Chapter 1 : Static Electric Fields 1-1 to 1-38

Syllabus : Charge, Coulomb's law, Charge configurations, Electric field intensity

1.1 Sources and Effects of Electromagnetic Field ...1-1
1.2 Co-ordinate System ...1-1
1.2.1 Cartesian Co-ordinate System ... 1-1
1.2.1(A) Point in Cartesian Plane ... 1-2
1.2.1(B) Unit Vectors in Cartesian System ... 1-2
1.2.1(C) Differential Length, Area and Volume in Cartesian Co-ordinate System ... 1-3
1.2.2 Cylindrical Co-ordinate System ... 1-3
1.2.2(A) Unit Vectors in Cylindrical System ... 1-3
1.2.2(B) Differential Length, Area and Volume in Cylindrical Co-ordinate System ... 1-4
1.2.2(C) How to Convert Cartesian to Cylindrical System and Vice-Versa ? ... 1-4
1.2.3 Spherical Co-ordinate System ... 1-4
1.2.3(A) Unit Vectors in Spherical System ... 1-5
1.2.3(B) Differential Lengths, Area and Volume ... 1-5
1.2.3(C) How to convert Cartesian to Spherical System and Vice-Versa ? ... 1-5
1.3 Vector Fields : Gradient, Divergence and Curl.1-6
1.3.1 Gradient ... 1-7
1.3.2 Divergence ... 1-7
1.3.3 Curl ... 1-8
1.4 Coulomb's Law of Electrostatics ...1-9
1.4.1 Dielectric Constant (K) or Relative Permittivity ($\in_r$) ... 1-10
1.4.2 Coulomb's Law in Vector Form ... 1-10
1.4.3 Solved Examples on Coulomb's Law (Due to two Charges) ... 1-11
1.4.4 Principle of Superposition of Forces ... 1-11
1.4.5 Solved Example on Forces ... 1-12
1.5 Electric Field Intensity ($\bar{E}$) ... 1-14
1.5.1 Electric Field ... 1-14
1.5.2 Definition of Electric Field Intensity ... 1-14
1.5.3 Derivation of Electric Field Intensity ... 1-15
1.5.4 Electric Field Intensity due to Discrete Charges ... 1-15
1.5.5 Solved Examples on Electric Field Intensity ... 1-15
1.6 Electric Field Intensity due to Continuous Charges ...1-19
1.7 Electric Field due to an Infinite Line Charge ..1-20
1.7.1 Solved Examples on Line Charge ... 1-21
1.8 Electric Field Intensity due to Infinite Sheet Charge (Surface Charge) ...1-27
1.8.1 Solved Examples on Sheet Charge ... 1-28
1.9 Electric Field Intensity due to Volume Charge Distribution ...1-34
1.9.1 Solved Examples on Volume Charge Distribution ... 1-35
1.10 Electric Potential due to an Electric Dipole 1-36

Chapter 2 : Gauss's Law and Electric Potential 2-1 to 2-39

Syllabus : Electric flux density, Gauss's law and applications, Current density and Continuity equation Scalar Electric Potential, Potential gradient, Laplace's and Poison's equations

2.1 Introduction ... 2-1
2.2 Electric Flux ... 2-1
2.2.1 Properties of Electric Flux (ψ) ... 2-1
2.3 Electric Flux Density ($\bar{D}$) ... 2-2
2.3.1 Relationship between $\bar{D}$ and $\bar{E}$ ... 2-2
2.3.2 Solved Examples on Electric Flux Density ... 2-3
2.4 Gauss's Law ... 2-6
2.5 Applications of Gauss's Law ... 2-7
2.5.1 The Case of Point Charge ... 2-7
2.5.2 The Case of Infinite Line Charge ... 2-7
2.5.3 The Case of Infinite Sheet Charge ... 2-8
2.5.4 The Case of Co-axial Cable ... 2-9
2.5.5 Applications of Gauss's Law for Uniformly Charged Sphere ... 2-10
OR Derivation of $\bar{E}$ due to Uniform Volume Charge Density (ρ_v) C/m3 Distributed in a Sphere of Radius 'a' Centered at Origin ... 2-10

2.5.6 Applications of Gauss's Law for Spherical Shell of Charge 2-12

OR Derivation of $\bar{E}$ due to Uniform Surface Charge Density ρ_s (C/m2) Distributed on the Surface of a Sphere of Radius 'a' Centered at Origin 2-12

2.5.7 Solved Examples on Gauss's Law 2-13

2.6 Divergence Theorem 2-22

2.6.1 Solved Examples on Divergence Theorem 2-22

2.7 Electric Current 2-27

2.7.1 Current Density 2-27

2.8 Equation for Continuity of Current 2-27

2.8.1 Steady State Current 2-28

2.8.2 Solved Examples on Current Density 2-29

2.9 Electric Potential 2-29

2.9.1 Potential Difference (P.D.) 2-29

2.9.2 Potential due to a Point Charge 2-30

2.9.3 Scalar or Absolute Potential 2-30

2.9.4 Electrical Potential due to Charge Distributions 2-30

2.9.5 Potential Difference in the Field of Infinite Line Charge 2-31

2.9.6 Potential Difference in the Field of an Infinite Surface Charge 2-32

2.10 Solved Examples on Electric Potential 2-32

2.11 Potential Gradient 2-35

2.11.1 Relation Between $\bar{E}$ and $\bar{V}$ 2-35

2.11.2 Solved Examples on Potential Gradient 2-36

2.12 Laplace and Poisson's Equations 2-38

2.12.1 Laplace's Equation in Different Co-ordinate System 2-38

2.12.2 Significance of Poisson's and Laplace's Equations 2-39

Chapter 3 : Static Magnetic Fields 3-1 to 3-48

Syllabus : Biot-Savart Law, Ampere Circuit law, Gauss's law for magnetic field, Vector magnetic potential

3.1 Introduction 3-1

3.1.1 Magnetic Field Intensity (H) 3-1

3.2 Biot-Savart's Law 3-1

3.2.1 Mathematical Equation of Biot-Savart's Law 3-2

3.2.2 Solved Examples on Calculation of $d\bar{H}$ 3-3

3.3 Magnetic Field Intensity ($\bar{H}$) due to an Infinite Straight Conductor 3-4

3.3.1 Magnetic Field Intensity due to Finite Length Current Filament 3-6

3.3.2 Magnetic Field Intensity due to Surface Current Density 3-7

3.3.3 Magnetic Field Intensity on the Axis of a Circular Loop 3-8

3.3.4 Solved Examples on Magnetic Field Intensity 3-9

3.4 Amperes Circuital Law or OR Ampere's Law 3-15

3.4.1 Applications of Ampere's Circuital Law 3-16

3.4.2 Solved Examples on Ampere's Circuital Law 3-20

3.5 Curl [Point Form of Ampere's Circuital Law] 3-22

3.6 Stoke's Theorem : (Applications of Ampere's Circuital Law) 3-23

3.6.1 Solved Examples on Curl and Stoke's Theorem 3-23

3.7 Magnetic Flux Density 3-30

3.7.1 Magnetic Flux over a Closed Surface 3-30

3.7.2 Relation between $\bar{B}$ and $\bar{H}$ 3-30

3.7.3 Solved Examples on Magnetic Flux Density 3-31

3.8 Magnetic Flux ψ_m 3-32

3.8.1 Ampere's Law to Differential Elements 3-33

3.9 Scalar and Vector Magnetic Potential 3-34

3.9.1 Scalar Magnetic Potential 3-34

3.9.2 Vector Magnetic Potential 3-34

3.10 Concept of Vector Magnetic Potential 3-35

3.11 Boundary Conditions 3-36

3.11.1 Boundary Condition between Conductor and Free Space 3-36

3.11.2 Boundary Condition between Conductor and Dielectric 3-38

3.11.3 Boundary Condition between Conductor-Conductor Interface 3-38

3.11.4 Boundary Conditions between Perfect Dielectrics [Dielectric-Dielectric Boundary] 3-39
3.11.5 Solved Examples on Boundary Conditions 3-41

Chapter 4 : Electromagnetic Field and Maxwell's Equations 4-1 to 4-42

Syllabus : Faraday's Law, Displacement current density, Maxwell's equation for time varying filed, Boundary conditions. EM wave propagation through lossy, perfect dielectric and conducting medium. Power in EM Wave: Poynting theorem and Poynting vector

4.1 Introduction 4-1
4.2 Faraday's Law 4-1
4.3 Translational and Motional EMF 4-2
4.3.1 Lenz's Law 4-3
4.3.2 Solved Examples on Faraday's and Lenz's law 4-3
4.4 Displacement Current 4-7
4.4.1 Ratio of Conduction Current Density and Displacement Current Density (Jc/Jd) 4-8
4.4.2 Solved Examples on Displacement Current 4-8
4.5 Time Varying Maxwell's Equations 4-10
4.5.1 Maxwell's Equation for Static Fields 4-11
4.5.2 Maxwell's Equation for Time Varying Fields 4-12
4.5.3 Maxwell's Equation for Free Space 4-13
4.5.4 Maxwell's Equation for Good Conductor 4-14
4.5.5 Solved Examples on Maxwell's Equations 4-14
4.6 Flow of Electromagnetic Power and Poynting Theorem 4-20
4.6.1 Interpretation of Poynting Theorem 4-22
4.6.2 Energy stored and Radiated Power 4-22
4.6.3 Complex Poynting Vector 4-23
4.6.4 Solved Examples on Poynting Theorem 4-24
4.7 Concept of Retarded Magnetic Vector Potential 4-29
4.8 Boundary Conditions 4-30
4.8.1 Solved Examples on Magnetic Boundary Conditions 4-32
4.9 Propagation of Electromagnetic Waves in a Conducting Medium 4-38
4.10 Reflection and Transmission from Interface of a Conductor 4-41
4.11 Surface Impedance 4-41

Chapter 5 : Basics of Antenna 5-1 to 5-23

Syllabus : Basic concepts : Radiation mechanism, Near field and far field radiation, Retarded potential, Antenna Parameters : Isotropic antenna, Radiation pattern, Radiation intensity, Beamwidth, Directivity, Gain, Beam efficiency, Bandwidth, polarization, Input impedance, Antenna efficiency, Radiation resistance, Loss resistance, aperture concept, FRII's transmission formula, Wire Elements : Infinitesimal dipole, Wire dipole, Monopole antennas : radiation field derivations and related parameters, Introduction to loop antenna.

5.1 Introduction 5-1
5.2 Antenna Radiation Mechanism 5-1
5.3 Near Field and Far Field Radiation 5-2
5.4 Retarded Potential ($\vec{A}$) 5-3
5.5 Antenna Parameters 5-5
5.6 Concept of Antenna Aperture 5-9
5.7 FRIIS Transmission Formula 5-10
5.8 Various Wire Elements as Radiating Elements 5-10
5.8.1 Infinitesimal Dipole 5-10
5.8.2 Wire Dipole-Small Dipole 5-11
5.8.2(A) Input Impedance of Small Dipole 5-12
5.8.2(B) Current Distribution for Small Dipole 5-15
5.8.2(C) Radiation Pattern for Small Dipole 5-15
5.8.3 Monopole Antenna 5-17
5.9 Loop Antenna 5-17
5.10 Small Loop as Short Magnetic Dipole 5-18
5.11 Comparison of Far Fields of Small Loop and Short Dipole 5-20
5.12 Far Field Pattern of Circular Loop Antenna 5-20
5.13 Radiation Resistance of Loop 5-21
5.14 Directivity of Circular Loop Antenna with Uniform Current 5-22
5.15 Solved Examples 5-22

Chapter 6 : Antenna Array 6-1 to 6-10

Syllabus : Linear arrays of two isotropic point sources, Linear arrays of N elements, Principle of pattern multiplication Introduction to Planner and circular arrays, Introduction to array synthesis using Binomial array

6.1 Introduction....6-1
6.2 Arrays of Two Isotropic Point Source-Two Element Array....6-1
6.3 Pattern Multiplication....6-2
6.4 Array Factor for N-Element Array : Uniform Amplitude and Spacing....6-3
6.5 To Get Null and Maxima from of N-Element Array from Array Factor....6-4
6.6 Uniformly Spaced Linear Broadside Array....6-5
6.7 Uniformly Spaced End-fire Array....6-7
6.8 Planar and Circular Array....6-8
6.9 Array Synthesis using Binomial Array....6-9
6.10 Various Antenna Array Parameters....6-10

Chapter 7 : Types of Antenna 7-1 to 7-19

Syllabus : Yagi antenna, Broadband antenna like Helical and Log Periodic antenna, Horn Antennas : E-Plane Sectoral Horn, H-Plane Sectoral Horn, Pyramidal Horn and Conical Horn, Reflector Antennas : Plane Reflectors, Corner Reflectors and Parabolic Reflector, Patch Antenna : Microstrip antenna, Feeding Techniques, Introduction to design of Microstrip antenna (Rectangular and circular patch)

7.1 Introduction....7-1
7.2 Yagi Antenna....7-1
7.3 Broadband Antenna....7-2
7.3.1 Helical Antenna....7-2
7.3.1(A) Helix Modes....7-3
7.3.1(B) Axial Mode Helix....7-4
7.3.2 Log-periodic Antenna....7-5
7.4 Microstrip Antenna....7-6
7.4.1 Microstrip Patch Antenna....7-7
7.4.2 Feed Techniques....7-7
7.4.3 Methods of Analysis....7-7
7.4.4 Design Consideration of Microstrip Antenna....7-9
7.4.5 Advantages and Disadvantages of Microstrip Antenna....7-9
7.4.6 Applications of Microstrip Antenna....7-10
7.5 Horn Antenna....7-10
7.5.1 Types of Rectangular and Circular Horn Antenna....7-10
7.6 H-Plane Sectoral Horn....7-11
7.7 E-Plane Sectoral Horn....7-12
7.8 Pyramidal Horn Antenna....7-14
7.9 Reflector Antenna....7-14
7.9.1 Plane Reflector....7-15
7.9.2 Corner Reflector....7-15
7.9.3 Parabolic Reflector Antenna....7-16
7.9.3(A) Principle of Parabolic Reflector....7-16
7.9.3(B) Parameter to be Considered while Designing Parabolic Reflector....7-17
7.9.3(C) Feed Types for Parabolic Reflector Antenna....7-18
7.10 Solved Examples....7-18

Chapter 8 : Electromagnetic Wave Propagation 8-1 to 8-12

Syllabus : Ground Wave Propagation, Sky Wave Propagation and Space Wave Propagation

8.1 Introduction....8-1
8.2 Ground Wave Propagation....8-3
8.3 Space Wave Propagation....8-6
8.4 Sky Wave Propagation....8-7
8.4.1 Mechanism of Radio Frequency Bending by Ionosphere....8-8
8.4.1(A) Critical Frequency....8-8
8.4.2 Effect of the Earth's Magnetic Field on Ionospheric Radio Wave Propagation....8-9
8.5 Virtual Height....8-9
8.6 Maximum Usable Frequency (MUF)....8-11
8.6.1 Skip Distance....8-11

❑❑❑