by.

Ultrasound Physics vCourse Test Prep & Review

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Ultrasound MedAcademy by R&A Blue Sonoworlds

Syllabus

Course Title	Ultrasound Physics vCourse
Course Number	N/A
Course Delivery Mode	Online/ Self-paced
Pre-requisites	None
Co-requisites	None
Credit Hours	14 SDMS CME
Contact Hours	N/A
Lecture Hours	14
Laboratory Hours	N/A
Externship Hours	0 hours
Outside Work Hours	As many as the student wants to use to success.
Textbook Title	*Understanding Ultrasound Physics*, 4th edition
Author	Sidney K. Edelman, Ph. D.
Publisher	ESP, Inc.
ISBN #	0962644455
Instructor Contact	Instructor: Alain Fernandez. BHS, RDMS, RMSKS, RDCS, RVT, RT(S) Email Address: alain@rabluesonoworlds.com Phone Number: (954) 247-4395 Office Hours: 4:00 PM - 8:00 PM
Course Schedule	Monday – Friday
Goal	To prepare competent entry-level general sonographers in the cognitive (knowledge), psychomotor (skills), and affective (behavior) learning domains.
Course Description	Presents in-depth training in the properties of ultrasound and Doppler physics, instrumentation, equipment operation, display systems, recording devices, image artifacts, biological effects of ultrasound and quality assurance methods.
Course Topics	• Ultrasound principles and properties • Transducer types and operation • Imaging instruments • Doppler Effect • Spectral Doppler instruments • Color Doppler instruments • Artifacts • Performance and safety
Course Objectives	Upon completion of the course, students are able to: Cognitive 1. Demonstrate knowledge and understanding of acoustical physics and ultrasound instrumentation.

4. Recognize various types of transducers and their applications.

Scope and Sequence	
Section 1: Ultrasound Physics Basic Principles/ 5 lectures	
Learning Objectives	1. Audible, infrasound, and ultrasound frequency ranges. 2. Relation between frequency, resolution and penetration. 3. Compression and rarefaction. 4. Longitudinal waves. 5. Concepts of pressure, density, and distance aka particle motion. 6. Frequency and period as inversely related acoustic parameters. 7. Mechanical waves. 8. The "three bigness parameters" : amplitude, intensity, and power. 9. Dependency of amplitude, intensity, and power initially on the system and after on the medium. 10. Mathematical relation between amplitude and intensity, amplitude and power, and power and intensity. 11. SATA, SPTA, SPTP 12. Bioeffects related to intensities values for unfocused and focused sound beams. 13. Propagation speed and its dependency on the stiffness and density of the medium. 14. Propagation speed value in soft tissue. 15. Wavelength. 16. Mathematical relation between wavelength and frequency. 17. Comparison between acoustic variables and parameters. 18. Operator adjustable parameters. 19. Acoustic parameters dependency. 20. Pulse duration.

	21. Spatial pulse length. 22. Pulse repetition period. 23. Pulse repetition frequency. 24. Duty factor.
Assigned Reading	*Understanding Ultrasound Physics*, Chapters 1 – 5
Suggested Learning Activities	• Review recordings and take notes about the concepts. Separate formulas from content. Maintain organization.
Evaluation	• Complete Basic Principles Quiz
Section 2: Interaction of Sound with the Medium/ 3 lectures	
Learning Objectives	1. Attenuation concept. 2. Relation between frequency and attenuation. 3. Decibels. 4. Types of reflections. 5. Impedance as an important determinant of the amount of reflection. 6. Impedance mismatch as a determinant of the amount of reflection. 7. Scattering. 8. Rayleigh scattering. 9. Absorption. 10. Attenuation coefficient. 11. Attenuation coefficient in soft tissue. 12. Half value layer thickness. 13. Total attenuation. 14. Integration of sound-medium interaction concepts through calculations. 15. Refraction. 16. Oblique incidence. 17. Snell's Law.
Assigned Reading	*Understanding Ultrasound Physics*, Chapters 6-7
Suggested Learning Activities	• Review recordings and take notes about the concepts. Separate formulas from content. Maintain organization.
Evaluation	• Complete Interaction of Sound with Medium Quiz
Section 3: Range Equation / 1 lecture	
Learning Objectives	1. The range equation.

	depth. 3. Concept of round trip time and total distance. 4. The 13 microseconds rule in soft tissue.
Assigned Reading	*Understanding Ultrasound Physics* Chapter 7
Suggested Learning Activities	• Review recordings and take notes about the concepts. Separate formulas from content. Maintain organization.
Evaluation	• Repeat Quiz 1 and Quiz 2
Section 4: Sound Beam Anatomy and Resolutions/ 3 lectures	
Learning Objectives	1. Transducer diameter. 2. Initial diameter. 3. Focal point. 4. Convergence. 5. Divergence. 6. Near zone. 7. Far zone. 8. Focal zone. 9. Relation between frequency, focal depth, and divergence. 10. Relation between sound beam initial diameter, focal depth, and divergence. 11. The concept of resolution as minimum distance between two structures and still detectable by the ultrasound system. 12. The different nomenclatures for the axial resolution. 13. Axial resolution equation. 14. Dependency of the axial resolution on the frequency and number of cycles. 15. Damping material. 16. Bandwidth. 17. Frequency tuning. 18. Quality factor. 19. Sensitivity. 20. The different nomenclatures for lateral resolution. 21. Relation between lateral resolution and sound beam diameter. 22. Focal point as the place for the optimal lateral resolution.

	23. Relation between frequency and lateral resolution. 24. Multizone transmit focusing. 25. Multizone receive focusing. 26. Dynamic aperture. 27. Slice thickness or elevational resolution. 28. Z plane. 29. Partial volume artifact. 30. Dimensional transducer.
Assigned Reading	*Understanding Ultrasound Physics*, Chapters 8-11
Suggested Learning Activities	• Review recordings and take notes about the concepts. Separate formulas from content. Maintain organization.
Evaluation	• Complete Resolutions Quiz
Section 5: Transducers/ 3 lectures	
Learning Objectives	1- Transducer design. 2- Matching layer. 3- PZT. 4- Damping material. 5- Piezoelectric effect. 6- Case. 7- Acoustic insulator. 8- Curie point. 9- Depolarization. 10- Slope to steer. 11- Curve to focus. a 12- Time delays. 13- Mechanical trasnducer. 14- Annular phased array. 15- Linear phased array. 16- Linear sequential array. 17- Convex sequential array. 18- Vector array. 19- 1 ½ Dimensional transducer for elevational resolution. 20- Clinical applications.
Assigned Reading	*Understanding Ultrasound Physics*, Chapter about Transducers.
Suggested Learning Activities	• Review recordings and take notes about the concepts. Separate formulas from content. Maintain organization.
Evaluation	• Complete Transducers Quiz

	3- Frame rate. 4- Factors affecting frame rate. 5- Settings affecting frame rate. 6- Relation depth-frame rate. 7- Relation number of pulses-frame rate. 8- Focal points 9- Sector width. 10- Line density. 11- Interpolation. 12- Pulser. 13- Beam former. 14- Piezoelectric crystal. 15- Receiver. 16- Output power. 17- ALARA. 18- Preamplification. 19- Amplification. 20- Compensation. 21- Compression. 22- Demodulation. 23- Rejection. 24- Scan converter 25- Spatial resolution. 26- Contrast resolution. 27- Bit. 28- Pixel. 29- Pre-processing zoom. 30- Post-processing zoom. 31- PACS. 32- A-mode. 33- M-mode. 34- B-mode. 35- Contrast harmonics. 36- Tissue harmonics. 37- Contrast agents. 38- Mechanical index. 39- Contrast safety. 40- Non-linear behavior. 41- Cavitation.

Assigned Reading	*Understanding Ultrasound Physics*, Chapters related to Instrumentation, Display modes, and Harmonics.
Suggested Learning Activities	• Review recordings and take notes about the concepts. Separate formulas from content. Maintain organization.
Evaluation	• Complete Instrumentation Quiz
Section 7: Hemodynamics/ 4 lectures	
Learning Objectives	1. The relation between volume flow rate, pressure gradient, vessel diameter, vessel length, and blood viscosity. 2. The relation between resistance, vessel diameter, and volume flow rate. 3. The different types of flows: pulsatile, phasic, and steady. 4. The difference between laminar and turbulent flow. 5. The significance of the Reynolds number. 6. The energies contributing to the blood flow. 7. The Continuity Rule. 8. What happens before, during, and after a stenosis. 9. The different ways the flow loses energy. 10. The venous hemodynamics. 11. The transmural and hydrostatic pressures concepts. 12. How the venous flow returns to the heart.
Assigned Reading	*Understanding Ultrasound Physics* Chapter related to Hemodynamics.
Suggested Learning Activities	• Review recordings and take notes about the concepts. Separate formulas from content. Maintain organization.
Evaluation	• Complete Hemodynamics Quiz
Section 8: Doppler/ 6 lectures	
Learning Objectives	1. Doppler effect. 2. The Doppler equation. 3. The aliasing artifact. 4. The Nyquist limit. 5. How aliasing is produced and how to get rid of it.

	6. The disadvantages of the adjustments done when fixing the aliasing. 7. Continuous wave Doppler (CWD). 8. Pulsed wave Doppler (PWD). 9. Color flow Doppler (CFD). 10. Power Doppler (PDI). 11. Spectral analysis. 12. The difference between FFT and autocorrelation. 13. Doppler artifacts. 14. The difference between resistive index (RI) and pulsatility index (PI).
Assigned Reading	*Understanding Ultrasound Physics*, Chapters related to Doppler and Doppler Instrumentation.
Suggested Learning Activities	• Review recordings and take notes about the concepts. Separate formulas from content. Maintain organization.
Evaluation	• Complete Doppler Quiz

Section 9: Artifacts/ Quality Assurance/ Bioeffects/ 1 lecture	
Learning Objectives	1-Mainly focused in artifacts.
Assigned Reading	*Understanding Ultrasound Physics*, Chapters related to Artifacts.
Suggested Learning Activities	• Review recordings and take notes about the concepts. Separate formulas from content. Maintain organization.
Evaluation	• Complete Artifacts/ QA/ Bioeffects Quiz

Course Evaluation Strategies

To obtain 14 CME credits the student must:

1- Review all recordings.
2- Pass all 8 quizzes obtaining 80% or more on each.
3- Pass the Ultrasound Physics Test with 80% or more.
4- Complete the Course Evaluation Form.