

MATH REVIEW

Symbols

Terms

Operations

Conversions

MATH REVIEW

Reciprocals

Exponents

Scientific Notation

Units

MATH REVIEW

Metric System

Metric Conversions

Direct and Indirect Proportionality

Distance Equation

$D = R \times T$
$R = \frac{D}{T}$
$T = \frac{D}{R}$

MATH REVIEW

Logarithms

Decibels

X & Y Axis

Cosines

SECTION 1 - ULTRASOUND PHYSICS PRINCIPLES

Wavelength

Sound Propagation

Frequency

Wavelength Equation

$\lambda \text{ (mm)} = \frac{c \text{ (mm/}\mu\text{s)}}{f \text{ (MHz)}}$

SECTION 1 - ULTRASOUND PHYSICS PRINCIPLES

Pulsed Ultrasound

Pulse Repetition Frequency (PRF)

$PRF = \frac{1}{PRP}$

Pulse Repetition Period (PRP)

$PRP = \frac{1}{PRF}$

Spatial Pulse Length (SPL)

$SPL (mm) = \# \text{ of Cycles} \times \lambda (mm)$
$SPL (mm) = \# \text{ of Cycles} \times \frac{C (mm/\mu s)}{f (MHz)}$

SECTION 1 - ULTRASOUND PHYSICS PRINCIPLES

Pulse Duration (PD)

$$PD (\mu s) = \# \text{ of Cycles} \times \text{Period} (\mu s)$$

$$PD (\mu s) = \frac{\# \text{ of Cycles}}{f \text{ (MHz)}}$$

Duty Factor (DF)

$$DF = \frac{PD (\mu s)}{PRP (\mu s)}$$

$$DF = PD (\mu s) \times \frac{PRF \text{ (kHz)}}{1,000}$$

Amplitude

Power

$$\text{Power} \propto \text{Amplitude}^2$$

$$\text{Power} \propto \text{Intensity}$$

SECTION 1 - ULTRASOUND PHYSICS PRINCIPLES

Attenuation

$$\text{Attenuation Coefficient (dB/cm)} = \frac{f \text{ (MHz)}}{2}$$

$$\text{Attenuation (dB)} = \frac{f \text{ (MHz)}}{2} \times \text{Pathlength (cm)}$$

$$\text{Half Value Layer (cm)} = \frac{3}{\text{AC (dB/cm)}}$$

Absorption

Reflection

Scatter

$$\text{Rayleigh Scattering} \propto f^4$$

SECTION 1 - ULTRASOUND PHYSICS PRINCIPLES

Contrast Agents

Transmission

Impedance

$IRC = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2}$

Refraction

$\text{Snell's Law} = \frac{\sin \theta_t}{\sin \theta_i} = \frac{C_2}{C_1}$

SECTION 1 - ULTRASOUND PHYSICS PRINCIPLES

Ultrasound Terminology

Echogenic -

Anechoic -

Hypoechoic -

Hyperechoic -

Isoechoic -

Acoustic Enhancement / Good Through Transmission -

Shadowing -

Homogeneous -

Heterogeneous -

SECTION 2 - ULTRASOUND TRANSDUCERS

Transducer Basics

Transducer Components

Bandwidth

Sensitivity

SECTION 2 - ULTRASOUND TRANSDUCERS

Q-Factor

$Q \text{ Factor} = \frac{\text{Operating } f}{\text{Bandwidth}}$

Damping

Frequency Determination

$f_o = \frac{C_{PZT} \text{ (mm/}\mu\text{s)}}{2 \times \text{Thickness of PZT}}$

Sound Beam Structure & Formation

SECTION 2 - ULTRASOUND TRANSDUCERS

Focal Depth

Near Zone Length = $\frac{(\text{Transducer Diameter})^2 \times f}{6}$

Beam Divergence

Sound Beam Focusing Techniques

Spatial Resolution – Lateral

Lateral Resolution (mm) = Beam Diameter (mm)

SECTION 3 - PULSE ECHO INSTRUMENTATION

Distance Equation

$$D = R \times T$$

$$R = \frac{D}{T}$$

$$T = \frac{D}{R}$$

Imaging modes

Temporal Resolution

Frame Rate \propto Temporal Resolution

$$\text{Frame Rate (Hz)} = \frac{77,000}{\text{Penetration Depth (cm)} \times \text{Lines per Frame} \times \text{Line Density}}$$

Imaging System Components - Master Synchronizer

SECTION 3 - PULSE ECHO INSTRUMENTATION

Imaging System Components - Pulsar / Beam Former

Imaging System Components - Pulse Echo Receiver

Imaging System Components - Memory / Scan Converter

Pre Processing

SECTION 3 - PULSE ECHO INSTRUMENTATION

Post Processing

Imaging System Components - Display

Archiving & Storage

Imaging Artifacts - Resolution

Axial Resolution -
Lateral Resolution -
Slice Thickness Resolution -
Speckle -

SECTION 3 - PULSE ECHO INSTRUMENTATION

Imaging Artifacts - Propagation Speed

Reverberation -
Comet Tail -
Ring Down -
Multipath -
Mirror Image -
Speed Error -
Side Lobes -
Grating Lobes -
Refraction -
Range Ambiguity -

Imaging Artifacts - Attenuation

Shadowing -
Enhancement -
Focal Enhancement -

Imaging Artifacts - Doppler

Aliasing -
Cross Talk -
Noise -
Flash -
Clutter -

SECTION 4 - DOPPLER INSTRUMENTATION & HEMODYNAMICS

Hemodynamics

Poiseuille's Law $VF = \frac{P}{R}$ or $VF = \frac{(P_1 - P_2) \pi R^4}{8\eta L}$

Doppler Shift

$DS = \frac{2 \times V_R \times f_T \times \cos \theta}{c}$
$DS \text{ (kHz)} = \text{Reflected } f \text{ (MHz)} - \text{Incident } f \text{ (MHz)}$

Doppler Instruments

Pulsed Wave

SECTION 4 - DOPPLER INSTRUMENTATION & HEMODYNAMICS

Continuous Wave

Doppler System Components

Spectral Analysis

Color Doppler

SECTION 4 - DOPPLER INSTRUMENTATION & HEMODYNAMICS

Packet Size

Autocorrelation

Doppler Artifacts

Power Doppler

SECTION 4 - DOPPLER INSTRUMENTATION & HEMODYNAMICS

Doppler Image Optimization

SECTION 5 - QUALITY ASSURANCE & QUALITY CONTROL

Purpose & Objectives

Testing Devices

Testing Parameters

SECTION 6 - PATIENT CARE, COMMUNICATION, & SAFETY

Patient Interaction

HIPAA

Emergencies

Universal Precautions

SECTION 6 - PATIENT CARE, COMMUNICATION, & SAFETY

Bio-effect Concepts

ALARA Principle

Bio-effect Techniques

Bio-effect Mechanisms

SECTION 6 - PATIENT CARE, COMMUNICATION, & SAFETY

Safety Standards
