BIRZEIT UNIVERSITY – FACULTY OF ENGINEERING
ELECTRICAL ENGINEERING DEPARTMENT
Electromagnetic Theory - EE3408
Course Outline
Instructor: Dr. Ashraf Al-Rimawi
Text Book: Elements of Electromagnetic, 6h edition
BY: Matthew N. O. Sadiku
Oxford University Press, New York

Intended Learning Outcomes (ILO's)

1. To understand the math modeling of fields and waves in different coordinate systems.
2. To understand the laws of Electrostatic and Magnetostatic fields, both in different materials.
3. To understand the electric and magnetic energy, and to be able to solve boundary value problems.
4. To learn Maxwell's equation.
5. To understand the dynamic fields through Maxwell's equations.
6. To understand plane waves and the concept of wave propagation.
7. To understand the equations of transmission line and their relation to Maxwell's equations.

Course Contents:

1. Vector Algebra

Scalars and Vectors, Unit Vector, Vector Addition and Subtraction, Position and Distance Vectors, Vector Multiplication, Components of a Vector

2. Coordinate Systems and Transformation

Cartesian Coordinates, Circular Cylindrical Coordinates, Spherical Coordinates. Transformations of vectors.

3. Vector Calculus

Differential Length, Area, and Volume, Line, Surface, and Volume Integrals Del Operator, Gradient of a Scalar, Divergence of a Vector and Divergence Theorem, Curl of a Vector and Stokes's Theorem, Laplacian of a Scalar Classification of Vector Fields

4. Electrostatic Fields

Coulomb's law and Field Intensity, Electric Fields due to discrete and Continuous Charge Distributions, Electric Flux Density, Gauss's Law – Maxwell's Equation, Applications of Gauss's Law, Electric Potential, Relationship Between E and V - Maxwell's Equation, An Electric Dipole, Electric Flux Lines and Equipotential Surfaces, Energy Density in Electrostatic Fields

5. Electric Fields in Material Space

Properties of Materials, Convection Current, Conduction Current, Polarization in Dielectrics, Dielectric Constant and Strength, Linear, Isotropic, and Homeogeneous Dielectrics, Continuity Equation and Relaxation Time, Boundary Conditions

6. Electrostatic Boundary-Value Problems

Poisson's and Laplace's Equations, General Procedure for Solving Poisson's or Laplace's Equation: Problems in one dimension, Resistance and Capacitance, Method of Images

7. Magnetostatic Fields

Biot-Savart's Law, Ampere's Circuital Law – Maxwell's Equation, Applications of Ampere's Law, Magnetic Flux Density – Maxwell's Equation

Maxwell's Equations for Static EM Fields, Magnetic Scalar and Vector Potentials

8. Magnetic Forces, Materials, and Devices

Forces Due to Magnetic Fields, Magnetic Torque and Moment, A Magnetic Dipole, Magnetization in Materials, Classification of Magnetic Materials, Magnetic Boundary Conditions, Inductors and Inductances, Magnetic Energy, Magnetic Circuits, Force on Magnetic Materials

9. Maxwell's Equations

Faradays' Law, Transformer and Motional EMFs, Displacement Current, Maxwell's Equations in Final Forms, Time-Varying Potentials, Time-Harmonic Fields

10. Electromagnetic Wave Propagation

Waves in General, Wave propagation in lossy Dielectrics, Plane waves in lossless Dielectrics, Plane waves in Good Conductors, Power and the Poynting Vector, Reflection of a Plane Wave at Normal Incidence, and Reflection of a Plane Wave at Oblique Incidence.

Grading System

Quizzes, and project	20 %
Midterm Exam	35 %
Final Exam	45 %

References:

1. Electromagnetic, BY: Crauss and Carver

2. Field and Wave Electromagnetic, BY: David K. Cheng

3. Engineering Electromagnetic, BY: Hayt Buck

Course Management

No.	Topic	Hours
1	**Vector Analysis** 1. Basic Laws of Vector Algebra 2. Orthogonal Coordinate Systems 3. Transformations between Coordinate Systems 4. Gradient of a Scalar Field 5. Divergence of a Vector Field 6. Curl of a Vector Field 7. Laplacian Operator	**6**
2	**Electrostatics** 1. Maxwell's Equation 2. Charge and Current Distributions 3. Coulomb's Law 4. Gauss's Law 5. Electric Scalar Potential 6. Electrical Properties of Materials 7. Conductors 8. Dielectrics 9. Electric Boundary Conditions 10. Capacitance	**12**
3	**Magnetostatics** 1. Magnetic Forces and Torques 2. The Biot-Savart Law 3. Magnetic Forces between Two parallel Conductors 4. Maxwell's Magnetostatic Equations 5. Vector Magnetic Potential 6. Magnetic Boundary Conditions 7. Inductance	**10**
4	**Maxwell's Equations** 1. Faraday's Law 2. Stationary Loop in a Time-Varying Magnetic Field 3. Displacement Current	**8**
5	**Electromagnetic Wave Propagation** 1. Waves in General 2. Review of Waves and Phasors 3. Time-Harmonic Fields 4. Plane-Wave Propagation in Lossless Media, free space and good conductors 5. Wave Polarization 6. Wave Reflection and Transmission at Normal Incidence	**12**
Total		**48**