1 Making Sense of an Ultrasound Image (12 points)

(a) bladder

(b) fluid has low scatter, B has posterior acoustic enhancement

(c) the beam getting to C has gone through more soft tissue than the beam getting to B.

(d) the beam getting to C has gone through about 7 cm of tissue more than the beam getting to B. With an attenuation coefficient of 1 dB/cm/ MHz, that’s 56 dB. We assume no reflection for the beam that goes to B, for simplicity.

(e) no since they are at the same depth. Can’t affect the relative gain.

(f) 11 cm
2 Doppler (9 points)

\[ \Delta f = \frac{2vf\cos(\theta)}{c} = \frac{2 \times 15 \times 10^{-2} \times 8 \times 10^6 \cos(45^\circ)}{1540} = 1101.98 \text{Hz} = 1.1 kHz \]

PRF needs to be at least twice as much as \( \Delta f \) to avoid aliasing: \( PRF \geq 2 \times 1.1 \Rightarrow PRF_{\text{min}} = 2.2 kHz \)

\[ PRF_{\text{max}} = \frac{v}{2 \times d} = \frac{1540 \sin(45)}{2 \times 3 \times 10^{-2}} = 18149 \text{ Hz} = 18 kHz \]

\( 2.2 kHz \leq PRF \leq 18 kHz \)

3 More Ultrasound Imaging (12 points)

![Figure 2: CT for problem 3.](image)

(a) Anterior since there is air shown posteriorly.

(b) \( v_{\text{max}} = \frac{c^2}{8\pi f\cos(\theta)} = \frac{1540^2}{8 \times 8 \times 10^{-2} \times 0 \times 10^6 \times 1} = 74 \text{ cm/s} \). Since this is less than 100 cm/s, we expect aliasing.

(c) The center of the vessel where the velocity is greater than 0.74 m/s is expected to alias (under the assumption of laminar flow). Credit was given for expressing that not all of the blood signal will alias, the center of the vessel will, and for velocities \( > 0.74 \text{ m/s} \).

(d) reduce the frequency to lower than 3.7 MHz or use the baseline shift, decrease depth.
4 Color Doppler (12 points)

In the image below,

Figure 3: Color Doppler.

(a) Color flow
(b) Left to right
(c) Aliasing
(d) Change any parameter in $V_{max}$ equation to lower $V_{max}$. 