00049

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX7231 Advanced Circuit Design and Analysis**
Academic Year	: 2020/21
Date	: 06th February 2022
Time	: 1400-1700 hrs

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Five (5)** questions in **Three (3)** pages.
3. Answer all **Five (5)** questions.
4. Answer for each question should commence from a new page.
5. No charts/ codes are provided.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear handwriting.
8. Do not use Red colour pen.

Question 01 – (30 marks)

Figure 1 shows a circuit which is having an input u(t) and two outputs $y_1(t)$ and $y_2(t)$. Answer the questions based on the circuit.

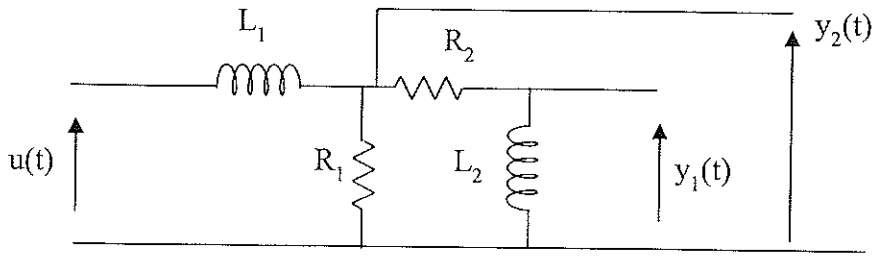

Figure 1

$R_1 = 100\ \Omega, R_2 = 100\ \Omega, L_1 = 100\ mH, L_2 = 100\ mH$

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 initial currents of L_1 and L_2 are similar and equal to 0.1 A. 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)*

v. Using Laplace transform, convert the state space equations into s-domain. *(05 marks)*

vi. Derive an expression for the transfer function of the system in matrix form. *(05 marks)*

Question 02 – (15 marks)

Consider the circuit given in Figure 2. Assume that the circuit is working in the steady-state.

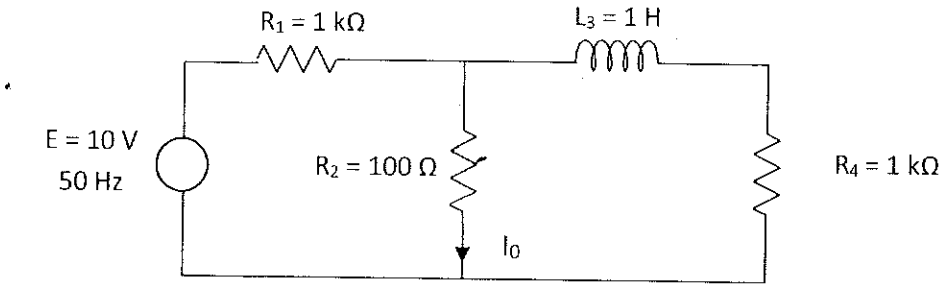

Figure 2

i. Draw the adjoint network for the circuit shown in Figure 2. Use standard notation to mark currents and voltages in the adjoint network. *(05 marks)*

ii. Using the extended Tellegen's theorem, find the sensitivity of the current through R_2 (I_0) for changes in each element R_1, R_2, L_3 and R_4 separately. Assume a change in only one component at a time. *(10 marks)*

Question 03 – (15 marks)

A first order RL circuit has series connected 30 mH inductor and a 1 kΩ resistor. The circuit is energized at t = 0 s using a 12 V DC source. Initially, energy stored in the inductor is zero.

i. Using Backward Euler method of integration, formulate the companion model of energy storing element for nodal analysis. (Time step = 10 μs) *(05 marks)*

ii. Draw the complete equivalent circuit using the companion model. *(02 marks)*

iii. Calculate the current through the circuit at 20 μs. *(03 marks)*

iv. Develop an algorithm to generate the transient response of the current through the circuit and interpret it using a flow chart. *(05 marks)*

Question 04 – (20 marks)

Consider the MOSFET amplifier circuit shown in Figure 3. The high frequency model of the MOSFET is shown in Figure 4. Assume that the circuit is operating at steady-state.

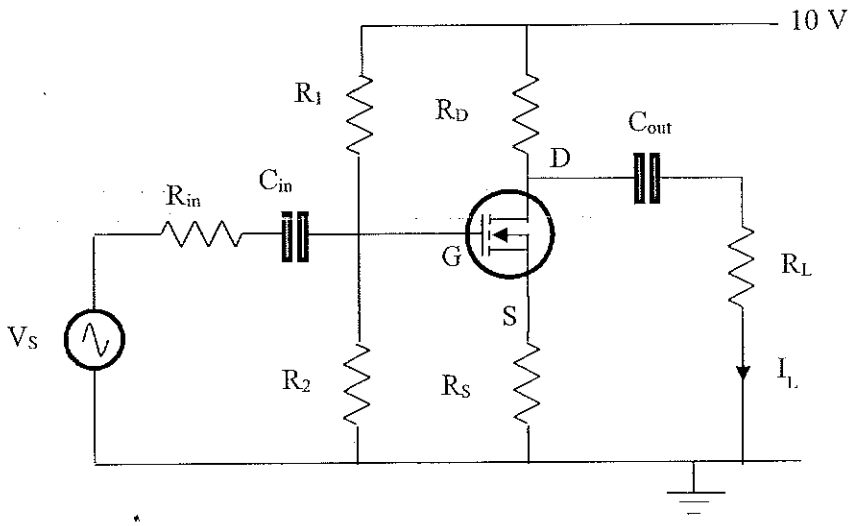

Figure 3

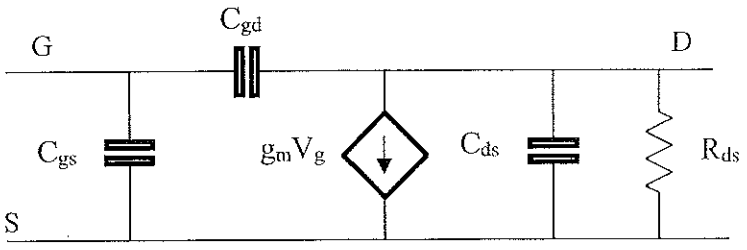

Figure 4

i. Draw the high frequency equivalent circuit of the MOSFET circuit shown in Figure 03, using the high frequency model of the MOSFET shown in Figure 04. Clearly indicate the assumptions you make. *(04 marks)*

ii. Write 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)*

Question 05 – (20 marks)

Figure 5 shows an electric circuit consisting passive elements and two AC voltage sources.

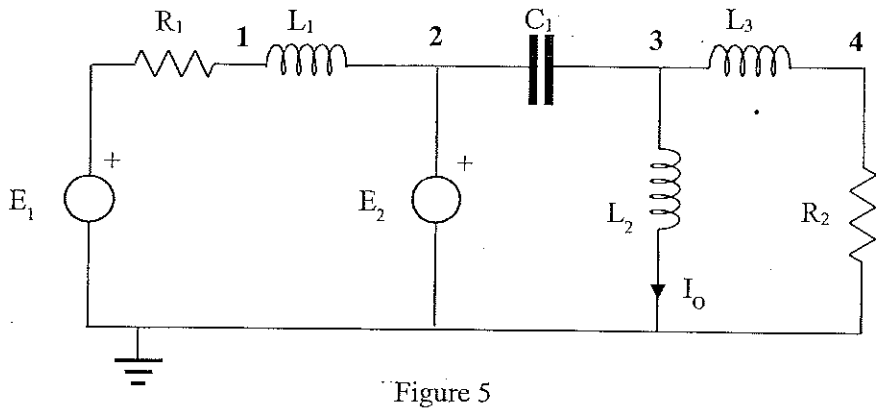

Figure 5

i. Write the stamps for each element of the circuit using modified nodal analysis *(10 marks)*

ii. Write the matrix equation to find the voltages at points 1, 2, 3, 4 with respect to ground, and output current I_O using the stamps you have obtained in (i). Solving the equation is not required. *(10 marks)*