DMS-525: ULTRASOUND PHYSICS AND INSTRUMENTATION I (FORMERLY DMS-125)

Effective Term
Fall 2024

BOT Approval Date
01/11/2024

Discipline
DMS - Diagnostic Medical Sonography

Course Number
525

Course Title
Ultrasound Physics and Instrumentation I (formerly DMS-125)

Short Title
Ultrasnd Phy/Inst I

Credit Status (CB 04)
D - Credit - Degree applicable

Units

Lecture Units
2.00

Total Units
2.00

Hours

Lecture Contact Hours
32-36

Out of Class Hours Lecture
64-72

Total Contact Hours
32 - 36

Total Out of Class Hours
64 - 72

Total Student Learning Hours
96 - 108

Distance Education
Yes

Distance Education

Distance Education Type
Hybrid Only

What will be done in face-to-face meetings

Face to face meetings will be generally utilized for lab demonstrations by the instructor; hands-on student learning and practice of physics concepts and instrumentation; Lab practical evaluations will be done in the campus lab.

Are you using publisher content?

No

Regular Substantive Interaction

Instructor-to-student, student-to-student, and student-to-content contact shall be distributed in a manner that will ensure regular substantive interaction (RSI) is maintained not only weekly but also for the duration of the course. Instructor interactions should be equivalent in time, quality and consistency to the engagement students would receive in a face-to-face course—for example, through announcements, discussion participation, personalized feedback, video messages, or other instructional communications. Instructors are expected to be responsive to student inquiries within a 24-72 hour time frame excluding holidays. RSI will be maintained through a variety of methods: • Orientation - Students must be oriented to the online and face-to-face portions at the start of the course. • Announcements - Announcements using the course management system must be posted at least weekly to keep students current on course events, due dates, materials, etc. • Discussion Forums - Content-related discussion forums within the designated CMS will include appropriate instructor participation and will be initiated and maintained, with timely feedback provided. Instructors are required to monitor the discussions and related activities to provide guidance and direction. Open-ended discussion boards may be used to further learning and interaction. • MSJC Communication – Instructor will use MSJC-administered communication tools (such as email or the designated CMS communication tools) to regularly communicate with and provide ease of access to students. • Timely Feedback - Timely feedback on student work will be provided by the instructor, which may include comments and/or rubrics, within the Grades area of the designated CMS. • Scheduled Meetings – Hybrid and synchronous courses will meet at regularly scheduled times. ADA Compliance - All course interactions and content must be designed with accessibility in mind and meet ADA requirements.

Catalog Description

This is the first of two sequential courses designed to teach Ultrasound Physics and Instrumentation. The focus of Ultrasound Physics and Instrumentation I is the basic mathematics used in the physics of sound, elementary principles of ultrasound physics and instrumentation, the propagation of ultrasound through tissue, Ultrasound transducers, pulse echo instruments and the principles of pulse echo imaging. (formerly DMS-125)

Requisites

Prerequisite(s)

Prerequisite(s) (must be taken before)
Acceptance into the Diagnostic Medical Sonography Program.

Codes

TOP Code (CB 03)

1227.00* - *Diagnostic Medical Sonography

CIP Code

51.0910 - Diagnostic Medical Sonography/Sonographer and Ultrasound Technician.

Repeatability Code

No

Grading Option

Letter grade OR P/NP

Learning Objectives

Learning Objectives

Learning Objective
1. Analyze the basic mathematical concepts as they are related to ultrasound physics and instrumentation.
2. Compare the nature of sound and the properties of sound waves and how the different body tissues that effect the sound and the image.
3. Differentiate between the frequencies used in ultrasound and why they are so important in diagnostic ultrasound imaging

4. Apply the concept of pulsed waves to image formation.
5. Illustrate the affect of an image by manipulating the parameters of pulsed ultrasound.
6. Analyze how a transducer generates the ultrasound pulses.
7. Illustrate how a transducer receives echoes.
8. Compare linear, convex, phased and vector array transducers.
9. Differentiate between three aspects of detail resolution.
10. Evaluate the primary components of sonographic instruments.
11. Explore the contributions of diverse historical figures in physics as a universal language.

Learning Outcome Information

Course Learning Outcomes

Learning Outcome
1. Students will calculate the pulse repetition frequency of a pulse repetition period of 5 ms.
2. Student will calculate the duty factor % using the equation x=(pulse duration)/PRP x100.
3. Students will determine the elapsed time from a pulse creation to the pulse reception (round trip).
4. Students will analyze the impact of diverse perspectives in the advancement of physics.

Program Learning Outcomes

Learning Outcome
1. Apply knowledge of proper use of ultrasound equipment and demonstrate image improvement through manipulating the instrumentation of the equipment.
2. Complete the American Registry of Diagnostic Medical Sonographers Physics and Instrumentation exam and one or more specialty exams of Abdomen and Obstetrics/Gynecology.

Institutional Learning Outcomes

Aesthetic Awareness: The student will identify and evaluate how aesthetic expression leads to an appreciation of social and cultural context as well as the values of art and nature.
Critical Thinking: The student will analyze problems, gather and synthesize relevant information, evaluate ideas, information, and evaluate alternative points of view to create, innovate and implement effective solutions.
Information and Technology Literacy: The student will access, interpret, evaluate, and apply relevant information sources and digital media effectively, and in an ethical and legal manner.
Scientific Awareness: The student will apply the scientific method of inquiry to assess potential solutions for real-life challenges by employing science-based knowledge and methodologies in daily life.

Content

Course Lecture Content

I. Basic Mathematics

- A. Numbers
  - 1.Basic mathematical notation
  - 2. Basic mathematical definitions
- B. Fractions, Decimal form, and Percentages
- C. Reciprocals
- D. Units
- E. Variables
- F. Applying reciprocals
- G. Numbers raised to a power
  - 1. Positive powers
    - a. Dimensional Measurement
  - 2. Numbers to a negative power
  - 3. Numbers to the zero power and exponent rules

H. Exponential Form (Scientific Notation)
I. Non-metric system unit conversion
J. The metric system and metric abbreviations
1. Metric abbreviations
a. Complementary (reciprocal) metric units
2. Abbreviations: Physical Units
a. Combining abbreviations
3. Reciprocals of metric units
4. Converting between metric units
K. Proportionality
1. Graphs
a. Labeling
2. Direct Linear (simple) proportionality
3. Inverse (simple) proportionality
a. Reciprocals
L. Distance Equation

II . Elementary Principles

A. Historical exploration
1. Universal language
2. Diversity in contemporary physics
a. Contributions of diverse individuals and cultures
A. Nature of Ultrasound
1. Definition of sound
a. Propagation of vibration
(1) compression
(2) Rarefaction
2. Differentiation between audible sound and ultrasound
B. Frequency, Wavelength, Propagation Speed
1. Definition of terms
2. Relationships
C. Properties of Ultrasound Waves
1. Amplitude
2. Pressure
3. Power
4. Intensity
D. Decibels
1. Definition
a. related to intensity
b. related to amplitude
2. Numerical examples
E. Physical Units
1. Scientific notation
2. Metric notation (e.g., micro, Mega)
3. Common units
F. Measurement Dimensions
1. Distance
a. Linear
b. Circumference
2. Area

3. Volume I

III. Propagation of Ultrasound through Tissues

A. Speed of Sound
1. Average speed of sound in tissues
2. Range of propagation speeds in the body
a. air
b. soft tissue (average)
c. soft tissue: specific tissues (e.g., muscle, fat, parenchyma)
d. bone

B. Reflection
1. Characteristic of acoustic impedance – definition
2. Reflection and transmission at specular interfaces
a. interface size and contour (smooth or irregular)
b. dependence on angle
c. dependence on acoustic impedance mismatch
3. Scattering
a. definition of scattering
b. frequency dependence (Rayleigh scattering)
c. Interface contour (smooth or irregular)
d. contrast media
e. harmonics

C. Refraction
1. Definition of refraction
2. Dependence of angle
3. Dependence of velocity mismatch
4. Numerical example

D. Attenuation
1. Definition and sources of attenuation
a. Scattering
b. Absorption
(1) heat
(2) Measurement
c. Reflection
2. Typical values in soft tissue
3. Variation with frequency - numerical example
4. Effects on images

E. Useful Diagnostic Frequency Range
1. Numerical values
2. Tradeoff: penetration vs. spatial resolution

F. Terminology Associated with Image Characteristics
1. Echogenic (e.g., hyperechoic, hypoechoic, anechoic, isoechoic, etc.)
2. Homogeneity, Heterogeneity, etc.
3. Other

IV. Ultrasound Transducers

A. The Piezoelectric Effect
1. Definition and concept
2. Curie point
3. Piezoelectric materials

B. Transducer Construction and Characteristics

1. Thickness resonance of crystal
2. Operating (resonance) frequency
   a. Crystal thickness
   b. Speed of sound in crystal material
3. Frequency characteristics (spectrum)
   a. Bandwidth
      (1) Quality factor
      (2) Effect of damping
   b. Multi-Hertz
      (1) Harmonics
4. Damping
5. Matching layer-numerical example

C. Sound Beam Formation - Near Field and Far Field (Fresnel and Fraunhofer Zones)
1. Interference phenomena
   a. Huygen's principle
   b. diffraction (divergence)
   c. Bandwidth
2. Length of near field (focal distance)
3. Shape of near field and far field
   a. Beam width b. Natural focus
4. Dependence on frequency and crystal or aperture size

D. Axial Resolution
1. Dependence on spatial pulse length/ pulse duration
2. Numerical example
3. Effect of damping
4. Transducer frequency spectrum-relation to pulse duration
5. Bandwidth

E. Lateral Resolution
1. Dependence on beam width
2. Frequency
3. Transducer size and focal characteristics
4. Range

F. Slice Thickness Resolution (Elevational Resolution)
1. Dependence on beam width
2. Transducer array and focal characteristics
3. Frequency
4. Lateral and axial resolution relationship

G. Focusing
1. Methods of focusing
   a. Mechanical (internal and external)
   b. Electronic (transmit and receive)
2. Focal zone characteristics
   a. Focal distance (length)
   b. Focal zone region
      (1) Maximum intensity

H. Transducer Arrays and Image Appearance
1. Mechanical and/or electronic construction
2. Multiple element construction
   a. Linear array

b. Curved array
c. Annular array
d. Multi-dimensional array
3. Multiple element operation
a. Sequenced
b. Phased
c. Annular
d. Vector
e. Multi-dimensional
4. Beam Steering
a. Transmission time delays
b. Reception time delays
5. Beam focusing
a. Time delays
b. Dynamic reception focus
c. Multiple transmission foci
d. Apodization
e. Subdicing
f. Dynamic aperture
I. Transducer Care and Maintenance

V. Pulse Echo Instruments

A. Range Equation - General Concepts
B. Pulsing Characteristics
1. Pulse repetition frequency
2. Pulse repetition period
3. Pulse duration
4. Spatial pulse length
5. Duty factor
C. Transmitter (Output)
1. Effect of transmitter voltage on penetration
2. Effect of transmitter voltage on intensity and on patient exposure
D. Receiver
1. Amplification (overall gain)
2. Compensation (swept gain-TGC or DGC)
a. Attenuation with range
b. Effects on return signal and display
c. Dynamic frequency tuning
d. Harmonic processing
3. Compression
a. Dynamic range
(1) Definition
(2) Dynamic range (receiver)
a. Compare to other system components
b. Numerical values; decibels
4. Demodulation
a. Rectification
b. Smoothing (enveloping)
5. Rejection

VI. Principles of Pulse Echo Imaging

1. Principal Display Modes (A-mode, B-mode, 3-D, M-mode)
   a. Definition of each mode
   b. Information displayed on each mode
   c. Advantages and disadvantages of each mode
2. Principles of Real-time, B-Mode Image Formation
   a. Relationship between echo amplitude and B-mode display
   b. Positioning of echoes
   c. Harmonics

3. Scanning Speed Limitations
1. Applications of range equation and relationship to pulsing characteristics
2. Real-time systems-relationships between
a. Pulsing characteristics
b. Frame rate and time required to generate one frame
c. Number of lines per frame
d. Number of focal regions
e. Field of view (e.g., sector angle)
f. Image depth (penetration)
3. Temporal resolution, ability to evaluate rapid motion.

VII. Ultrasound Transducers

A. The Piezoelectric Effect
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2. Curie point
3. Piezoelectric materials

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2. Operating (resonance) frequency
a. Crystal thickness
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C. Sound Beam Formation - Near Field and Far Field (Fresnel and Fraunhofer Zones)
1. Interference phenomena
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c. Bandwidth
2. Length of near field (focal distance)
3. Shape of near field and far field
a. Beam width
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4. Dependence on frequency and crystal or aperture size

D. Axial Resolution
1. Dependence on spatial pulse length/ pulse duration
2. Numerical example

3. Effect of damping
4. Transducer frequency spectrum-relation to pulse duration
5. Bandwidth
E. Lateral Resolution
1. Dependence on beam width
2. Frequency
3. Transducer size and focal characteristics
4. Range
F. Slice Thickness Resolution (Elevational Resolution)
1. Dependence on beam width
2. Transducer array and focal characteristics
3. Frequency
4. Lateral and axial resolution relationship
G. Focusing
1. Methods of focusing
a. Mechanical (internal and external)
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2. Focal zone characteristics
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H. Transducer Arrays and Image Appearance
1. Mechanical and/or electronic construction
2. Multiple element construction
a. Linear array
b. Curved array
c. Annular array
d. Multi-dimensional array
3. Multiple element operation
a. Sequenced
b. Phased
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4. Beam Steering
a. Transmission time delays
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VII. Pulse Echo Instruments

1. Range Equation - General Concepts
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(2) Dynamic range (receiver)
a. Compare to other system components
b. Numerical values; decibels
6. Demodulation
a. Rectification
b. Smoothing (enveloping)
5. Rejection

Methods of Instruction

Method

Group Projects

Integration

Each week, the instructor will facilitate weekly online Kahoot game. The quiz will consist of physics concepts for each weeks' chapter as a review and will be played by the entire class. To create a Kahoot game, the instructor will log onto Kahoot.com, create a user name and password, and follow the steps to add questions and mark the correct answer. In the classroom, the overhead projector will display the Kahoot game. Students will use an android or Iphone, log into Kahoot.com, enter pin number and name. As each question is displayed, students will select their answer using their phone. All answers will be displayed anonymously with the fastest time recorded for each question and final game winner.

DE Adaptations for MOI

Kahoot! can be played online as a synchronous Zoom meeting with classmates or as an individual chapter review. Using an android or Iphone to log into Kahoot.com, enter the game pin number and player name. Answer questions in the fastest time to win the game. Answers will be entered via cloud from each phone at students home. The game can be observed or recorded via Zoom

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Method

Homework

Integration

Instructor will post a weekly reading assignment and chapter homework questions from the Physics and Instrumentation textbook by Sydney Edelman or Sandra Hagen-Ansert on Canvas CMS under files and displayed in the syllabus view. Students will download and print the homework questions. The homework question document will be turned in during the next class meeting. Homework questions will be reviewed in class, students will share one question that they missed with their adjacent classmate. The instructor will clarify any questions or wrong answers in class as a group.

DE Adaptations for MOI

Instructor will post a weekly reading assignment and chapter questions from the Physics and Instrumentation textbook by Sydney Edelman or Sandra Hagen-Ansert on Canvas CMS under files and displayed in the syllabus view. Students will download and print the homework questions. The homework question document will be uploaded before the next class meeting.

Method

Discussion

Integration

The instructor will lead an online web search discussion for a current or historical person from a marginalized group who has made contributions or discoveries to sound physics. The students will participate as a class to share their findings as a group in a classroom discussion: The persons name, contribution or discovery, and 3 facts about this person.

DE Adaptations for MOI

The instructor will post a prompt for an online web search for a current or historical person from a marginalized group who has made contributions or discoveries to sound physics. Students will share their findings in the Discussion board on Canvas CMS: The persons name, contribution or discovery, and 3 facts about this person.

Method

Individual Projects

Integration

At the end of the semester, the instructor will facilitate a student led group presentation and demonstration in the classroom: Students will individually prepare and present a Power Point slide show on a chosen topic of Ultrasound Physics and Instrumentation from chapters 13-24 of the assigned text. Students should include a visual learning tool to demonstrate the location and function of the ultrasound instrumentation knobs to demonstrate a chosen topic. Lastly, complete a demonstration using an ultrasound machine platform keyboard in the classroom lab. Examples of topics for Power Point presentation should include one or more of the following concepts: proper transducer selection, gain optimization, depth, TGC, focal zone, imaging artifacts, and image resolution.

DE Adaptations for MOI

At the end of the semester, the instructor will facilitate a student lead an online group presentation and demonstration. The student will upload a Power Point presentation to Canvas, this will be presented via share screen on Zoom with the class. An image of the ultrasound machine platform keyboard will also be shared via Zoom and presenter will demonstrate which instrumentation (knob/toggle) to use to acquire the goal of their presentation. Examples of topics for Power Point presentation should include one or more of the following concepts: proper transducer selection, gain optimization, depth, TGC, focal zone, imaging artifacts, and image resolution.

Method

Observation and Demonstration

Integration

Using a skills check-off sheet of the required instrumentation, The instructor will facilitate student demonstrations of their knowledge of physics and instrumentation concepts, discussed in class, by having students show manipulation of the ultrasound equipment and reasoning for: transducer selection, frequency settings, decibels, brightness gain, depth, and focal zones. Students will demonstrate their knowledge of equipment function and instrumentation on an ultrasound machine in the classroom lab by explaining each required knob and its function to the instructor. Example: gain optimization, depth, TGC, focal zone, frequency.

DE Adaptations for MOI

None, demonstrations need to be done in the campus lab using an ultrasound machine.

Method

Lecture

Integration

The instructor will post power point lectures with Canvas voice-over studio recordings each week in a power point format to instruct students about basic physics and instrumentation concepts. Weekly chapters will include sound physics and instrumentation concepts as listed in the course syllabus. Ultrasound physics and instrumentation concepts include: frequency, wavelength, propagation speed, resolution, transducer function.

DE Adaptations for MOI

Power Point lectures and Voice-over lectures will be posted on Canvas CMS. Students will review the power point or voice-over during each week of study and be prepared to participate in an online Zoom to review with the instructor using a Kahoot review quiz each week. The instructor will clarify concepts that students miss on the review quiz.

Method

Observation and Demonstration

Integration

The instructor will conduct lab demonstrations of physics and instrumentation concepts discussed in weekly chapters, every 4 weeks during face to face meetings. Demonstrations will be done by the instructor through manipulation of the ultrasound equipment (instrumentation) and reasoning for: transducer selection, frequency settings, decibels, brightness gain, depth, and focal zones. The instructor will include demonstrations of lateral and axial resolution using an ultrasound calibration phantom in the campus lab.
This MOI supports the assignment example: Demonstrate (Scan) and explain which focal points are examples of lateral resolution, using the calibration phantom and image displayed on the ultrasound monitor. Example: As sound travels through fluid filled structures, cysts or urinary bladder, the sound travels faster and creates "through transmission" artifact posterior to the fluid on an ultrasound image.

DE Adaptations for MOI

None, this demonstration must be done in the campus lab on an ultrasound machine.

Method

Discussion

Integration

9. Class discussions will use the CMS discussion board feature. Students will post their answer to the prompt and then reply to at least one classmates post. The instructor will respond to each student post with additional information and/or clarifications. Discussion example: Please discuss how the application of physics concepts relates to the creation of optimal diagnostic ultrasound images when using the ultrasound machine.
Online activity example: A photo is taken of each different ultrasound machine keyboard, then students will identify specific platform keys and label the function that each one controls on the printed handout answer sheet.

DE Adaptations for MOI

Class discussions will use the CMS discussion board feature. Students will post their answer to the prompt and then reply to at least one classmates post. The instructor will respond to each student post with additional information and/or clarifications. Discussion example: Please discuss how the application of physics concepts relates to the creation of optimal diagnostic ultrasound images when using the ultrasound machine.

Methods of Evaluation

Method

Self-Evaluation

Integration

Kahoot! quiz can be displayed by instructor in the classroom. Students answer the questions via phone by entering the game pin number. This MOE is a review for students for the prior weeks' concepts and they do not receive a grade for this activity. The MOE is a teaching method to evaluate student understanding as a percentage of the class, so that the instructor can further clarify concepts if the Kahoot! question has wrong answers.
This MOE can also be used as a student self evaluation method to review the prior week concepts. Students do not receive a grade, this prepares them for the online graded quiz.

DE Adaptations for MOE

Kahoot! quiz can be displayed by instructor in a group Zoom session or posted as an individual concept review quiz for each student. Students answer the questions via phone by entering the game pin number. This MOE is a review for students for the prior weeks' concepts and they do not receive a grade for this activity. The MOE is a teaching method to evaluate student understanding as a percentage of the class, so that the instructor can further clarify concepts if the Kahoot! questions have wrong answers.
This MOE can also be used as a student self evaluation method to review the prior week concepts. Students do not receive a grade, this prepares them for the online graded quiz.

Method

Homework

Integration

Instructor will post a weekly reading assignment and chapter homework questions from the Physics and Instrumentation textbook by Sydney Edelman or Sandra Hagen-Ansert on Canvas CMS under files and displayed in the syllabus view. Students will download and print the homework questions. The homework question document will be turned in during the next class meeting. Homework questions will be graded for correctness and reviewed in class, students will share one question that they missed with their adjacent classmate and discuss why they may have answered incorrectly. The instructor will clarify any questions or wrong answers in class as a group.

DE Adaptations for MOE

Instructor will post a weekly reading assignment and chapter questions from the Physics and Instrumentation textbook by Sydney Edelman or Sandra Hagen-Ansert on Canvas CMS under files and displayed in the syllabus view. Students will download and print the homework questions. The homework question document will be uploaded before the next class meeting. Homework will be graded for correctness of multiple choice questions. The instructor will clarify any questions or wrong answers with written feedback on Canvas CMS comments option.

Method

Class Participation

Integration

The instructor will moderate the classroom discussion from an online web search for a current or historical person from a marginalized group who has made contributions or discoveries to sound physics. Students will be evaluated on their willingness to contribute to the discussion earning points for sharing: the persons name, contribution or discovery, and 3 facts about this person.

DE Adaptations for MOE

The instructor will post a prompt on Canvas CMS, Discussions board: Conduct an online web search for a current or historical person from a marginalized group who has made contributions or discoveries to sound physics. Students will be evaluated on their willingness to contribute to the discussion earning points for a post that includes: the persons name, contribution or discovery, and 3 facts about this person.

Method

Presentations

Integration

At the end of the semester, the instructor will facilitate a student led presentation and demonstration in the classroom: Students will individually prepare and present a Power Point slide show on a chosen topic of Ultrasound Physics and Instrumentation from chapters 13-24 of the assigned text. Students should include a visual learning tool to demonstrate the location and function of the ultrasound instrumentation knobs to demonstrate a chosen topic. Lastly, complete a demonstration using an ultrasound machine platform keyboard in the classroom lab. Examples of topics for Power Point presentation should include one or more of the following concepts: proper transducer selection, gain optimization, depth, TGC, focal zone, imaging artifacts, and image resolution.

Students will be graded using a rubric for completeness and accuracy of their power point and demonstration in the lab: 3 points=high level of understanding and accuracy , 2 points= adequate level of understanding and accuracy 1 point= low level of

understanding and accuracy, 0 points= Student does not display understanding or accuracy. Feedback from the instructor will be in writing on the rubric grading sheet.

DE Adaptations for MOE

At the end of the semester, the instructor will facilitate a student led presentation and demonstration as a synchronous Zoom meeting: Students will individually prepare and present a Power Point slide show on a chosen topic of Ultrasound Physics and Instrumentation from chapters 13-24 of the assigned text. Students should include a visual learning tool to demonstrate the location and function of the ultrasound instrumentation knobs to demonstrate a chosen topic.

Demonstration must be done in the campus lab using an ultrasound machine platform keyboard.

Students will be graded using a rubric for completeness and accuracy of their power point and demonstration in the lab: 3 points=high level of understanding and accuracy , 2 points= adequate level of understanding and accuracy 1 point= low level of understanding and accuracy, 0 points= Student does not display understanding or accuracy. Feedback from the instructor will be in writing on the rubric grading sheet.

Method

Simulation

Integration

The instructor will evaluate student knowledge of a standard ultrasound machine console by asking them to identify each required knob from a skills list and demonstrate how its function affects the image optimization. Evaluation will be scored and initialed by the instructor using a skills check off sheet. To demonstrate a students knowledge of physics and instrumentation, students will be required to show manipulation of the ultrasound equipment and reasoning for: transducer selection, frequency settings, decibels, brightness gain, depth, TGC, and focal zones and frequency.

Evaluation will be done using a rubric for each required function identification as the instructor observes the demonstration: 3 points=high level of understanding and accuracy; 2 points= adequate level of understanding and accuracy; 1 point= low level of understanding and accuracy; 0 points= Student does not display understanding or accuracy. Feedback from the instructor will be in writing on the rubric grading sheet.

DE Adaptations for MOE

None, evaluation needs to be demonstrated using the ultrasound machine in the campus lab.

Method

Quizzes

Integration

Weekly quizzes based on text chapters will allow students to demonstrate formative learning and evaluate the student's weekly understanding of ultrasound physics and instrumentation concepts that include: frequency, wavelength, propagation speed, resolution, transducer function. Evaluation is scored on the number of correct answers to multiple choice, key term matching, and fill -in questions.

Quizzes from textbook chapters will be given online through Canvas CMS. The quizzes are multiple choice, key term matching, and fill -in questions and found under the "Quiz" tab and also listed in the "modules" for weekly assignments. Students will be graded on correctness and view their grades at the end of each quiz and recorded in the "Grades" tab in CMS, they will receive feedback from the instructor via "comments" option in Canvas CMS or through "Announcements" to clarify any questions for the entire class.

DE Adaptations for MOE

Weekly quizzes based on text chapters will allow students to demonstrate formative learning and evaluate the student's weekly understanding of ultrasound physics and instrumentation concepts that include: frequency, wavelength, propagation speed, resolution, transducer function. Evaluation is scored on the number of correct answers to multiple choice, key term matching, and fill -in questions.

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Method

Exams/Tests

Integration

Exams will be posted online through Canvas CMS. Examinations will be given at midterm and a final to assess the students ability to retain and process information of physics concepts that includes dynamic range, brightness gain, depth, focal zones, decibels, attenuation, speed of sound calculations, and machine instrumentation. Exams will be evaluated on the number of correct answers to multiple choice, key term matching, and fill -in questions. Exams will be found in the "Quizzes" tab on Canvas and listed in the weekly modules. Students will view their grades at the end of each exam and recorded in the "Grades" tab in CMS, they will receive feedback from the instructor via "comments" option in Canvas CMS or through "Announcements" to clarify any questions for the entire class.

DE Adaptations for MOE

Exams will be posted online through Canvas CMS. Examinations will be given at midterm and a final to assess the students ability to retain and process information of physics concepts that includes dynamic range, brightness gain, depth, focal zones, decibels, attenuation, speed of sound calculations, and machine instrumentation. Exams will be evaluated on the number of correct answers to multiple choice, key term matching, and fill -in questions. Exams will be found in the "Quizzes" tab on Canvas and listed in the weekly modules. Students will view their grades at the end of each exam and recorded in the "Grades" tab in CMS, they will receive feedback from the instructor via "comments" option in Canvas CMS or through "Announcements" to clarify any questions for the entire class.

Method

Simulation

Integration

The student will demonstrate their knowledge of physics and instrumentation while using an ultrasound machine in the classroom lab. This is a practicum exercise will consist of: the instructor creating an unacceptable image on the display monitor and then the student will demonstrate how to correct the image. Evaluation will be conducted by using a graded skills check-off sheet: Categories of : Student demonstrates minimal understanding, needs improvement, adequate, proficient. Students will receive grades online through Canvas Grade book and feedback via written critique on their check-off sheet.

DE Adaptations for MOE

None, evaluation needs to be done in the campus lab using an ultrasound machine.

Method

Other

Integration

Class online discussions will use the Canvas CMS discussion board feature. Students will post their answer to the prompt and then reply to at least one classmates post. The instructor will respond to each student post with additional information and/or clarifications. Evaluation of the discussion is determined by a well formulated, accurate answer and participation. Students post is required to be at least one paragraph and a reply to another students post. Grade points will be subtracted for an incomplete or inaccurate answer. Feedback will be given through the Canvas gradebook comments feature.

DE Adaptations for MOE

Class online discussions will use the Canvas CMS discussion board feature. Students will post their answer to the prompt and then reply to at least one classmates post. The instructor will respond to each student post with additional information and/or clarifications. Evaluation of the discussion is determined by a well formulated, accurate answer and participation. Students post is required to be at least one paragraph and a reply to another students post. Grade points will be subtracted for an incomplete or inaccurate answer. Feedback will be given through the Canvas gradebook comments feature.

Assignments

Assignment Type

Other

In-class and/or outside of class

In-class
Outside of class

Formative or Summative

Formative

Assignment

Participate in a weekly online Kahoot review quiz. The quiz will consist of physics concepts for each weeks' chapter as a review and will be played by the entire class.
In the classroom, the overhead projector will display the Kahoot game, using an android or Iphone- log into Kahoot.com, enter game pin number and your name. As each question is displayed, select the correct answer using an android or Iphone. All answers will be displayed anonymously with the fastest time recorded for each question and final game winner's name.

How assignment will be adapted in online format

Kahoot! can be played online as a synchronous Zoom meeting with classmates or as an individual chapter review. Using an android or Iphone to log into Kahoot.com, enter the game pin number and player name. Answer questions in the fastest time to win the game. Answers will be entered via cloud from each phone at students home. The game can be observed or recorded via Zoom

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Assignment Type

Reading

In-class and/or outside of class

Outside of class

Formative or Summative

Formative

Assignment

Complete the scheduled weekly reading assignment and chapter questions from the Physics and Instrumentation textbook by Sydney Edelman or Sandra Hagen-Ansert. The chapter questions document is located on Canvas CMS under files and also displayed in the syllabus view. Download and print the homework questions. The homework question document will be turned in during the next class meeting.

How assignment will be adapted in online format

Instructor will post a scheduled weekly reading assignment and chapter questions from the Physics and Instrumentation textbook by Sydney Edelman or Sandra Hagen-Ansert on Canvas CMS under files and displayed in the syllabus view. Download and print the homework questions. The homework question document will be uploaded before the next class meeting.

Assignment Type

Writing

In-class and/or outside of class

Outside of class

Formative or Summative

Formative

Assignment

Conduct an online web search for a current or historical person from a marginalized group who has made contributions or discoveries to sound physics. Share your findings as a group in a classroom discussion: The persons name, contribution or discovery, and 3 facts about this person.

How assignment will be adapted in online format

Conduct an online web search for a current or historical person from a marginalized group who has made contributions or discoveries to sound physics. Share your findings as a group in a classroom discussion: The persons name, contribution or discovery, and 3 facts about this person.

Assignment Type

Writing

In-class and/or outside of class

In-class
Outside of class

Formative or Summative

Summative

Assignment

At the end of the semester, prepare a Power Point presentation on a chosen topic of Ultrasound Physics and Instrumentation from chapters 13-24 of the assigned text. Include a visual learning tool to demonstrate the location and function of the ultrasound instrumentation knobs to demonstrate a chosen topic. Complete the demonstration using an ultrasound machine platform keyboard in the classroom lab. Examples of topics for Power Point presentation should include one or more of the following concepts: proper transducer selection, gain optimization, depth, TGC, focal zone, imaging artifacts, and image resolution.

How assignment will be adapted in online format

Upload a Power Point presentation to Canvas, this will be presented via share screen on Zoom with the class. An image of the ultrasound machine platform keyboard will be shared via Zoom and presenter will demonstrate which instrumentation (knob/toggle) to use to acquire the goal of their presentation. Examples of topics for Power Point presentation should include one or more of the following concepts: proper transducer selection, gain optimization, depth, TGC, focal zone, imaging artifacts, and image resolution.

Assignment Type

Other

In-class and/or outside of class

In-class

Formative or Summative

Summative

Assignment

Using a skills check-off sheet of the required instrumentation, practice and demonstrate your knowledge of equipment function and instrumentation on an ultrasound machine in the classroom lab by identifying each required knob and demonstrate how its function affects the image optimization. Example: gain optimization, depth, TGC, focal zone, imaging artifacts, and image resolution.

How assignment will be adapted in online format

None, needs to be demonstrated using the ultrasound machine in the campus lab.

Assignment Type

Reading

In-class and/or outside of class

Outside of class

Formative or Summative

Formative

Assignment

Study weekly chapters that include sound physics and instrumentation concepts as listed in the course syllabus. View Power Point lectures and listen to Voice-over lectures that are posted on Canvas CMS. Review the power point or voice-over during each week of study and be prepared to participate in an online Zoom to review with the instructor using a Kahoot review quiz each week. The instructor will clarify concepts that students miss on the review quiz in the next scheduled face to face class.

How assignment will be adapted in online format

Study weekly chapters that include sound physics and instrumentation concepts as listed in the course syllabus. View Power Point lectures and listen to Voice-over lectures that are posted on Canvas CMS. Review the power point or voice-over during each week of study and be prepared to participate in an online Zoom to review with the instructor using a Kahoot review quiz each week. The instructor will clarify concepts that students miss on the review quiz during a synchronous Zoom meeting.

Assignment Type

Writing

In-class and/or outside of class

Outside of class

Formative or Summative

Summative

Assignment

Complete Midterm and final exams at the mid-semester and end of the semester respectively. Exams will be given in a multiple choice and short answer format to assess your ability to retain and process information in physics and instrumentation. Exams will be posted on Canvas CMS under "quizzes" option and listed in the syllabus. Grades will be posted online and feedback from instructor through comments in gradebook option.

How assignment will be adapted in online format

Complete Midterm and final exams at the mid-semester and end of the semester respectively. Exams will be given in a multiple choice and short answer format to assess your ability to retain and process information in physics and instrumentation. Exams will be posted on Canvas CMS under "quizzes" option and listed in the syllabus. Grades will be posted online and feedback from instructor through comments in gradebook option.

Assignment Type

Other

In-class and/or outside of class

Outside of class

Formative or Summative

Formative

Assignment

Schedule an initial one-on-one Zoom meeting with instructor by email or Canvas mailbox during the first week of classes; meeting with the instructor will be done to ensure student understanding of course format, grading, and discuss any specific needs you need to be successful in the course.

Hybrid courses will meet at regularly scheduled times (at least 5 times per semester). In class, face to face, meetings will be scheduled according to the syllabus found online under "Syllabus" view on Canvas CMS. Face-to-face meetings will consist of chapter reviews using Kahoot quizzes, practicing skills in the lab, and lab demonstrations for skills check off.

How assignment will be adapted in online format

8. Schedule an initial one-on-one Zoom meeting with instructor by email or Canvas mailbox during the first week of classes; meeting with the instructor will be done to ensure student understanding of course format, grading, and discuss any specific needs you need to be successful in the course.

Hybrid courses will meet at regularly scheduled times (at least 5 times per semester). In class, face to face, meetings will be scheduled according to the syllabus found online under "Syllabus" view on Canvas CMS. Face-to-face meetings will consist of chapter reviews using Kahoot quizzes, practicing skills in the lab, and lab demonstrations for skills check off.

Assignment Type
Writing

In-class and/or outside of class
Outside of class

Formative or Summative
Formative

Assignment
Use the Canvas CMS discussion board to post your answer to the prompt: Discuss how the application of physics concepts relates to the creation of optimal diagnostic ultrasound images when using the ultrasound machine. Posts should be at least a paragraph in length and then reply to at least one classmates post. The instructor will respond to each students post with additional information and/or clarifications.

How assignment will be adapted in online format
Use the CMS discussion board to post your answer to the prompt: Discuss how the application of physics concepts relates to the creation of optimal diagnostic ultrasound images when using the ultrasound machine. Posts should be at least a paragraph in length and then reply to at least one classmates post. The instructor will respond to each students post with additional information and/or clarifications.

Assignment Type
Other

In-class and/or outside of class
In-class

Formative or Summative
Formative

Assignment
Students will demonstrate knowledge of lateral and axial resolution using an ultrasound calibration phantom in the campus lab. Example: Demonstrate (Scan) and explain which focal points are examples of lateral resolution, using the calibration phantom and image displayed on the ultrasound monitor.

How assignment will be adapted in online format
None, demonstrations must be done in the campus lab using an ultrasound phantom.

Assignment Type
Other

In-class and/or outside of class
In-class

Formative or Summative
Formative

Assignment
Compare and demonstrate how linear, convex(curved), phased array, and sector array transducers differ from each other. Example: Using the campus lab, activate each type of transducer: Linear, convex (curved), phased, and sector array. Compare the differences in each type of display and what type of exam each transducer is used for. Be prepared to explain your findings to your instructor.

How assignment will be adapted in online format

None, demonstrations must be done in the campus lab using an ultrasound machine.

Course Materials

Textbooks

Edelman, S. (2012). Understanding Ultrasound Physics, 4th Edition ESP. ISBN: 9780962644450
Penny, S.; Fox, T. (2018). Examination Review for Ultrasound: SPI Lippincott Williams & Wilkins. ISBN: 9781496377326
Hagen-Ansert, S. (2022). Textbook of Diagnostic Sonography 9th edition Elsevier.
ISBN: 9780323826495

Class Size Information

Class Size

30

Class Size Category

F - Individualized, skills#based instruction/field practice 30

Diversity and Inclusion

Explain how diversity and inclusion(e.g., gender, culture/race, sexuality, etc.) is infused into the course.

Diversity and inclusion are supported through classroom content that includes images or quotes of women and people from marginalized groups who have made contributions to physics theory and research. Course objectives and learning outcomes are supported through classroom discussions, proper imaging technique and protocols, which are presented to foster knowledge, team work, and patient advocacy in developing future healthcare professionals.

Describe how assignments, instruction, evaluation, course content, and interactions are contextualized for diverse learners promoting an equitable course.

The course resources are offered in multiple forms to offer diverse learning methods to students. Audio learners can utilize voice-over lectures; Visual learners can utilize power-point diagrams, textbook, lab demonstrations, and videos; Hands-on learners can utilize lab simulation and practice concepts or protocols in the campus lab; Interactions are created by using pairs and group projects.

Interactions

Explain how the course will incorporate student-to-student interaction.

This course has a lab component which enhances the classroom discussions with hands-on student interaction in pairs or groups. Assignment example: Create an online Kahoot! Quiz in groups of 2. The quiz will consist of physics concepts for each four weeks' chapters as a review and will be played by the entire class. Collaboration between students enhances student learning by working together as a team to formulate quiz questions and reinforce physics concepts.

Explain how the course will incorporate instructor-to-student interaction.

This course provides opportunities for students to observe instructor demonstrations of knobology, ultrasound machine, transducers, scanning protocols and then practice what was observed. Instructors interact through face-to-face lectures where students may ask questions. The CMS houses announcements, syllabi, voice-over lectures, and course schedule through modules. Instructor uses real-life experience stories during lectures to enhance student learning. Instructor encourages use of office hours or meeting after class if student needs assistance or guidance.

Explain how the course will incorporate student-to-content interaction.

This course has a detailed textbook which acts as a study guide and prepares them to attend the Edelman Physics conference and in passing the ARDMS SPI (Ultrasound Physics and Instrumentation) registry exam for sonographer credentialing. Students study text content, power point, video, and carry out hands-on tasks in the campus lab.

Explain how the course will incorporate student-to-self interaction (metacognitive).

This course provides opportunities for students to think about how they will make a plan that provides the best patient care and diagnostic interpretation from beginning to end of their interaction with each patient they care for. Students are encouraged to reflect on how sound is used to create diagnostic information.

Key: 1227