The Open University of Sri Lanka
Department of Electrical and Computer Engineering
Diploma in Technology – Level 03

ECX3231 – Electrical Circuits & Measurements
Final Examination 2011/2012

Closed Book

Duration: 3 hours

Date: 29.02.2012 **Time: 13.30 – 16.30**

This paper consist of two sections over 6 pages. Answer **five** questions selecting **three** questions from section A and **two** questions from section B. All questions carry equal marks.

SECTION - A

Q1.

(a) State reciprocity Theorem. (2 Marks)

(b) Linear active network N connected to a load impedance Z_L via inductive reactance X_L as shown in Figure Q1.

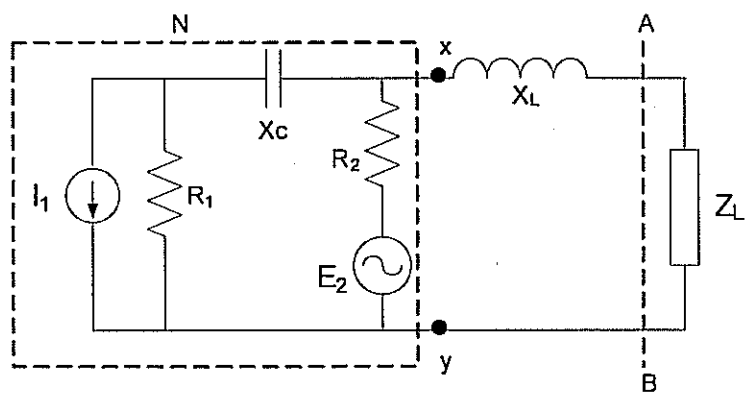

Figure Q1

$I_1 = 1\angle 0^0 A$, $E_2 = 10\angle 30^0 V$, $R_1 = R_2 = 1\Omega$, $X_c = -1j\Omega$, $X_L = 1j\Omega$

i) Apply Millman's Theorem for the network N to obtain the simplified equivalent source across the terminal x -y.

(6 Marks)

ii) Represent the network N with simplified source x-y and find the Thevenin's equivalent circuit across the terminal A – B.

(6 Marks)

iii) What should be the value of Z_L to deliver maximum power?

(3 Marks)

iv) Determine the maximum power available across the load Z_L

(3 Marks)

Q2. Consider the circuit shown in Figure Q2. The Switch S has been closed for long time and opened at t = 0. The inductor L is an ideal one.

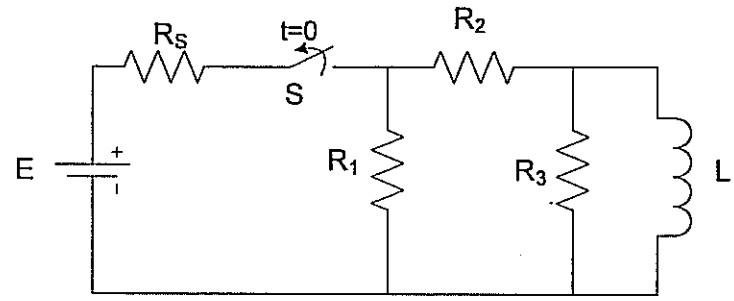

Figure Q2

$E = 16V$, $R_S = 1.5k\,\Omega$, $R_1 = 10k\,\Omega$, $R_2 = 30k\Omega$, $R_3 = 10k\Omega$, $L = 40mH$

(a) Find the voltage across the R_3 when circuit was at steady state.($t = 0^-$)

(2 Marks)

(b) Determine the steady state current through the inductor. ($t = 0^-$)

(6 Marks)

(c) Derive an expression for the inductor current just after the switch S is opened.($t = 0^+$)

(8 Marks)

(d) Calculate current through the inductor 10μs after switch S is open. ($t = 0^+$)
Sketch the graph of variation of inductor current with the time.

(4 Marks)

Q3.

(a) What is mean by "linear network" in circuit theory?

(3 Marks)

(b) The circuit shown in figure Q3 to be solved by using loop/mesh current method. The loop currents I_1, I_2 and I_3 are indicated in figureQ3.

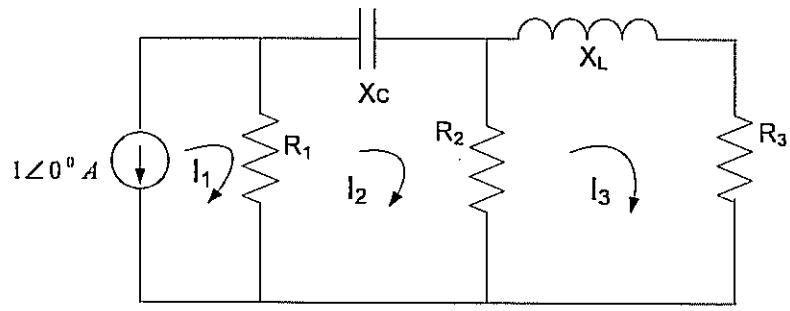

Figure Q3

$R_1 = R_2 = R_3 = 10\Omega$, $X_c = -10j\Omega$, $X_L = 10j\Omega$

i) Formulate loop/mesh equations for the circuit.

(8 Marks)

ii) Solve the formulation to obtain loop currents

(6 Marks)

iii) Determine current through each component using the loop currents.

(3 Marks)

Q4.

(a) State four properties of an Operational Amplifier.

(4 Marks)

(b) An ideal Operational Amplifier shown in figure Q4.

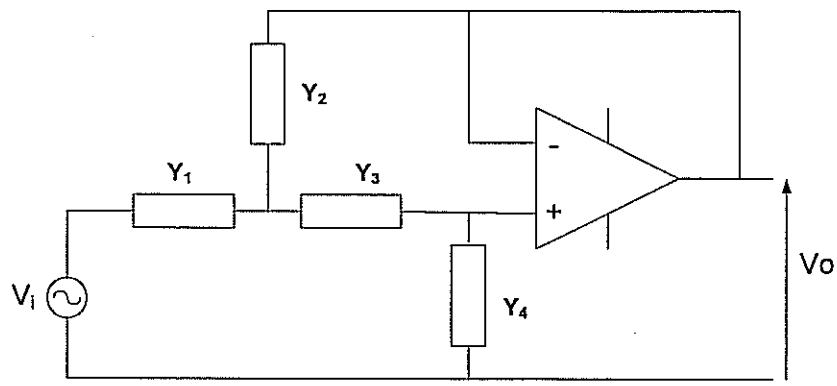

Figure Q4

i) Derive transfer function for given filter.

(10 Marks)

ii) Select suitable components for Y_1, Y_2, Y_3 and Y_4 to behave the circuit as a low pass filter. (4 Marks)

iii) Find the mid band gain K and cut off frequency in terms of the components.

(2 Marks)

Q5.

(a) State the properties that an impedance or admittance function should have in order to realize it using L and C components.

(2 Marks)

(b) Sketch the pole zero diagram to indicate the poles and zeros of the following driving point impedance functions.

i) $Z(s) = \frac{s^2+7s+10}{s^2+4s+3}$ ii) $Z(s) = \frac{s^3-9s}{s^2+4s^2+4}$

(4 Marks)

(c) State which of above impedance functions are realizable. Give reasons.

(4 Marks)

(d) Synthesis the realizable function by using Foster -1 and Cauer-1 forms selecting suitable components. (10Marks)

Q6. Figure Q6 shows (Next page) a resistive ladder network and it is required to find the Transmission parameters of the two port network. Follow the steps given below.

- Break the given network in to two parts as networks N_1 and N_2 (2 Marks)
- Find the Transmission parameters of N_1 and N_2 (10 Marks)
- Given network can be consider as cascade connection of N_1 and N_2
- Hence, Find the Transmission parameters of given network. (8 Marks)

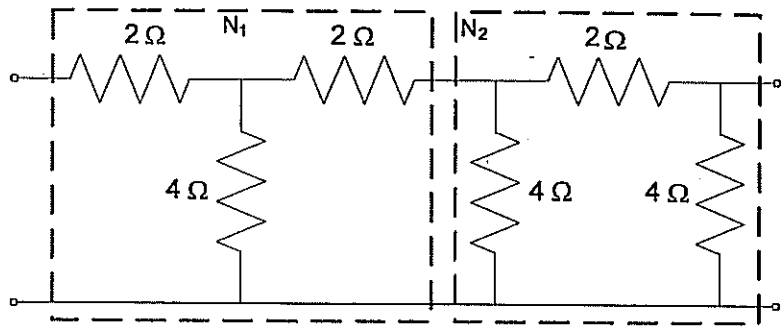

Figure Q6

SECTION – B

Q7. During a practical session, a student had to measure wave forms shown in FigureQ7- a and b.

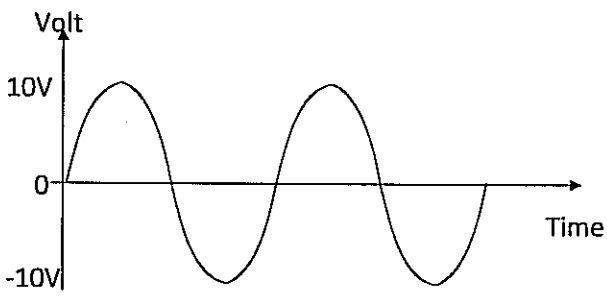

Figure Q7 – a

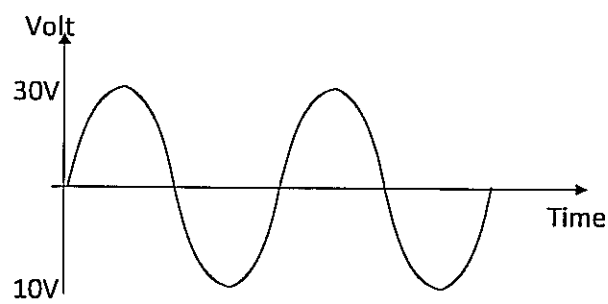

Figure Q7 – b

(a) Find the meter reading of two wave forms, if the student uses,

- A calibrated average reading PMMC voltmeter
- A true RMS reading voltmeter

(6 Marks)

(b) The student has observed two different meter reading when he measures the wave form in Figure 7-b. Explain the reason for this observation.

(3 Marks)

(c) Suggest a modification for input stage of basic average reading meter to show a similar reading to true RMS meter reading for waveform in figure 7-b.

(6 Marks)

(d) If the resolution of the RMS meter is 10mV, find the minimum number of digits required to display above wave forms. Find the measuring range.

(5 Marks)

Q8. A student wanted to measure capacitance and loss factor of an insulating material. His proposed bridge arrangement shown in Figure Q8 and S is the insulating specimen.

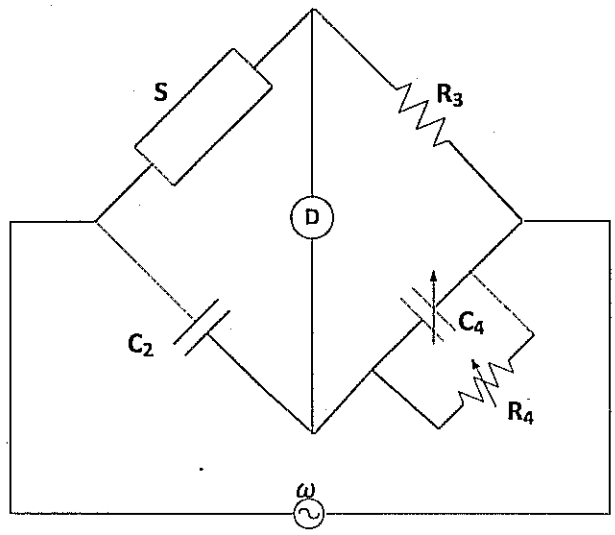

Figure Q8

(a) What is the name of the above bridge?

(2 Marks)

(b) Draw an equivalent circuit for specimen **S**.

(2 Marks)

(c) Write impedance equation at balance condition. Hence find the unknown capacitance and loss factor of the specimen in terms of C_2, C_4, R_3, R_4 and ω.

(8 Marks)

(d) The student has modified the bridge by adding a variable resistor $\boldsymbol{R'}$ in series with specimen **S**. Obtain an expression for capacitance and loss factor of the specimen.

(5 Marks)

(e) Comment on use and effect of $\boldsymbol{R'}$ for measuring variables.

(3 Marks)

Q9. Analyze the Ramp type analog to digital converter given Figure Q9. (Next page) IC1 functions as a voltage to current converter and IC2 functions as a comparator. T1 is a MOSFET which open circuit source (S) and drain (D) when gate (G) is supplied with a positive voltage. Otherwise the source and drain are short circuited.

(a) Write an expression for the current (I) through resistor R.

(4 Marks)

(b) Write an expression for the time taken (Δt) to change the voltage of the capacitor by ΔV. *(Hint: The capacitor will be charged through a current source.)*

(6 Marks)

(c) Using the expressions obtained from i) and ii) above, obtain a relationship for input voltage (V_{in}) and charging time (Δt). Clearly note the variables and constants of your expression.

(5 Marks)

(d) Draw a complete block diagram of the system. Name all the blocks and signals transferred between each block. (5Marks)

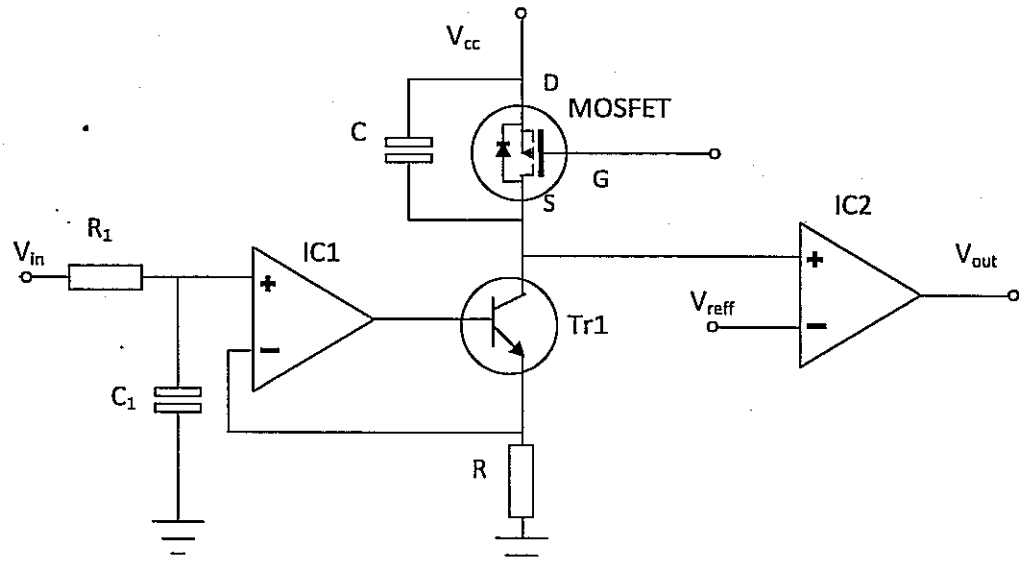

Figure Q9

Q10. Write short notes on **four** of following topics. Limit it for **200** words.

(a) Briefly describe four applications of A.C potentiometers.

(b) Describe by drawing a suitable circuit diagram, how the insulation resistance of a cable may be accurately measured using the direct deflection method.

(c) State the common source of errors in four arm bridges and state how they may be reduced.

(d) State the losses that occur in magnetic materials and explain how these may be separated.

(e) Describe four methods of measuring magnetic flux density used in modern instrumentation.

(f) Briefly describe four advantages of electronic voltmeters over permanent magnet moving coil (PMMC) voltmeters.

(5 Marks × 4)

END