

Enrollment No./Seat No.:

# GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering - SEMESTER - III EXAMINATION - WINTER 2025

Subject Code: BE03009031

Date: 19-12-2025

Subject Name: Electrical Circuit Analysis

Time: 10:30 AM TO 01:00 PM

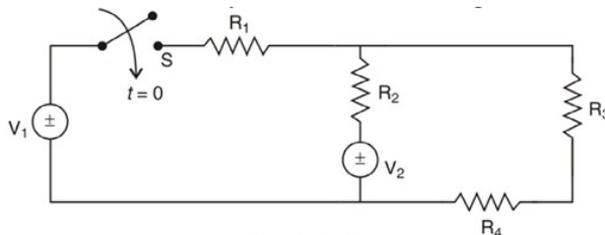
Total Marks: 70

## Instructions

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

**Q.1 (a)** Explain the Maximum Power Transfer Theorem with the help of a suitable example. **Marks 03**

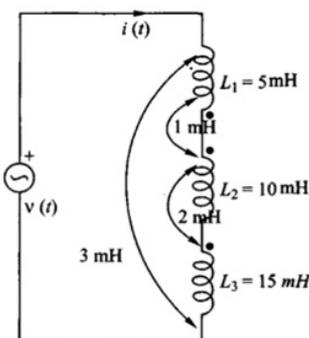
**(b)** Draw the dual network of the network shown in the figure. **Marks 04**



**(c)** State and explain the classification of dependent sources with neat diagrams. **Marks 07**

**Q.2 (a)** Explain the concept of transient and steady-state response in an RL circuit with the help of a neat sketch. **Marks 03**

**(b)** Obtain the effective inductance of the network shown in figure. **Marks 04**



**(c)** Explain the step response of a series RL circuit by solving the differential equation. Also, discuss its key features with the help of a sketch. **Marks 07**

OR

**(c)** Explain the zero-input and zero-state responses of a series RC circuit for a step input. Include the governing equations and a neat sketch for each response. **Marks 07**

**Q.3 (a)** Analyse how the Laplace Transform simplifies the process of solving differential equations in electrical circuits. Explain how this approach helps in determining the total response of the system. **Marks 03**

- (b) Explain the concept of poles and zeros of a transfer function. How do their locations in the s-plane influence the stability and transient response of an electrical circuit? Illustrate your answer with a suitable example. **04**
- (c) A series RLC circuit has  $R=10\ \Omega$ ,  $L=0.1\ \text{H}$ , and  $C=100\ \mu\text{F}$ . It is excited by a DC step voltage of  $50\ \text{V}$  applied at  $t=0$ . Derive the differential equation governing the current  $i(t)$ . Find the damping factor ( $\alpha$ ) and undamped natural frequency ( $\omega_0$ ). Determine the nature of the transient response (overdamped, underdamped, or critically damped). Sketch and analyse the expected shape of the current response  $i(t)$  over time, commenting on transient and steady-state behavior. **07**

**OR**

- (a) A system is represented by the transfer function **03**
- $$H(s) = \frac{10(s + 2)}{s^2 + 3s + 2}$$
- Analyse the location of poles and zeros, and explain how they affect the stability and transient behavior of the system.
- (b) Explain the Initial Value Theorem (IVT) and Final Value Theorem (FVT) of the Laplace Transform. Derive the expressions for both and discuss their significance in analysing circuit responses. Provide one example for illustration. **04**
- (c) A series RL circuit has  $R=20\ \Omega$  and  $L=0.5\ \text{H}$ . A DC step voltage of  $10\ \text{V}$  is applied at  $t=0$ . Derive the differential equation for the current  $i(t)$ . Solve the equation to find the time-domain response  $i(t)$ . Analyse the transient and steady-state behaviour of the circuit. Determine the time constant of the circuit. **07**

- Q.4** (a) What is the significance of the s-domain equivalent of circuit elements? Explain how representing resistors, inductors, and capacitors in the s-domain helps in solving circuit differential equations. Give one simple example. **03**
- (b) Explain the significance of the transmission (ABCD) parameters of a two-port network. How can these parameters be used to analyse the cascade connection of two two-port networks? Provide a simple illustrative example. **04**
- (c) Given the series RL circuit with  $R=2\ \Omega$  and  $L=1\ \text{H}$ , and a step input  $V(t)=10u(t)\ \text{V}$ , use Laplace transform to determine: 1. The s-domain equivalent circuit. 2. The Laplace transform of the current  $I(s)$ . 3. The time-domain response  $i(t)$ . Also, analyse the transient and steady-state behavior from the obtained response. **07**

**OR**

- (a) Explain the concept of a transfer function. How can it be used to determine the output of a circuit for any given input? Illustrate your explanation with a simple example. **03**
- (b) Explain the concept of a two-port network and its practical significance. Choose any one type of two-port parameter (e.g., Z-parameter or Y-parameter) and describe how it relates the input and output voltages and currents of the network. Give a simple example. **04**
- (c) A series RLC circuit has  $R=4\ \Omega$ ,  $L=1\ \text{H}$ , and  $C=0.25\ \text{F}$ . A step voltage  $V(t)=12u(t)\ \text{V}$  is applied. Using Laplace transform: 1. Determine the s-domain equivalent circuit. 2. Find the Laplace transform of the capacitor voltage  $V_C(s)$ . 3. Obtain the time-domain response  $v_C(t)$ . 4. Analyse whether the circuit is overdamped, underdamped, or critically damped, and explain the transient behaviour. **07**

- Q.5 (a)** Compare Z-parameters and Y-parameters of a two-port network. Which type of parameter is more suitable for networks connected in series and which for networks connected in parallel? Justify your answer. **03**
- (b)** A two-port network can be represented by Z-parameters, Y-parameters, or ABCD parameters. Evaluate the advantages and disadvantages of using each type of parameter in practical circuit analysis. **04**
- (c)** A series R–L circuit has  $R=20\ \Omega$  and  $L=0.2\ \text{H}$  connected to a sinusoidal voltage source  $v(t)=50\sin(200t)\ \text{V}$ . 1. Explain how the circuit can be represented in the phasor domain. 2. Determine the phasor current in the circuit. 3. Explain how the sinusoidal steady-state voltage across the inductor can be obtained from the phasor current. **07**

**OR**

- (a)** Evaluate the advantages and limitations of using transmission (ABCD) parameters for representing long-distance communication or power transmission networks. Justify your evaluation. **03**
- (b)** Evaluate the advantages of using two-port network parameters for analyzing complex electrical circuits instead of directly applying Kirchhoff's laws. Justify your answer with practical examples. **04**
- (c)** Explain the concept of a phasor and its significance in analysing AC circuits. Transform a simple series R–C circuit ( $R = 10\ \Omega$ ,  $C = 100\ \mu\text{F}$ ) with a sinusoidal voltage source  $v(t)=10\sin(100t)$  into its phasor equivalent. Determine the phasor current and explain how the sinusoidal steady-state response of the circuit can be obtained from it. **07**

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