204183 Network Theory

Teaching Scheme:

Lectures: 3 Hrs/ Week

Tutorial : 1 Hr/Week

Examination Scheme:

Theory Online : 50 Marks

Theory Paper : 50

Term work: 25

Course Objectives and Outcomes:

The objective of the course is to introduce the student to fundamentals of Network theory including its concepts, initial and final conditions of components, transient ant steady state response, network theorems, two-port network, network parameters, resonance and LC filters. With this the students will have the knowledge of how to evaluate and analyze any complex network.

Having successfully completed this course, the student will be able to:

1. Understand, Analyze the basic AC and DC circuits using KCL,KVL and network Theorems
2. Determine the voltages, currents, power and impedances at various nodes and loops using all the simplification techniques.
3. Understand and apply graph theory to solve network equations
4. Understand, and calculate the initial conditions of RL, RC circuits
5. Formulate, solve the differential equations for RL, RC, and RLC circuits and carry out the transient analysis.
6. Understand, identify and analyze the series, parallel resonance circuits, calculate the bandwidth, selectivity, Q-factor also.
7. Understand, analyze and design prototype LC filters and Resistive attenuators.
8. Characterize; model the network in terms of all network parameters and analyze.
8. Understand and formulate the network transfer function in s-domain and pole, zero concept.

Unit I : Basic Circuit Analysis and Simplification Techniques 8L

Kirchoff's Current and Voltage Laws, Independent and dependent sources and their interconnection, and power calculations.

Network Analysis: Mesh, Super mesh, Node and Super Node analysis. Source transformation and source shifting.

Network Theorems: Superposition, Thevenin's, Norton's and Maximum Power Transfer Theorems,

Millers Theorem and its dual.(AC circuit analysis for all the topics of this unit)

Unit II : Graph Theory and Network Equations **5L**

Network graph, tree, co-tree, and loops. Incidence matrix, tie-set, cut-set matrix. Formulation of equilibrium equations in matrix form, solution of resistive networks and principle of duality

Unit III : Transient Analysis of Basic RC, RL and RLC Circuits **6L**

Initial conditions, source free RL and RC circuits, properties of exponential response, Driven RL and RC circuits, Natural and Forced response of RL and RC circuits. Introduction to Source free and driven series RLC circuit. Over damped and Under damped series RLC circuit.

Unit IV : Frequency Selective Networks **6L**

Significance of Quality factor.

Series Resonance: Impedance, Phase angle variations with frequency, Voltage and current variation with frequency, Bandwidth, Selectivity. Effect of R_g on BW & Selectivity. Magnification factor.

Parallel resonance: Resonant frequency and admittance variation with frequency, Bandwidth and selectivity. General case: Resistance present in both branches.

Comparison and applications of series and parallel resonant circuits.

Unit V : Filters and Attenuators **6L**

Classifications: Symmetrical and Asymmetrical networks.

Properties of two port Network: Symmetrical Networks (T and π only). Z_0 and γ in terms of circuit components.

Asymmetrical Networks: Image Impedance and Iterative Impedance (L-Section only).

Filters: Filter fundamentals, Constant K-LPF, HPF, BPF and BSF, introduction to concept of m-derived LPF and HPF, Terminating half sections, and composite filters. (Derivation and design of m-derived filters is not expected).

Attenuators: Introduction to Neper and Decibel. Symmetrical T and π type attenuators.

Unit VI : Two Port Network Parameters and Functions 6L

Terminal characteristics of network: Z, Y, h, ABCD Parameters; Reciprocity and Symmetry conditions, Applications of the parameters. Application of Laplace Transforms to circuit analysis. Network functions for one port and two port networks, Pole-zeros of network functions and network stability.

Text Books :

1. William H Hayt, Jack E Kimmerly and Steven M.Durbin, Engineering Circuit Analysis, Tata McGraw Hill
2. D Roy Choudhury, Networks and Systems, New Age International Publishers

Reference Books :

1. John D. Ryder, Network Lines and Fields by, PHI
2. M. E. Van Valkenburg, Network Analysis, PHI / Pearson Education, 3rd Edition. Reprint 2002
3. Franklin F. Kuo, Network analysis and Synthesis, , Wiley International Edition
4. B.Somanahan Nair and S.R.Deepa, " Network analysis and Synthesis " Elsevier ,2012

Network Theory

(Tutorial Assignments)

Tutorials must be conducted batch wise. Batch size should not be more than 20 students.

The main objective of this tutorial is to focus on the outcomes defined in the theory syllabus by solving the following assignment based on paper work.

1 Determine the following using KCL,KVL, node, loop analysis and circuit simplification techniques

1. Currents through various given branches
2. Voltages across the given branches
3. Power absorbed or delivered by a given component

(Various network involving resistors, inductors, capacitors, dependent and independent current and voltages sources may be given and students are expected to analyze the network and determine the above. Analysis of AC, and DC both is expected)

2 Determine the following using Network Theorems. One problem statement on each theorem.

1. Currents through various given branches
2. Voltages across the given branches
3. Power absorbed or delivered by a given component

(Various network involving resistors, inductors, capacitors, dependent and independent current and voltages sources may be given and students are expected to analyze the network and determine the above. Analysis of AC, and DC both is expected)

3 Carry out the following analysis of a given network.

1. Draw relevant network graph, tree, co-tree, and loops.
2. Formulate incidence matrix, tie-set, cut-set matrix whichever is applicable.
3. Formulate equilibrium equations in matrix form, and solve.
4. Find the duality.

(One problem on each technique is expected)

4	1.	Formulate differential equation for RL and RC circuits and solve for current and voltages by determining initial conditions for driven and source free conditions.
	2.	Carry out the transient analysis and determine the voltage, current expressions for a given network involving RL, RC, RLC (One problem statement on each combination, source free and driven RL, RC, series RLC network)
5	A.	Analyze the series and parallel resonant circuits and derive the equations of Q-factor, resonance frequency, bandwidth, impedance, and selectivity.
	B.	Determine Q-factor, resonance frequency, bandwidth, impedance, and selectivity for a given problem. (One problem on series and parallel resonant circuit each)
6	A.	Analyze the LC low pass, high pass, band pass and band stop by deriving cut off frequency, impedance, and draw the frequency response in terms of impedance curves.
	B.	Design prototype constant K – Low, High, Band pass, band stop filters for given specification. (One problem on each type of filter)
7		Formulate the z, y, h, ABCD parameters and find the conditions for Reciprocity and Symmetry conditions.
8		Determine the z, y, h, ABCD parameters for a given network
9		Analyze the given network using Laplace Transform and find the network transfer function