GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Electrical Engineering
Subject Code: BE03009031
Subject Name: Electrical Circuit Analysis

w. e. f. Academic Year:	2024-25
Semester:	3
Category of the Course:	Professional Core Course

Prerequisite:	Solution of simultaneous linear equations, Solution of linear constant coefficient differential equations, Basics of LaPlace transform
Rationale:	Electrical Circuit Analysis equips students with essential skills to analyze and solve complex electrical circuits and networks. The syllabus encompasses key topics such as network theorems, transient and steady-state responses, sinusoidal analysis, Laplace transforms, and two-port networks. These concepts enable students to understand, model, and optimize circuit performance, fostering problem-solving and analytical abilities. This course lays the groundwork for advanced studies and practical applications in electrical engineering, preparing students for challenges in power systems, electronics, and control systems.

Course Outcomes:

The students will be able to

Sr. No.	CO Statement	Marks % weightage
CO-1	Analyze electrical circuits with independent and dependent sources by nodal analysis and mesh analysis, and network theorems	25
CO-2	Assess the initial and final conditions of circuit elements, and evaluate the transient and steady-state responses of first-order RL, RC, and second-order RLC circuits	25
CO-3	Apply the concept of the complex exponential forcing function to determine the sinusoidal steady-state response of electrical circuits by transforming circuits into their phasor equivalent representations	10
CO-4	Apply Laplace transform methods to solve differential equations and analyze electrical circuits in the s-domain by developing s-domain equivalent circuits	25
CO-5	Analyze the network behavior using two-port parameters and evaluate the interrelationships between these parameters	15

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	15	30	30	120	04	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Content:

Sr. No.	Content	Total Hrs.	% Weightage
1	**Network Theorems and Coupled circuits** Solution of circuits with independent sources using Node and Mesh analysis, Classification of dependent sources, Solution of circuits with dependent sources using Node and Mesh analysis, Concept of Super-node and Super- mesh in circuits with independent and dependent sources, Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem for circuits with independent and dependent sources, Concept of duality and dual networks, Mutually coupled circuits, Dot Convention in coupled circuits.	12	25
2	**Initial and Final Conditions** Initial and final conditions in elements, Concept of steady state and transient state response, The series RL circuit, Step response of RL circuit by solving differential equations, Features of RL circuit step response, Steady state response and forced response, Linearity and superposition in dynamic circuits, RC Circuit equations, Zero-Input response of RC circuit, Zero-State response of RC circuits for various inputs, The series RLC circuit zero-input response, Step response of series RLC circuit, Transient response of RLC circuit with sinusoidal excitation.	09	25
3	**Sinusoidal Steady State Analysis** The complex exponential forcing function, Sinusoidal steady state response using complex exponential ($e^{\pm j\omega}$), Concept of the phasor, Transforming a circuit in to phasor equivalent circuit, Sinusoidal steady state response from phasor equivalent circuit	05	10
4	**Electrical Circuit Analysis Using Laplace Transforms** Introduction to Laplace Transform, Laplace transform of standard input signals, Initial value and final value theorem, Inverse Laplace transform, Solution of differential equations using Laplace transform, s-Domain equivalents of circuit elements, The s-Domain equivalent circuit, Total response of first order and second order circuits using s-Domain equivalent circuit, Introduction of transfer function, Concept of Poles and Zeros, Transfer function representation of electrical circuits.	09	25
5	**Two Port Network and Network Functions** Introduction to Two Port Networks, relationship of two port variables, Short-circuit admittance parameter, Open-circuit impedance parameter, Transmission Parameter, Hybrid Parameter, Relationships between parameters, Parallel connection of two-port networks.	10	15
	TOTAL	**45**	**100**

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**30**	**30**	**15**	**10**	**-**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C:Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

- K.S. Suresh Kumar, "Electric Circuit Analysis", Pearson Publications, 2013.
- M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
- Nimje and D. P. Kothari, "Electrical Circuit Analysis and synthesis", New Age InternationalPublications, 2017
- D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.
- W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
- K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
- K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.

List of Experiments :

This is a suggestive list only:

(1) To verify the Superposition Theorem by comparing analytical and experimental results.
(2) To verify the Thevenin and Norton's theorems by comparing analytical and experimental results.
(3) To verify the maximum power transfer theorem by comparing analytical and experimental results.
(4) To verify the Superposition Theorem by comparing analytical and simulated results with dependent sources.
(5) To verify the Thevenin and Norton's theorems by comparing analytical and simulated results with dependent sources.
(6) To simulate and analyze the steady-state and transient time-response of series R-L circuit.
(7) To simulate and analyze the steady-state and transient time-response of series R-C circuit.
(8) To simulate and analyze the steady-state and transient time-response of series R-L-C circuit.
(9) To verify the analytical steady state solution of AC circuits using phasors with experimental

results

(10) To verify experimental results of open-circuit impedance parameter of a tow-port network with analytical results

(11) To verify experimental results of short-circuit parameter of a tow-port network with analytical results

(12) To verify experimental results of hybrid parameter of a tow-port network with analytical results

(13) To verify experimental results of transmission parameter of a tow-port network with analytical results

Major Equipment:

List of Open Source Software/learning website:

- Bhattacharya, T. K. *Network Analysis* [MOOC]. NPTEL-NOC. https://archive.nptel.ac.in/courses/108/105/108105159/
- De, N. K.,et. Al. . *Basic Electrical Technology* [Handout]. NPTEL Online Course. https://nptel.ac.in/courses/108105053

- **List of suggested activities for Problem Based Learning:**

Sr. No.	Name of the activity	Activity Description and No. of hours	Suggested Evaluation Criteria	Targeted CO
1.	NPTEL Video Lectures	Watch core lecture videos from NPTEL – Network Analysis to build fundamental understanding **(20 hrs.)**	Submit assignment of the modules that student learned	CO1–CO5
2.	DIY (Do It Yourself) Circuit Construction	Construct and test circuits on a breadboard/PCB to verify Superposition, Thevenin, Norton, and Maximum Power Transfer theorems **(At least One Circuit) (6 hrs.)**	Submit the circuit observation sheet; instructor validation or peer review	CO1
3.	MATLAB Programming for Circuit Analysis	Write code for mesh/nodal analysis, Laplace solutions, and response plots **(At least five problems) (20 hrs.)**	Summary report on curated content and learning outcomes.	CO1–CO4
4.	Simulation Practice (LTspice/ngSpice/MATLAB)	Simulate RL, RC, RLC for transient response analysis **(10 hrs.)**	Submit circuit files (screenshots), results (graphs/waveforms), and a comparison table with theoretical values	CO2

5.	DIY (Do It Yourself) Circuit Construction	Construct and test circuits on a breadboard/PCB to analyse the transient response of RL, RC, RLC **(At least One Circuit) (6 hrs.)**	Submit the circuit observation sheet; instructor validation or peer review	CO2
6.	Problem Solving Practice	One Assignment per module should be given with minimum 10 question per module. The difficulty level should be medium to hard. **(20 Hrs.)**	Submit scanned solutions (on LMS) or of written work; assess accuracy, clarity of steps, and coverage of problem types	CO1–CO5
7.	Mini Case Studies (Real-World Applications)	Document at least 2 real-world examples where network theorems are used in systems like power supply, filters, audio electronics **(4hrs.)**	Submit a 2–3-page report with circuit diagram, theorem used, and explanation of functionality.	CO1–CO3
8.	MATLAB Programming for Transfer Function Analysis	Write MATLAB code for transfer function, pole-zero plots, and frequency response **(At least two problems) (8 hrs.)**	Submit .m files with plotted outputs, explain poles/zeros, and relate to system behaviour; evaluated for correctness and insightfulness	CO3–CO4

Note:

1. All the suggested activity should be related to the subject.
2. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.
4. Preferably these activities should be conducted on some LMS and not using pen and paper. The LMS which can be used are as follows (But not limited to): Google Classroom, MS Teams, Moodle etc.
5. The usage of LMS platform shall be done for as many activities as possible. The assessment of these activities shall also be carried out on the some LMS platform.
6. The total work assigned should be of 30 hours to every student.
7. The faculty/teacher/teachers should display the distribution of Self Learning activities at the beginning of the semester.
8. The course file should include the Rubrics of the distribution of marks as per the distribution of activities.
9. All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
10. Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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