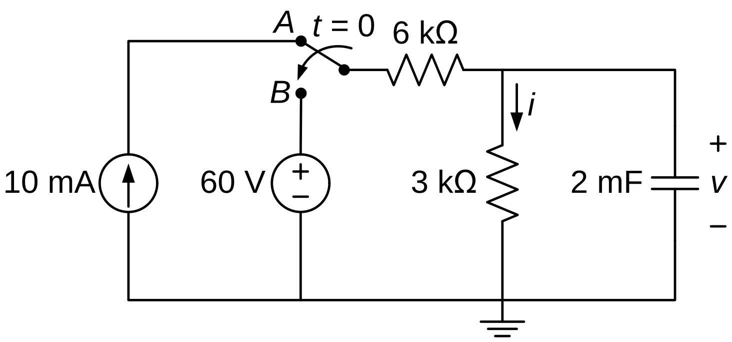

Figure 4

QUESTION 3 [20 marks]

(i) **[8 marks]** For the Op Amp circuit shown in Figure 5 show that the output v_0 can be given by the following equation,

$$v_o = a_1 v_1 - a_2 v_2$$

and determine the parameters a_1 and a_2 in terms of resistors R_1 to R_5.

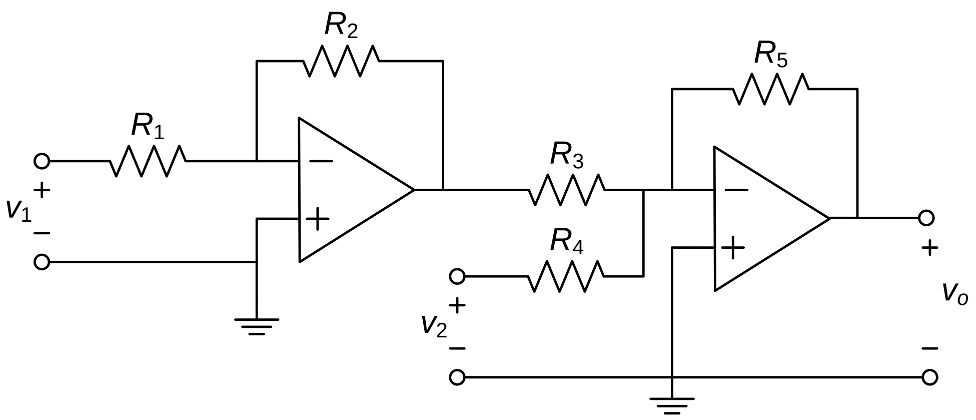

Figure 5

(ii) **[12 marks]** In the circuit of Figure 6, the switch has been in position *A* for a long time before changing its position to *B* at $t = 0$.

a. **(10 marks)** Derive an expression for the inductor current $i_L(t)$ for all time (i.e., for both $t < 0$ and $t > 0$) and sketch $i_L(t)$ as a function of time showing all critical points in the sketch.

b. **(2 marks)** Find the voltage $v(t)$ across the 2-Ω resistor for $t > 0$.

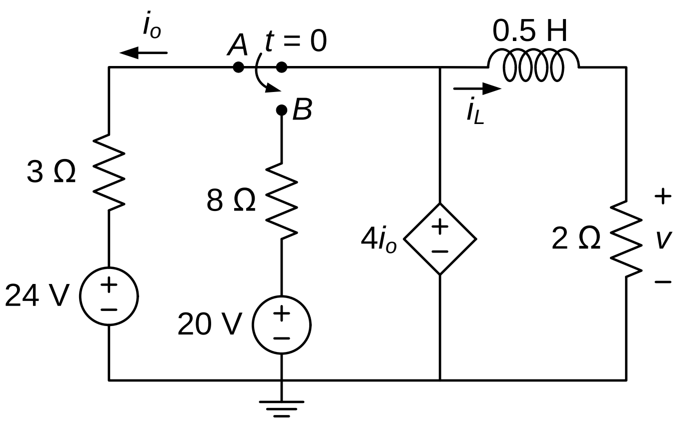

Figure 6

QUESTION 4 [20 marks]

(i) **[10 marks]** For the circuit shown in Figure 7,

a. **(4 marks)** Find the equivalent impedance Z_{eq} seen from terminals *a*-*b*
b. **(6 marks)** Apply phasor analysis and source transformation to calculate the voltage v_x across the 80-Ω resistor.

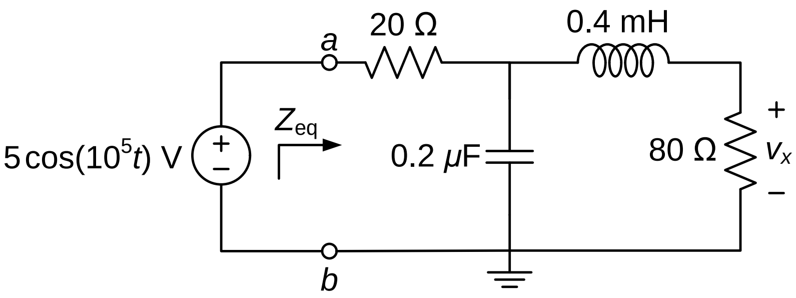

Figure 7

(ii) **[10 marks]** For the circuit shown in Figure 8,

a. **(6 marks)** Find the Thevenin equivalent circuit as seen from the terminals *a*-*b*, and draw the equivalent circuit.
b. **(2 marks)** Determine the value of the load impedance Z_L for maximum average power transfer.
c. **(2 marks)** Calculate the maximum average power that can be delivered to the load Z_L from this circuit.

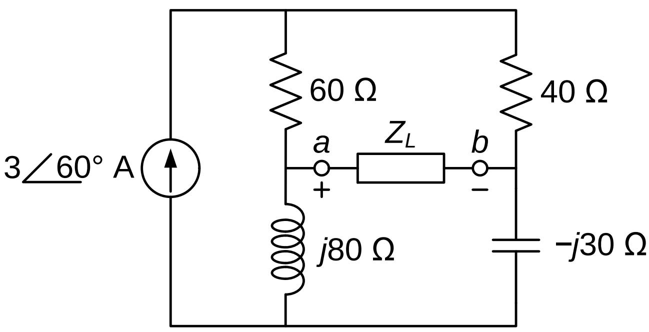

Figure 8

QUESTION 5 [20 marks]

(i) **[10 marks]** For the circuit shown in Figure 9,

a. **(6 marks)** Find the output voltage v_x using phasor analysis and superposition principle.
b. **(4 marks)** Sketch the phasors of voltage source V and current source I along with phasor of voltage V_x on a phasor diagram.

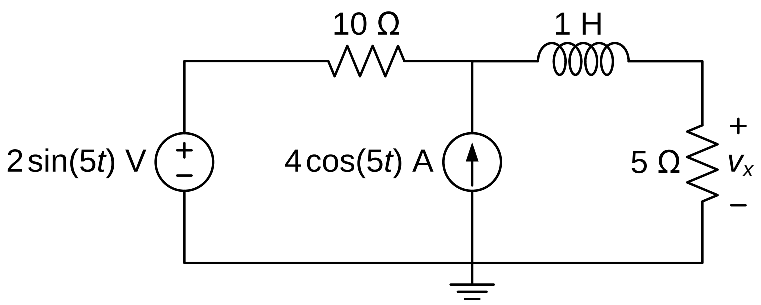

Figure 9

(ii) **[10 marks]** Consider the following logical diagram shown in Figure 10.

a. **(4 marks)** Derive and simplify the logical expression for Z.
b. **(4 marks)** Construct the truth table relating Z to inputs A, B, and C.
c. **(2 marks)** Using part a. and/or part b., show that Z can be realised using exactly one 3-input AND gate and one 1-input NOT gate showing all working.

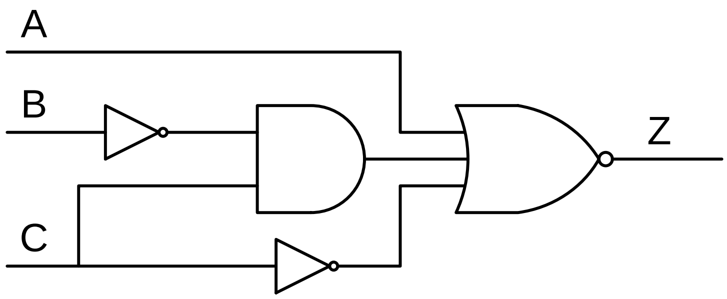

Figure 10

END OF PAPER