The Open University of Sri Lanka
Department of Electrical and Computer Engineering
Bachelor of Technology Honors in Engineering – Level 3
ECX 3231 – Electrical Circuits and Measurements
Academic Year 2015/2016
Final Examination **Closed Book**
Date: 25 - 11 - 2016 **Time: 13:30 – 16:30**

This question paper consists of 8 questions. Answer **any five** questions. All questions carry equal marks.

Q1. Consider the circuit given in figure 1.

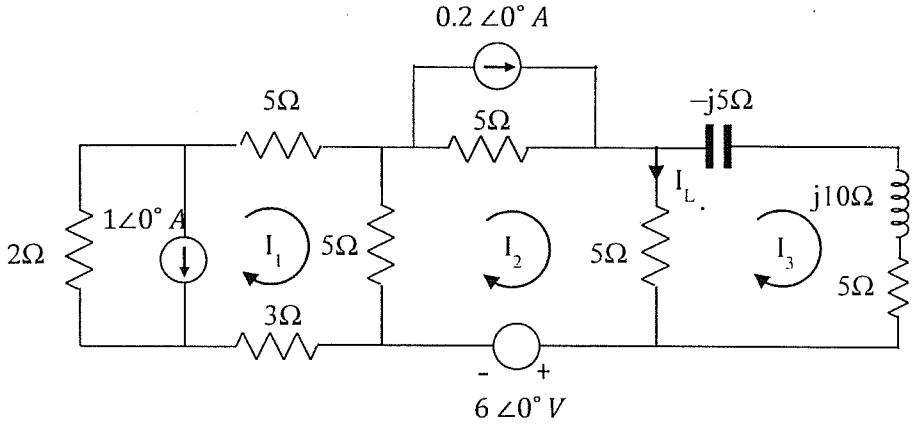

Figure 1

i. Redraw the circuit after converting all the current sources to equivalent voltage sources. *(4 marks)*
ii. Obtain directly, matrix equation to solve the circuit using mesh method. *(8 marks)*
iii. Solving matrix equations, find mesh currents I_1,I_2 and I_3 *(5 marks)*
iv. Calculate the current I_L. *(3 marks)*

Q2. Consider the RLC circuit shown in figure 2.

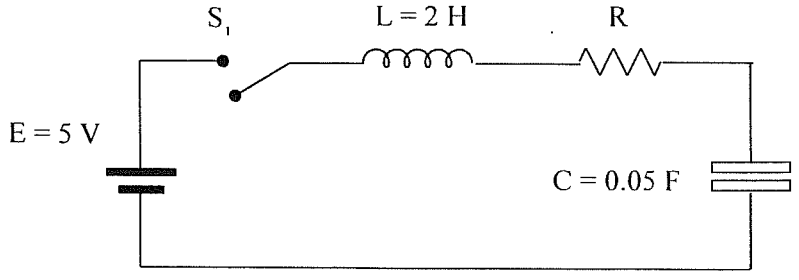

Figure 2

i. At $t = 0$ the switch S_1 is closed. Write a differential equation relating voltages across each element of the circuit. Assume the capacitor is initially fully discharged. *(4 marks)*

ii. Determine the required resistor value to obtain an under damped response with oscillation frequency of 4 $rads^{-1}$ (show all the calculations and clearly state any assumptions made) *(6 marks)*

iii. Using the nearest higher integer value for the resistor obtained in ii, find the roots of the characteristic equation. *(4 marks)*

iv. Solve the differential equation solved in i and find an expression for i(t).

Q3. Consider the RL circuit shown in figure 3.

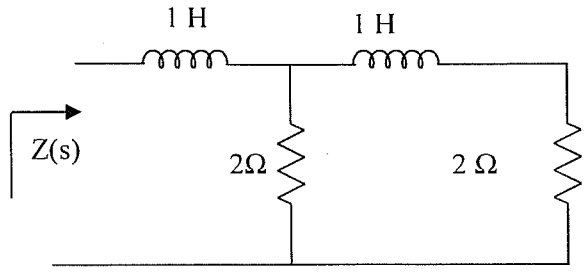

Figure 3

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)* *(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)*

Q4. Consider the two port network shown in figure 4.

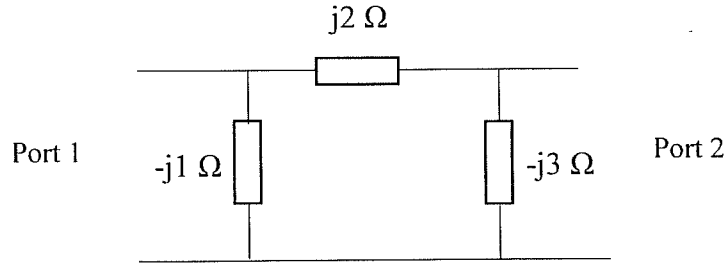

Figure 4

i. Using standard parameter notation, calculate Y – parameters of the given circuit. *(4×2 = 8 marks)*

ii. Write the terminal characteristic equation of the circuit in matrix form. *(2 marks)*

iii. Using the parameter values you have found in part i, show that, the system is reciprocal. *(2 marks)*

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

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

Q5. Consider the voltage waveform shown in figure 5.

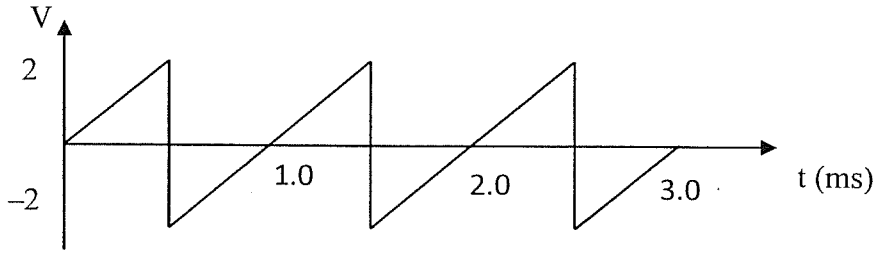

Figure 5

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

a) Average responding voltmeter
b) Peak responding voltmeter

What would be the reading of the voltage in each case? *(2×3 = 6 marks)*

ii. Calculate the actual RMS value of the given waveform using first principles. *(8 marks)*

iii. Calculate the percentage errors of readings of i. a) and i. b) when they are compared with the actual RMS value of the waveform. *(6 marks)*

Q6 A student has prepared a practical setup as shown in figure 6 to measure an unknown resistor (R_x).

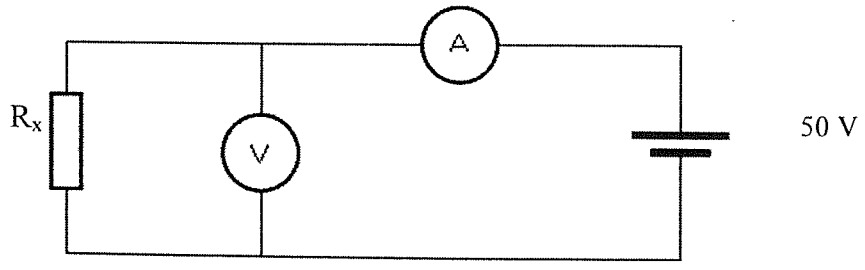

Figure 6

The readings he has obtained are as follows.
Voltmeter reading = 49.9975 V
Ammeter reading = 10.00 μA

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

ii. The unknown resistor has been measured using an insulation tester and the value is found to be 11 MΩ, what is the percentage error of value obtained in i ? *(4 marks)*

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

iv. Suggest an alternative to the setup shown in Figure 6 to minimize the error (you need to sketch the setup). Justify your answer by calculating the new error percentage. *(6 marks)*

v. If a resistor having a value of 270 Ω is given, what will be the most suitable practical setup (setup shown in Figure 6 or the alternative setup in part iv) to measure it with the minimum error? Justify your answer by comparing the errors occurred by each setup. *(5 marks)* *(5 marks)*

Q7

i. Define 'Equivalent Series Resistance (ESR)' with reference to capacitors. *(2 marks)*

ii. Draw the modified form of De Sauty's bridge to measure the capacitance of a lossy capacitor. You may use the series equivalent resistance model for the lossy capacitor. *(8 marks)*

iii. Obtain expressions for capacitance and series equivalent resistance. *(4 marks)*

iv. What are the most suitable components to be selected as variables in your setup? Justify your answer with the help of a sketch of out-of-balance voltage variation in complex domain. *(6 marks)*

Q8 Write short notes for each topic given below. You may limit each short note to a maximum of 100 words. Each topic will carry equal marks. *(4×5 = 20 marks)*

i. Function of the 'Guard Terminal' for high resistance measurement.

ii. Use of 'loss of charge method' for high resistance measurement.

iii. Significance of use of instrument transformers (potential and current transformers) in electrical measurements.

iv. Measurement of impedance using AC potentiometer.