School of Physics and Materials Science
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APPLIED PHYSICS (UPH 004)

TUTORIAL SHEET # 2 & 3: ACOUSTICS & ULTRASONICS

1. An office room is 15 ft high, 20 ft wide and 30 ft long. It has walls made up of plaster, wood and glass with mean absorption coefficient 0.03. The floor is covered with a carpet of absorption coefficient 0.20 and the ceiling with acoustic plaster of absorption coefficient 0.15. What is the reverberation time of the room?

2. Average absorption coefficient of a room of height 15 ft, breadth 20 ft and the length 30 ft is 0.20. Find the reverberation time of the room. What should be the average absorption coefficient of the room if the reverberation time needs to be reduced by 50 %?

3. A hall has a volume of 7500 m^3. It is required to have reverberation time of 1.5 s. Calculate the total absorbing power of the hall.

4. An auditorium is 20 ft high, 40 ft wide and 100 ft long with seating capacity of 400. Each seat has average absorption of 0.15 ft^2-OWU. The walls, floor and ceiling have an average absorption coefficient 0.03. What is the reverberation time when auditorium is empty? What would be the reverberation time when auditorium is full? Assume that each person is equivalent to 4.7 ft^2 OWU. Also calculate the area of additional absorbing material to be mounted on the walls/ceiling having absorption coefficient 0.2 required to reduce the reverberation time to 2 s for empty auditorium.

5. Let the reverberation time be 1.5 s for an empty hall and 1.3 s when a curtain cloth of 20 m^2 is suspended at the centre of the hall. If the dimensions of the hall are 10mx8mx6m, calculate the coefficient of absorption of the curtain cloth. What area of the empty hall wall should be covered by the similar curtain cloth so as to reduce the reverberation time to 1.1 s?

6. A rectangular hall measures 10 x 20 x 30 ft^3 and has average absorption coefficient 0.3. Calculate the reverberation time using Sabine's formula and Eyring's formula. Comment on the result.

7. A curtain of dimensions 4 ft x 4 ft is hanged at the centre of the reverberation chamber whose dimensions are 10 x 20 x 30 ft3. If the reverberation time is 1 s and 1.5 s respectively, for two different sources of sound of 50 W and 80 W respectively then calculate the average absorption coefficient of the room with the curtain. Velocity of sound is 1126 ft/s.

8. An ultrasonic source of frequency 0.07 MHz sends down a pulse towards the sea bed which returns after 0.65 s. The velocity of sound in sea water is 1700 m/s. Calculate the depth of sea and the wavelength of pulse.

9. Calculate the natural frequency of 40 mm length of iron rod. Density and Young's modulus of iron are given to be 7.25×10^3 kg/m^3 and 1.15×10^{11} N/m^2. Can you use it in magnetostriction oscillator to produce ultrasonic waves?

10. Two ships are anchored at some distance away in the deep sea. An ultrasonic signal of 50 kHz is from one ship to another through air and water. Calculate the distance between the two ships when the time difference to receive two signals is 3 s. The velocities of ultrasonic wave in air and water are given to be 342 and 1372 m/s.

11. Find the fundamental frequency of a 1 mm thick quartz crystal. The density and Young's modulus of quartz are 2.65 g/cm^3 and 8.516×10^{11} $dynes/cm^2$ respectively. This crystal is placed in a liquid and mounted in front of a moveable reflector. The piezoelectric detector current varies between 30 μA to 80 μA. If the distance travelled by the reflector between two successive maxima in the current is 0.816 mm then calculate the speed of ultrasonic wave in the liquid.

12. A bat emits ultrasonic waves of frequency 200 kHz in air. If this wave is incident on water surface then calculate the wavelength of the reflected wave and transmitted wave. Speeds of ultrasonic waves in air and water are given to be 340 and 1486 m/s respectively.