

ECE 473  
Homework Assignment #6  
Due: Friday, October 19, 2018

1. a) A 20 kHz SONAR source is producing sound underwater (assume a  $B/A = 5$  and 1.1 atm ambient pressure at the depth of the source at  $20^\circ\text{C}$ ). If fully developed shock wave formation occurs at a distance of 1 m, determine the SPL of the source (ref  $20 \mu\text{Pa rms}$ ).  
b) If the SONAR source operates at 2 MHz (ultrasonic imaging frequencies) with the same SPL, determine the distance that shock formation would occur.
2. Problem 6.2.1 from Kinsler et al. Assume fresh water at  $20^\circ\text{C}$ .
3. A 500-kHz piezoelectric transducer is made of a material with a density of  $2600 \text{ kg/m}^3$  and a sound speed of 4200 m/s. It is desired to provide a perfect match to water using a special composite material with a density fixed at  $1600 \text{ kg/m}^3$  but a sound speed that can be adjusted by changing the composite mixture. (a) What must be the sound speed in the composite and its thickness? (b) With the composite in place, what is the sound power transmission coefficient from the transducer into the water at 750 kHz? (c) What is the sound power transmission coefficient from the transducer to the water without the composite?
4. A plane wave in water of 100 Pa peak pressure amplitude is incident at  $45^\circ$  on a mud bottom having  $\rho_2 = 2,000 \text{ kg/m}^3$  and  $c_2 = 1,200 \text{ m/s}$  (consider the mud to act as a fluid rather than a solid). Compute (a) the angle of the ray transmitted into the mud, (b) the peak pressure amplitude of the transmitted ray, (c) the peak pressure amplitude of the reflected ray, and (d) the sound power reflection coefficient.
5. Problem 6.4.6 from Kinsler et al. Assume sea water at  $13^\circ\text{C}$ .

**Note to graduate students taking the course for 4 credit hours:** For the additional unit of credit, you are required to write a paper (typically about 8-10 pages, double spaced) that discusses in some detail any topic on acoustics for which the fundamentals of engineering acoustics are explicitly described (this should be a Typed Paper on Sound or what I like to call the **TPS report**). The paper is typically a summary of some acoustic topic and based on 4-5 peer-reviewed publications. The paper will be due Dec 12, 2018. However, topic and publications must be approved by me. For the approval process, prepare a one-page outline (including 4-5 peer-reviewed references) for submission **October 26, 2018**.