Indian Institute of Technology, Kharagpur

Centre for Educational Technology

**End Semester Examination 2016 (Spring)**

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

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

***PART-A***

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

1. A critically damped shock absorber is to be design for a motorcycle of mass ***200 kg***. When the shock absorber is subjected to an initial vertical velocity due to a road bump, the resulting relaxation time is found ***2 sec***. Find the necessary stiffness and damping constants of the shock absorber.
2. If the input voltage of a loud speaker is raised by ***30%*** how many ***dB*** will be increase the acoustic pressure
3. If the intensity of a sound in air at ***1 kHz*** is ***10-12W/m2***. Find out the value of root mean square pressure? Where density of air is ***ρ0 =1.21 kg/m3*** and sound velocity is ***c=350 m/s***
4. A loudspeaker has a sensitivity of ***LP=99dB*** at ***4ft*** with ***1 watt*** input power. What will be the level of the sound pressure at ***100 ft***.
5. The rms speech value in an auditorium is ***LP=65dB*** at ***2 ft*** from source in the ***500Hz-1kHz*** octave band and the ambient noise level ***LP=16dB*** with air conditioning off and ***32dB*** with air conditioning on. Calculate the SNR at ***4ft*** from the source when air conditioning of the auditorium is on.
6. During the testing, a microphone produced an open circuit voltage ***E0=0.002 V***, at ***100 dB*** sound pressure level (SPL) find out the sensitivity (***Sv***) of the microphone.
7. A piano string is ***1.10 m*** long and has a mass of ***9.00 g***. (a) How much tension must the string be under if it is to vibrate at a fundamental frequency of ***135 Hz***?
8. The equation of a plane wave given in equation no.-1. In what direction does this wave travel? Calculate the speed of the wave.



1. An acoustic room has the dimensions ***9 m x 11 m x 5 m*** determine the lowest ***2*** standing wave frequencies?
2. In an outdoor acoustic the ambient noise level is ***70dB*** and a sound system generate SPL of ***110dB*** at ***4ft***. How far the sound will travel before it submerged with noise.

**PART-B**

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

1. **(a)** Draw the schematic construction of a Moving – Coil Loudspeaker. **(b)** Draw its equivalent electrical circuit. **(c)** Prove that Moving – Coil Loudspeaker is antireciprocal Transducers **(d)** draw the directivity pattern of an omni-directional microphone.

[4+4+6+2]

1. A moving –coil loudspeaker is used both as a microphone and as a loudspeaker in an intercom system the specification of the loudspeaker is as given below. **(a)** Calculate the open circuit voltage sensitivity level ***re 1V/Pa*** for ***1 kHz***. **(b)** calculate the Available Input Power level (***LAIP***) of the microphone

[8+8]

1. Mass of the speaker diaphragm and voice coil, ***m=3g***
2. Radius of the diaphragm, ***a=0.05 m***
3. Stiffness of the speakers ***s=50,000N/m***
4. Mechanical resistance of the speaker ***Rm=10N.s/m***
5. Inductance of the voice coil ***L0=0.01H***
6. Resistance of the voice coil ***R0= 5 Ω***
7. Length of the voice coil ***l=5m***
8. Magnetic field ***B=0.8T***
9. In a factory a motor produces a steady-state reverberant sound pressure level of ***74 dB*** (***re 20 μPa)*** in a room ***4m x 8m x 15 m***. the measured reverberation time of the room is ***2s***. **(a)** Determine the acoustic output level of the motor? **(b)** Calculate the additional sound absorption (in Sabine) required in the room to lower down the steady-state reverberant sound pressure level to ***10dB*** **(c)** what is the new reverberation time. [*where* ***ρ0 = 1.21 kg/m3*** *and* ***c=343 m/s***]

[6+6+4]

1. A concert hall has floor dimension ***20m x 50m*** and is ***15m*** high. The reverberation time of the hall is ***1.5 s***. **(a)** Is the hall volume support large room acoustic if yes then **(b)** calculate the average Absorptivity of the hall. **(c)** Determine the steady-state reverberant sound pressure level if a ***3x10-2 W*** average output acoustic source is placed in the center of the front wall. **(d)** Calculate the critical distance and mean free path of the hall. . [*where* ***ρ0 = 1.21 kg/m3*** *and* ***c=343 m/s***]

[2+5+5+4]

[8+4+4]

1. **(a)** A microphone is connected to an amplifier and the specification of microphone and amplifier as in given below. If the microphone is placed in a speech studio and if a talker produces 80dB near the microphone find out the signal to noise ratio at amplifier output at ***20° C*** temperature. **(b)** Calculate the ***GAIP*** of the given microphone **(c)** what is pressure gradient or Velocity microphone give one example of such microphone.

**Amplifier specification**

**Microphone specification**



*V=RMS value of the noise voltage; K=1.38x10-23* J/K

***End***