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The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**:EEX3531/ECX3231 Electrical circuits and measurements**
Academic Year	: 2017/18
Date	: 25th January 2019
Time	: 1400-1700hrs

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (8)** questions in **four (4)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. Relevant charts/ codes are provided.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear hand writing.
8. Do not use Red colour pen.

1. Consider the circuit given in figure 01. The switch S_1 is closed at t = 0s (Before closing the switch the circuit is at neutral state)

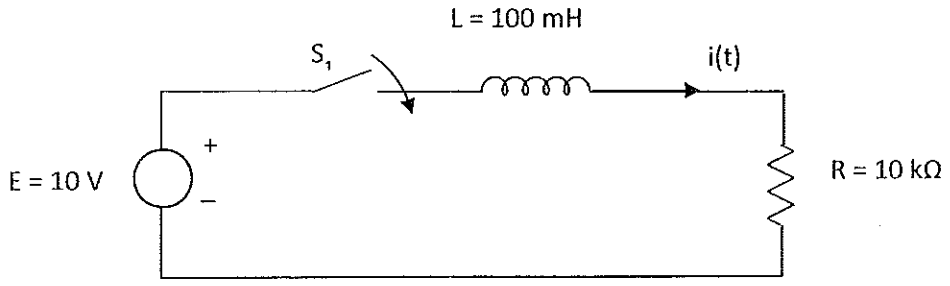

Figure 01

i. Write the differential equation to find the current through the circuit after closing the switch. *(2 marks)*

ii. Convert the differential equation written in (i) in to s – domain using Laplace Transform and obtain an expression for the impedance function Z(s) which is also in s – domain. *(5 marks)*

iii. Find the solution for current through the circuit in s – domain I(s). *(4 marks)*

iv. Using inverse Laplace transform, derive the expression for current through the circuit in time domain i(t). *(5 marks)*

v. Using the expression derived in step (iii) above, obtain the natural response of the circuit in time domain. *(4 marks)*

2. Consider the two port network shown in figure 02.

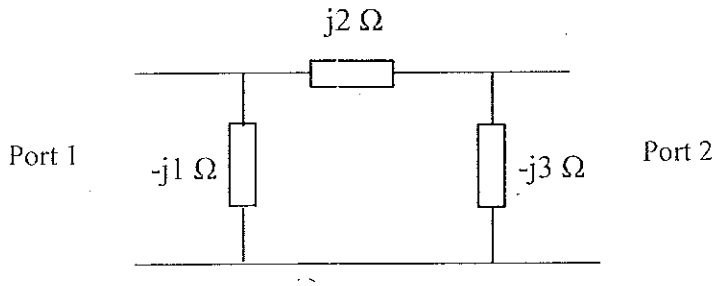

Figure 02

i. Using standard parameter notation, calculate Y – parameters of the given circuit. *(6 marks)*

ii. Write the terminal characteristic equation of the circuit in matrix form. *(4 marks)*

iii. Show that the system is reciprocal. *(2 marks)*

iv. Derive a relationship between Y and Z parameters. *(4 marks)*

v. Using the relationship derived in iv, determine Z – parameters of the circuit. *(4 marks)*

3. Select **any four topics** from the list below and write short note for each. The short note may include operating principles, application examples and sketches where applicable. Each short note should not exceed 150 words. *(5 X 4 = 20 marks)*

i. Current transformer as a measuring instrument.
ii. Potential transformer as measuring instrument.
iii. Guard terminal used in high resistance measurements.
iv. Use of oscilloscope to observe the B – H loop of a magnetic specimen.
v. Use of cathode ray (analogue) oscilloscope to observe the transient response of an electrical circuit.
vi. Measurement of phase difference between two sinusoidal signals using X – Y mode of an oscilloscope.

4. Consider the RL circuit shown in figure 03.

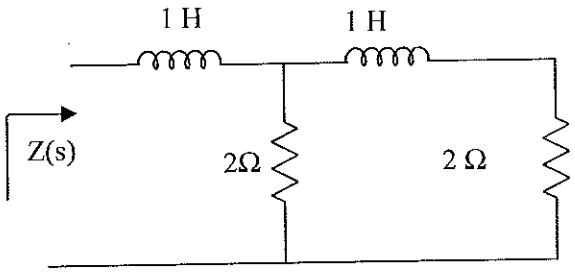

Figure 03

i. Derive the driving point impedance function Z(s) for the given circuit. *(4 marks)*
ii. Draw the pole-zero diagram for the given circuit. *(4 marks)*
iii. Redesign the circuit using foster 1st form and Cauer 2nd form of network synthesis. (Clearly indicate the steps of calculation for each type of synthesis) *(12 marks)*

5.

a. Define the term 'RMS' of a voltage signal. *(4 marks)*
b. Consider the diagram shown in figure 04 to answer the following questions.

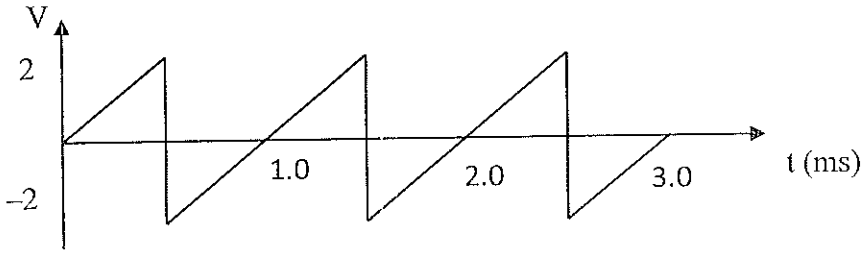

Figure 04

i. The waveform is measured using following types of voltmeters separately.

a) Average responding voltmeter
b) True RMS voltmeter

Calculate the reading of each voltmeter. *(12 marks)*

ii. Calculate the percentage errors of readings of i. a) and i. b) when compared to the actual RMS value of the waveform. *(4 marks)*

6. Consider the circuit given in figure 05.

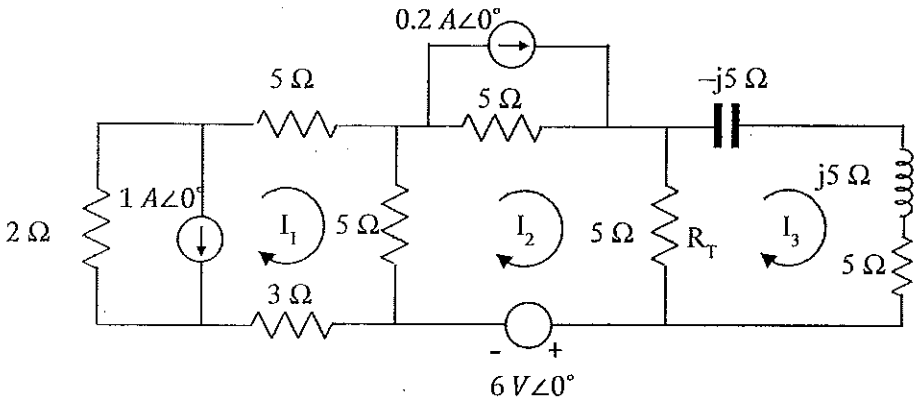

Figure 05

i. Redraw the circuit after converting all current sources to equivalent voltage sources. *(4 marks)*

ii. Apply mesh analysis and directly obtain the matrix equation. *(8 marks)*

iii. Solving matrix equations, determine mesh currents I_1,I_2 and I_3 *(5 marks)*

iv. Find the current through resistor R_T. *(3 marks)*

7. A student has prepared a practical setup as shown in figure 06 to measure an unknown resistor (R_x).

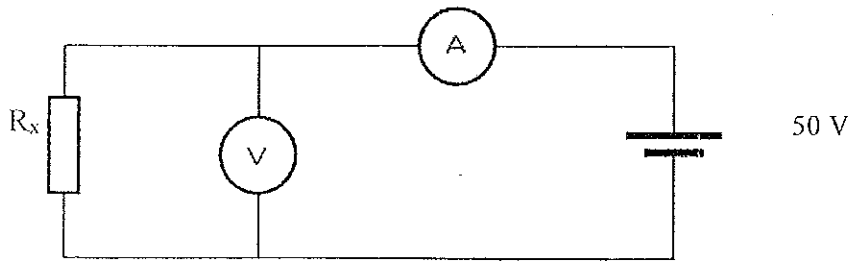

Figure 06

The readings obtained by the student are as follows.
Voltmeter reading = 49.9975 V

Ammeter reading = 10.00 μA

i. Calculate the resistance using meter readings. *(2 marks)*

ii. If the exact value of the unknown resistance found to be 11 MΩ, what is the percentage error of the measurement? *(2 marks)*

iii. Briefly describe the most probable reason for the error. *(5 marks)*

iv. Suggest a modification to the setup shown in figure 06 to minimize the error (you need to sketch the setup). Justify your answer by calculating the new error percentage. *(6 marks)*

v. If the 11 MΩ resistor is replaced by a 270 Ω resistor, which setup will be giving more accurate results? (Setup shown in Figure 06 or modified setup in part iv) Sketch the set-up and justify your answer by comparing the errors occurred by each setup. *(5 marks)*

8. Answer the following questions.

i. List down two real world examples where the measurement of insulation is important and write what are the benefits of measuring insulation for each example. *(4 marks)*

ii. A certain coil of PVC insulated single core cable which is having a length of 100 m has been given for quality testing. You are required to measure the insulation of the full length of wire.

(a). Draw a sketch of the experimental setup to measure the insulation of the wire. (Physical view). *(5 marks)*

(b). Draw the simplified circuit diagram of the experimental setup. *(4 marks)*

(c). List down two assumptions made during the experiment. *(4 marks)*

(d). Write the equation to calculate the insulation. (Use standard notation) *(3 marks)*