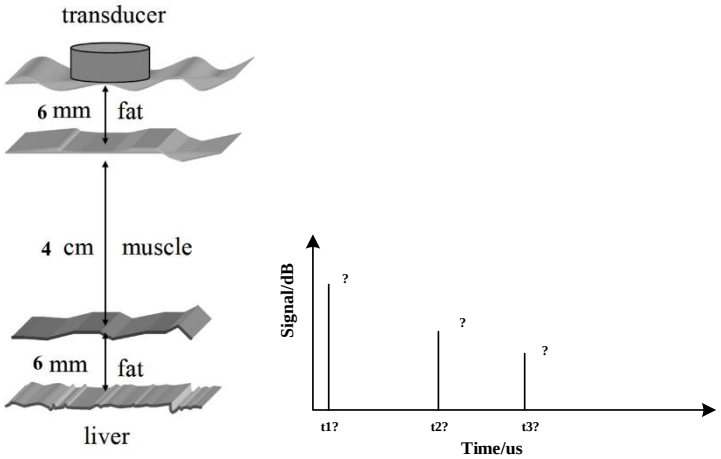
Homework 6

Due: May 25th Submit: Blackboard

1. Calculate the distance at which the intensity of a 1 MHz and 5 MHz ultrasound beam will be reduced by half traveling through (a) bone, (b) air, and (c) muscle. (The attenuation coefficient for muscle, bone and air are 1, 8.7 and 45 dB cm^{-1} MHz^{-1}, respectively.dB $= 10\log_{10}(\frac{I_x}{I_0})$)

2. Use the following data to **sketch** the A-mode scan from Figure 1 (a) to Figure 1 (b). The amplitude axis should be on a dB scale, and the time axis in microseconds. Ignore any reflected signal from the transducer/fat interface, and assume that a signal of 0 dB enters the body. At a transducer frequency of 5 MHz, the linear attenuation coefficient for muscle and liver is 5 dB cm^{-1}, and for fat is 4dBcm^{-1}. Relevant values of the characteristic acoustic impedance and speed of sound can be found in Table 1.
   Hint:
   1. Only the first reflection between layers need to be considered, multi-reflection can be neglected
   2. dB $= 10\log_{10}(\frac{I_r}{I_i})$.



(a) (b)

Figure 1(a) and (b)

	$Z \times 10^5$ (g cm^{-2} s^{-1})	Speed of sound (m s^{-1})	Density (gm^{-3})	Compressibility x10^{11} (cm g^{-1} s^2)
Air	0.00043	330	1.3	70 000
Blood	1.59	1570	1060	4.0
Bone	7.8	4000	1908	0.3
Fat	1.38	1450	925	5.0
Brain	1.58	1540	1025	4.2
Muscle	1.7	1590	1075	3.7
Liver	1.65	1570	1050	3.9
Kidney	1.62	1560	1040	4.0

Table 1: Acoustic properties of biological tissues

3. The three ultrasound images in Figure 2 are of the same object. **Explain** which single operating parameter changes from image (a) to image (b) to image (c) and.

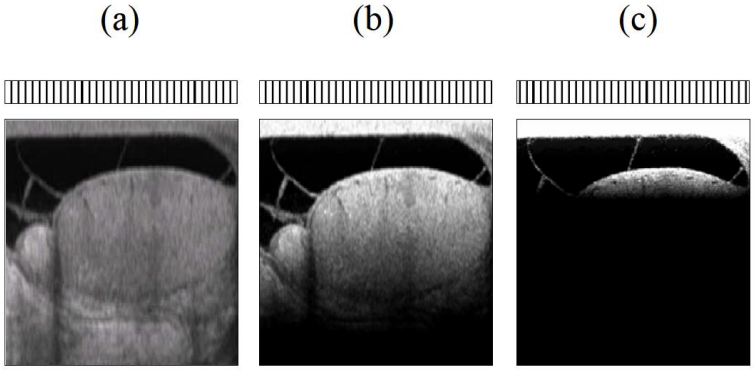


Figure 2

4. **Sketch** the Doppler spectral patterns at points 1, 2, and 3 below in a stenotic artery, shown in Figure 3. (All of the plots need be made over one cardiac cycle)

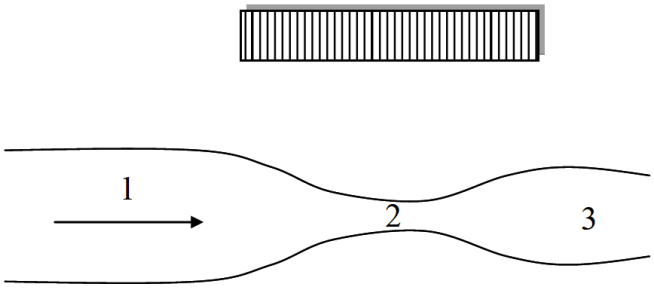


Figure 3