For sonography students and residents, ultrasound physics can be intimating and seemingly remote from their clinical responsibilities. This is primarily because of the difficulty in translating textbook physics concepts into their clinical practice. Although this may be a challenge in any discipline, in ultrasound physics it is compounded by the fact that what is seen, or measured, on the scanner is not always consistent with what is expected based on basic principles. The confusion between expectation and observation is usually artifact or results from a particularly clever implementation of technology. Demystifying the physics not only helps the student develop an intuition on how the scanner creates an image; it also gives them a greater appreciation of imaging as a science.

This course is designed to assist physicists in teaching ultrasound physics concepts to non-physics personnel (residents, sonographers, graduate students, etc.). Several demonstrations and exercises are reviewed which emphasize the clinical implications of various scan parameter settings, including: power, gain, dynamic range, time-gain compensation, field-of-view, displayed depth, postprocessing, zoom (magnification). The effect of these parameters on resolution (axial and lateral), frame rate, depth of penetration, blood flow velocity, and overall image appearance are discussed where appropriate. Doppler ultrasound physics measurements are introduced and briefly discussed. Introductory physics concepts are provided along with sample data and images. Additionally, an explanation of possible discrepancies between measured and “theoretical” results are presented, with attention focused on relationships and trends.

Although the target audience of this session is physicists who have teaching responsibilities, the material provides an excellent review, with examples, of the effect of various scan parameters on image appearance. Additionally, the experiments and demonstrations reviewed in this course illustrate many important relationships between ultrasound imager scan parameters and image or measurement quality. Anyone with an interest in clinical ultrasound imaging would benefit from this session.

Educational Objectives:

1. The course participants are introduced to procedures used to demonstrate and explore the following relationships:
   a) Real-time image frame rate and the following: maximum imaging depth, and the number of focal, or transmit, zones;

b) Imaging depth and spatial (axial and lateral) resolution. The relationship between frequency and spatial resolution is also discussed;

c) Depth of penetration and transducer frequency;

d) Image quality and changes in several operator-adjustable variables, including: transmit power, gain (overall gain), Time Gain Compensation (TGC), dynamic range (log compression), image post-processing, and magnification (zoom).

2. Doppler ultrasound physics measurements are introduced and briefly discussed.