GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRICAL (09) / ELECTRONICS (10) / ELECTRONICS & COMMUNICATION (11) / INSTRUMENTATION & CONTROL (17)/ POWER ELECTRONICS

CIRCUITS AND NETWORKS

SUBJECT CODE: 2130901

B.E. 3RD SEMESTER

Type of course: Passive circuit analysis and synthesis

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 are required to understand the concepts of advanced courses and develop skills that are needed in Electronics field.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% 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.	3	5.72
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 and Independent Voltage Sources- Mesh Analysis of Circuits with Independent Sources - Mesh Analysis of Circuits Containing Dependent Sources.	5	9.62
3	**Circuit Theorems and Their Application in Electric Networks:** Linearity of a Circuit and Superposition Theorem-Substitution Theorem-Compensation Theorem - Thevenin's Theorem and Norton's Theorem - Determination of Equivalents for Circuits with Dependent Sources - Reciprocity Theorem - Maximum Power Transfer Theorem - Millman's	6	11.54

	Theorem-Duality Theorem-Duality between Electricity and Magnetism		
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 Op Amp Circuits.	4	7.7
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.	4	7.7
6	**Initial Conditions:** Initial conditions in elements, procedure for evaluating initial conditions, Solution of circuit equations by using Initial Conditions.	4	7.7
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	9.6
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	7.7
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 two- Port 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-Various Combinations of Two port n/w.	7	13.5
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 cut-set matrix Qa- Orthogonality relation between Cut-set matrix and Circuit matrix - The Fundamental Cut-set Matrix Qf - Relation between Qf , A and Bf) - Kirchhoff's Laws in Fundamental Cut-set formulation - Tie set -Tie set Matrix (F-loop matrix)- Tie set schedule.	7	13.5
11	**Introduction to Passive Network Synthesis:** Introduction of Hurwitz Polynomial, Positive Real Function (PRF), Elementary Synthesis Procedure.	3	5.72
	Total	52	

Reference Books:

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

Course Outcome:

1. To apply various circuit laws like Ohm's Law, KVL, KCL, etc.
2. To apply dot convention technique for analysis of transformer based circuits.
3. To apply node and mesh circuit analysis techniques..
4. To apply various network theorems such as Superposition, Thevenin, Norton, Reciprocity, Maximum Power Transfer, Millman's Theorem, etc..
5. To analyze behavior of passive circuits such as RC, RL and RLC.
6. To apply Laplace Transform for circuit analysis.
7. To obtain transfer function of a network.
8. To analyze circuit taking into account initial conditions.
9. To calculate two port parameters such as y, z, h, ABCD, etc. for the given two port network.
10. To understand basics of network topologies and the tieset and cutset schedules.
11. To understand basics of network synthesis from the transfer function.

List of Experiments:

EXP. NO.	NAME OF THE EXPERIMENT
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 RC 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.

Design based Problems (DP)/Open Ended Problem (to be modified):

1. Write a 'c' program to obtain RC time constant from a given step response of RC circuit.
2. Write a 'c' program to plot frequency response of RC circuit for different values of R and C.
3. Write a 'c' program to obtain 3-dB bandwidth and RC time constant from a given frequency response of RC circuit.
4. Write a 'c' program to plot impedance of a given series RLC circuit as a function of frequency. Also obtain minimum value of impedance and series resonance frequency using 'c' program.

5. Write a ‘c’ program to obtain following parameters from step response of series RLC circuit for different values of R, L and C.
    a. Propagation delay
    b. Overshoot
    c. Undershoot
    d. Damping factor
    e. Natural frequency
    f. Settling time

Major Equipments:

i. Function Generator
ii. Oscilloscope
iii. Digital Multi-meter
iv. DC Power Supply (0-30 V)

C. List of Software:

Multisim, PSPice, NGspice (**Open Source Software)**

Learning website:

www.nptel.ac.in, www.allaboutcircuits.com

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.