The Open University of Sri Lanka
Department of Electrical and Computer Engineering
Bachelor of Technology (Engineering) – Level 3
ECX 3231 – Electrical Circuits and Measurements
Academic Year 2014/2015
Final Examination **Closed Book**
Date: 26 - 08 - 2015 **Time: 13:30 – 16:30**

This question paper consists of eight questions on five pages. Answer **any five** questions. All questions carry equal marks.

Q1. Consider the circuit given in figure 1. The switch S_1 is closed at t = 0s (Before closing the switch the circuit is at neutral state)

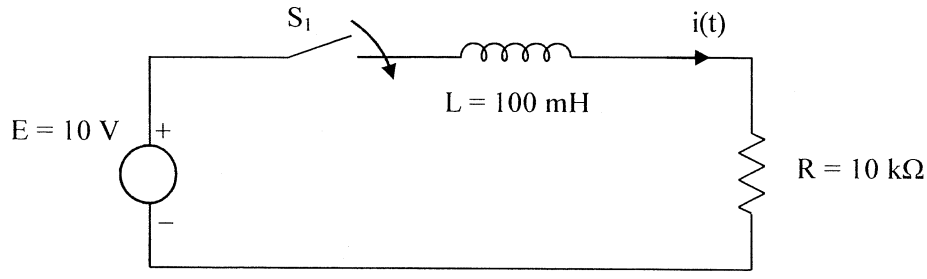

Figure 1

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)*

Q2. Consider the RLC circuit shown in figure 2. At $t = 0$ the switch S_1 is closed. (Before closing the switch the circuit is at neutral state)

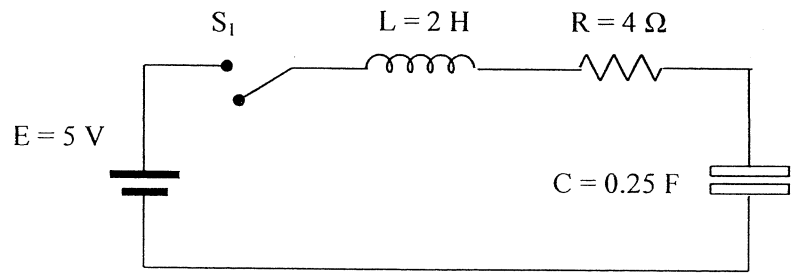

Figure 2

i. Write a differential equation relating voltages across each element using Kirchhoff's voltage law. Assume that the capacitor is initially fully discharged. *(5 marks)*

ii. Solve the differential equation found in (i) and obtain an expression for the current through the circuit for $t > 0$. (consider the initial voltages across and currents through each element) *(12 marks)*

iii. State the type of the response of this circuit. *(3 marks)*

Q3. A simplified equivalent circuit diagram of a transmission line is shown in figure 3.

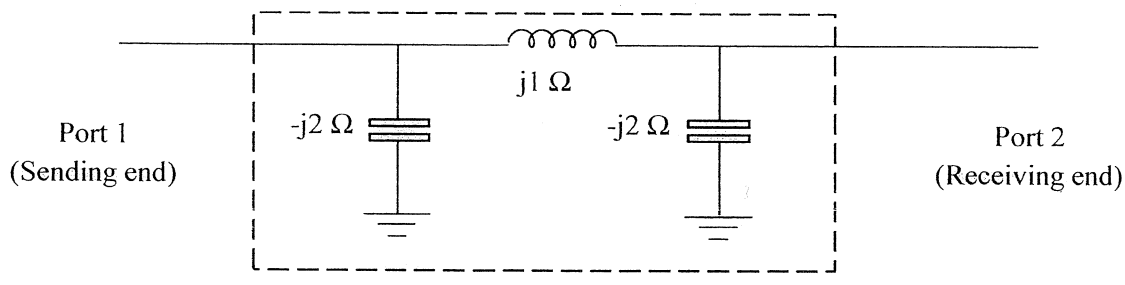

Figure 3

i. Considering that the circuit as a two port network, find the ABCD parameters of the network. *(8 marks)*

ii. Using the parameters found in (i), write the terminal characteristic equation in matrix form. *(4 marks)*

iii. Now an AC generator with internal impedance of $2/\sqrt{3}\ \Omega$ is connected to the sending end while a load of $2/\sqrt{3}\ \Omega$ is connected to the receiving end. If the voltage at the load is to be maintained at 100 V_{RMS}, determine the magnitude and phase angle of sending end voltage (which is port 1). *(8 marks)*

Q4. Pole zero maps of three different impedance functions Z(s) are shown in figure 4. (Locations of poles and zeros are not to scale)

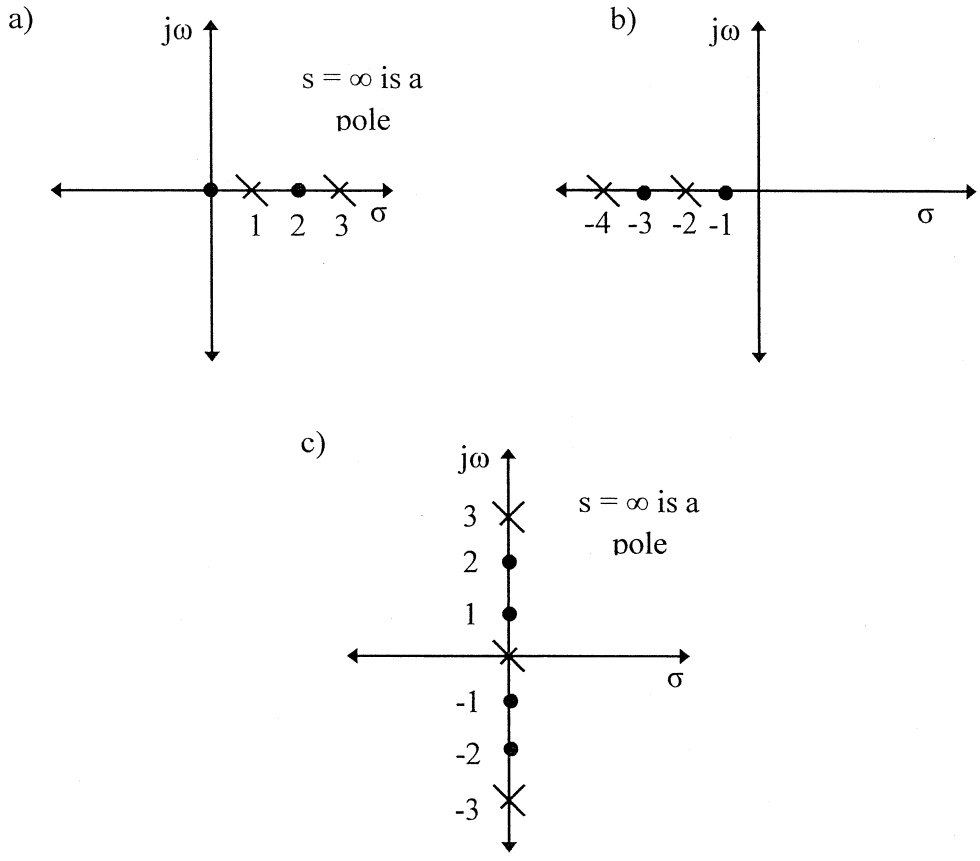

Figure 4

i. State which of the above system/s are realizable in the form of RC, RL or LC. Give reasons for each. *(2 marks)*

ii. Formulate the driving point impedance function for the realizable system/s that you have figured out. *(4 marks)*

iii. Realize each network that you have figured out in part ii. using:
   a. Foster 1st form
   b. Cauer 1st form

(14 marks)

Q5. Select **any four** topics from the following list and write a short note for each. Limit each of your short notes to a maximum of 100 words. *(4 × 5 = 20 marks)*

i. Use of guard terminal in insulation testers. (You are required to draw a sketch)
ii. Loss of charge method for high resistance measurement.
iii. Importance of measurement of contact resistance.
iv. Principle of operation of single ramp type analog to digital converter.
v. Use of X-Y mode of the oscilloscope to plot the V-I characteristics of a rectifier diode. (You are required to draw a sketch of the connection diagram)
vi. Selection of variable components of an AC bridge circuit to obtain the balance condition effectively.

Q6.

i. Briefly describe a method used to measure magnetic flux density. *(4 marks)*
ii. Define the term "Dielectric loss". Briefly explain how it affects the operation of an electrical circuit. *(4 marks)*
iii. Explain the method of measuring capacitance and loss factor of an insulating material using Schering Bridge. *(12 marks)*

You may include,

(a). Circuit diagram
(b). Balance equations
(c). Assumptions made

Q7.

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)*

Q8.

i. Define following terms regarding a digital voltmeter.
   (a). Accuracy
   (b). Resolution *(4 marks)*

ii. Briefly explain how the internal impedance of a voltmeter can change the readings from the actual values. You may use appropriate circuit diagram. *(4 marks)*

iii. The output voltage of a power supply circuit has been observed using an oscilloscope. The observed waveform pattern is given in figure 5. *(12 marks)*

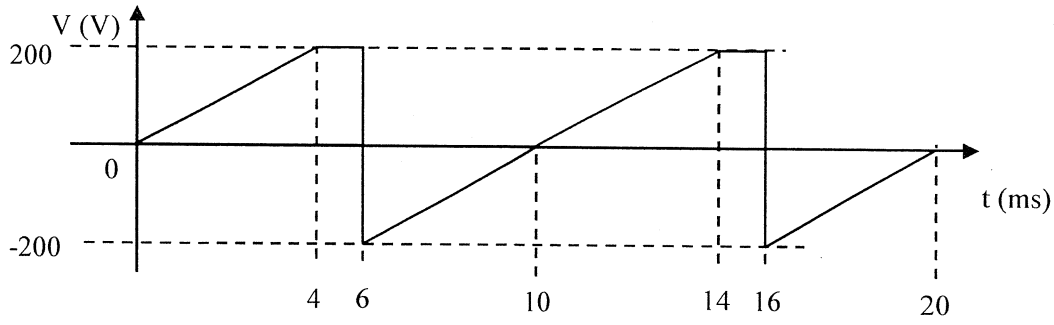

Figure 5

Calculate the voltmeter RMS reading if the output has been measured using an Average responding voltmeter. You may assume the internal impedance of the voltmeter as infinite.