EE101 Homework 3

Please submit it via Blackboard Due：November 17th 23：59

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Your name: _____ Student ID: _____

Problem 1: (30 pts)

(1) Calculate the intensity transmission coefficient, T_I, for the following interfaces, assuming that the ultrasound beam is exactly perpendicular to the interface: (i) bone/brain, (ii) air/muscle, and (iii) fat/muscle.

(2) Repeat the calculations in (1) with the angle of incidence of the ultrasound beam now being $45°$.

Table 4.1: Acoustic properties of biological tissues

	$Z \times 10^5$ (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

Problem 2: (20 pts)

Calculate the distance at which the intensity of a 2 MHz and 10 MHz ultrasound beam will be reduced by half traveling through (a) bone, (b) air, and (c) soft tissue. (The frequency dependence of μ is 8.7 dB/cm/MHz for bone, 45 dB/cm/MHz for air, and 1 dB/cm/MHz for soft tissue.)

Problem 3: (20 pts)

If we only consider the transmission process of ultrasound wave and neglect the multiple reflection in different boundaries, please answer the following questions:

(1) Given values of Z_{PZT} and Z_{skin} of $25 \times 10^5\ g\ cm^{-2}s^{-1}$ and $2.7 \times 10^5\ g\ cm^{-2}s^{-1}$, respectively, calculate what fraction of the energy from the transducer is actually transmitted into the patient if one matching layer is used.

(2) If two matching layers are used instead of one, and the respective acoustic impedances are given by the analogues of the equation above, then calculate the increase in efficiency in transmitting power into the patient.

Problem 4: (30 pts)

Sketch the Doppler spectral patterns at points 1, 2, and 3 below in a stenotic artery, which is shown in Figure 1, and explain briefly why. (All of the plots are made over one cardiac cycle.)

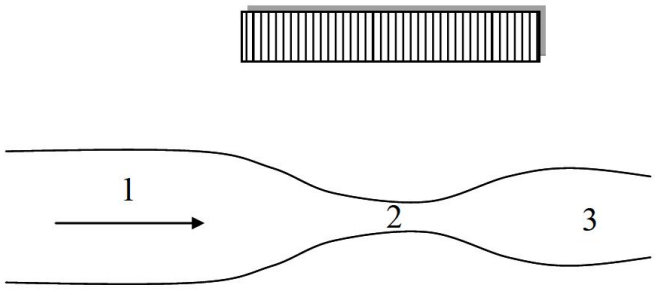

Figure 1