00411

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

ECX3231 - Electrical Circuits & Measurements
Final Examination 2009/2010

Duration: 3 hours

Date: 10.03.2010 Time: 13.30-16.30

This question paper consist of two sections over four pages. Answer **six** questions selecting **at least three from section A and at least two from section B.** All questions carry equal marks.

SECTION -A

Q1. Analyze characteristics of the supply available across the terminals **A-A'** of the circuit shown in the figure Q1 using following techniques.

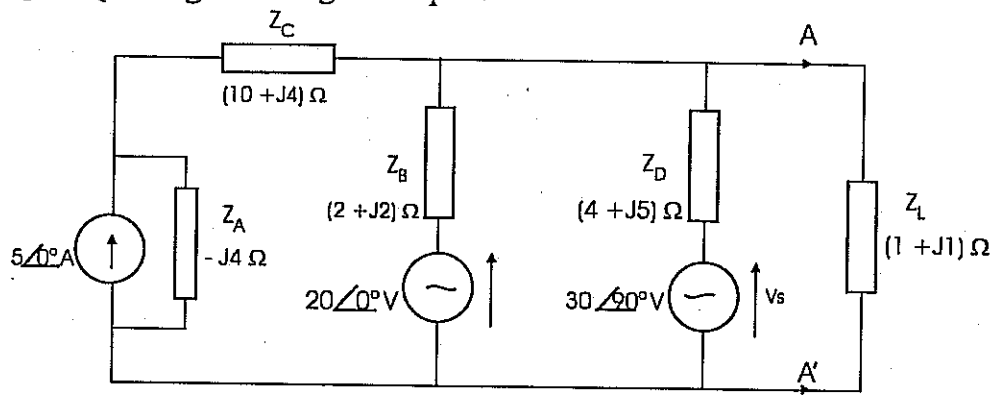

Figure Q1

(a) Use Millman's theorem to find the simplified equivalent circuit across terminals **A-A'**

(b) Determine the load impedance that gives maximum power flow across the terminals **A-A'.**

(c) Find actual power delivered to the load $\mathbf{Z_L}$ through the terminals A-A'.

Note: Form of the source can be converted whenever it is required.

Q2. Three matrices M^T, Z_b, and E_b are respectively transpose of tie set matrix, branch impedance matrix, and branch emf vector of a circuit.

$$M^T = \begin{bmatrix} 1 & 0 & 0 \\ -1 & 1 & 0 \\ -1 & 0 & 1 \\ 0 & 1 & -1 \\ 0 & 0 & 1 \\ 0 & -1 & 0 \end{bmatrix} \quad Z_b = \begin{bmatrix} -j5 & 0 & 0 & 0 & 0 & 0 \\ 0 & j5 & 0 & 0 & 0 & 0 \\ 0 & 0 & 10 & 0 & 0 & 0 \\ 0 & 0 & 0 & 2.5 & 0 & 0 \\ 0 & 0 & 0 & 0 & 2.5 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2-j2 \end{bmatrix} \quad E_b = \begin{bmatrix} 5 \\ 0 \\ 8\angle 30^\circ \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

(a) Draw the directed graph and the circuit diagram which is represented by the given formulation.

(b) Determine the mesh equation of the circuit using the relationship $ME_b = MZ_bM^Ti_m$.

(c) Write a tabulation which formulates branch currents in terms of loop currents.

Q3. A simple linear electrical circuit is shown in the figure Q3. Formulate the given circuit and solve the formulation to find the nodal voltages taking node o as the reference node.

(a) Write matrix the nodal equations in matrix form. .

(b) Determine the nodal voltages $\mathbf{V_1}$ and $\mathbf{V_2}$ using the formulation determined in Q3.(a)

(c) Rewrite nodal equations for the circuit if the circuit is modified by connecting a Voltage Control Current Source (VCCS) having strength of 2 units. The controlling voltage is the voltage at the **node2** with respect to the **node0** and output current of the VCCS is injected in to the **node 1.**

Note: Impedances of the elements are given.

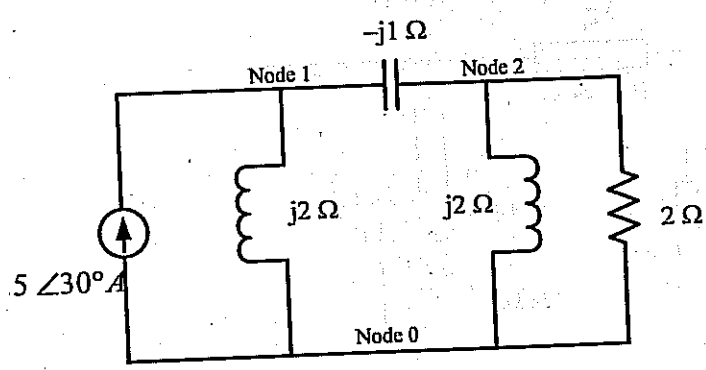

Figure Q3

Q4. Passive LC filters can be analyzed with reactance sketches of open and short circu impedances Z_{oc} and Z_{sc}, Figure Q4 indicates reactance sketch of a T type passive LC filter.

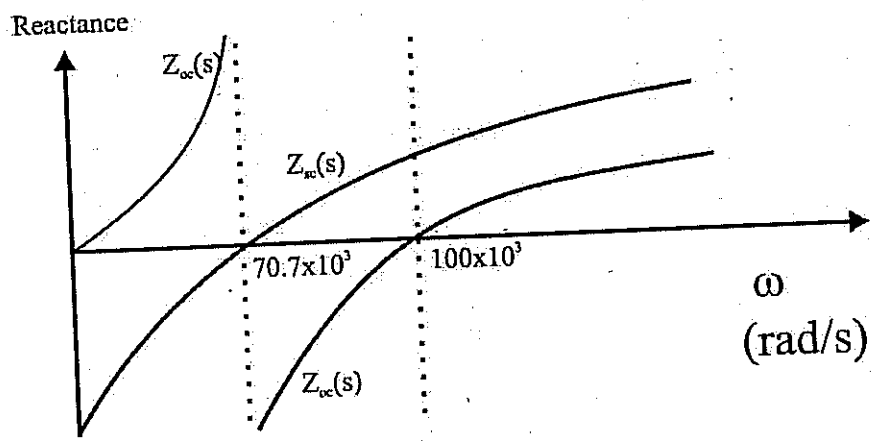

Figure Q4

(a) List disadvantages of passive LC filters with respect to active filters.

(b) Decide the type and pass band of the filter.

(c) Determine the components **L** and **C** of the filter having above characteristics, if the des resistance or $\sqrt{(L/C)}$ is 600Ω.

Q5. A 24 V AC supply is connected to a load of 10Ω through a symmetrical bridge T network as shown in the figure Q5. Impedances of the elements of the circuits are indicated in the figure. Determine the following input and output characteristics of the given circuit using the two port network approach with the given instructions.

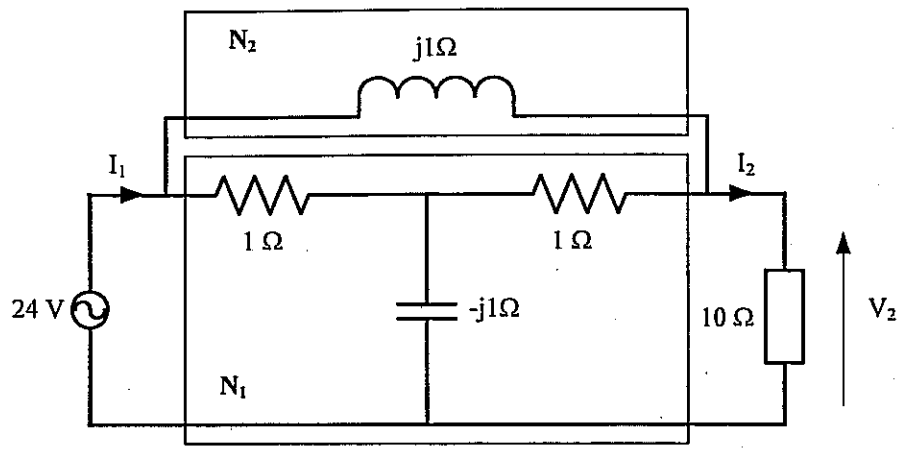

Figure Q5

(a) Find the admittance parameters of the T network N_1.

(b) Determine the admittance parameters of the overall network if the admittance parameters of shunting inductor [N_2] is $Y_2 = \begin{bmatrix} 1/j\omega & 1/j\omega \\ 1/j\omega & 1/j\omega \end{bmatrix}$

(c) Use the result in Q5.(b) to find the output voltage V_2 and the supplied current I_1 .

Q6. The switch **Sw** shown in the figure Q6 is controlled by the relay and it is closed when the current through the relay reaches to 0.5A. Coil current decays as switch **Sw** closes and relay contact opens when the current becomes less than 0.38A. Therefore this circuit arrangement is oscillate.

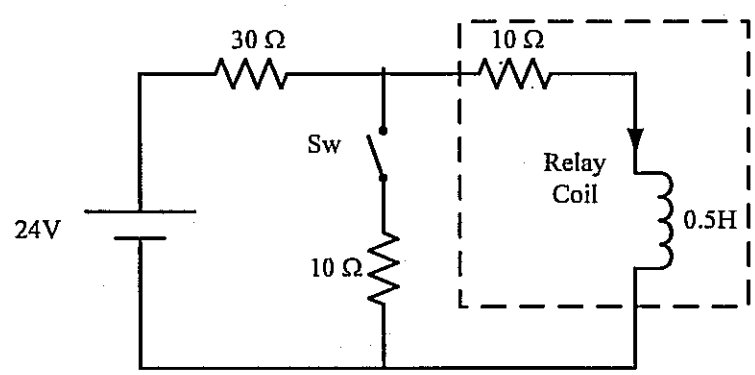

Figure Q6

(a) Calculate the time taken to reach the inductor current to 0.5A at the initial switching.

(b) Write an expression for the inductor current for time duration between the instant of Sw get closed at first and at the instant Sw opens. **Note:** Response of this period of time is sum of zero input and zero state responses.

(c) Sketch a graph indicating the magnitude and directional variations of inductor current for the period specified in the Q6.(b)

SECTION -B

Q7. Permanent Magnet Moving Coil (PMMC) instrument is a low cost instrument and responds to the average current through it. This instrument can be used to measure AC voltages by rescaling measurement for a particular wave form.

(a) List types of instruments that can be directly used to measure AC voltages.

(b) A PMMC instrument having 100 turns, 0.15 Wb/m^2 magnetic flux density, and 3 cm x 2.5 cm is the coil size. Determine the Full Scale Deflection (FSD) current if the torque exerted by the spring at FSD is $5X10^{-5}$ Nm.

(c) The above mentioned average responding instrument calibrated to measure sinusoidal AC voltages. Determine the meter reading if waveform shown in the figure Q7 measured with this instrument.

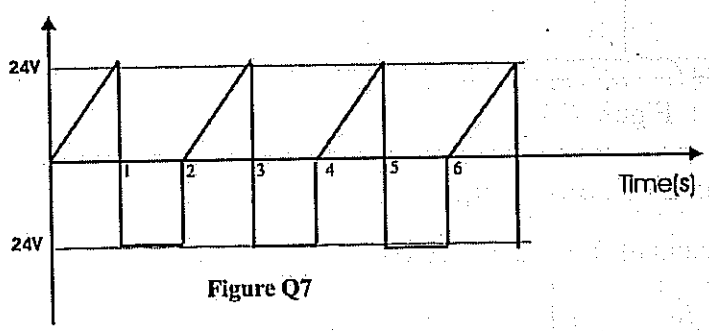

Figure Q7

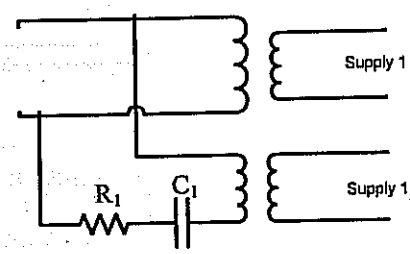

Figure Q8

Q8. Different types of AC potentiometers are used to calibrate AC instruments. GALL-TINSLEY AC potentiometer is called as Cartesian type potentiometers and a quadrature AC power supply is required for these potentiometers.

(a) List applications of AC potentiometers.

(b) Briefly describe the principle of GALL-TINSLEY AC potentiometers with aid of a sketch

(c) Figure Q8 shows a phase quadrature supply used to a GALL-TINSLEY AC potentiometer, it comprises with two identical transformers, and operating at 50 Hz supply. Determine the capacitance $\mathbf{C_1}$ and resistance $\mathbf{R_1}$ used in the phase shifting network, if the winding resistance and inductance are 1.6Ω and 7mH respectively.

Q9. Answer any **three** questions given below.

(a) Briefly explain the applications of spectrum analyzers **or** logic analyzers..

(b) Describe the operational principle of a Digital Storage oscilloscope **or** Function generator.

(c) Derive an expression for the torque develops in a moving iron instrument.

(d) Briefly explain the techniques used to reduce errors in AC bridges

Q10. Multi meters contain many enhanced features when compared with the conventional instruments. Following questions are based on the enhancements of the electronic meters.

(a) Name two techniques used to extend the range of an ammeter

(b) Briefly describe two techniques used to increase the input impedance of electronic multi meters.

(c) State two methods used to measure rms value of an AC sinusoidal voltages using DC average responding meters.