**ELECTRIC CIRCUITS AND MACHINES**

**Year: I Part : II**

**Course Objectives:**

To continue work in Basic Electrical Engineering including transient analysis and electric machines.

1. Network Analysis of AC circuit & dependent sources (6 hours)
   1. Mesh Analysis
   2. Nodal Analysis
   3. Series & parallel resonance in RLC circuits
      1. Impedance and phase angle of series Resonant Circuit
      2. Voltage and current in series resonant circuit
      3. Band width of the RLC circuit.
      4. High-Q and Low-Q circuits
2. Initial Conditions (2 hours)
   1. Characteristics of various network elements
   2. Initial value of derivatives
   3. Procedure for evaluating initial conditions
   4. Initial condition in the case of R-L-C network
3. Transient analysis in RLC circuit by direct solution (10hours)
   1. Introduction
   2. First order differential equation
   3. Higher order homogeneous and non-homogeneous differential equations
   4. Particular integral by method of undetermined coefficients
   5. Response of R-L circuit with DC, Sinusoidal and Exponential excitations
   6. Response of R-C circuit with DC, Sinusoidal and Exponential excitations
   7. Response of series R-L-C circuit with DC, Sinusoidal and Exponential excitations
4. Transient analysis in RLC circuit by Laplace Transform (8 hours)
   1. Introduction
   2. The Laplace Transformation
   3. Important properties of Laplace transformation
   4. Use of Partial Fraction expansion in analysis using Laplace Transformations
   5. Heaviside's partial fraction expansion theorem
   6. Response of R-L circuit with DC. Sinusoidal and Exponential excitations
   7. Response of R-C circuit with DC, Sinusoidal and Exponential excitations
   8. Response of series R-L-C circuit with DC, Sinusoidal and Exponential excitations
   9. Transfer functions Poles and Zeros of Networks
5. Two-port Parameter of Networks  (6 Hours)
   1. Definition of two-port networks
   2. Short circuit admittance parameters
   3. Open circuits impedance parameters
   4. Transmission Short circuit admittance parameters
   5. Hybrid parameters
   6. Relationship and transformations between sets of parameters
   7. Application to filters
   8. Applications to transmission lines
   9. Interconnection of two-port network (Cascade, series, parallel)
6. Magnetic Circuits and Induction  (4hours)
   1. Magnetic Circuits
   2. Ohm’s Law for Magnetic Circuits
   3. Series and Parallel magnetic circuits
   4. Core with air gap
   5. B-H relationship (Magnetization Characteristics)
   6. Hysteresis with DC and AC excitation
   7. Hysteresis Loss and Eddy Current Loss
   8. Faraday’s Law' of Electromagnetic Induction, Statically and Dynamically Induced EMF
   9. Force on Current Carrying Conductor
7. Transformer (8 hours)
   1. Constructional Details, recent trends
   2. Working principle and EMF equation
   3. Ideal Transformer
   4. 4No load and load Operation
   5. Operation of Transformer with load
   6. Equivalent Circuits and Phasor Diagram
   7. Tests: Polarity Test, Open Circuit test, Short Circuit test and Equivalent Circuit Parameters
   8. Voltage Regulation
   9. Losses in a transformer
   10. Auto transformer: construction, working principle and Cu saving
8. DC Machines  (8 hours)
   1. Constructional Details and Armature Winding
   2. Working principle of DC generator and EMF equation
   3. Working principle of DC motor and Torque equation
   4. Back EMF
   5. Method of excitation, Types of DC motor
   6. Performance Characteristics of D.C. motors
   7. Starting of D.C. Motors: 3 point and 4 point starters
   8. Speed control of D.C. motors: Field Control, Armature Control
   9. Losses and Efficiency
9. AC Motors  (8 hours)
   1. Three phase induction motor- construction, operating principle and torque  speed characteristics
   2. Single phase Induction Motors: Construction and Characteristics
   3. Double Field Revolving Theory
   4. Split phase Induction Motor
      1. Capacitors start and run motor
      2. Reluctance start motor
   5. Alternating Current Series motor and Universal motor
   6. Special Purpose Machines: Stepped motor, Schrage motor and Servo motor

**Practical:**

1. Resonance in RLC series circuit
   * measurement of resonant frequency
2. Transient Response in first order system passive circuits
   * measure step and impulse response of RL and RC circuit using oscilloscope
   * relate time response to analytical transfer functions calculations
3. Transient Response in second order system passive circuits
   * measure step and impulse response of RLC series and parallel circuits using oscilloscope
   * relate time response to transfer functions and pole-zero configuration
4. Two Winding Transformers
   * To perform turn ratio test
   * To perform open circuit (OC) and short circuit (SC) test to determine equivalent circuit parameter of a transformer and hence to determine the regulation and efficiency at full load
5. DC Motor
   * speed control of DC Shunt motor by (a) armature control method (b) field contol method
   * To observe the effect of increasing load on DC shunt motor's speed, armature current and field curent.
6. Single Phase AC Motors
   * To study the effect of a capacitor on the starting and running of a single-phase induction motor
   * Reversing the direction of rotation of a single phase capacitor induct

**References:**

1. M. E. Van valkenburg, "Network Analysis", prentice Hall, 2010.
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3. Michel D. Cilletti, "Introduction to Circuit Analysis arid Design", Holt, Hot Rinehart and Winston International Edition, New York, 1988.  
   P.C.Sen. “ Principles of Electric Machines and Power Electronics”, Wiley.
4. I.J. Nagrath & D.P.Kothari,” Electrical Machines”, Tata McGraw Hill  
   S. K. Bhattacharya, “Electrical Machines”, Tata McGraw Hill
5. B. L. Theraja and A. K. Theraja, “Electrical Technology (Vol-11)”, S. Chand
6. Husain Ashaq ,” Electrical Machines”, DhanpatRai& Sons