COMMUNITY COLLEGE OF CITY UNIVERSITY

Course code & title	:	AST10401 Introduction to Electrical Engineering
Session	:	Semester B 2014/15
Time allowed	:	Two hours

This paper has SEVEN pages (including this cover page).

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1. This paper consists of 9 questions in 2 sections.
2. Answer ALL questions in Section A and ANY THREE questions in Section B.
3. Use the supplied answer book to answer all the questions.
4. Write the question numbers that you attempted on the front cover of your answer book and at the top right-hand corner of each page that you have written answers on.
5. Start a new page for each question. If additional sheet is used, insert appropriately to the corresponding question.

This is a ***closed-book*** *examination.*

Candidates are allowed to use the following materials/aids:

Approved Calculators

Materials/aids other than those stated above are not permitted. Candidates will be subject to disciplinary action if any unauthorized materials or aids are found on them.

NOT TO BE TAKEN AWAY

<u>Section A</u> (40%)

Attempt <u>ALL</u> questions from this section

1. By source transformation and nodal analysis, determine i_x in Figure Q1. 8 marks

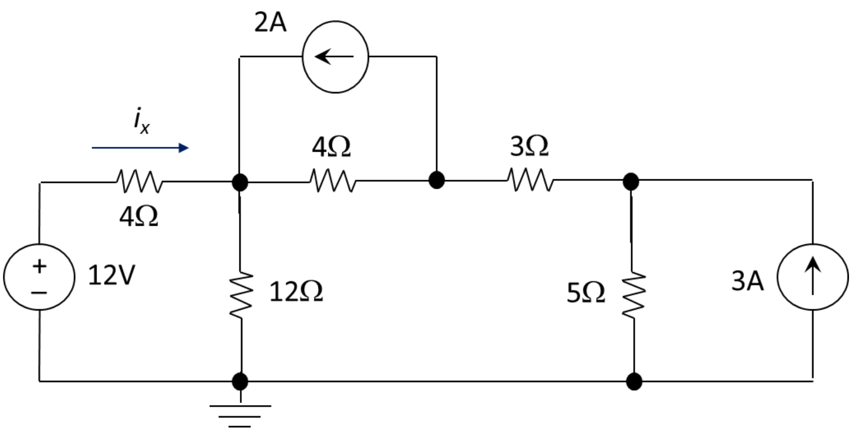


Figure Q1

2. Determine the mesh currents i_1 and i_2 in Figure Q2. Find the power of 1V voltage source. 8 marks

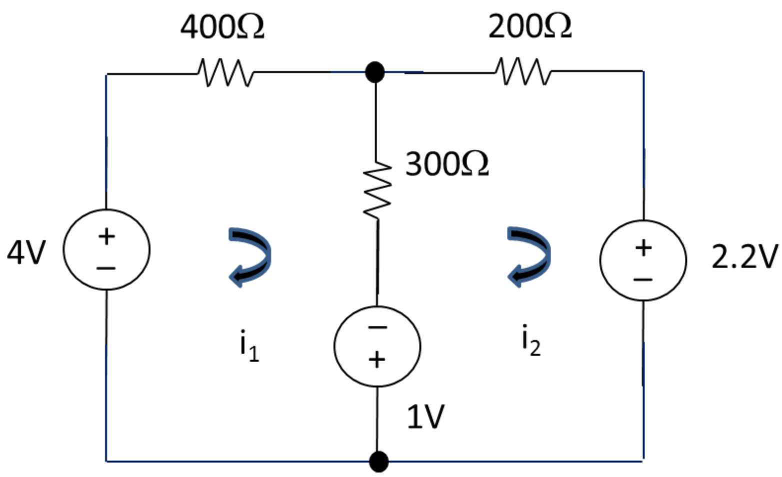


Figure Q2

3. In the AC circuit shown in Figure Q3, the AC voltage source has voltage $Vs(t)$ = 100cos(10^4t). Find the AC current of the voltage source $Is(t)$ and the AC current of the 100Ω resistor $I_R(t)$. 8 marks

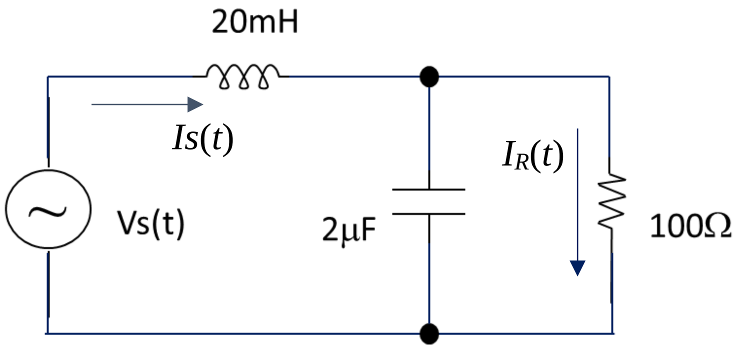


Figure Q3

4. Consider the first order circuit in Figure Q4. The switch in the circuit has been in position *a* for a long time. It is moved from position *a* to position *b* at t = 0. Find the expression of the inductor current $i(t)$ for $t \geq 0$. Also sketch $i(t)$ for $t \geq 0$. 8 marks

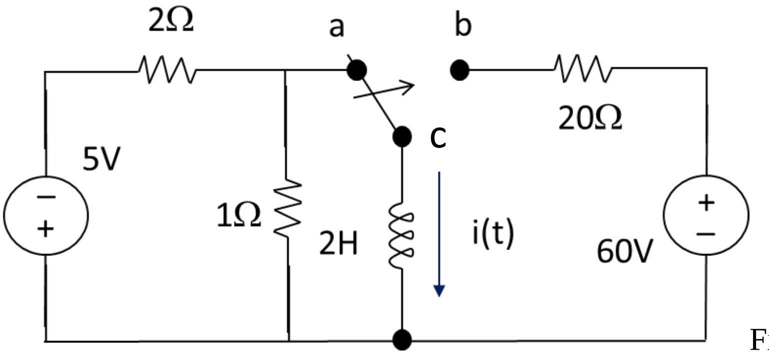


Figure Q4

5. Design a circuit using one current source, one three-terminal switch shown in Figure Q4, one 0.5mF capacitor and resistors to produce a voltage response as follows: 8 marks

$$v(t) = 3 + 4e^{-2t} \; for \qquad t \geq 0.$$

You are required to draw a circuit diagram for your design.

<u>Section B</u> (60%)

Attempt <u>ANY THREE</u> questions from this section

6. Consider the circuit shown in Figure Q6.

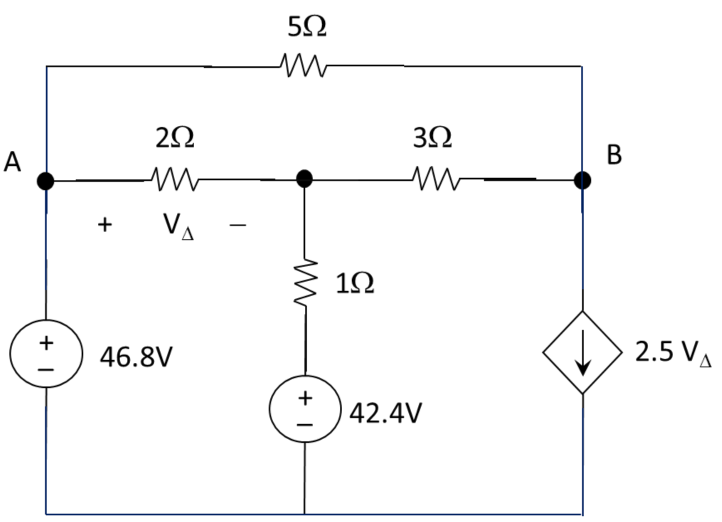


Figure Q6

(a) Explain why the Thevenin resistance R_{Th} of a two terminal linear circuit can be found by V_{Th} / I_{SC}, where V_{Th} is the Thevenin voltage of the two terminal linear circuit and I_{SC} is the short-circuit current of a short wire connecting the two terminals. — 3 marks

(b) By considering nodes A and B as the two terminals of the circuit in Figure Q6, find the Thevenin equivalent of the circuit in Figure Q6. — 11 marks

(c) Now we connect a resistor R_o between nodes A and B. Find the resistance of R_o for receiving the maximum power transfer from the circuit. Find also the maximum power that can be received by R_o in the circuit. — 2 marks

(d) Suggest a way to modify the circuit so that the receive power of R_o with the same resistance you obtained in (c) is doubled and explain why it works. — 4 marks

7. The switch in Figure Q7 has been in position *a* for a long time. It moves to position *b* at $t = 0$.

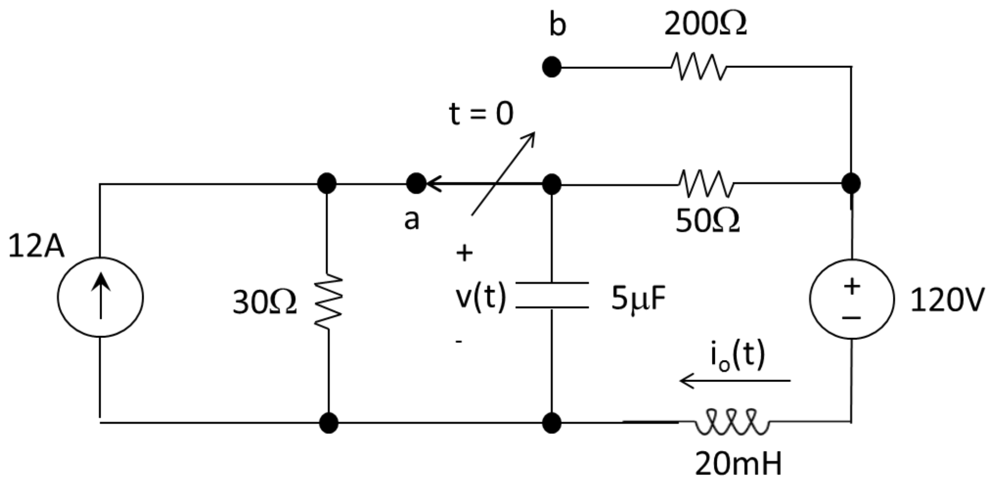


Figure Q7

(a) Determine the capacitor voltage $v(t)$ at $t = 0$. 3 marks

(b) Determine the inductor current $i_o(t)$ at $t = 0$. 2 marks

(c) Determine the expression of the capacitor voltage $v(t)$ for $t \geq 0$. 9 marks

(d) Determine the expression of the inductor current $i_o(t)$ for $t \geq 0$. 6 marks

8. There are two switches S1 and S2 in Figure Q8. S1 has been closed and S2 has been opened for a long time. There is no current in the inductor before $t = 0$. At $t = 0$, S1 is opened while S2 is closed. (Note that n = $1\text{x}10^{-9}$)

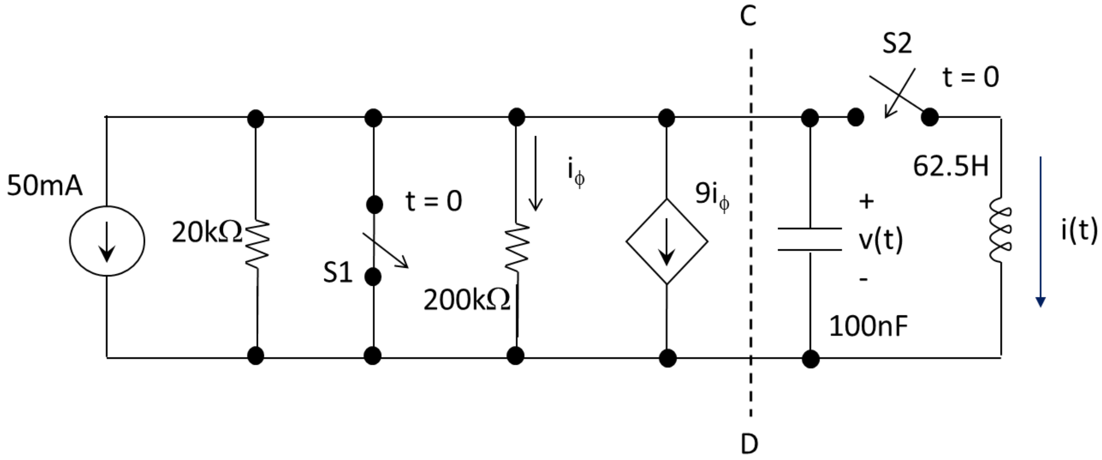
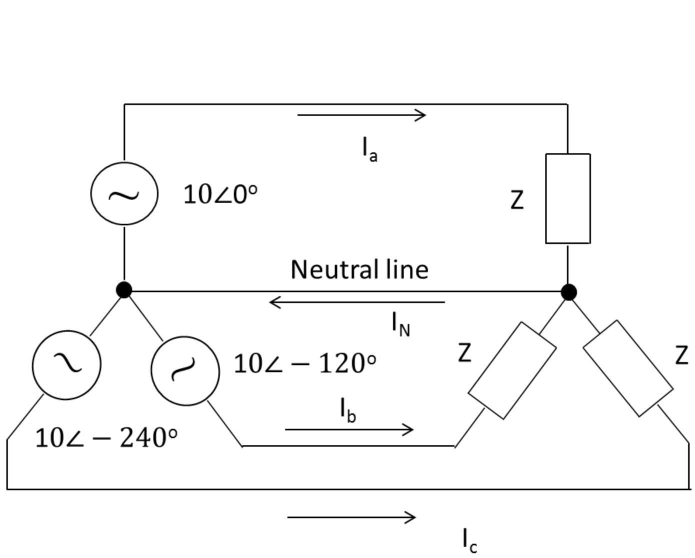


Figure Q8

(a)	Determine the Norton equivalent to the left hand side of C-D for $t \geq 0$.	4 marks
(b)	Determine the capacitor voltage $v(t)$ and the inductor current $i(t)$ at $t = 0$.	2 marks
(c)	Determine the expression of the inductor current $i(t)$ for $t \geq 0$.	9 marks
(d)	Determine the expression of the capacitor voltage $v(t)$ for $t \geq 0$.	3 marks
(e)	Find the energy stored in the inductor after activating the switches at $t = 0$ for a very long time.	2 marks

9. Consider the balanced three-phase circuit with an angular frequency ω = 1000 rad/s shown in Figure Q9.



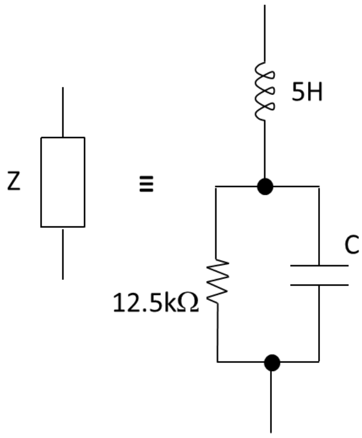


Figure Q9a

Figure Q9

(a) What are the advantages of a balanced three-phase circuit over a single phase AC circuit? 2 marks

(b) Mathematically show that, for any load Z, there is no current flow in the neutral line of the balanced three-phrase circuit in Figure Q9. 6 marks

(c) Suppose the load Z is a connection shown in **Figure Q9a**. Determine the capacitance C in the connection so that the power factor of Z is 1. (i.e. the AC current of Z is in-phase with the AC voltage of Z.) 8 marks

(d) With the results in (c), determine the instantaneous receive power of the entire load of the whole three-phrase circuit. 4 marks

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