GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code: BE03024011
Subject Name: Network Theory

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

Prerequisite:	BE01000051 (Basic Electrical Engineering).
Rationale:	This course introduces network analysis techniques applied to various dc and ac electric circuits. Analyses of electric circuits in steady state and dynamic conditions are discussed. Network analysis is introduced with network parameters and transfer functions. This course will help the students to use principles of circuit and analyze to maintain the electric circuit/network.

Course Outcome:

After Completion of the Course, the student will be able to:

No	Course Outcomes
01	To understand basic concepts of electrical network.
02	Use various network theorems for the analysis of electrical circuits.
03	To obtain the transient and steady-state response of electrical circuits.
04	To analyze electrical circuits using Laplace Transformation.
05	To determine the circuit parameters of two port network and study various passive filters.

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

Course Content:

Unit No.	Content	No. of Hours	% Of Weightage
1.	**NETWORK FUNDAMNETALS AND ANALYSIS** Introduction, Electric charge. Electric work. Potential. Potential difference. Electric current, Power, Energy, Kirchhoff's laws. Analysis with dependent current and voltage sources, Node and Mesh Analysis. Concept of duality and dual networks. Star-delta conversion, source transformation. Concept of analysis v/s synthesis.	5	10

2.	**NETWORK THEOREMS** Introduction, Source transformation, Superposition theorem, , Thevenin theorem, Norton theorem, Maximum power transfer theorem, Millman's Theorem, Reciprocity theorem, Compensation theorem.	5	10
3.	**FIRST AND SECOND ORDER NETWORKS** Introduction, Solution of first and second order differential equations for Series and parallel R-L, R-C, R-L-C circuits, initial and final conditions, forced and free response, time constants, steady and transient response.	9	25
4.	**SINUSOIDAL STEADY STATE ANALYSIS** Sine function as rotating phasor, phasor diagrams, AC circuit analysis, effective or RMS values, average power and complex power, Instantaneous Power in AC circuit and power triangle, Three-phase circuits. Mutual coupled circuits, Dot Convention in coupled circuits.	8	20
5.	**NETWORK ANALYSIS USING LAPLACE TRANSFORMS** Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, inverse Laplace transform and transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots) for series and parallel resonances, tuned circuits.	6	15
6	**TRANSIENT RESPONSE OF PASSIVE CIRCUITS** Initial conditions in elements, Transient response of series & parallel R-L, R-C & RLC circuits having DC excitation and having sinusoidal excitation.	6	10
7	**TWO PORT NETWORK AND PASSIVE FILTERS** **Two Port Networks**: terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks. **Passive Filters**: Concept of the Low-Pass, High-Pass, Band-Pass, Band-Stop, Butterworth and Chebyshev Filters.	6	10
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
40	**20**	**20**	**10**	**10**	**0**

Where: Remember; U:Understanding;A:Application,N:AnalyzeandE:EvaluateC:Create(asperRevisedBloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. "Network Analysis" by M.E. Van Valkenburg-PHI.
2. "Circuit Theory" by A. Chakrabarti - Dhanpat Rai Publishing Co Pvt Ltd.
3. "Electrical Circuits" by James W. Nilsson and Susan A. Riedel-Pearson.
4. "Network Theory: Analysis and Synthesis" by GHOSH, SMARAJIT-PHI.
5. " Electric Circuits and Networks" by K. S. Sureshkumar-Pearson.

(b) Open-source software and website:

1. LTspice https ://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html
2. KiCad : https://kicad.org/
3. Ngspice: http://www.ngspice.org/
4. VLab-IIT :https://www.vlab.co.in/
5. Scilab: https://www.scilab.org/
6. Octave: https://www.gnu.org/software/octave/
7. Fritzing: https://fritzing.org/
8. Matlab
9. NPTEL/SWAYAM/MOOC etc.

Suggested Course Practical List:

Sr. No.	Title
1.	To verify Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL).
2.	To verify Thevenin's theorem for resistive network.
3.	To verify Norton's theorem for resistive network.
4.	To verify Maximum Power Transfer Theorem for resistive network
5.	To verify Superposition theorem for resistive network.
6.	To obtain transient response of a series RL/RC circuit.
7.	To obtain transient response of a series RLC circuit.
8.	To analyze the performance of electrical circuits using Laplace Transform for standard inputs.
9.	To determine Z-parameters of given Two Port Network.
10.	To determine ABCD parameters of the given Two Port Network.
11.	To determine H- Parameters of given Two Port Network.
12.	To determine Y-parameters of given Two Port Network.
13.	To develop RC low pass filter / High-Pass Filter and plot its frequency response.
14.	To analyze performance of Band-Pass/ Band-Stop Filter.
15.	To analyze performance of Butterworth/Chebyshev Filter.

List of Laboratory/Learning Resources Required:

- Experiment Kit, Oscilloscope, Multimeter, AC/DC Sources, AC/DC Meters etc.

Suggested Activities for Students: -Problem solving based on various topics of course content.

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

Sr. No.	Name of the activity	No. of hours	Evaluation Criteria
1	Network Theorems	Verify Network Theorems via circuit simulation.	Based on the understanding of the simulation
2	Write simple MATLAB programs for circuit analysis	Introduction to MATLAB for engineering problem-solving	Based on the understanding of MATLAB
3	Network Theorems	Real-life Applications of Thevenin and Norton Theorems in Power Systems	Based on the type of application and explanation
4	Initial conditions	Modeling Initial Conditions using Simulation Tools	Based on the simulation tool used and explanation
5	Write simple MATLAB programs for circuit analysis using Laplace	Implementation of Laplace Transform in MATLAB for RLC Circuits	Based on the understanding of MATLAB
6	Write simple MATLAB programs for circuit analysis using Inverse Laplace	Implementation of Inverse Laplace in MATLAB for RLC Circuits	Based on the understanding of MATLAB
7	Write simple MATLAB programs for two port networks	Implementation of Two port network parameters in MATLAB for RLC Circuits	Based on the understanding of MATLAB
8	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
9	Technical Video based learning related to the Network	Duration of video = 5h Report preparation = 5h	Report /presentation based on the video

	Analysis	Total = 10h	learning outcomes.
10	Assignment writing. Numericals based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
11.	Online Certification Courses (NPTEL / SWAYAM / Coursera / edX) In ECA	Complete one MOOC (Massive Open Online Course) from NPTEL/SWAYAM relevant to ECA-Electrical Engineering	Certificate + a 1-page summary or review presentation of the course. Certificate of the course
12	Complex problem solving in ECA	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
13	Real world case studies based learning in ECA	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14	Discussion on research paper based on ECA	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
15	Poster/chart/power point preparation on ECA	Duration = 6 h	Based on poster/chart preparation and presentation skills
16	Working/non-working model on technical topics of ECA	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
17	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
18	Group Discussion on emerging/trending technical topics based on ECA	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
19	Involvement in Student Chapter Activities (IEEE/ISTE/IEI)	Organizing student chapter activities/workshops (5h)+ Report /writing articles for the chapter newsletter(5h)	Based on short activity report and reflection
20	Industry Visit and Report Preparation	Attend an industry visit (e.g., to a substation, manufacturing	Based on the report

		unit, renewable energy plant) and prepare a detailed report.	
22	Mini Project or DIY Challenge in ECA	Undertake a small home-based or simulation-based project (10 h)	Based on application of theoretical knowledge in practice.

Note:

- All the suggested activity should be related to the subject.
- 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.
- Rubrics for the evaluation can be prepared by the faculty.
- 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.
- 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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