



Study Programme : Bachelor of Science Honours in Engineering
Name of the Examination : Final Examination
Course Code and Title : EEX4331- Circuit Theory and Design
Academic Year : 2024/25
Date : 17th March 2026
Time : 0930-1230h
Duration : 3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Six (6)** questions in **Four (4)** pages.
3. Answer any **Five (5)** questions.
4. All questions carry equal marks.
5. Answer for each question should commence from a new page.
6. This is a Closed Book Test (CBT).

Question 01

- a. Consider the circuit shown in Figure Q1-(a).

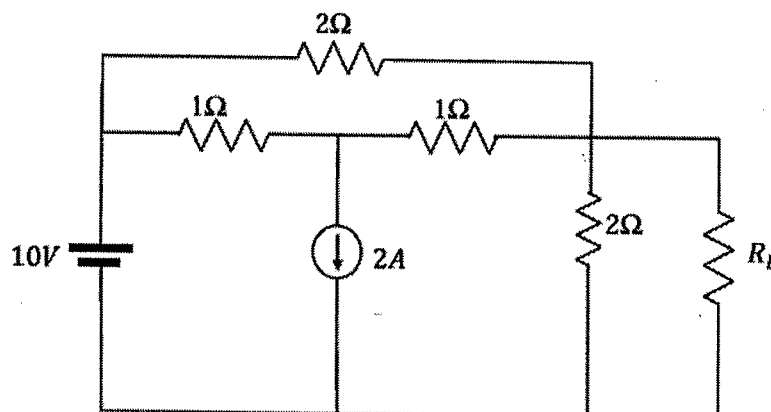


Figure Q1-(a)

- i. Determine the Thevenin's voltage (V_{Th}) and Thevenin's resistance (R_{Th}) with reference to the resistance R_L of the circuit. (4 marks)
- ii. Draw the Thevenin's equivalent circuit with reference to R_L and indicate V_{Th} and R_{Th} determined in part 'i'. (2 marks)
- iii. Determine the value of R_L to transfer the maximum power from the source to R_L . (2 marks)
- iv. Calculate the maximum power transferred in the circuit. (2 marks)

b. Consider the circuit shown in Figure Q1-(b).

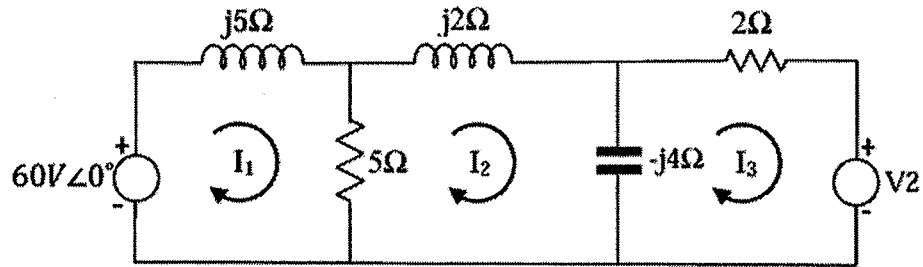


Figure Q1-(b)

- i. Apply mesh analysis to the circuit and obtain the matrix equation. (4 Marks)
- ii. Using the above matrix equation, determine the value of V_2 such that $I_3 = 0$. (6 Marks)

Question 02

Consider the circuit given in Figure Q2. The switch S_1 is closed at $t = 0$ s.

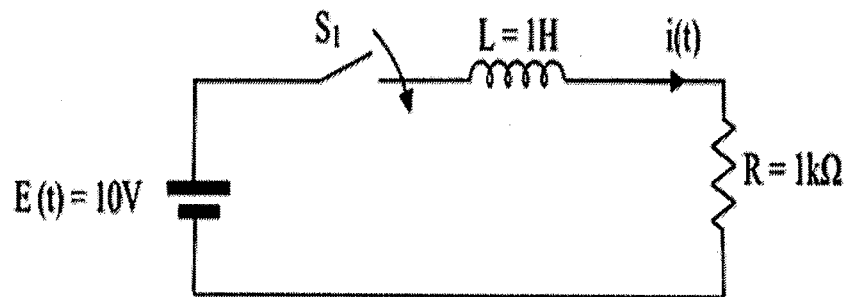
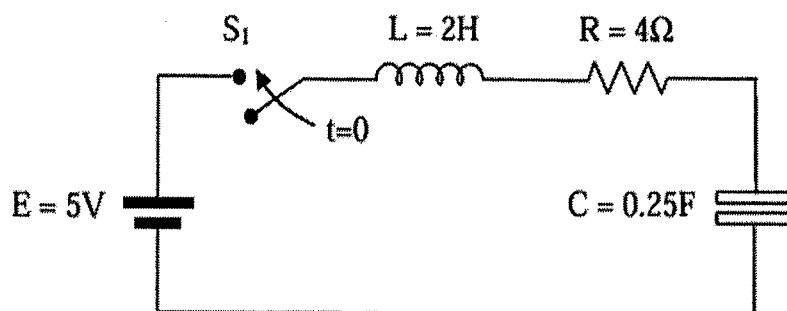


Figure Q2

- i. Apply Kirchoff's voltage law to the circuit after closing the switch and derive a differential equation to determine the current through the circuit. (5 Marks)
- ii. Convert the differential equation into s-domain using Laplace Transform and obtain an expression to the impedance function $Z(s)$ which is also in s-domain. (5 Marks)
- iii. Derive the solution to the current through the circuit in s - domain $I(s)$. (5 Marks)
- iv. Using inverse Laplace transform, derive the solution to the current through the circuit in time domain $i(t)$. (5 Marks)

Question 03

Consider the RLC circuit shown in Figure Q3. At $t = 0$ the switch S_1 is closed.

**Figure Q3**

- i. Write a differential equation relating voltages across each element using Kirchhoff's voltage law. Assume that the capacitor is initially fully discharged and no energy is stored in the inductor L . (2 marks)
- ii. Solving the differential equation, you have written in 'i', obtain an expression for the current through the circuit $i(t)$ for $t > 0$. (12 marks)
- iii. Sketch the variation of current of the circuit against the time (start from $t = 0$). (4 marks)
- iv. State the type of response of this circuit. (2 marks)

Question 04

- i. Realize the following LC impedance function using Foster 1st and 2nd forms. (14 marks)

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

- ii. Realize the following LC impedance function using Cauer 1st form. (6 marks)

$$Z(s) = \frac{2s^5 + 12s^3 + 16s}{s^4 + 4s^2 + 3}$$

Question 05

- i. Write the terminal characteristic equations of a general two port network in matrix form using, (2 marks)
 - a. Open circuit impedance (Z) parameters.
 - b. Transmission (ABCD) parameters.

ii. Consider the two-port network in Figure Q5.

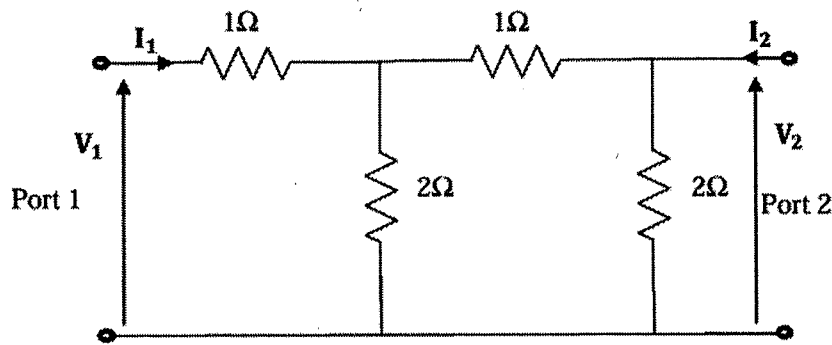


Figure Q5

- Determine the ABCD parameters of the above network. (8 marks)
- Is the network reciprocal? Justify your answer. (2 marks)
- Calculate the image impedances at port 1 and port 2 (6 marks)
- Hence, find the image transfer constant of the network. (2 marks)

Question 06

Part A

- Derive the expressions for the open-circuit impedance (Z_{oc}) and short-circuit impedance (Z_{sc}) of a symmetrical T-network in terms of Z_1 and Z_2 . (3 marks)
- Derive the expressions for the open-circuit impedance (Z_{oc}) and short-circuit impedance (Z_{sc}) of a symmetrical π -network in terms of Z_1 and Z_2 . (3 marks)
- Briefly describe the "Propagation Constant" in filters? (2 marks)
- How is the propagation constant mathematically represented? Write the equation and define its components. (2 marks)

Part B

- State one key advantage in Butterworth filter. (2 marks)
- The magnitude function of a certain filter needs to be determined using Butterworth approximation. Specifications of the filter are as follows,
 - Pass Band = 0 to 5 MHz
 - Pass Band tolerance = 0.25 dB
 - High frequency attenuation(minimum) 20 dB at 7.5 MHz
 - Attenuation, $A_{db} = 10\log_{10}(1+\epsilon^2 X^{2n})$
 - $K_0 = 1$
 - $\epsilon^2 = 0.0593$

Find the magnitude function of the above filter. (8 marks)