Indian Institute of Technology, Kharagpur

Centre for Educational Technology

**End Semester Examination 2018 (Spring)**

**Subject: Audio System Engineering Code: ET60006**

**Time: 3:00 Hours** **Full Marks = 100**

***PART-A***

*Answer all the questions (****10x2=20)***

1. A sound system gain is raised by ***15dB***. Calculate the ***%*** increase of the output power.
2. A sound source producing ***60 dBm*** intensity and the sound is propagated as a spherical wave. What will be the sound intensity for a person hearing it from ***30 m*** away?
3. An earth quake wave was traveling through the earth and the intensity detected ***100 Km*** from source was ***16.0x 106 W/m2***. What is the intensity of the earth quake wave at a distance ***400 km*** from the source?
4. A loudspeaker produces Sound Pressure level (SPL) ***Lp=99dB*** at ***4ft*** with a ***1 watt*** input. How many watts are needed to produce ***Lp=115 dB*** at the same distance.
5. In a lecture room Sound Pressure level (SPL) ***Lp=99dB at 2 ft*** from the source at ***1kHz-2Khz*** octave band. Let the ambient noise level ***Lp=32 dB*** when the air conditioning of the room is on. Determine the Signal to Noise ratio (SNR) of the room.
6. At some location the pressure amplitude and particle speed of a ***100Hz*** sound wave in air are measured to be ***2 Pa*** and ***0.01m/s***. Assuming that this is a spherical wave calculate the distance of the location from the source. Where density of air ***ρ0=1.21kg/m3*** and speed of sound in air ***c=343m/s***
7. Plane wave in water of ***100 Pa*** peak pressure amplitude, is incident at ***45o*** on a mud bottom having ***ρ2=2000kg/m3 and c2=1000m/s***. Compute the angle of the transmitted pressure ray. Where speed of sound in water ***c1= 1450 m/s and density ρ1=1000kg/ m3***.
8. A plane wave is reflected from the ocean floor at normal incidence with a level ***20 dB*** below that of the incident wave. Calculate the specific acoustic impedance of the ocean floor material. Where speed of sound in ocean water ***c1= 1450 m/s*** and density ***ρ1=1000kg/ m3***.
9. During the testing, a microphone produced an open circuit voltage ***E0=0.008*** ***V***, the sensitivity (Sv) of the microphone is ***-60dB***. Calculate the sound pressure level (SPL) of the testing condition.
10. Draw the directivity pattern of a bidirectional pressure gradient microphone.

**PART-B**

*Answer all the questions (5x16=80)*

1. A room has dimensions ***12 m x 24 m x 16 m*** and the acoustic treatment details of the room is given in table-1. Absorption Coefficients of the treatment materials are given in table-2.

***Table-1***

|  |  |  |
| --- | --- | --- |
| S/l | Location | Treatment material name |
| 1 | Front wall | Concrete |
| 2 | Back Wall | Acoustic Blanket |
| 3 | Two Side wall | Acoustical board |
| 4 | Ceiling | Plasterboard |
| 5 | Floor | Carpet |

***Table-2***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Material name | Absorption Coefficients [in Sabin] | | | | | |
| 125 Hz | 250 Hz | 500 Hz | 1000 Hz | 2000 Hz | 4000 Hz |
| Concrete | 0.01 | 0.04 | 0.06 | 0.08 | 0.09 | 0.10 |
| Acoustic Blanket | 0.45 | 0.55 | 0.65 | 0.75 | 0.85 | 0.95 |
| Acoustical board | 0.25 | 0.35 | 0.45 | 0.65 | 0.75 | 0.95 |
| Plasterboard | 0.20 | 0.25 | 0.30 | 0.40 | 0.50 | 0.60 |
| Carpet | 0.10 | 0.20 | 0.30 | 0.35 | 0.40 | 0.45 |

1. Determine whether the room volume support large room acoustic for speech system.
2. Calculate the maximum reverberation time (*RT60*) and mean free path (MFP) of the room.
3. If two loudspeakers are placed in two side of the front wall find out the distance from the source where the Articulation Loss of Consonants is ***15%***.
4. Is the room acoustic treatment is adequate for speech intelligibility?

[6+4+4+2]

**R->**Distance from speaker to listener

**Tr ->** Reverb time

**Q->** directivity factor

**V->** room volume

**n->** number of reinforcing loudspeakers

Where



1. An auditorium is observed to have a reverberation time of ***1.6s***. Its dimensions are ***10m x 16m x 24m*** are. If central air conditioner of the auditorium is switch on it produce noise pressure level of ***54 dB*** (***re 20 μPa).***
2. Determine the steady-state reverberant sound pressure level of the auditorium when central air conditioner is switch on.
3. Calculate the additional sound absorption (in Sabine) required to lower down the steady-state reverberant sound pressure level to ***20dB***
4. Calculate new reverberation time of the auditorium after above additional sound absorption treatment. [*where density of air* ***ρ= 1.21 kg/m3*** *and sound speed in air* ***c=343 m/s***]

[6+6+4]

1. A condenser microphone having a diameter of ***0.8cm***. The steel diaphragm is ***0.001cm*** thick and is stretch to maximum allowable tension of ***10,000 N/m***. The spacing between the diaphragm and backing plate is ***0.001cm*** and the polarizing voltage is ***150 V*** [where steel density ***ρ*= 8.05 g/cm3]**
2. Determine the fundamental frequency of the diaphragm
3. Calculate the open circuit voltage sensitivity in ***dB (re 1V/pa)***
4. Find the blocked input impedance at ***5 KHz***
5. If the microphone is exposed to ***94dB SPL*** of ***1Khz***, determine the displacement of the diaphragm

[4+4+4+4]

1. If an auditorium has dimensions of ****** and average absorptivity ***a=0.3***
2. Find the critical distance and Liveness of the auditorium.
3. Write three effect of critical distance
4. If ***200*** people are present, each adding ***0.5*** Sabin to its total absorption, determine the change of Liveness?
5. if a ***5x10-2 W*** average output acoustic source is placed in the center of the front wall determine the sound pressure level (SPL) at ***2m*** from the acoustic source

[6+2+4+4]

1. A microphone produced an open circuit voltage ***E0=0.006*** ***V*** when a talker produce 94dB sound pressure level (SPL) near the microphone.

**(a)** Calculate the Sensitivity of the microphone in dB

**(b)** Calculate Available Input Power (LAIP) of the microphone [where output resistance of the microphone is **120*Ω***.

**(c)** Determine the thermal noise produce by the microphone if it operates at ***30° C*** temperatures (where the frequency response of the microphone is ***200Hz to 10 KHz***)

[6+4+6]