Department of Physics

College of Education

University of Salahaddin-Erbil

Subject: RADIO WAVE PROPAGATION

Course Book – (PH.D.) Students

Lecturer's name: Dr. Sattar Othman Hasan

Academic Year: 2023/2024

Course Book

1. Course name	**Radio Wave Propagation**
2. Lecturer in charge	**Dr. Sattar Othman Hasan**
3. Department/ College	**Physics / Education**
4. Contact	e-mail: sattar.hasan@su.edu.krd e-mail: star_os2004@yahoo.com Tel: **(0750 4514637)**
5. Time (in hours) per week	**3 HOURS**
6. Office hours	**Sunday:** **From** 8:30 AM To 11:30 PM **Monday:** **From** 12:30 AM To 2:30 AM **Tuesdays:** **From** 11:30 AM To 2:30 PM

7. Teacher's academic profile: I am a Staff member of physical Department of Education College at Salahaddin University-Erbil.

I earned a **BSc** degree in Physics at **1990-1991** with first class honour from Physical department of Education college, university of Salahaddin. **MSc** degree in theoretical nuclear physics at **1998-1999** under the title of "The Background Function Effects on the Analysis of Gamma-Ray Spectrum" with honour degree., and a **Ph.D.** in communication "Electromagnetic Theory" at **2006-2007** with the title of "Analysis and Design of Compact Microstrip Antenna Using Cavity Model" from Physical department of Science college, university of Salahaddin.

From **2000-2002**, I was a head of register unit within the college of education. During **2002-2003** I was a deputy of deans of Education College, University of Salahaddin. I was a representative of teaching staff at College of Education for about eight years.

I was a dean of Hawler Tourism Technical Institute during the years of **2008-2010** and also, I was a dean of Hawler Technology Institute during the years of **2010-2014**. I am an assistant professor of theoretical Electromagnetic Theory "Field of Communication", and I have **several** research publications in different field of physics. My research interests span a number of topical themes in electromagnetic wave propagation, theoretical physics and mobile communication. Finally, I supervised **four MSc**. students and **two Ph.D.** in the field of Communication.

8. Course objective: The objective of this course is to introduce the fundamental principles of propagation of electromagnetic wave in different mediums using Maxwell's equations and studying the transmission lines, waveguide, optical fibre and radar radio wave propagation regarding ground, sky and space waves. Students will learn the principle of voltage and current wave propagating along transmission lines and how they relate to the propagation of electric and magnetic field in space and along waveguide or optical fibres. Different types of waveguides and cavity resonators will be described and propagation of radio waves through the space will be studied in detail. Formation of the atmospheric layers around the earth is also learned and their benefits for radio wave propagation will be understood.

9. 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.

In addition, 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.

10. Assessment scheme: Attaining the **requirements** set to succeed in this study subject requires developing a **mathematical** sense, related to this topic, based on emergent analytical and problem-solving skills and memorizing topics cannot secure success.

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

- **First**, **(25%)** for **the** semester examination.
- **Second**, **(25%)** of the **mark** is based on the preparation of an **article review** about propagation of electromagnetic wave in specific medium or about communication in general.
- **Third**, **(50%)** of the **mark** is based on **final** examination that is comprehensive for the whole of the study material **reviewed** during the academic **semester** and it usually occurs after completing the course semester.

11. Student learning outcome: The learning objects and the main goals of studying radio wave propagation are summarized in the following important points:

- List Maxwell's equations and solve them for specific regular geometries and in different mediums and interpretation of the effects of lossy and low loss dielectrics medium upon the propagation of electromagnetic waves will be specified clearly.
- Specifying the shielding material behaviour against propagation of electromagnetic wave and design of radar radome is described and their appropriate equations are derived.
- Learning the principle of voltage and current distribution along transmission lines and application of TL in communication systems.
- Understanding of waveguide and cavity resonators with their benefits in propagating electromagnetic wave between two distinct points.
- Another objective of this course is to introduce a detail description about the formation of the atmospheric layers around the earth and their effects on the radio wave propagations.
- Students will learn how radio waves propagate through ionosphere and also along the earth surface.
- Student will also learn the concept of ground wave, sky wave and space wave propagations with their applications ranges in communication systems.
- Wireless communications devices such as radars and satellites are also given to understanding how their equations are derived to applied them in the communication systems.

12. Course Reading List and References:

1- John Griffiths, (Radio wave propagation and Antennas an Introduction) University of Bath UK,**1987**.

2- Kai Chang, (RF and Microwave wireless system), Texas A and M University, John Wiley and Sons, Inc., **2000**.

3- Uday A. Bakshi and Ajag V. Bakshi, (Antennas and wave propagation.), Technical publications pure, **2007**.

4- Constantine A. Balanis, (Antenna Theory, Analysis and Design), Second Edition, John Wiley and Sons Inc., **2005**.

5- Stutzman, (Antenna Theory and Design), John Wiley and Sons Inc., **2013**

6- John A. Richards, " Radio Wave Propagation ", Canberra ACT 0200, Australia, Springer, **2008**

13. The Topics:	Syllabus
CHAPTER ONE **Electromagnetic Wave Propagation in Different Mediums** 2 Weeks	1-1: General Plane EMW Equation of Motion 1-2: Concept of Uniform Plane Wave (UPW) and its properties 1-3: Propagation of (UPW) in Lossless Media or free space: 1-4: Propagation of (UPW) in Perfect Dielectric Media 1-5: Propagation of (UPW) in Good Conductor Media 1-6: Power Flow of EMW and the Poynting Vector 1-7: Normal Incident of UPW on Plane Boundaries 1-8: Power Flow of UPW on Plane Boundaries 1-9: Communication with Submarine 1-10: Design of Radar Radome 1-11: Shielding of Electronic Equipment
CHAPTER TWO **Transmission Lines** 2 Weeks	2-1: Introduction 2-2: Common Type of Transmission Line 2-3: Transmission Line Definition 2-4: Distributed Parameter Representation of TL 2-5: Lossless Transmission Line 2-6: Distortion-less Transmission Line 2-7: Transmission Line Circuit 2-7-1: Open Circuited Lossless Line 2-7-2: Short Circuited Lossless Line 2-8: Reflection Coefficient and VSWR
CHAPTER THREE **Waveguide & Cavity Resonator** 3 Weeks	3-1: Introduction 3-2: Ideal Metal Waveguide 3-3: TE and TM- Modes in Waveguide 3-4: Rectangular TE-mode and TM-mode Waveguides 3-5: Waveguide Group Velocity and Phase Velocity 3-6: Attenuation in Waveguides 3-7: Rectangular Cavity Resonators 3-8: Circular Waveguide
CHAPTER FOUR **Optical Fibres** 2 Weeks	4-1: Fibre Types and Modes 4-2: Attenuation and dispersion 4-3: Critical angle of total reflection 4-4: Acceptance angle and Numerical aperture 4-5: Single mode/multiple mode operation (V-number) 4-6: Pulse spread and Maximum bit rate
CHAPTER FIVE **Wave Propagation** 3 Weeks	5-1: Introduction 5-2: Different Mode of Propagation 5-3: Ground Wave Propagation 5-4: Space Wave Propagation 5-5: Sky wave propagation - Critical Frequency and Maximum Usable Frequency - Virtual Height and Skip Distance

CHAPTER SIX **Radar and Wireless Communication Systems** **2 Weeks**	**6-1:** Introduction and Classifications of Radars 6-1-1: Radar Equation 6-1-2: Radar Cross Section 6-1-3: Pulse Radar 6-1-4: Continuous Wave or Doppler Radar **6-2:** Friis Transmission Formula **6-3:** Space Loss **6-4:** Link Equation and Link Budget **6-5:** Effective Isotropic Radiated Power and G/T Parameters **6-6:** Radio / Microwave Links **6-7:** Satellite Communication Systems

14. 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 transmission line, waveguide and radio wave propagation are provided.
2. **Description** questions for every subject that are given in radio wave propagation topics are also provided to them.

15. Extra notes: Due to a number of unforeseen reasons that may lead to the shifting of the academic season 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 if and when they may occur.