Certificate in Clinician Performed Ultrasound (CCPU)

Syllabus

Physics Tutorial

Australasian Society for Ultrasound in Medicine PO BOX 943, Crows Nest NSW 1585, SYDNEY, AUSTRALIA
P (61 2) 9438 2078 **F** (61 2) 9438 3686 **E** asum@asum.com.au **W** www.asum.com.au
ACN 001 679 161 **ABN** 64 001 679 161

Physics Tutorial Syllabus

Purpose:

This unit is designed to cover the theoretical and practical curriculum for Physics.

Training:

Recognised either through the ASUM online tutorial or attendance at an ASUM accredited Physics course or equivalent.

Assessments:

There is one multiple choice question throughout each topic, and each topic concludes with a 5 multiple choice question quiz.

Introduction:

Ultrasonic imaging provides impressively detailed images of gross anatomy and pathology. The high quality of these images can lead to overconfidence in interpretation of the images in a clinical setting. In practice, all ultrasound images are distorted to some extent and are subject to artifact. While not always materially detracting from the image, it is essential to recognise the presence of artifacts and minimise their effects in order to draw appropriate clinical conclusions from ultrasound images. This is of particular significance in studies involving accurate measurement (for example, estimating tumour growth) and where accurate localisation of a structure is required. As most artifacts must be dealt with by the user at the time of the ultrasound examination, the importance of understanding the imaging process and its limitations has led to the inclusion of a compulsory 'physics' component in all qualifications issued by ASUM. Although commonly referred to as physics, this syllabus deals more generally with the technology relied upon in ultrasonic imaging and defining its limitations in clinical applications.

Course Objectives

On completing this course learners should be able to:

- Know the parameters that define the safe use of diagnostic ultrasound
- Understand how an ultrasound image is obtained and how the use of the controls on ultrasound equipment can be used to alter the image in order to obtain an optimal image.
- Recognise the limitations of machine default settings
- Demonstrate understanding of the physical principles underpinning the practice of diagnostic ultrasound.

Course Content

Introduction:

Australasian Society for Ultrasound in Medicine PO BOX 943, Crows Nest NSW 1585, SYDNEY, AUSTRALIA
P (61 2) 9438 2078 **F** (61 2) 9438 3686 **E** asum@asum.com.au **W** www.asum.com.au
ACN 001 679 161 **ABN** 64 001 679 161

- The Ultrasound Examination
- Optimal Plane of Scan
- Optimising the Image
- Imaging Artifacts
    - Origins of Artifacts
    - Dealing with Artifacts
- Interactions

Principles of Imaging:

- Forming a Greyscale Image
    - Greyscale Imaging
    - Tissue Harmonics
- Imaging Controls
    - Gain
    - TGC
    - Preset Controls
    - Strengths and Limitations
    - Flow Measurement and Imaging
- Spectral Doppler
- Colour Doppler
- Power Doppler
- Strengths and Limitations
    - Doppler Controls
    - Gain
    - TGC
    - Doppler Gain
    - Colour Gain
    - Velocity Range
- Aliasing
- Baseline Shift
- Colour Quality
- Preset Controls
- High Pass Filters (HPF)

Australasian Society for Ultrasound in Medicine PO BOX 943, Crows Nest NSW 1585, SYDNEY, AUSTRALIA
P (61 2) 9438 2078 **F** (61 2) 9438 3686 **E** asum@asum.com.au **W** www.asum.com.au
ACN 001 679 161 **ABN** 64 001 679 161

    - Doppler Artifacts
- Frequency Aliasing
- Intrinsic Spectral Broadening
- Inappropriate HPF
- Inadequate Frame Rate
- Flow Reversal vs. Aliasing
    - Transducer Arrays
- Single element transducer
    - Multi-element arrays
- Scanning
- Steering
- Focussing
- Multiple Focal Zones
- Frame rate limitations
    - Guidelines for Safe Practice

Section 1

- Propagation
- Ultrasound
- Wavelength
- Propagation Speed
- Relationship between parameters
- The Pulse-Echo principle
- Range Errors
- Attenuation
- Attenuation Coefficient
- Scattering Reflection
- Attenuation
- Specular reflection
- Characteristic Impedance
- Reflection Coefficient
- Scattering
- Refraction

Australasian Society for Ultrasound in Medicine PO BOX 943, Crows Nest NSW 1585, SYDNEY, AUSTRALIA
P (61 2) 9438 2078 F (61 2) 9438 3686 E asum@asum.com.au W www.asum.com.au
ACN 001 679 161 ABN 64 001 679 161

- Effect of Differences in Propagation Speed
- Critical Angle
- Effect of Refraction
- Relevance of Propagation
    - Imaging Technology
    - Single Element Transducers
    - Multi-Element Transducer Arrays
    - Transducers in Practice

Section 2

- Tissue Harmonic Imaging
- Frequency Components
- Distortion of the Ultrasound Wave
- Harmonic Generation in Tissue
- Tissue Harmonic Imaging
- Strength of Harmonics
- Reverberation Artifacts
- Other Artifacts
- Transmit Pulse Bandwidth
- Pulse inversion harmonics
- Limitations
- Contrast harmonics
- Imaging Artifacts
- Resolution artifacts
    - Axial resolution
    - Lateral resolution
- Slice thickness
- Temporal resolution
- Depth of origin artifacts
- Reverberation artifact
- Propagation speed artifact
- Range ambiguity
- Beam path artifacts

Australasian Society for Ultrasound in Medicine PO BOX 943, Crows Nest NSW 1585, SYDNEY, AUSTRALIA
P (61 2) 9438 2078 **F** (61 2) 9438 3686 **E** asum@asum.com.au **W** www.asum.com.au
ACN 001 679 161 **ABN** 64 001 679 161

- Refraction artefact
- Mirror artefact
- Mirror artefact and Doppler
- Attenuation artifacts
- Shadowing
- Enhancement
    - Equipment settings artifacts
    - TGC settings
- Movement artifact
    - Bioeffects and Safety
- Types of Bioeffect
- Thermal bioeffect
- Mechanical bioeffect
- Determining the acoustic output
- Acoustic pressure
- Intensity
- Time variation
- Spatial variation
- Power
- Thermal and mechanical indices
- Thermal index
- Mechanical index
- Policies and advice
- ALARA
    - Equipment Performance
- Spatial resolution
- Axial resolution
- Lateral resolution
- Contrast resolution
- Temporal resolution
- Image processing
- Testing equipment performance
- Test object

Australasian Society for Ultrasound in Medicine PO BOX 943, Crows Nest NSW 1585, SYDNEY, AUSTRALIA
P (61 2) 9438 2078 **F** (61 2) 9438 3686 **E** asum@asum.com.au **W** www.asum.com.au
ACN 001 679 161 **ABN** 64 001 679 161

- Phantom
- Measurement accuracy
- Spatial resolution
- Slice thickness
- Contrast resolution
- Penetration
- Equipment settings
- Doppler phantoms
- Flow phantoms
- Moving string phantom

Section 3

- Advances in Ultrasound
- Spacial compound imaging
- Advantages and limitations
- Ultrasound contrast agents
- Contrast agents and harmonics
- Three dimensional ultrasound
- Spatial resolution
- 3D display methods
- Re-slicing
- Orthogonal plane view
- Surface rendering
- Maximum projection rendering
- 4D ultrasound
- Extended field of view
- Automatic image optimisation
- Image processing
- Depth of penetration
- Coded signals
- Matrix transducers
    - Spectral Doppler
- The Doppler effect

Australasian Society for Ultrasound in Medicine PO BOX 943, Crows Nest NSW 1585, SYDNEY, AUSTRALIA
P (61 2) 9438 2078 **F** (61 2) 9438 3686 **E** asum@asum.com.au **W** www.asum.com.au
ACN 001 679 161 **ABN** 64 001 679 161

- Doppler ultrasound
- The Doppler equation
- The Doppler angle
- How is the Doppler angle determined?
- Limits on the Doppler angle
- Continuous wave Doppler
- Continuous wave Doppler processing
- Controls
- Advantages
- Pulsed Doppler
- Pulsed Doppler processing
- Spectral analysis
- The spectral display
- Measurements from the spectral display
- The Sampling Theorem
- Pulsed Doppler sample volume
- Patient exposure
    - Colour Doppler
- Acquiring the colour Doppler information
- Colour Doppler signal processing
- Wall filter and tissue/blood discrimination
- Colour Doppler signal processing
- The colour Doppler display
- Spatial filtering, persistence
- Variance
- Colour Doppler controls
- Colour box, line density
- Gain, power
- Wall filter
- Grey-scale priority
- Colour velocity scale, baseline shift
- Colour map
- Persistence

Australasian Society for Ultrasound in Medicine PO BOX 943, Crows Nest NSW 1585, SYDNEY, AUSTRALIA
P (61 2) 9438 2078 **F** (61 2) 9438 3686 **E** asum@asum.com.au **W** www.asum.com.au
ACN 001 679 161 **ABN** 64 001 679 161

- Uses and limitations of colour Doppler
- Colour Doppler and pulsed Doppler
- Angle effects
- Power mode colour Doppler
- Tissue Doppler
    - Doppler Artifacts
- Frequency aliasing
- Baseline shift
- Other remedies
- High PRF mode, range ambiguity
- Frequency aliasing in colour Doppler
- Intrinsic spectral broadening
- Spectral mirror artifact
- Thump and flash artefact
- Colour Doppler temporal artefact
- Twinkle artifact

Miscellaneous

- Glossary
- Mathematics
- Multiplication and division
- Units
- Powers of 10
- Scientific notation
- Logarithms
- Decibels
- Reality checking answers
- Exercises
- Answers

Teaching Methodologies

- The ASUM Physics Tutorial is conducted online through MyASUM. It is a self-paced tutorial.

Australasian Society for Ultrasound in Medicine PO BOX 943, Crows Nest NSW 1585, SYDNEY, AUSTRALIA
P (61 2) 9438 2078 **F** (61 2) 9438 3686 **E** asum@asum.com.au **W** www.asum.com.au
ACN 001 679 161 **ABN** 64 001 679 161

- Accredited courses can be found on the ASUM website, www.ASUM.com.au. Go to Education Programs, CCPU, Course Accreditation information, List of Accredited Courses.

Assessment

- There is one multiple choice question throughout each topic, and each topic concludes with a 5 multiple choice question quiz.

Australasian Society for Ultrasound in Medicine PO BOX 943, Crows Nest NSW 1585, SYDNEY, AUSTRALIA
P (61 2) 9438 2078 **F** (61 2) 9438 3686 **E** asum@asum.com.au **W** www.asum.com.au
ACN 001 679 161 **ABN** 64 001 679 161