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

ECX3231 - Electrical Circuits & Measurements
Final Examination 2007/2008

Duration: 3 hours

Date: 06.05.2007 Time: 9.30-12.30

This question paper consist of two sections over four pages. The paper contains ten questions and each question carry equal marks. Answer ***six*** questions selecting **at least two** questions from **section B.**

Section – A

Q1. An AC circuit having two sources of same frequency is shown in the figure Q1.

(a) Find the Thevenin's equivalent circuit across the terminals **AA´** of the circuit.

(b) There is a value of the capacitance **C** that causes maximum power $\mathbf{P_{max}}$ that flows across the terminals **AA´**. Determine the capacitance **C** and power $\mathbf{P_{max}}$ using the Thevenin's equivalent circuit. Assume that only value of the C can be varying for this purpose, but the real part of the load impedance cannot change.

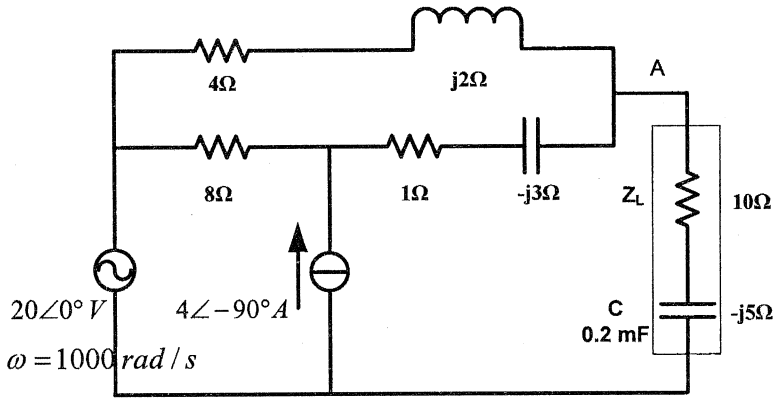

Figure Q1

Q2.The switch **S** shown in the figure Q2 has been closed for long time. Hence, the inductor is act as a short circuit, because this condition is like a dc stage. Switch is opened at t=0, so, current will decay through the resistors as in a simple first in order RL circuit, but in this case not via a single resistor instead of the equivalent resistance.

(a) Determine the steady state current through the inductor before the transition of the switch

(b) Write an expression to the inductor current $i_L(t)$ for $t \geq 0$

(c) Find the current through the inductor 10 μs after the switching.

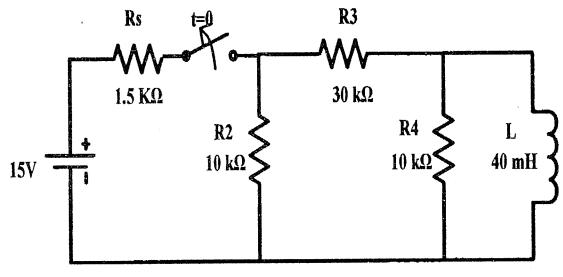

Figure Q2

Q3. Consider an equivalent circuit of a practical amplifier shown in the figure Q3/4.

(a) Write the current balance equations (KCL) to the Node 1 and Node 2 in terms of the nodal voltages and the input current $\mathbf{I_1}$ of the amplifier.

(b) Obtain the matrix form of the nodal equations by eliminating $\mathbf{I_1}$ from the results of Q3 (a) [1].

(c) Determine the nodal voltages $\mathbf{V_1}$ and $\mathbf{V_2}$ of the given circuit using the derived formulation in Q3 (b).

1. **Hint:** Get another independent expression for $\mathbf{I_1}$ and eliminate it from above equations.

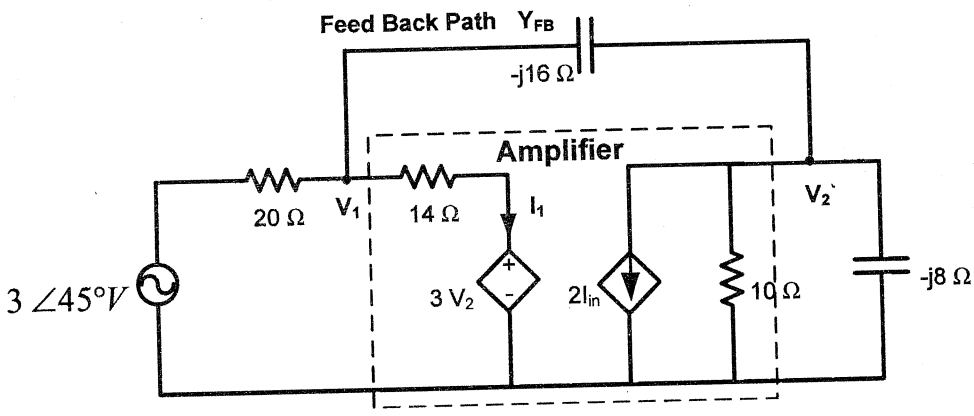

Figure Q3/4

Q4. Formulate the circuit given in the figure Q3/4 using two port network modeling by following the steps given below.

(a) Obtain Y parameters of the amplifier[1]

(b) Determine the Y parameters of the parallel resultant of the amplifier and the feed back[2].

(c) Use Y parameter model of the resultant circuit to obtain two expressions for $\mathbf{V_1}$ and $\mathbf{V_2}$.

1. **Hint**: You can determine the h parameters first and then obtain Y using $Y = \begin{vmatrix} 1/h_{11} & -h_{12}/h_{11} \\ h_{21}/h_{11} & |h|/h_{11} \end{vmatrix}$

2. **NB**: All elements of the Y parameters model of a single series resistor R is 1/R.

Q5. A passive constant K filter has to be designed to suppress the frequencies below 6 kHz.

(a) Derive expressions for the open circuit input impedance and the short circuit input impedances of the T type high pass filter circuit.

(b) Determine the pass band of the T type high pass filter using a reactance sketch.

(c) Calculate the values of the components **L** and **C** that fix the cut off frequency f_c to the 3 kHz and the design resistance $\mathbf{R_o}$ or the value of $\sqrt{L/C}$ to the 600Ω.

Q6. A driving point impedance function Z(s) of a realizable LC network is given below.

$$Z(s) = 3\frac{(s^2+1)(s^2+16)}{s(s^2+9)}$$

(a) Sketch the pole zero diagram to indicate the poles and zeros of the driving point impedance function Z(s).

(b) Plot the variation of the reactance X(s) versus the angular frequency ω.

(c) Realize the driving point impedance function.

Section – B

Q7

(a) Determine the number of turns **N** required to set the full scale deflection current to 5 mA of Permanent Magnet Moving Coil (PMMC) instrument if the magnetic flux density at the air gap is 5×10^{-3} Wb/m^2, and the area of the bobbin is $2\times10^{-2} \times 1.5\times10^{-2}$ m^2. If the torque required for the full scale deflection is 0.3×10^{-5} Nm.

(b) Resistance per unit length of the wind the coil is 125 mΩ/m. Determine the shunt resistor required to extend the measuring range to 50 mA.

(c) The full scale deflection voltage of the above instrument is set to 1 V using a limiting resistor R_1, and another resistor R_2 used to extend the measuring range to 20 V. Determine the values of R_1 and R_2

Q8. An AC Bridge circuit is shown in the figure Q8.

(a) Given that the Z_2 and Z_3 contain pure resistors. Show that a practical inductor having self inductance as well as effective series resistance can be measured with help of another parallel capacitor and a variable resistor Z_4 or Z_1[1].

(b) Briefly explain why this bridge is not suitable to measure low quality inductors if two resistors varies to obtain the balance condition. The quality factor of an inductor at a given frequency is the ratio of inductive reactance to self resistance or $\omega L_s / R_s$.

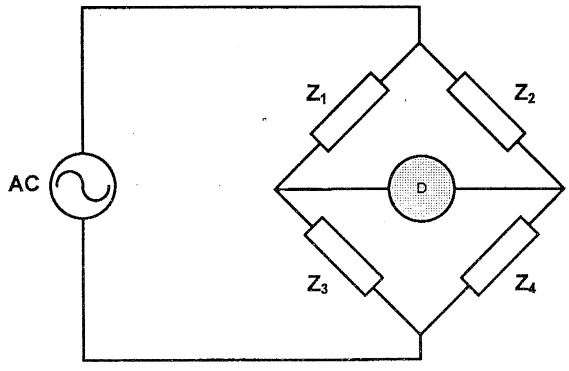

Figure Q8

1. **Hint**: For the given components show that balance can be obtain hence given parameters can be measured

Q9. It is required to design a simple digital voltage measuring instrument that indicates the voltage through displaying devices. The voltage range to be measured is between 0 V to 200 V and at least it should indicate measured values in steps of 100 mV.

(a) Draw a functional block diagram of such a digital voltmeter.

(b) Select an appropriate Analogue to Digital Converter (ADC) for the above application which used to measure the random voltage samples. Briefly explain the operation of the selected ADC by using a sketch and with proper justification of your selection.

(c) Determine the number bits required to achieve the required resolution of the measuring device.

Q10. Write brief short notes on three of following topics.

(a) Advantages and disadvantages of using analogue multi meters for electrical measurements.

(b) Application of Digital Storage Oscilloscope

(c) Operational principles of Spectrum Analyzer

(d) Role of electronic circuit simulators in circuit analysis