

**LINCOLN UNIVERSITY**  
**FALL 2011 COURSE SYLLABUS**

**Course Number:** DI 10 / UT 10  
**Course Units:** 3 Units = 45 hours of lecture  
**Course Title:** Physical Principles of Ultrasound  
**Instructor:** Chris T. Nguyen, Ph. D. (\*)

**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. (3 units)

*Prerequisite: SCI 10 or equivalent*

**COURSE OBJECTIVES AND STUDENT LEARNING OUTCOMES**

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

- Describe the characteristics of sound wave
- Explain the fundamental requirement for sound to travel
- Discuss medium stiffness, density
- Explain the three processes in which attenuation occurs
- Explain how attenuation is calculated
- Explain the different types of scattering
- Discuss echogenicity, hyperechoic, hypoechoic, isoechoic
- Explain the difference between pulsed wave and continuous wave
- Relate frequency / period, pulse repetition frequency / pulse repetition period
- Discuss bandwidth, quality factor. Duty factor
- Identify elements of an ultrasound transducer. Types of probes
- Discuss characteristics of transducer, frequency, crystal thickness, matching layer
- Discuss attenuation, penetration, resolutions. Line density, frame rate
- Relate impedance / reflection, velocity / refraction
- Discuss near zone, far zone, focal zone, beam width
- Identify different components of an ultrasound system
- Discuss transmit power, receiver gain, TGC, dynamic range, pre-processing, post-processing, persistence
- 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
- Discuss different types of flows: plug, laminar, parabolic, turbulent
- Discuss artifacts: reverberation, mirror image, comet tail, ring-down, shadow, enhancement, edge shadow, speed error, registration error, section thickness, aliasing. Side lobe / grating lobe
- Discuss probe and system quality and reliability, bio-effect, safety, calibration, maintenance
- Discuss ALARA, thermal bioeffect, mechanical bioeffect, cavitation, temperature
- 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 and effectively operate Ultrasound 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.

### **EVALUATION**

- 1). Weekly Quiz – Homework assignments will be given on a weekly basis. Additionally, unannounced quizzes will be given in Class.
- 2). Final examination

Grading Scale:

|                     |     |
|---------------------|-----|
| Class participation | 20% |
| Quiz                | 20% |
| Homework            | 20% |
| Final               | 40% |
| 90 - 100            | A   |
| 80 - 89             | B   |
| 70 - 79             | C   |
| 60 - 69             | D   |
| Below 60            | F   |

To successfully complete this Course, the student must attend 80% of the Lectures, and pass Quiz, Homework, and Final Exam portions with a 70% of the score or better.

### **RESOURCE MATERIALS**

- “Diagnostic Ultrasound: Principles and Instruments” by Frederick W. Kremkau ISBN-13: 978-0-7216-3192-9, Edition 2006 or later
- ARDMS Physics Test samples from different sources
- “Ultrasonography Examination” by Appleton & Lange
- “Ultrasound Physics Review” by Davies Publishing

### **(\*) 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)
- A Reviewer for the Journal “Ultrasound in Medicine”
- A Reviewer for the Journal “Ultrasound in Medicine and Biology”

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

Revised: August 25, 2011