TKU212241

Electromagnetic Field Theory

Medan Elektromagnetik

BASIC INFORMATION

Course Credit	3 / 150 minutes per Week
Course Type	Required
Course Classification	Engineering Topics
Prerequisites	Fluid, Heat & Waves; Electricity & Magnetism

STUDENT AND LEARNING OUTCOMES

Covered Student Outcomes

Fundamental and Engineering Knowledge (KP.1)   Development of Engineering Solution (KP.2)

Learning Outcomes

LO1 Students are able to calculate and find appropriate solutions of fundamental electromagnetic field.

LO2 Students are able to formulate and use the Maxwell Equations to model the behavior of the electromagnetic field in a line, field, or volume and can analyze the behavior of the field.

LO3 Students are able to solve magnetic strand-related cases, electronic induction and its application.

LO4 Students are able to model and calculate electromagnetic wave parameters of uniform plane wave types.

LO5 Students are able to understand the concept of left-handed EMW metamaterial and propagation.

COURSE DESCRIPTION

Understand the basic concepts of Electromagnetic Fields include: Concept of Field and Vector Calculus, Coordinate System, Electrical Field Theory, Electric Current, Magnetic Field Theory, Electrical and Magnetic Material, Hysteresis, Electromagnetic Boundary Condition, Electromagnetic Induction, Inductance, Capacitance, Resistance, Ampere’s Law, Faraday’s Law, Gauss’ Law, Ohm, Joule's Law, Magnetic Circuit, Transmission Line, Maxwell's Equation, Electromagnetic Waves

TOPICS

1. Introduction

1.1 Definition of Field

1.2 Relation between Field and Force

1.3 Vector Addition and Multiplication

2. Concept of Field and Vector Calculus

2.1 Vector Calculus of Electromagnetic Field

2.2 Line Integral, Surface Integral and Volume Integral fo Vector Calculus

2.3 Coordinate Systems : Cartesian, Cylindrical and Spherical
2.4 Coordinate Transformation

3. Electric Field and Potential
3.1 Coulomb's Law
3.2 Electric Field due to Point Charge
3.3 Electric Flux due to Point Charge
3.4 Point, Line, Surface and Volume Charges
3.5 Electric Flux through a Surface
3.6 Line Integral for Vector Electric Field
3.7 Electric Flux Density (**D**)
3.8 Gauss' Law, Volume Charge Density and Divergence
3.9 Laplace and Poisson Equations
3.10 Energy in Electric Field
3.11 Electric Potential, Absolute Potential and Potential Difference
3.12 Response of Electric Material in Electric Field
3.13 Boundary Condition

4. Electric Current
4.1 Free Electron inside Electric Material
4.2 Electric Current and Current Density
4.3 Ohm's Law
4.4 Joule's Law
4.5 Conductivity of Electric Material

5. Magnetic Field Theory
5.1 Biot-Savart's Law
5.2 Ampere's Law
5.3 Curl and Stoke's Theorem
5.4 Magnetic Flux and Flux Density

6. Magnetic Force and Electromagnetic Induction
6.1 Magnetic Force due to Current Element
6.2 Ampere's Force
6.3 Magnetic Force and Torque
6.4 Magnetic Materials
6.5 Magnetization
6.6 Magnetic Boundary Condition

7. Magnetic Circuit
7.1 Magnetization Curve and Hysteresis
7.2 Ampere's Law in Magnetic Circuit
7.3 Magnetic Core with Air Gap
7.4 Multi Turn Coil

7.5 Self Inductance

7.6 Mutual Inductance

8. Time Dependent Magnetic Field and Maxwell's Equations

8.1 Introduction

8.2 Faraday's Law

8.3 Eddy Current

8.4 Maxwell's Equations

9. Transmission Line

9.1 Transmission Line Propagation

9.2 Transmission Line Equation (Telegrapher's Equation)

9.3 Lossless Propagation

9.4 Sinusoidal Voltage

9.5 Complex Sinusoidal Wave

9.6 Phasor

9.7 Low Loss Propagation

9.8 Power Transmission

9.9 Wave Reflection

9.10 Voltage Standing Wave Ratio (VSWR)

9.11 Transmission Line with Limited Length

10. Uniform Plane Waves

10.1 Wave Propagation in Free Space

10.2 Poynting Vector

10.3 Wave Polarization

REFERENCES

[1] W.H.Hayt dan J.A. Buck, Engineering Electromagnetic 8ed , Mc Graw Hill, 2010

[2] Maxwell Equations, J. A. Kong, EMW Publishing, 398 pg, 2002

[3] Li, Ji Chun, dan Huang, Yun Qing, 2013, Tine Domain Finite Element Method for Maxwell’s Equations in Metamaterials, Springer Series in Computational Mathematics

[4] Katsarakis, N., dkk, 2004, Electric coupling to the magnetic resonance of split ring resonators, Applied Physics Letters, Vol. 84., No.15