Family Name ....

Given Name ....

Student No. ....

Signature ....

UNSW SYDNEY

School of Electrical Engineering & Telecommunications

FINAL EXAMINATION

Semester 1, 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.

QUESTION 1 [20 marks]

(i) **[10 marks]** In the circuit of Figure 1,

a. **[5 marks]** Calculate the voltage V_x.

b. **[3 marks]** Calculate the power dissipated in the 4 Ω resistor.

c. **[2 marks]** Does the dependent voltage source in this circuit supply or absorb power? Explain your answer.

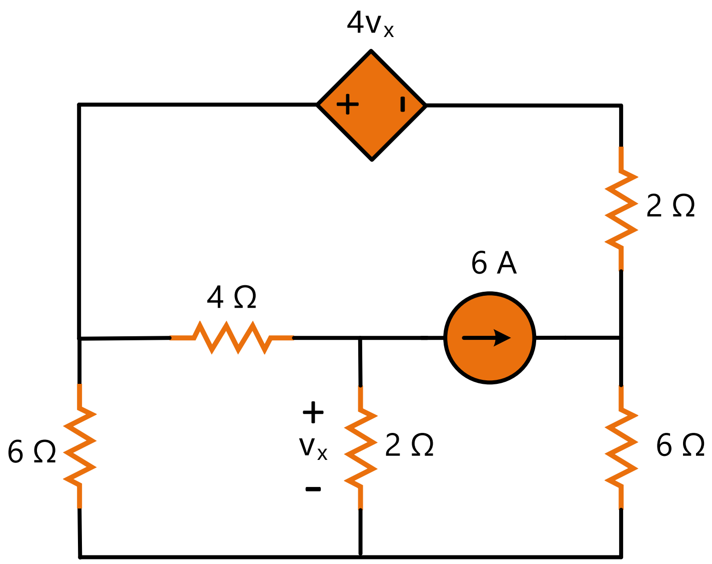

Figure 1

(ii) **[10 marks]** For the circuit of Figure 2

a. **[4 marks]** Calculate the Thevenin voltage for terminals a-b

b. **[4 marks]** Find the Thevenin resistance R_{th} for terminals a-b and draw the equivalent Thevenin circuit.

c. **[2marks]** What is the maximum power that can be delivered to a load from this circuit?

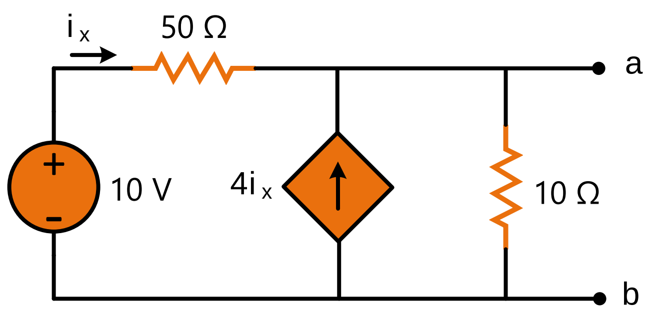

Figure 2

QUESTION 2 [20 marks]

(i) **[8 marks]** Operational Amplifiers

a. **[5 marks]** Demonstrate, deriving the required equations, that the gain of a *non-inverting amplifier* circuit is given by

$$\frac{V_{out}}{V_{in}} = 1 + \frac{R_f}{R_{in}}$$

where R_f and R_{in} are the feedback and input resistances, respectively.

b. **[1 mark]** From the following set of resistors select R_f and R_{in} to achieve a gain of 12.

1 Ω	5 Ω	8 Ω	10 Ω	20 Ω	50 Ω
60 Ω	80 Ω	100Ω	110 Ω	120 Ω	150 Ω
100 Ω	220 Ω	240 Ω	330 Ω	470 Ω	600 Ω

c. **[2 marks]** What resistors from the ones above should be used if you would like to construct an *inverting amplifier* where $\frac{V_{out}}{V_{in}} = -12$.

(ii) **[12 marks]** Find the output voltage v_{out} of the following Operational Amplifier circuit. Plot the voltages v_{in} and v_{out} in the same phasor diagram.

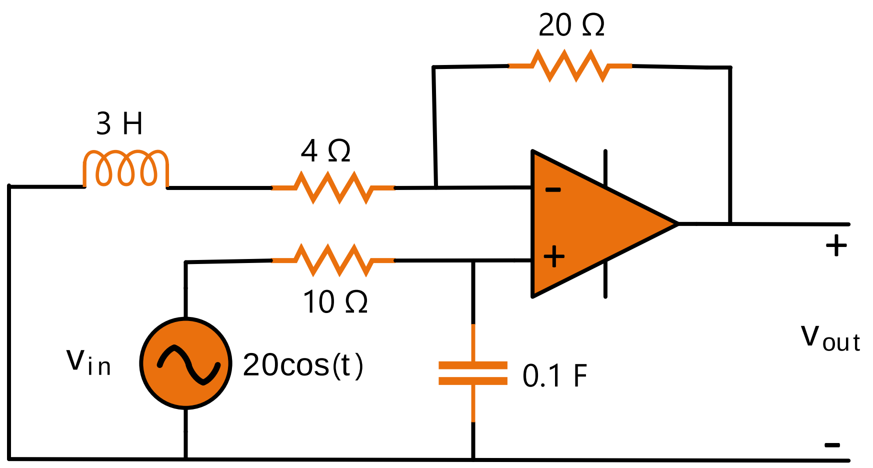

Figure 3

QUESTION 3 [20 marks]

(i) **[10 marks]** Find the voltage $v_x(t)$ in the circuit of Figure 4.

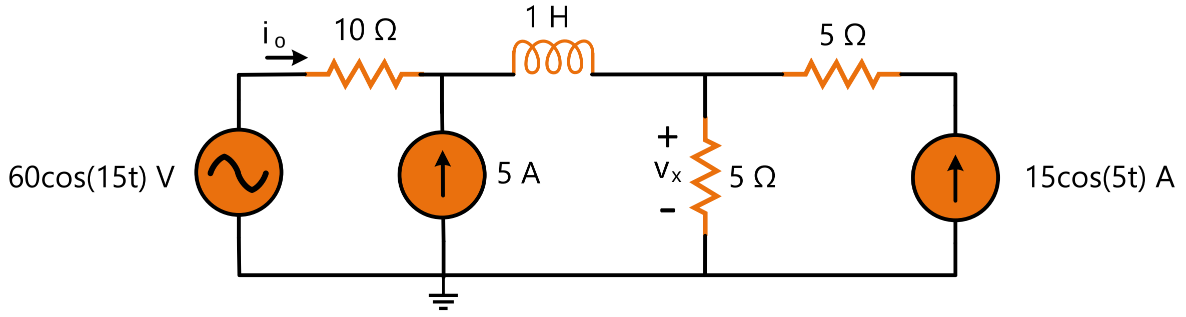

Figure 4

(ii) **[10 marks]** In the following circuit of Figure 5,

a. **[2 marks]** Find the energy stored in the inductor under steady-state when the switch is in the open position.

b. **[4 marks]** If the switch has been in the open position for a long time and closes at t=0, derive an analytical expression for the current i_L through the inductor for t>0.

c. **[2 marks]** Plot the current through the inductor as a function of time.

d. **[2 marks]** Derive an analytical expression for the voltages across resistors R_1 and R_2 (v_{R1} and v_{R2}) as a function of time for t>0.

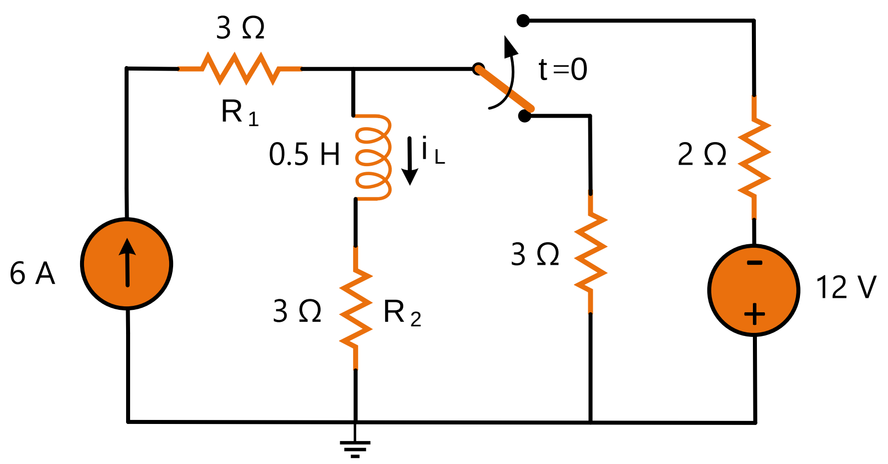

Figure 5

QUESTION 4 [20 marks]

(i) **[8 marks]** Calculate the equivalent impedance of the circuit of Figure 6 as seen by:

a. **(2 marks)** a *dc* voltage source

b. **(6 marks)** an *ac* voltage source with a frequency of ω = 2 rad/sec. (Provide your answer in rectangular or polar form)

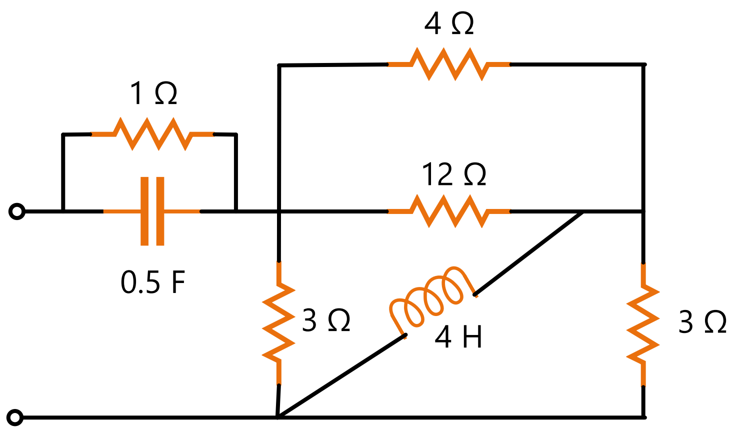

Figure 6

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

a. **[7 marks]** Calculate and draw the Thevenin equivalent of the circuit for terminals a-b

b. **[3 marks]** Calculate and draw the Norton equivalent of the circuit for terminals a-b

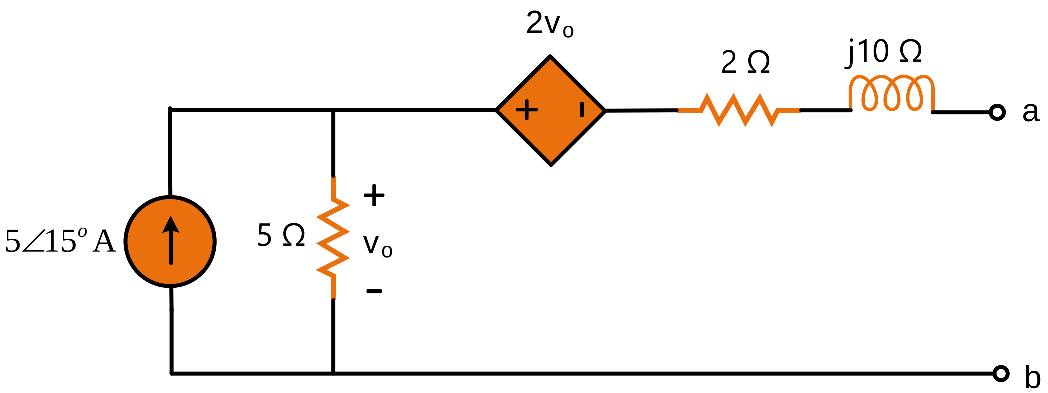

Figure 7

(iii) **[2marks]** Consider the Thevenin equivalent of a circuit that consists of a voltage source and an impedance Z_{Th}. What is the value of the load impedance Z_L that should be connected to its terminals for maximum power transfer?

QUESTION 5 [20 marks]

(i) **[8 marks]** Two loads are connected in parallel and are supplied by a 230 V_{rms}, 50 Hz voltage source.
Load 1 consumes 20 kVA of power at a power factor of 0.8 leading (capacitive)
Load 2 consumes 6 kW at a power factor of 0.6 lagging (inductive)

Calculate:

a. **[2 marks]** The total complex power of the two loads.
b. **[2 marks]** The total apparent power.
c. **[2 marks]** The combined power factor of the two loads, and
d. **[2 marks]** The rms value of the current supplied by the source.

(ii) **[6 marks]** A ideal 500V:100V transformer is rated at 20 kVA and is supplied by a 500 V_{rms}, 50 Hz voltage source in its primary windings. A load of 10+j10 Ω is connected in its secondary windings. Draw the circuit and calculate:

a. **[2 marks]** The currents through the primary and secondary windings
b. **[2 marks]** The power consumed by the load
c. **[2 marks]** The loading of the transformer (Transformer loading is the ratio of power through the transformer over the rated power of the transformer.)

(iii) **[6 marks]** Consider the following logical diagram

a. **[3 marks]** Derive and simplify the logical expression for Z.
b. **[3 marks]** Write the truth table of the circuit.

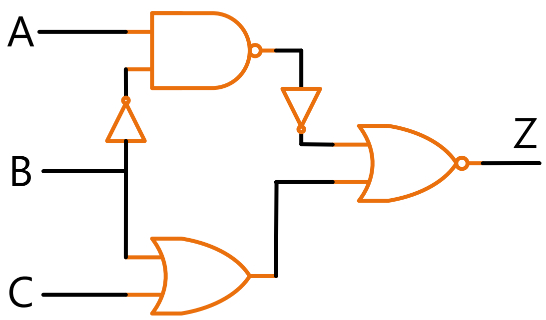

Figure 8

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