Department of Physics

College of Science

University of Salahaddin- Erbil

Subject: Electromagnetic Theory

Course Book –4th *Year- Physics-Medical*

Lecturer's name Dr. Saman Khabbat Ezzulddin

Academic Year: (2022- 2023)

Course Book

1. Course name	**Electromagnetic Theory**
2. Lecturer in charge	**Dr. Saman Khabbat Ezzulddin**
3. Department/ College	**Physics / Science**
4. Contact	**e-mail: saman.ezzulddin@su.edu.krd**
5. Time (in hours) per week	**Theory: 3 hrs./ Week** **Practical: 0 hrs./ Week**
6. Office hours	**Wednesday (8:30- 12:30), Monday (8.30- 10:30), Thursday (8:30- 12:30).**
7. Course code	
8. Teacher's academic profile	**I have more than 13 years' experience teaching, during my academic life I have tough, the following subjects for undergraduate students such as: General Physics of the second year Geology department, Modern physics Lab of the second year students, Nuclear physics, for the fourth year of physics students, also I have eleven (11) papers are published in different local and foreign journals.** **I participated in many international and local conferences and I published many scientific articles. I current research interests include Radioactivity measurement, Radiation dosimeter, Radiation Protection and Solid State Nuclear Track Detector SSNDs.** **- I awarded B.Sc. in Physics (College of Science) in 2008 Salahaddin University-Erbil.** **- M.Sc. in 2014 (Salahaddin University-Erbil).** **- Assist. Lecturer from 2014 to 2018.** **- Lecturer from 2018 till now.** **-PhD In 2022 (Electromagnetic Theory/Communication Physics) (Salahaddin University-Erbil).**
9. Keywords	**Electric Field, Magnetic field, Time vary fields, Wave propagation.**

10. Course overview:

This course provides in depth general field properties; review of vector calculus and coordinate systems; static electric fields, static magnetic fields; Coulomb, Gauss, Biot-Savart and Ampere's laws; Boundary value problems and method of images; Magnetic vector potential. Materials: dielectric and magnetic materials, their properties, capacitance and inductance, applications.

The course also coverage of all aspects of electromagnetics, with a focus on field and wave generation and propagation. The course will focus on the more practical aspects of E-M theory, with application examples taken from the problems in the textbook as well as from other references. The specific subjects covered will be vectors and fields, electrostatics, electric current flow, magnetic fields, Maxwell's equations, electromagnetic wave propagation in differential, integral and phasor forms as well as their propagations in

different mediums.

11. Course objective:

Electromagnetics is of fundamental importance to physical and electrical engineers. Electromagnetic theory is indispensable in understanding electro- mechanical energy conversion, transmission & electric power utilization systems and communication systems, RF/microwave devices, optical fiber systems, antennas, remote sensing, radio astronomy, and electromagnetic compatibility.

This course will consider electromagnetic theory as a general theory that includes the standard electro- and magneto-statics. The relationship between electric and magnetic fields, and their links expressed through the Maxwell equations, lead to wave propagation with associated wave behaviours

12. Student's obligation

- The students should have presence in all lectures.
- Every lecture the first 10 min should be debate about the previous lecture and the interested student (participant in the debate) take marks.

13. Forms of teaching

Different forms of **teaching** will be used to come across with objectives of the course. **Power** point presentations for the head titles, definitions, graphs and many useful illustrations with summary at the end of each chapter will be presented and discussed. **There** will be also classroom discussions and the lecture will cover enough information about the description of the **subjects**, solution of many **examples**, analysis and **derivation** for all necessary equations and **proving** theorems and many problems are presented as a home work for improving student abilities.

Homework problems will be **solved** and **discussed** weekly to improve the student's ability for understanding materials to let the chance for practicing on several aspects of the course in the classroom.

14. Assessment scheme

In this system the **maximum** mark is **(100%)**. The grading system is based on the summation of two categories of **evaluations**:

First, **(40%)** of the **mark** is based on the **academic** year effort of the student which includes:

- **25%** for **two** monthly examinations, **((25 X 2) %2)** = **25%**, for semester **25%**.
- **15%** for quizzes and solving home works.
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Second, **(60%)** of the **mark** is based on **final** examination that is comprehensive for the whole of the study material **reviewed** during the academic **year** and it usually occurs during the month of **June**

At the **end** of the **evaluation** process, if the students could not **secure** a minimum of **(50%),** they are given a **chance** to **repeat** the **final** exam in **September** and they should be able by then to **equal** or **exceed** the **(50%)** limit otherwise they will have to **repeat** this **subject** during the **next** academic year if it did not **contradict** with the **administrative** regulations.

15. Student learning outcome:

By the end of the course, the successful student is expected to know at the basic level: In

support of these objectives, students will understand and calculate EM fields and key physical parameters for:

1. Fields and energies in simple planar, cylindrical, and spherical geometries
2. Fields within conducting and anisotropic media
3. Resistors, capacitors, inductors, transformers, transmission lines, and resonators
4. Electric and magnetic forces on charges, wires, and media
5. Electric and magnetic motors and sensor/generators
6. Sinusoids and transients on TEM lines with mismatched impedances and tuning
7. EM fields at planar boundaries and within waveguides, including evanescence
8. Wireless and wired systems for communicating at R bits/second
9. Wire, aperture, and array antennas for transmission and reception

In most cases students will derive these results from Maxwell's equations and the Lorentz force law, and will demonstrate their achieved outcomes in homework problems and, on a random sampling basis, examinations

16. Course Reading List and References:

1) Engineering Electromagnetic, Sixth Edition, By William H. Hayt , 2006.
2) Schoum's online of Theory and Problems of Electromagnetics, by Joseph A. Edminister 1979.
3) Elements of Electromagnetics, By Matthew N. O. Sadiku, 2001.
4) Fundamentals of Applied Electromagnetics, By Fawwaz T. Ulaby, 2004.
5) Fundamentals of Electromagnetics With Engineering Application, By Stuart M. Wentworth,2005.

17. The Topics:	Lecturer's name Dr. Saman K. Ezzulddin
1-1: Introduction 1-2: Scalar and Vectors 1-3: Unit Vector and Equality of Two Vectors 1-4: Vector Addition and Subtraction 1-5: Position and Distance Vector 1-6: Vector Multiplications 1-7: Scalar and Vector Triple Product 1-8: Orthogonal Coordinate Systems 1-8-1: Cartesian Coordinates 1-8-2: Cylindrical Coordinates 1-8-3: Spherical Coordinates	**Chapter One: Vector Analysis and Coordinate Systems (2 Weeks)**
2-1: Transformation between Coordinate systems 2-1-1: Cartesian to Cylindrical Transformation 2-1-2: Cartesian to Spherical Transformation 2-1-3: Cylindrical to Spherical Transformation 2-2: Line, Surface and Volume Integrals 2-3: Del ▼ Operator 1-3-2: Gradiant Operator 1-3-3: Divergence Operator and Divergence Theorem	**Chapter Two: Vector Calculus and Transformation between Coordinate Systems (2 Weeks)**

1-3-4: Curl Operator and Stokes Theorem 2-4: Laplacian of a Vector 2-5: Classification of Vector Fields 3-1: The Nature of Electromagnetism 3-1-1: The Gravitation Force, a Useful Analogue 3-1-2: The Electromagnetic Force 3-2: Charge and Current Densities 3-2-1: Charge Densities 3-2-2: Current Densities 3-3: Force between Charges 3-4: Electric Field Intensity of a Group of Charges 3-5: Electric field Intensity of a Uniform Charge Distributions 3-5-1: Uniform Line Charge Distribution 3-5-2: Uniform Surface Charge Distribution 3-5-3: Uniform Volume Charge Distribution 3-6: Electric Flux Density (or Electric Displacement) 3-7: Gauss's Law and Applications 3-7-1: Application of gauss's Law on Point Charge 3-7-2: Application of gauss's Law on Line Charge Distribution 3-7-3: Application of gauss's Law on Surface Charge Distribution 3-7-4: Application of gauss's Law to Uniformly Charged Sphere 3-7-5: Application of gauss's Law to Coaxial Cable 3-8 : Electric Potential 3-9: Gradiant of Potential Difference 3-10: Electric Dipole Moment 3-11: Energy Density in Electrostatic Field	**Chapter Three: Electrostatic Fields** **(4 Weeks)**
4-1: Introduction 4-2: Moving Charges 4-3: Conductor, Semiconductor and Conductivity 4-4: Resistance 4-5: Joule's Law 4-6: Continuity Equation and Relaxation Time 4-7: Dielectric and Polarization 4-8: Linear , Isotropic and Homogenous Medium 4-9: Capacitance 4-10: Boundary Conditions 4-10-1: Dielectric-Dielectric Boundary Condition 4-10-2: Conductor-Dielectric Boundary Condition	**Chapter Four: Electrostatic Field in Material Space and Boundary Conditions** **(3 Weeks)**

4-10-3: Conductor-Free Space Boundary Condition 4-11: Electric Images 5-1: Introduction and history 5-2: Sources and Applications of Magnetic Field 5-3: Magnetic Force and Torque 5-3-1: Magnetic force on a carrying current conductor 5-3-2: Magnetic Torque on a current carrying loop 5-3-3: Magnetic dipole moment 5-4: Biot-Savart's Law and Their Application 5-5: Magnetic force between two parallel conductor 5-6: Ampere's Law 5-7: Application of Ampere's Law 5-7-1: Infinite Line Current 5-7-2: Infinite Sheet Current 5-7-3: Infinitely Long Coaxial Transmission Line 5-8: Magnetic Flux Density and Gauss's law in Magnetostatic fields 5-9: Magnetic Scalar and Vector Potential 5-10: Magnetization and classification of magnetic materials 5-11: Magnetic Scalar and Vector Potential 6-1: Introduction 6-2: Faraday's Law of induction 6-3: Displacement current 6-4: Maxwell's Equations in Final Forms 6-5: Time Varying Potential 6-6: Derivation of electromagnetic wave equation 6-7: Propagation of Electromagnetic Waves in Different Medium 6-7-1: In Free Space 6-7-2: In Lossy medium 6-7-2 : In Perfect Medium 6-7-2: In Good conductor 6-8: Power and the Poynting Vector	**Chapter Five: Magnetostatic Field** **(3 Weeks)** **Chapter Six: Dynamic Electromagnetic Fields** **(3 Weeks)**
18. Practical Topics (If there is any)	

19. Examinations:

Different types of questions will be provided to the student as an exercise and also in examinations such as given them in the question banks which contain each of the following ones:

1. Mathematical **derivation** and **explanation** questions for different subjects in Electromagnetic theory are provided.

2. Mathematical **calculation questions** for different analytical calculation subjects also given to them.
3. **Multiple choices** questions for every subject that are given in electromagnetic theory topics are also provided to them.
4. **Physical** interpretation and blanket question are also given for various electromagnetic problems.
5. Finally, the **true** and **false** questions are also given to them for several Electromagnetic theory subjects.

Each of these mentioned question types will be seen clearly in the question banks that are given to the quality assurance committee of our physics department.

20. Extra notes:

Due to a number of **unforeseen** reasons that may lead to the **shifting** of the academic year **program**, it may be subjected to **modifications**. Also extra **curriculum** hours may be **needed** to cover all the **topics** mentioned above. The students shall be **notified** of the **changes** when they may **occur**.

21. Peer review