00126

The Open University of Sri Lanka
Department of Electrical and Computer Engineering
Bachelor of Technology Honors in Engineering – Level 5
ECX 5231 – Network Theory
Academic Year 2015/2016
Final Examination | Closed Book
Date: 26 - 11 - 2017 | Time: 09:30 – 12:30

This question paper consists of **seven** questions. Answer **any five** questions. All questions carry equal marks.

Q1. Figure 01 shows a LTIC system which is having an input u(t) and two outputs $y_1(t)$ and $y_2(t)$.

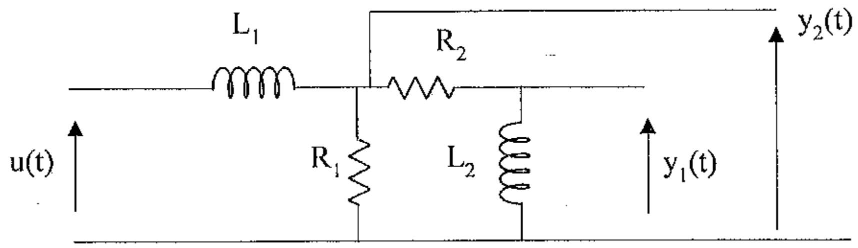

Figure 01

(i). Write state equations for the system given in figure 01, by selecting proper state variables. *(05 marks)*

(ii). Represent the state equations in standard matrix form and clearly indicate the matrices A, B, C, and D as per the standard notation. *(05 marks)*

(iii). Derive an expression for the zero-input response of the given system in terms of component values. Assume that, the initial currents of L_1 and L_2 are 0.1 A and 0.2 A respectively. (Evaluation of state transition matrix is not required) *(05 marks)*

(iv). Develop an algorithm to find the zero-input response of the system and interpret it using a flow chart. Period of response is T (0 to T seconds). Calculation step size should be T/100. *(05 marks)*

Q2. Consider the circuit given in figure 02.

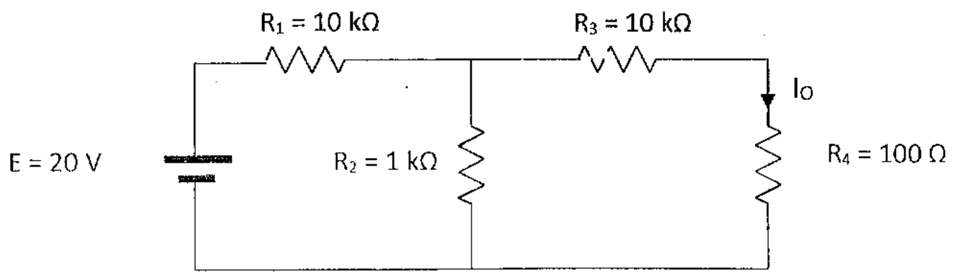

Figure 02

(i). Draw the adjoint network for the circuit shown in figure 02. Use standard notation to mark currents and voltages. *(05 marks)*

(ii). Using the extended Tellegen's theorem find the sensitivity of current I_O through R_4 for changes in each element R_1, R_2, R_3 and R_4 separately. Assume a change in only one component at a time. *(10 marks)*

(iii). If R_2 has a tolerance of 10%, calculate the range of variation of V_R. Assume all other components have their designated values. *(05 marks)*

Q3. State equations of a LTI system are given below.

$$[\dot{x}(t)] = [A]x(t) + Bu(t)$$

$$y(t) = [C]x(t) + Du(t)$$

(i). Using Laplace transform, convert the state space equations in to s-domain. *(02 marks)*

(ii). Obtain an expression for the transfer function of the system in matrix form. *(02 marks)*

(iii). Using the matrices given below, obtain the transfer function of the system. *(08 marks)*

$$A = \begin{bmatrix} -200 & 200 \\ 1000 & -11000 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 10000 \end{bmatrix}, C = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, D = [0]$$

(iv). Using the transfer function obtained in (iii), calculate the magnitude of the given system at following frequencies. You may consider the input to the system is always kept at unity (1 unit) for all the frequencies. *(03 marks)*

a. 10 $rads^{-1}$

b. 100 $rads^{-1}$

(v). Develop an algorithm to find the frequency response (magnitude only) of the system and interpret it using a flowchart. *(05 marks)*

Q4. Consider the circuit shown in figure 03

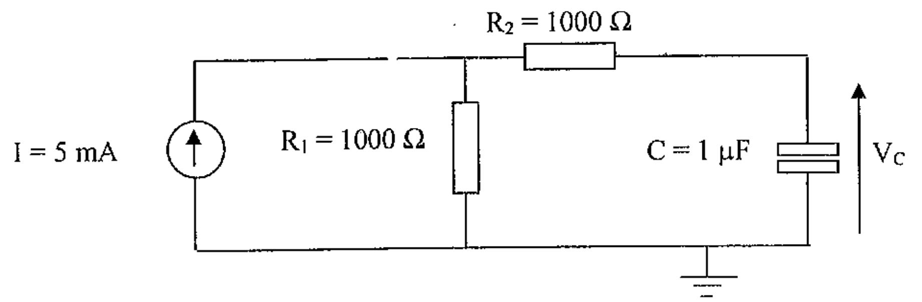

Figure 03

(i). Obtain the companion model for an ideal capacitor using backward Euler method. *(03 marks)* (ii). Replace the capacitor with its companion model you have obtained in (i) and redraw the circuit. *(04 marks)*

(iii). Write the matrix equation for the circuit by applying nodal analysis. *(05 marks)*

(iv). Write the steps of the algorithm to find the transient response (V_C) of the circuit. *(05 marks)*

(v). Draw a flow chart to represent the algorithm you have used in (iv). *(03 marks)*

Q5.

a) Consider the circuit shown in figure 04.

(i). Show how the circuit shown in figure 04 is solved graphically with the help of DC load line and diode characteristic equation. You may draw graphs and qualitatively indicate necessary details. *(05 marks)*

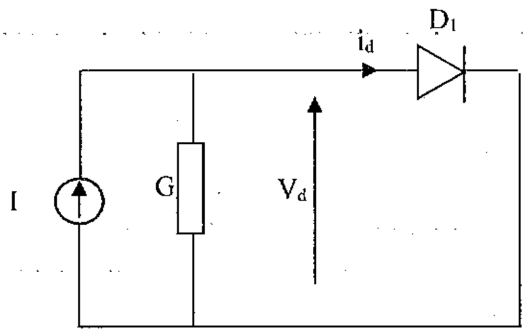

Figure 04

(ii). Develop the companion model of the diode. *(05 marks)*

b) A circuit with two diodes D_1 and D_2 is shown in figure 05. Characteristic equation of any of the diodes is given by $i_d = I_s(e^{\lambda V_d} - 1)$. Assume $I_s = 1 \times 10^{-13}$ A and $\lambda = 1/0.026$ V^{-1}.

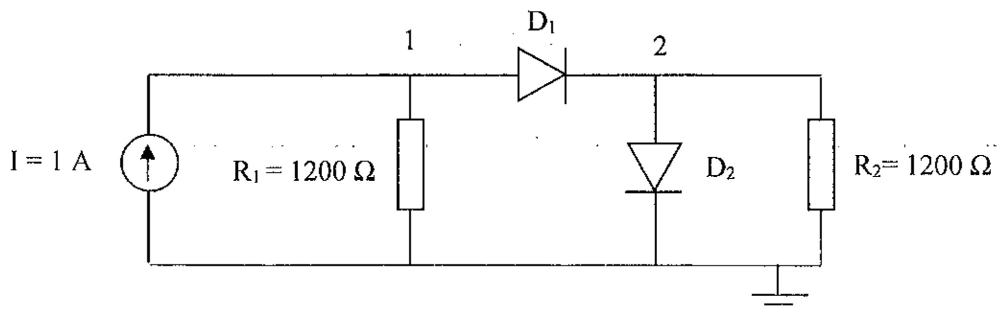

Figure 05

(i). Formulate the matrix equation using non-linear analysis for modified nodal analysis. *(03 marks)*

(ii). Write the steps of the algorithm to calculate the nodal voltages of the circuit. *(04 marks)*

(iii). Draw a flow chart to represent the algorithm you have used in (ii). *(03 marks)*

Q6. Figure 06 shows an electric circuit consisting passive elements and two AC voltage sources.

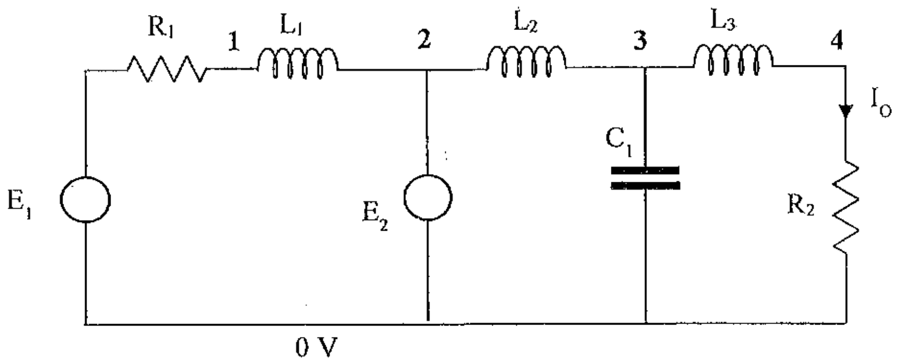

Figure 06

(i). Set the stamps for each element in the circuit shown in figure 06. *(10 marks)*

(ii). Write the matrix equation to find the voltages at points 1, 2, 3, 4 and output current I_O using the stamps you have obtained in (i). *(10 marks)*

Q7. Consider the MOSFET amplifier circuit shown in figure 07. The high frequency model of the MOSFET is shown in figure 08. Assume the circuit is working in steady state.

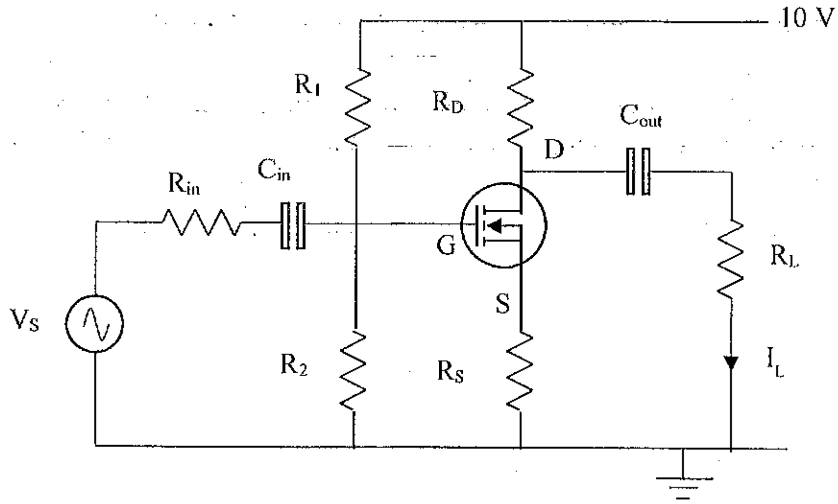

Figure 07

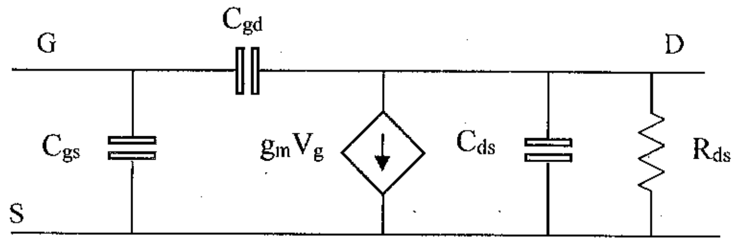

Figure 08

(i). Draw the high frequency equivalent circuit of the MOSFET circuit shown in figure 07, using the high frequency model of the MOSFET shown in figure 08. Clearly indicate the assumptions you make. *(04 marks)*

(ii). Set the stamps for each element using modified nodal analysis. *(06 marks)*

(iii). Write the matrix equation of the circuit to find the voltages at all nodes and output current I_L using the stamps you have set in (ii). *(10 marks)*