

# COURSE SYLLABUS

**Course Number:** DI 10 / UT 10  
**Course Title:** Physical Principles of Ultrasound  
**Course Credit:** 3 Units (45 hours of lectures)  
**Class Hours:** Monday, 9:00 AM to 11:45 AM  
**Pre-requisite:** SCI 10 or equivalent  
**Instructors:** Chris T. Nguyen, Ph.D. (\*) & Frank Porter

## COURSE DESCRIPTION

This Course introduces ultrasound physical principles and instrumentation. Topics include sound wave mechanics, transducers, ultrasound equipment, Doppler physics, safety techniques, imaging modes, artifacts, quality, and bio-effects.

*Prerequisite: SCI 10 or equivalent*

## COURSE OBJECTIVES AND STUDENT LEARNING OUTCOMES

Upon satisfactory completion of this Course, the students will be able to:

1. Describe the characteristics of sound wave
2. Explain the fundamental requirements for sound to travel
3. Discuss medium stiffness, density
4. Explain the difference between pulsed wave and continuous wave
5. Relate frequency / period, pulse repetition frequency / pulse repetition period
6. Discuss duty factor, pulse duration, spatial pulse length.
7. Explain different modes of scatterings
8. Explain the three processes in which attenuation occurs
9. Explain how attenuation is calculated
10. Identify elements of an ultrasound transducer. Types of probes.
11. Relate single crystal, arrays, matrix, and mechanical/electronic probes
12. Explain characteristics of a transducer, frequency, crystal thickness, matching layers
13. Relate frequencies, bandwidth, and quality factor
14. Discuss echogenicity, hyperechoic, hypoechoic, isoechoic
15. Relate near zone, far zone, focal zone, beam width.
16. Discuss attenuation, penetration. Resolutions, wavelength, line density, frame rate
17. Relate impedance / reflection, velocity / refraction
18. Identify different components of an ultrasound system
19. Discuss transmit power, receiver gain, TGC, dynamic range, pre-processing, post-processing, persistence
20. Learn 2D-imaging, 3D-imaging, M-mode, Doppler mode, color flow imaging, contrast imaging, harmonic imaging, PW Doppler, CW Doppler, tissue Doppler imaging, Color M-mode
21. Discuss different types of flows: plug, laminar, parabolic, and turbulent. Doppler effects.
22. Discuss artifacts: reverberation, mirror image, comet tail, ring-down, shadow, enhancement, edge shadow, speed error, registration error, section thickness, aliasing. Side lobe / grating lobe
23. Discuss probe and system quality & reliability, safety, phantom, calibration, maintenance
24. Discuss ALARA, thermal bioeffect, mechanical bioeffect, cavitation, temperature elevation
25. Operate ultrasound system and perform basic scanning

**The two main objectives of this Course are:**

- Prepare the students for the ARDMS Board Registration Test
- Show them how to properly, effectively utilize US Systems

## **INSTRUCTIONAL METHOD**

Instructional methods will include lectures by the Instructor and Lab. under his guidance. Classroom activities are collaborative – students should help one another in Class as well as in Lab. The Instructor will be available to help students with all tutorials and other assignments. **45 hours of lecture – 3 units**

## **SCHEDULE**

The Course consists of **15 Lectures, weekly Quizzes, 1 Mid-term, 1 Final and several LAB sessions.** Attendance will be **recorded at every class meeting.**

**Lecture #1** covers items 1, 2 & 3

**Lecture #2** covers items 3, 4 & 5. Quiz on Lecture #1

**Lecture #3** covers items 7, 8 & 9. Quiz on Lecture #2

**Lecture #4** covers items 10, 11 & 12. Quiz on Lecture #3

**Lecture #5** covers items 13, 14 & 15. Quiz on Lecture #4

**Lecture #6** covers items 16 & 17. Quiz on Lecture #5

**Lecture #7** reviews items 1 to 17 to prepare for Mid-term. Quiz on Lecture #7

**Lecture #8: MID-TERM.** Lecture on item 18

**Lecture #9** covers items 19 & 20. Quiz on Lecture #8

**Lecture #10** covers items 21 & 22. Quiz on Lecture #9

**Lecture #11** covers items 23 & 24. Quiz on Lecture 10

**Lecture #12** reviews all items from 1 to 24. Quiz on Lecture #11

**Lecture #13** reviews all items from 1 to 24, introduces 600+ ARDMS Physics Test Questions

**Lecture #14** reviews all items from 1 to 24, answers to 600+ ARDMS Physics Test Questions

**Lecture #15: FINAL. Celebration!**

**EVALUATION** is based on

- Attendance and Lab. Practice
- Quizzes
- Mid-term exam, Final exam.

### **Grading Scale:**

Class Attendance and Lab.	10%
Quizzes	25%
Mid-Term Exam	25%
Final	40%
Maximum total score	100%

90 - 100%	A
80 - 89%	B
70 - 79%	C
60 - 69%	D
Below 60%	F

To successfully complete this Course, the student should attend more than 80% of the Lectures, and have a total score of 70% or higher.

## RESOURCE MATERIALS

- **Diagnostic Ultrasound: Principles and Instruments** by Frederick W. Kremkau, Saunders Publishing, **8th edition** (Sonography Principles and Instruments, 2010), ISBN-10: **143770980X**, ISBN-13: **978-1437709803**  
7th edition, ISBN-10: **0721631924**, ISBN-13: **978-0721631929**
- **Ultrasonography Examination** by Odwin & Fleischer, Lange Review Series – McGraw-Hill, 4th edition (2012)  
ISBN-10: **007163424X**, ISBN-13: **978-0071634243**
- **Ultrasound Physics Review** by Davies Publishing (2009)  
**ISBN-10:** 0941022749, **ISBN-13:** 978-0941022743
- ARDMS Physics Test samples from different sources

## (\* ) INSTRUCTOR AFFILIATIONS

- Member of AIUM (American Institute of Ultrasound in Medicine)
- ASE (American Society of Echocardiography)
- HMS-PGA (Harvard Medical School Postgraduate Association)
- SDMS (Society of Diagnostic Medical Sonography)
- ISEECG (International Society of Electrocardiography)
- Member of CFA (California Faculty Association)
- A Reviewer for “Journal Ultrasound in Medicine”. Nominated Distinguished Reviewer in 2011
- A Reviewer for “Journal Ultrasound in Medicine and Biology” since 2006

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**OFFICE HOURS:** Contact Dr. Chris T. Nguyen for appointment

**STUDENT LEARNING FEEDBACK:** Results of the actual **ARDMS Physics Test** by my students are gauged as learning feedback.

(Updated in August 2012)