ECE 700 TOPIC 10: ULTRASOUND IN MEDICINE AND BIOLOGY
Winter 2024

Objectives

This course aims to cover the versatile applicability of ultrasound in biomedicine. Various practical applications of ultrasound will be studied, including medical imaging, flow measurements, microscopy, drug delivery, and thermal therapy. The engineering science principles behind these applications will be presented and derived. The overall goal of this course is to equip students with a firm understanding of the extensive role that ultrasound plays in biomedicine and the engineering science driving these biomedical ultrasound applications.

Course Learning Outcomes

By the end of this course, students should be able to demonstrate a threshold level of mastery of the following learning outcomes:

1. Describe how ultrasound is used in diagnostics and therapy
2. Summarize the technical principles related to ultrasound
3. Give examples on the biomedical applications of ultrasound
4. Explain the bioeffects that can be induced by ultrasound and its potential safety concerns
5. Perform experiments with an ultrasound scanner

Course Prerequisite

Literacy in human biology is not mandatory but will be a plus. Students should have some background in general wave physics and signals theory.

Instructor

Alfred C. H. Yu
Professor and Assistant Vice-President, Research & International
E-mail: alfred.yu@uwaterloo.ca

Grading Scheme

Assignments	30%
Imaging Laboratory	20%
Final Exam	50%

Course Topics

Theme 1: Introduction to ultrasound imaging

- Basic ultrasound principles
- Basics of ultrasound imaging
- Ultrasound imaging acquisition and beamforming
- Ultrasound-based blood flow measurements

Theme 2: Ultrasound wave-matter interactions

- General interactions in imaging
- Nonlinear ultrasonics and its imaging applications
- Principles of acoustic cavitation
- Principles of acoustic radiation and streaming

Theme 3: Therapeutic ultrasound

- Thermal-based ultrasound therapy
- Microbubbles in imaging and therapy

Theme 4: Biosafety considerations

- Ultrasound-induced bioeffects
- Ultrasound measurement and protection standards

Learning Resources

Required text / References

Review articles and tutorial papers will be provided by the instructor. No formal textbook is required.

Course website

Selected course material will be posted on LEARN in addition to announcements and important dates/deadlines: students are advised to regularly consult the LEARN site for this course.