EC031303 Network Theory L-T-P: 3-1-0; Cr: 04

***Prerequisite*:** Engineering Mathematics, Elements of Electrical Engineering

Course Objective- To develop a thorough understanding of electrical network fundamentals, analysis techniques, and the behavior of linear circuits under different conditions. The course aims to equip students with analytical skills for modeling, analyzing, and designing complex electrical networks and systems.

COURSE CONTENT:

Unit I: Network Topology- Concept of network graphs, Tree, Link, and Cut set. Network Matrices: Node Incidence matrix, Loop Incidence matrix, Cut-Set incidence matrix. Network analysis using network incidence matrices. **(4 L)**

Unit II: Fundamentals of Network Systems- Source transformation and Source shifting, Concept of Super-Mesh and Super node analysis. Analysis of networks by (i) Network reduction method including star delta transformation, (ii) Mesh and Node voltage methods for AC and DC circuits with independent and dependent sources. Duality, **AC Resonance-** Analysis of simple series RLC and parallel RLC circuits under resonances. Problems on Resonant frequency, Bandwidth and Quality factors at resonance. **(10L)**

Unit III: Transient Network Analysis- Transient analysis of RL and RC circuits under DC excitations: Behaviour of circuit elements under switching action, procedure for evaluating initial conditions and final conditions. Response of RL, RC and RLC networks using Laplace Transforms for unit step, impulse, ramp inputs and AC signals. **(6L)**

Unit IV: Single and Two-Port Networks and their Characterization- Driving point impedances, Open-circuit (Z), Short-circuit (Y), Hybrid (h) and Transmission (t) parameters. Series, Parallel, Series-Parallel and Tandem connections of two-port networks. Terminated two-port networks. **(8L)**

Unit V: Network Functions; Poles and Zeros- Network functions for the one port and two port, Calculation of network functions (i) General networks and (ii) Ladder networks, poles and zeros of network functions, Restrictions on pole and zero locations of Driving point functions, Restrictions on pole and zero locations of Transfer functions. **(8L)**

Unit VI: Network /System Realization- System realization through block-diagram representation and system interconnection. TF reduction through Signal flow graph. Network realizability, condition for driving point impedance. **(6L)**

Course Outcomes: After successful completion of the course, students would be able to-

CO1: Explain and apply network topology concepts and matrices for systematic circuit analysis.

CO2: Analyze DC and AC circuits using mesh, nodal, and reduction methods including resonance.

CO3: Apply network theorems to simplify and solve complex electrical networks.

CO4: Evaluate transient and steady-state responses of RL, RC, and RLC circuits using Laplace transforms.

CO5: Determine and interpret two-port network parameters and realize system representations.

Textbooks:

1. Network Analysis, M. E. Van Valkenburg, Pearson 3rd Edition, 2014
2. Fundamentals of Electric Circuits, Charles K Alexander, Matthew N. O. Sadiku, McGraw Hill 5th Edition, 2013
3. Network Analysis and Synthesis, F. Kuo, Wiley, 2nd Edition, 1999

Reference Books:

1. Networks, Lines and Fields, John D Ryder, Pearson, 2nd Edition, 2015
2. William H. Hayt, Jack Kemmerly, Steven M. Durbin, "Engineering Circuit Analysis, 8th Edition", Mc Graw Hill.
3. Engineering Circuit Analysis, J David Irwin et al., Wiley India, 10th Edition, 2014
4. Basic Electrical Engineering, V K Mehta, and Rohit Mehta, S Chand, 6th Edition, 2015