

TOPOLOGY AND CIRCUITS

Lumped circuits. Electric quantities and reference directions. Theory of graphs associated to two-terminal, n-terminal elements and circuits. Reduced incidence matrix and Kirchhoff's laws. Tellegen's theorem. Concept of tree, independent loops.

CONSTITUTIVE RELATIONS AND TABLEAU

Classification of elements and circuits by models. Tableau analysis for resistive, linear and time-invariant circuits. Superposition theorem.

TWO-TERMINAL ELEMENTS AND TRANSFORMS

Implicit and explicit representations of two-terminal resistors, power analysis. Real voltage and current sources. Sinusoids and phasors. Linear combination of phasors, first derivative and integral. Laplace transform overview. Capacitors and inductors: constitutive equations in time and transforms. Concept of impedance and admittance, polar and Cartesian representations. Resistive-capacitive, resistive-inductive and resonant two-terminal elements. Series and parallel connections of two-terminal elements, voltage and current dividers. Thevenin and Norton theorems. Millman theorems. Sinusoidal steady-state and Laplace analysis of a linear time-invariant circuit. Power and energy. Power classification of elements. Instantaneous power in AC steady state. Power factor and RMS values. Complex, real, reactive and apparent power, power triangle. Complex power balance and Boucherot theorem. Rephasing capacitor of an inductive load.

LINEAR TWO-PORTS

Implicit and explicit representations of two-ports. Properties of reciprocity and symmetry. Wye-delta (Tee-Pi) and delta-wye (Pi-Tee) conversions. Ideal and real controlled sources. Ideal transformer, linear ideal operational amplifier, mutual inductances. Interconnected two-ports. Connections of operational amplifiers. Miller theorems.

GENERAL CIRCUIT ANALYSIS

Modified Node analysis. Mesh analysis.

THREE-PHASE CIRCUITS

Balanced three-phase voltage sources in wye and delta connections. Phase and line voltages (abc and acb), common point O. Three-phase wires and line currents. Balanced and unbalanced three-phase loads in wye and delta connections. Three-phase power systems having a neutral wire. Complex, real and reactive power in a balanced and unbalanced three-phase power systems. Rephasing capacitor of a three-phase inductive load.

FIRST-ORDER TRANSIENT ANALYSIS

Transient analysis of first-order RC and RL circuits, with application of Thevenin and Norton theorems. Homogeneous equations, particular and general solutions. Superposition principle of particular solutions. List of fundamental particular solutions. Ideal switch and continuity property of a state variable. Analysis of a resonant series circuit of II order. Linear circuit stability. Parallel and series connection of capacitors and inductors. Substitution theorem and output variables. Solution with the Laplace transform.

NETWORK FUNCTIONS AND RESONANT CIRCUITS

Definition and analytic expression of network functions. Decomposition of network function in first and second order factors. Zeros, poles and circuit stability. Network function examined in $s=j\omega$ and relation with phasors. Notes on polar or Nyquist plot. Logarithmic units, decibel (dB), attenuation and Bode diagrams. Series real resonant circuits: resonant frequency, selectivity, network function, amplitude and phase plot, polar plot.