GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Subject Code: BE03000161

Subject Name: Network Theory

WEF Academic Year :	2024-25
Semester :	3
Category of the Course :	PCC

Prerequisite :	Fundamental knowledge of electric circuit sources and elements, basic mathematics (integration, differentiation, etc.)
Rationale :	Students of EC Engineering need to possess good understanding of concepts and principles of passive circuit analysis and synthesis by applying various circuit laws and theorems. This is one of the foundation courses which is required to understand the concepts of advanced courses and develop skills that are needed in Electronics field.

Course Outcome :

After Completion of the Course, Student will able to :

No	Course Outcomes	RBT Level*
01	Analyze passive circuits using various networks theorems	AN
02	Analyze and evaluate the transfer functions using classical and transform methods	EL and AN
03	Evaluate two port parameters for the given two port network configurations.	EL
04	Comprehend the basics of network topologies, graph theory and network synthesis	UN
05	Synthesis the knowledge of Circuit theory to electrical and electronic circuits	UN and CR

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

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	TW/SL	TH		ESE (E)	PA (M)	PA/ (I)	TW/ SL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

Course Content :

Sr. No.	Course Content	No. of Hours	% of Weightage
1	Circuit Variables and Circuit Elements and Sources: E.M.F, Potential and Potential Difference, Current and Current Density, Ideal and Practical Voltage and Current Sources. Conversion from one source into other. Internal Impedance of voltage and current source relative to load. Two-terminal Capacitance – Two terminal Inductance-Independent and Dependent Electrical Sources –Power and Energy Relations for Two-terminal Elements – Classification of Two-terminal Elements – Multi-terminal Circuit Elements, Dot Convention	2	6
2	Nodal Analysis and Mesh Analysis of resistive Circuits: Nodal Analysis of Circuits Containing Resistors and Independent and Dependent Sources – Source Transformation Theorem for circuits with independent sources – Source Transformation Theorem for circuits with Dependent sources –Nodal Analysis of Circuits Containing Dependent Sources - Mesh Analysis of Circuits with Resistors containing Independent Voltage Sources - Mesh Analysis of Circuits Containing Dependent Sources.	4	10
3	Circuit Theorems and Their Applications in Electric Networks: Linearity of a Circuit and Superposition Theorem-Substitution TheoremCompensation Theorem - Thevenin's Theorem and Norton's Theorem - Determination of Equivalents for Circuits with Dependent Sources -Reciprocity Theorem - Maximum Power Transfer Theorem - Millman's Theorem-Duality Theorem- Duality between Electricity and Magnetism.	5	12
4	Time domain response of First order RL and RC circuits: Mathematical preliminaries – Source free response –DC response of first order circuits – Superposition and linearity – Response Classifications – First order RC Circuits.	3	8
5	Time domain response of Second order linear circuits: Discharging of a Capacitor through an inductor – Source free second order linear networks – second order linear networks with constant inputs.	3	8
6	Initial conditions: Initial conditions in elements, procedure for evaluating initial conditions, Solution of circuit equations by using Initial Conditions.	3	8

7	Laplace Transform Analysis and Circuit Applications: Notions of Impedance and Admittance – Manipulation of Impedance and Admittance- Notions of Transfer Function- Equivalent circuits for inductors and capacitors – Nodal and Loop analysis in the s-domain – Switching in RLC circuits- Switched capacitor circuits and conservation of charge.	**5**	**10**
8	Laplace Transform Analysis and Transfer Function Applications: Poles, Zeros and the s-plane- Classification of Responses – Computation of sinusoidal steady state response for stable networks and systems.	**4**	**8**
9	Two –Port Networks : One port networks – Two port admittance Parameters (y parameters)– Admittance parameters analysis of terminated two- Port networks - Two port impedance parameters (z-parameters) –Impedance and Gain calculations of terminated twoPort networks modeled by z-parameters – Hybrid parameters (h para)– Inverse Hybrid Parameters (g-para)- Transmission parameters (ABCD parameters)- Scattering parameters(S parameters)-Scattering Transfer parameters(T parameters) –reciprocity- Various Combinations of Two-Port network.	**7**	**12**
10	Introduction to Network Topology: Linear Oriented Graphs (Connected Graph, Subgraphs and Some Special Subgraphs) - The Incidence Matrix of a Linear Oriented Graph -Kirchhoff's Laws in Incidence Matrix Formulation - Nodal Analysis of Networks – The Circuit Matrix of a Linear Oriented Graph- Kirchhoff's Laws in Fundamental Circuit Matrix Formulation - Loop Analysis of Electrical Networks – (Loop Analysis of Networks Containing Ideal Dependent Sources- Planar Graphs and Mesh Analysis –Duality)- The Cut-set Matrix of a Linear Oriented Graph (Cut-sets - The All cutset matrix - Orthogonality relation between Cut-set matrix and Circuit matrix - The Fundamental Cut-set Matrix of - Relation between of , A and Bf) - Kirchhoff's Laws in Fundamental Cut-set formulation - Tie set -Tie set Matrix (F-loop matrix)- Tie set schedule	**6**	**12**
11	Introduction to Passive Network Synthesis: Introduction of Hurwitz Polynomial, Positive Real Function (PRF), Elementary Synthesis Procedure.	**3**	**6**
	Total	**45**	**100**

Reference Book :

1. Network Analysis & Synthesis By Franklin S. KUO, Wiley Publication
2. Network Analysis :- By M.E Van Valkenburg PHI Publication
3. Electric Circuits and Networks :- By K. S. Suresh Kumar – Pearson Education
4. Linear Circuits Analysis 2nd edition :-By DeCarlo/ Lin – Oxford University Press(Indian

edition)
5. Engineering Circuit Analysis : - By W H Hayt, J E Kemmerly, S M Durbin 6th Edition TMH Publication
6. Graphs: Theory and Algorithms By K. Thulasiraman, m.n.s Swamy, Wiley Publication.
7. Electric Circuit Analysis By S N Sivanandam, Vikas Publishing House
8. Introductory Circuit Analysis by Robert Boylestad, Pearson

Suggested Course Practical List :

1. To measure and calculate currents and voltages for a given resistive circuit and verify KCL and KVL.
2. To verify superposition theorem experimentally for a given resistive circuit consisting two independent sources.
3. To verify Thevenin's theorem experimentally for a given circuit.
4. To verify maximum power transfer theorem experimentally for a given circuit.
5. To verify reciprocity theorem experimentally for a given circuit.
6. To measure and calculate RC time constant for a given RC circuit.
7. To measure and calculate RL time constant for a given RL circuit.
8. To measure and analyze (settling time, overshoot, undershoot, etc.) step response of for a given series RLC circuit for following cases: (1) $\zeta = 1$ (critically damped system), (2) $\zeta > 1$(over damped system), (3) $\zeta < 1$ (under damped system). Choose appropriate values of R, L, and C to obtain each of above cases one at a time.
9. To measure and calculate Z-parameters for a given two-port system.
10. To measure and calculate Y-parameters for a given two-port system.
11. To measure and calculate h-parameters for a given two-port system.
12. To measure and calculate ABCD-parameters for a given two-port system

List of Laboratory/Learning Resources Required:

i. Function Generator
ii. Oscilloscope
iii. Digital Multi-meter
iv. DC Power Supply (0-30 V)
v. Multisim, SCILAB, PSpice, NGspice (Open-Source Software)

- **Activities suggested under Self-learning/Team Work:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	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.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing.	5 assignments of 2h each.	Based on the assignment submitted.

	Numericals based assignment is preferable.	Total = 10h	
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	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
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.

14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software

Note:

- All the suggested activity should be related to the subject.
- The number of hours are 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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