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

324

ECX3231 - Electrical Circuits & Measurements
Final Examination 2008/2009

Duration: 3 hours

Date: 26.03.2009 Time: 14.00-17.00

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. Determine the output voltage $\mathbf{V_o}$ of the circuit shown in figure Q1.(A) using the following circuit analysis techniques. Given that the operational amplifier is ideal.

(a) Determine $\mathbf{Y_3}$', Y_4', and $\mathbf{Y_5}$' shown in the figure Q1.(B) by obtaining the star equivalent of the delta circuit arrangement marked as the **D** in Figure Q1.(B).

(b) Obtain Thevenin's equivalent circuit across the terminal **A-A'** shown in the figureQ1.(B).

(c) Use Equivalent circuit determined in the Q1.(B) to calculate **Vo.** Assume the current through the (-) ve terminal of the operation amplifier is negligibly small.

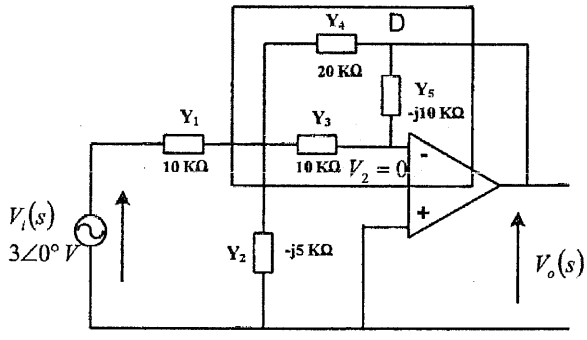

Figure Q1.(A)

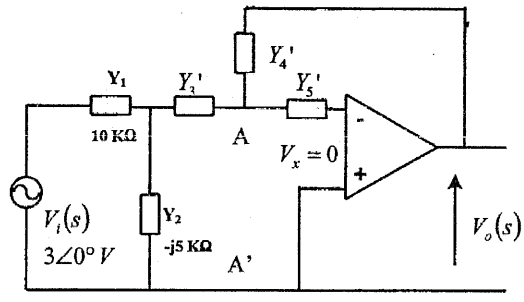

Figure Q1.(B)

Q2. Given that the operational amplifier of the circuit shown in the figure Q2 is ideal. Formulate and find the voltages across each branch of the circuit shown in the figure Q2 using following steps.

(a) Write matrix form of the nodal equations for the **node 1** and **node 2** of the circuit.

(b) Determine the nodal voltages $\mathbf{V_1}$ and $\mathbf{V_o}$ by assuming the voltage $\mathbf{V_2}$ is zero.

(c) State whether the nodal method or mesh method is more suitable to formulate the given circuit by considering the applicability and order of the resulted formulation.

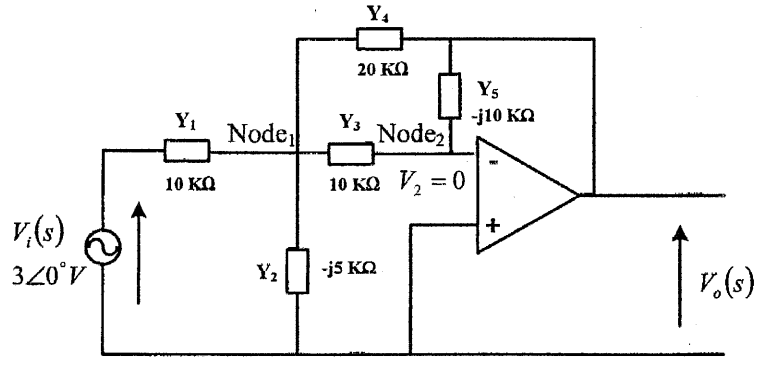

Figure Q2

Q3. It is required to analyze the transfer characteristics of the filter circuit shown in the figure Q3 at different frequencies in the sinusoidal steady state. Given that the operational amplifier is ideal.

(a) Derive transfer function $V_o(s)/V_1(s)$ for the given circuit.

(b) State the type and the pass band of the given filter.

(c) Calculate the output voltage $V_o(j\omega)$ when the amplitude of the input voltage is 10V and if the

(i) Angular frequency is 1000 radiant per second.

(ii) Angular frequency is 10, 000 radiant per second.

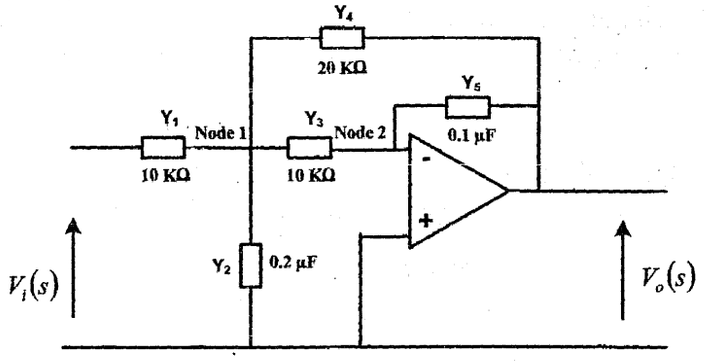

Figure Q 3

Q4. A symmetrical bridge T network is shown in the figure Q4.(A) and two port network representation of that circuit at termination by Z_L is shown in figure Q4.(B).

(a) Write three loop equations for the circuit shown in the figure Q4.(A)

(b) Obtain admittance parameters Y_{kj} from following expression $Y_{kj} = \Delta_{kj} / \Delta$. Where Δ is the determinant of loop basis equations and Δ_{kj} is the co-factor of the element in the k^{th} raw and j^{th} column.

(c) The circuit shown in figure Q4,(A) is represented by block N in figure Q4,(B). Derive an expression for Trans-conductance $I_2(s)/V_1(s)$, If the network terminated by impedance Z_L.

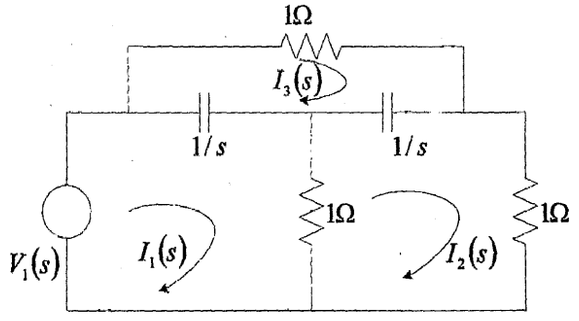

Figure Q4.(A)

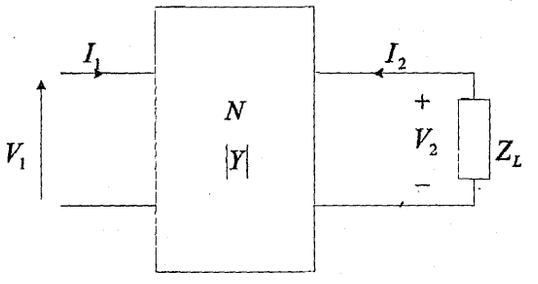

Figure Q4.(B)

Q5. Driving point impedance function of a passive realizable electrical circuit is given by

$$Z(s) = \frac{(s+2)(s+4)}{(s+1)(s+3)}$$

(a) Sketch the variation of $Z(j\omega)$ with the angular frequency ω

(b) Find residues of Z(s)

(c) Obtain the First Cauer form of the Z(s).

Q6. Voltage across a capacitor **C** when it is charging via a resistor **R** is given by the $V_c(t) = V_s\left(1 - e^{-t/RC}\right) + V_o\left(e^{-t/RC}\right)$, Where V_o is the initial voltage across the capacitor and V_s is the charging voltage. Use instruction given below to estimate the transient response of the circuit shown in the figure Q6.(A) when the square wave voltage signal shown in the figure Q6.(B) is applied.

(a) Calculate the voltages at time instant t_1 and t_2

(b) Derive an expression for the amplitude of the steady state voltage across the capacitor using the given equation. **Note:** The voltage across the capacitor is symmetrical about zero axis at the steady state

(c) Using the above results to sketch variation of the voltage across capacitor and resistor (Sketch applied waveform, capacitor voltage, and resistor voltage on same axis.)

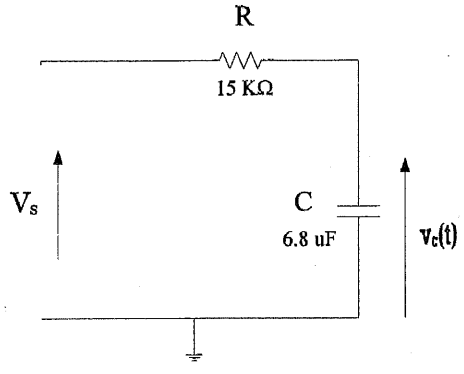

Figure Q6.(A)

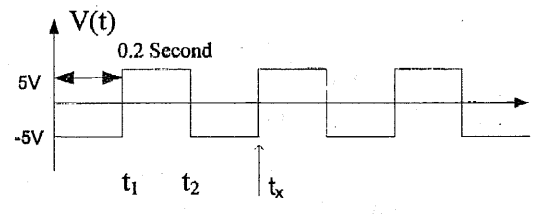

Figure Q6.(B)

SECTION -B

Q7. There are several classes of analogue and digital instruments having different characteristics and applications.

(a) Tabulate main applications of the following instruments. Permanent Magnet Moving Coil instrument (PMMC), induction type instruments, and electro dynamometer type instruments.

(b) Derive an expression for the deflection torque τ of a Permanent Magnet Moving Coil (PMMC) instrument.

(c) List advantages and disadvantages of using analogue multi meter when compared with digital multi meters.

Q8. Answer any **three** questions given below.

(a) Briefly explain the operational principle of the Drysdole phase shifting transformer with aid of sketches.

(b) Draw functional block diagram of a basic frequency counter.

(c) Write a short note on applications of spectrum analyzers in electrical circuit and signal analysis.

(d) Briefly explain the role of computer tools in circuit analysis.

Q9. A simple AC bridge setup used to measure practical inductance and capacitance using a switch is shown in the figure Q9. Z_1 is the component under measure and arm four contains two impedances; Z4.a and Z4.b. In order to obtain the balance condition one of them has to be select. Use the condition required to obtain the balance to answer the followings.

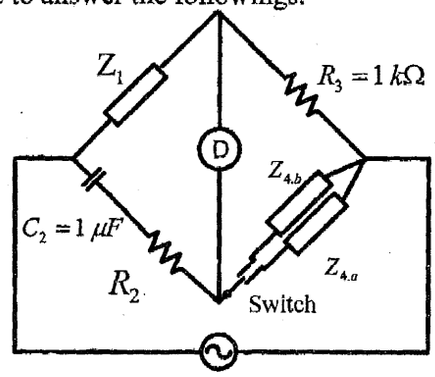

Figure Q9

(a) Determine the type of the component $Z_{4.a}$ that used to obtain the balance when it is used to measure a practical inductor having inductance **L** and series resistance $\mathbf{R_s}$.

(b) Is it possible to the balance independently for the real and imaginary components of the unbalance voltage using the above bridge configuration determined in Q9.(a)?

(c) Decide the component type and the value of $Z_{4.b}$ at the balance, if it is used to measure a capacitor of 10 μF.

Q10. An experimental setup used to measure two hybrid parameters of bipolar junction transistors is shown in the figure Q10.

(a) Answer the followings regarding to the given experimental setup.

(i.) What are the parameters that can be determine by the given circuit

(ii.) Briefly explain the required circuit conditions to measure the stated parameters.

(iii.) Name which parameter can be measured under the shown oscilloscope connection.

(b) Show the connection of two channels of the oscilloscope that required to observe two remain h parameters.

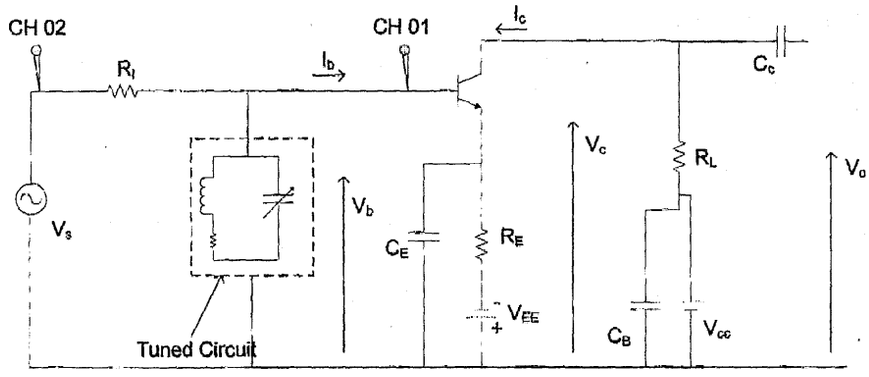

Figure 10