

Alexandria University
Faculty of Engineering
Department of Electrical Engineering

Course Title: Wave Propagation In Biological Media

Course Number: 10626

Instructor: Prof. Dr. Nour Eldin Hassan Ismail

Course Contents:

Chapter 1 : Introduction

- 1.1. Biomedical engineering development.
- 1.2. Useful medical terminologies.
- 1.3. Biological tissues and phantoms.
- 1.4. Tumor types.

Chapter 2 : Non-ionizing Electromagnetic Effects

- 2.1. Radio frequency and microwave effects.
 - 2.1.1. Thermal effect.
 - 2.1.2. Non-thermal effect.
- 2.2. Tissue classifications.
- 2.3. Power absorption.

Chapter 3: Electrical Behavior of Biological Tissues

- 3.1. Dielectric properties
- 3.2. Debye dispersion formula.
- 3.3. Frequency response of dielectric constants.

Chapter 4: Tissue Dielectric Constants Measurement Techniques

- 4.1. Low frequency measurements.
- 4.2. High frequency measurements.
- 4.3. Very High frequency measurements.

Chapter 5: Basic Ultrasound Physics

- 5.1. Definition of ultrasound.
- 5.2. Ultrasound transducers.
- 5.3. Interactions of ultrasound with tissues.
 - 5.3.1. Interference.
 - 5.3.2. Reflection.
 - 5.3.3. Scattering.
 - 5.3.4. Diffraction.
 - 5.3.5. Refraction and Snell's Law.
- 5.4. Medical ultrasound.
- 5.5. Ultrasound imaging.
- 5.6. Doppler ultrasound.
- 5.7. Piezoelectric effect and ultrasound transducers.

Chapter 6: Modified Radiative Transfer Theory

- 6.1. Fundamentals of radiative transfer theory.
- 6.2. Brightness temperature definition.
- 6.3. Brightness temperature of a multi-layered medium.
- 6.4. Propagation matrices for a multi-layered medium.
- 6.5. Examples.

Chapter 7: Microwave Hyperthermia

- 7.1. Focusing of microwave energy.
- 7.2. Noninvasive hyperthermia.
- 7.3. Invasive hyperthermia.

Chapter 8: Ultrasound Focusing

- 8.1. Phased array types.
- 8.2. Electronic focusing.
- 8.3. Hyperthermia.
- 8.4. Bio-heat transfer equation.
- 8.5. Simulation for a focusing process.

Text Book and References

1. Micheal M. Domach, Introduction to Biomedical Engineering, second edition, Prentic Hall, 2005.
2. F.T. Ulaby, R. K. Moore and A. K. Fung, Microwave Remote Sensing - Active and Passive ,Vol III, Atrech Hall, Dedham Massachusetts, 1986.
3. C. C. Johnson and A. W. Guy," Non-ionizing Electromagnetic Wave Effects in Biological Materials and Systems", Proc. IEEE, Vol.60, pp.692-718, 1972.

Assignments

Assignments are given to students at the end of each chapter.

Teaching and Assessments

Lecture: 2 hrs per week

Tutorials and quizzes: 1 hr per week

Distribution of marks:

Class works: 20 marks

Seminars: 20 marks

Final exam: 60 marks.

Attendance:

Attendance is conducted every week.

Students that will be absent more than 25% of total teaching weeks shall not be allowed to enter the final exam.