The Open University of Sri Lanka
Department of Electrical and Computer Engineering
Diploma in Technology – Level 3
ECX 3231 – Electrical Circuits and Measurements
Academic Year 2013/2014
Final Examination **Closed Book**
Date: 13 – 08 – 2014 **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 shown in Figure 01.

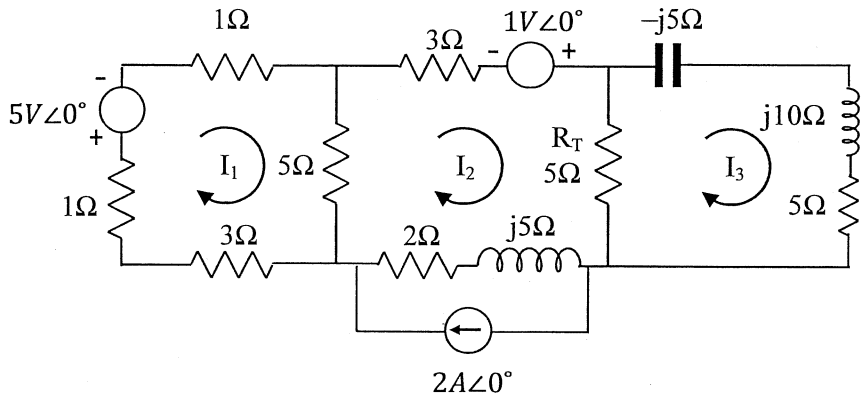

Figure 01

i. Draw the equivalent voltage source of the current source. *(4 marks)*
ii. Apply mesh analysis and directly obtain the matrix equation. *(7 marks)*
iii. Solving matrix equations or otherwise determine mesh currents I_1,I_2 and I_3 *(4 marks)*
iv. Find the current through resistor R_T. *(5 marks)*

Q2.

A circuit having a capacitor and a resistor is shown in Figure 02. Switch S1 is used to connect sources either E1 or E2 (E2>E1) to the RC branch of the circuit

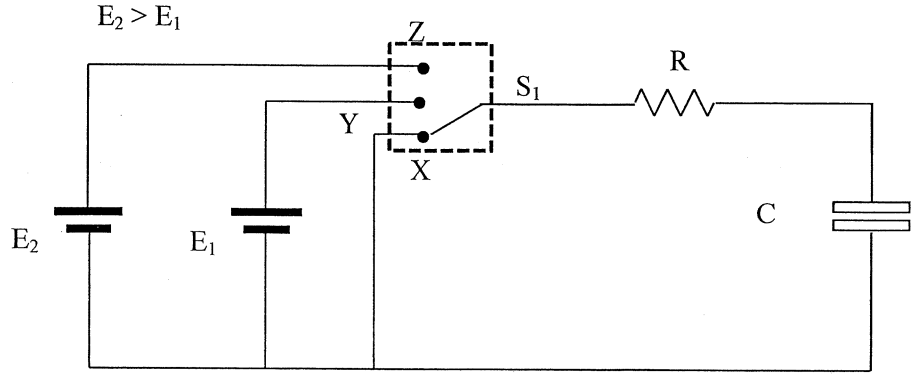

Figure 02

i. At $t = 0$ the switch is moved from position X to Y. Apply Kirchhoff's voltage law to the given circuit and write the voltage equation in differential form. ***(2 marks)***

ii. Obtain the solution to the differential equation you have obtained in 'i' and derive an expression for the instantaneous current through the circuit. ***(6 marks)***

iii. Calculate the voltage across the capacitor at $t = 50$ms. Use R = 1kΩ, C = 10μF and E_1 = 10V. ***(2 marks)***

iv. While the circuit is in operation at t = 5s the switch S1 is suddenly moved from position Y to Z without any interruption. Using the results obtained above, deduce an expression for the voltage across the capacitor from t = 5s onwards. State any assumptions you made. Select initial state as t = 0s again. ***(6 marks)***

v. Sketch the voltage variation of the capacitor against time of this new condition. (starting from 5s) ***(4 marks)***

Q3.

i. State what is meant by

a. Reciprocal two port network ***(1 marks)***

b. Symmetrical two port network ***(1 marks)***

Consider the two port network circuit shown in Figure 03.

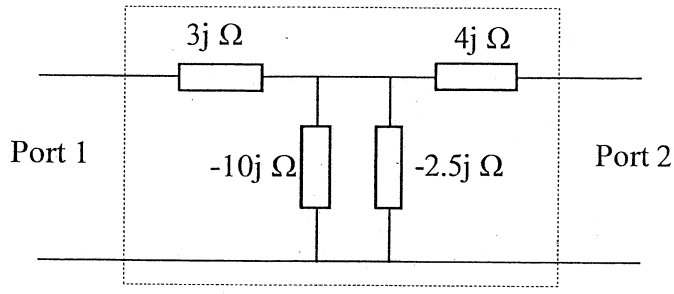

Figure 03

ii. Find the open circuit impedance parameters of the given two port network. ***(4 marks)***

iii. Using parameters found in 'ii' above, write the terminal characteristic equation of the network in matrix form. ***(4 marks)***

iv. After connecting a sinusoidal voltage source to port 1, the voltage at port 2 is measured by an oscilloscope having an internal impedance of 1MΩ. If the oscilloscope shows a sine wave of 10V amplitude, find the voltage and current at port 1. (You may use the matrix equation) ***(6 marks)***

v. Sketch the waveforms of voltages at port 1 (E_1) and port 2 (E_2) in a common time scale. Clearly indicate the phase relationship of the two waveforms on your sketch. ***(4 marks)***

Q4. Three different pole zero maps are shown in Figure 04 (a), (b) and (c).

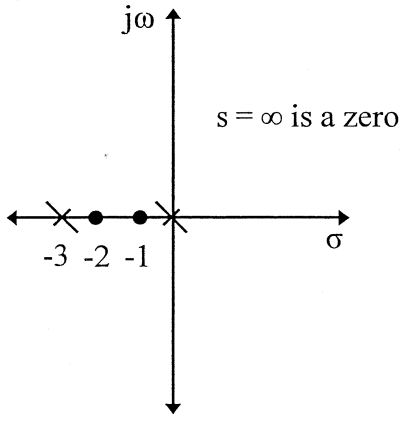

Figure 04 (a)

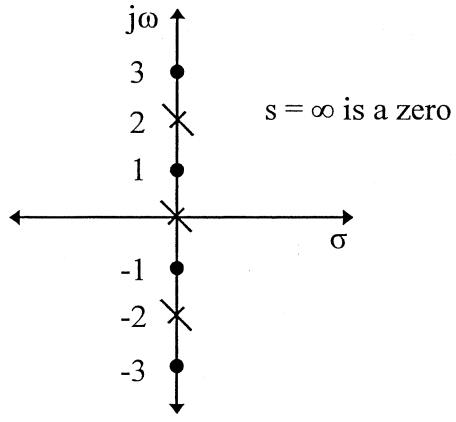

Figure 04 (b)

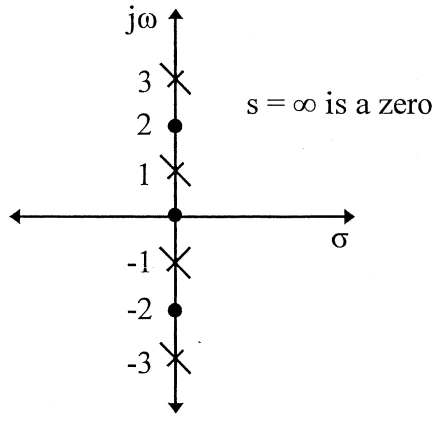

Figure 04 (c)

i. Giving reasons state which pole zero map represents a realizable network and mention the type of it. (RC, LC or RL) ***(3 marks)***

ii. Write the driving point impedance function Z(s) of the realizable network that you have found. ***(3 marks)***

iii. Realize the impedance function Z(s) using Foster's 1st form of network synthesis and draw the complete circuit diagram with component values. ***(7 marks)***

iv. Use Cauer 1st form to realize Z(s) again and draw the complete circuit diagram with component values. ***(7 marks)***

Q5.

Select **any four topics** from the list below and write short note for each. Include operating principles, application examples and sketches where applicable. Limit each short note to 200 words. ***(4 × 5 = 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.

Q6. Figure 05 shows a waveform pattern of a voltage signal.

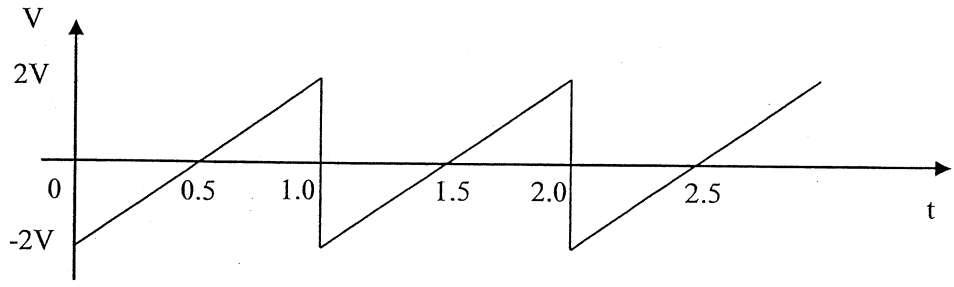

Figure 05

i. Define physical meaning "Root mean square value" (RMS) of a voltage signal ***(3 marks)***
ii. Calculate the RMS value of the given voltage signal. ***(7 marks)***
iii. Calculate the Rectified Average value of the given voltage signal. ***(5 marks)***
iv. The voltage signal is measured using an average responding voltmeter which is having an AC range calibrated to sinusoidal signals. Calculate the meter reading and the error percentage of meter reading. ***(5 marks)***

Q7.

i. Define the following terms related to AC bridge circuits. ***(4 marks)***
   a. Sensitivity
   b. Accuracy
ii. Draw the complete circuit diagram of **Wien Bridge**, including the source and measuring instrument. Use standard notation to name the components. ***(5 marks)***
iii. Write the impedance equation for the general balance condition and show that this bridge circuit can be used to measure frequency. ***(5 marks)***

iv. Briefly describe the function of a "mechanically ganged variable resistor" and state the significance of use of such instrument in Wien Bridge balancing. ***(4 marks)***

v. Is it possible to measure the frequency of a pulse train using Wien Bridge? Justify your answer. ***(2 marks)***

Q8.

Circuit diagram shown in Figure 06 is an experimental setup used by a student to measure a resistor which the value is unknown to him. Meter readings are as follows.

Voltmeter reading = 11.99975 V
Ammeter reading = 2.500 μA

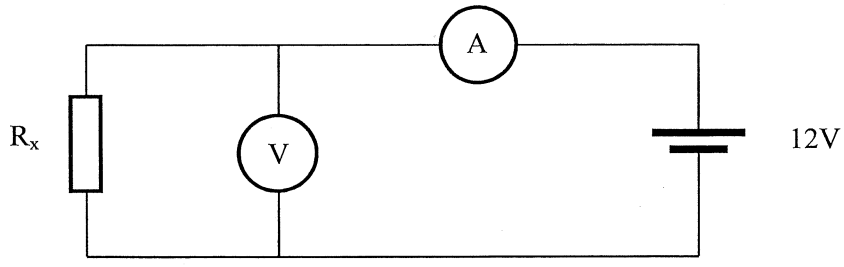

Figure 06

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

ii. If the given resistor's value is exactly equal to 10 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. ***(5 marks)***

v. If a resistor having a value of 100 Ω is given, what will be the most suitable practical setup (setup shown in Figure 06 or modified setup in part iv) to measure it with the minimum error? (Sketch the set-up) Justify your answer by comparing the errors occurred by each setup. ***(6 marks)***