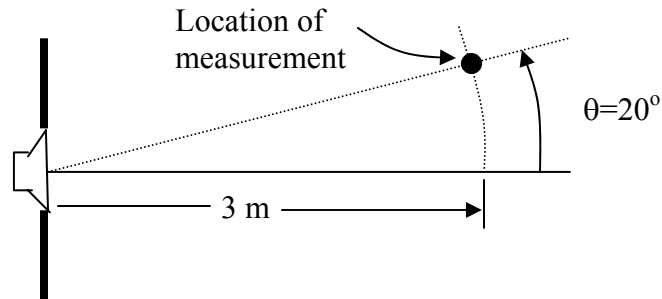


ME413/513 Exam II
Reflection/Transmission, Sources of Sound

Instructions: 55 minutes to complete the exam. Open-book, open-notes.

1. (50 Points) A circular tweeter speaker of diameter $d=1.5''=1.5*0.0254\text{m}$ is operated at a frequency of 20 kHz in an “infinite” baffle. The medium to the right of the baffle is air. A sound pressure measurement is performed by a



microphone located as shown.

- a. (5 Points) Determine the extent of the near-field.
- b. (10 Points) Given a measured SPL of 101 dB re $20\mu\text{Pa}$, what is the SPL on the axis of the transducer at the same radial distance?
- c. (10 Points) Compute the displacement amplitude of the transducer diaphragm indicated by the sound pressure measurement.
- d. (5 Points) At what frequency will the total angular width of the main lobe be 70° ?
- e. (5 Points) Compute the radiation resistance under the conditions specified.
- f. (5 Points) Compute the radiation mass under the conditions specified.
- g. (10) Given that the mass of the diaphragm is $m=2.5\text{mg}$, there is no mechanical damping R_m , and the diaphragm attachment has a spring stiffness of $s=50\text{ kN/m}$, what is the amplitude of force required to move the diaphragm?

2. (25 Points) A loudspeaker, comprised of an electromagnetic speaker with its diaphragm flush-mounted in one side of a square cabinet, generates sound at a frequency of 100 Hz. The side length of the cabinet is $12''=12*0.0254\text{m}$, and the diameter of the electromagnetic speaker is $8''=8*0.0254\text{m}$. A measurement of sound pressure in free space directly in front of the electromagnetic speaker at a distance of 10m gives 85 dB re $20\mu\text{Pa}$. You may assume that the diaphragm of the electromagnetic speaker vibrates as a rigid circular disk.
- (10 Points) What is the peak-to-peak displacement amplitude of the electromagnetic speaker diaphragm?
 - (10 Points) What is the SPL in dB re $20\mu\text{Pa}$ at a distance of 5 m directly behind the vibrating surface of the loudspeaker?
 - (5 Points) What is the time averaged sound power output of the loudspeaker?
3. (20 Points) A harmonic plane wave of frequency 20 kHz is normally incident from water to a coarse-silt sediment. The SPL of the incident wave is 105 dB re $20\mu\text{Pa}$.
- (5 Points) What is the amplitude of the acoustic wave transmitted into the coarse silt sediment?
 - (5 Points) What is the intensity of the acoustic wave transmitted into the coarse silt sediment.
 - (10 Points) It is desired to bury a sensor in the sediment to measure the transmitted wave. To improve the measured signal, a layer of solid elastic material is to be placed above the sensor between the water and sediment. Choose an elastic solid material that has the closest acoustic properties to an optimal design, and specify the thickness of the layer for that material.