Basic Ultrasound Physics (DMSO 1302)

Credit: 3 semester credit hours (3 hours lecture)

Prerequisite/Co-requisite: Passed all previous sonography courses.

Course Description

Basic acoustical physics and acoustical waves in human tissue. Emphasis on ultrasound transmission in soft tissues, attenuation of sound energy, parameters affecting sound transmission and resolution of sound beams.

Required Textbook and Materials

1. Understanding Ultrasound Physics by Sidney K. Edelman, Ph. D
   ISBN# 0-9626444-4-7

Course Objectives

Upon completion of this course, the student will be able to:

1. Describe the interaction of sound and soft tissues.

2. Explain sound production and propagation.

3. Summarize the basic principles and techniques of ultrasound.

Course Outline

A. Graphs
B. Unit conversions
C. Sound waves
  a. Acoustic variables
  b. Types of waves
      i. Transverse waves
      ii. Longitudinal waves
  c. Interference
      i. Constructive
      ii. Destructive
D. Describing sound waves
  a. Parameters
      i. Period and frequency
      ii. Amplitude, power and intensity
      iii. Speed of sound
          1. Tissue type
          2. Stiffness
          3. Density
      iv. Wavelength
E. Pulsed wave ultrasound
  a. Parameters

DMSO 1302
Course Syllabus

        i. Pulse duration
       ii. PRP, PRF and duty factor
     iii. Spatial pulse length

F. Intensities
    a. Methods for measuring intensities
        i. Spatial
       ii. Temporal
     iii. Pulsed
    b. The ten commandments of intensity

G. Interaction of Sound and Media
    a. Decibels
        i. Logarithms
       ii. Positive dB
     iii. Negative dB
    b. Attenuation
        i. Factors
            1. Reflection
                a. specular
            2. Scattering
                a. Raleigh's
            3. absorption
       ii. Relationship
    c. Attenuation coefficient
        i. Soft tissue
       ii. Other than soft tissue
    d. Half-value Layer thickness

H. Reflection and transmission
    a. Angles
    b. Normal incidence
    c. Oblique incidence

I. Intensity reflection coefficient (IRC)

J. Intensity Transmission Coefficient (ITC)

K. Refraction
    a. Different propagation speeds
    b. Oblique incidence
    c. Snell's Law

L. Range equation
    a. Time of flight
    b. Go-return time
    c. 13-microsecond rule

M. Axial resolution
    a. Determined by
    b. Synonyms
    c. Typical values

N. Piezoelectric effect

O. Transducers

  a. Basic construction
    i. Matching layer
    ii. Damping material
  b. Bandwidth
  c. Q factor
P. Transducer frequency
  a. Continuous wave
  b. Pulsed wave
Q. Shape of a sound beam
R. Anatomy of a sound beam
  a. Focus
  b. Near zone
  c. Far zone
  d. Focal zone
S. Determining focal depth
T. Sound beam divergence
U. Huygens' Principle
V. Lateral resolution
  a. Determined by
  b. Synonyms
  c. Typical values
W. Focusing
  a. Mechanical
    i. External focusing
    ii. Internal
  b. Electronic
    i. Phased array
X. Display modes
  a. A-mode
  b. B-mode
  c. M-mode
Y. Transducers
  a. 2D Imaging
  b. Types of Transducers
    i. Mechanical
    ii. Sequential
    iii. Phased Array
    iv. Vector
  c. Elevation Resolution
  d. Focusing
    i. Dynamic Receive Focusing
    ii. Dynamic Aperture
  e. 3D/4D Imaging

Grade Scale

       93 – 100 A
       85 – 92   B
       75 – 84   C
       68 - 74   D (not able to continue in sonography program)

Course Evaluation

Semester grades will be calculated according to the following criteria:
1.   Unit tests   **100%**

Course Requirements

1. Unit tests
2. Class participation
3. Daily work assignments (worksheets, reading assignments, presentations)

Course Policies

1.   No food, drinks, or use of tobacco products in class.

2.   Beepers, cell phones, head phones and any other electronic devices must be turned off while in class.

3.   Do not bring children to class.

4.   If a unit test is missed, arrangements will be made with the instructor to take the test in a timely manner.

5.   Attendance Policy: Absences must be limited to serious illness and/or immediate family emergencies. Unexcused absences are not allowed. **Three (3) absences will result in a letter grade reduction. Excessive tardiness (more than 10 minutes/class or more than 2 consecutive classes)** will result in an absence being awarded. In the event that LIT is forced to cancel classes due to inclement weather, DMS classes and clinical rotation will also be canceled. Notification of closures will be made through local radio and TV stations. Students out of the immediate broadcast area should contact the Program Director for information. It is extremely important that students communicate with the faculty regarding absences by telephone and/or email at all times.

6.   All assignments are due when stated. Late assignments will result in a drop of **10** points per late day, and more than five days past due will result in a grade of **0**.   If a student has an excused absence with written documentation, assignments will be accepted at the beginning of class upon return. Missed in-class assignments receive a grade of **0**.

7.   Cheating on any (lecture/lab) exam results in immediate dismissal from the program and an **F** for the course.

8.　　　If you wish to drop a course, the student is responsible for initiating and completing the drop process. If you stop coming to class and fail to drop the course, you will earn an "**F**" in the course.

Disabilities Statement

The Americans with Disabilities Act of 1992 and Section 504 of the Rehabilitation Act of 1973 are federal anti-discrimination statutes that provide comprehensive civil rights for persons with disabilities. Among other things, these statutes require that all students with documented disabilities be guaranteed a learning environment that provides for reasonable accommodations for their disabilities. If you believe you have a disability requiring an accommodation, please contact the Special Populations Coordinator at (409) 880-1737 or visit the office in Student Services, Cecil Beeson Building.

Course Schedule

Week of	Topic	Reference
Week 1	Definitions and basic units	Edelman: pgs. 1-10
Week 2	Chapter 2 Sound waves	Edelman: pgs. 11-18
Week 3	Chapter 3 Describing sound waves	Edelman: pgs. 19-25
Week 3	Chapter 3 - Parameters	Edelman: pgs. 26-33
Week 4	Chapter 3 – propagation speed	Edelman: pgs. 34-44
Week 4	Chapter 4 – Pulsed wave US	Edelman: pgs. 45-65
Week 5	**Test I**	
Week 5	Chapter 5 - Intensity	Edelman: pgs. 67-70
Week 6	Chapter 5 – methods for measuring intensities	Edelman: pgs. 71-72
Week 6	Chapter 6 – Interaction of Sound and Media	Edelman: pgs. 73-87
Week 7	Chapter 6 – Decibels, normal incidence and oblique incidence, refraction, range equation	Edelman: pgs. 73-104
Week 8	**Test 2**	
Week 8	Transducer, Sound beams	Edelman: pgs. 130-143
Week 9	Axial and Lateral resolution,	Edelman: pgs. 145-154
Week 10	Focusing, Display modes	Edelman: pgs. 154-162
Week 11	**Test 3**	
Week 12	2D Imaging – transducers	Edelman: pgs. 167-188
Week 13	2D Imaging – transducers	Edelman: pgs. 167-188
Week 14	2D Imaging – transducers	Edelman: pgs. 167-188

| Week 15 | **Test 4** | |
| Week 16 | **Review and Final** (If required) | |

Contact Information:

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