**MAE 298 Aeroacoustics**

**Questions**

**Class #1**

1. What brought the aircraft noise down in 1970s and 80s? Explain the reason.

Ans.: By introducing high-bypass ratio turbo fan engine, jet flow velocity and the associated jet noise were reduced.

2. What are three NASA’s green aviation visions?

Ans.: Reduce fuel burn (60% reduction by 2025), emission (80% reduction by 2025), and noise (52dB reduction by 2025)

3. What are the challenges in predicting aeroacoustics?

Ans.: Small magnitude and a wide range of pressure amplitudes. Because of numerical dissipation and dispersion errors, high-order schemes in space and time are required. Non-reflective boundary condition is needed.

4. Who is the father of aeroacoustics? What is acoustic analogy?

Ans.: James Lighthill. He rearranged the Navier-Stokes equation into linear acoustic wave equation with the Lighthill stress tensor as the source term. Acoustics is generated by the Lighthill stress tensor and it is propagated with the speed of sound.

5. In FW-H equation, what are the three main sources?

Ans.: Thickness noise (displacement of fluid particle due to body motion), loading noise (unsteady pressure on the surface), quadrupole noise (nonlinear volume source)

6. Describe three aircraft noise certification locations? What is the metric of aircraft noise certification?

Ans.: Side-line (take-off), cut-back (flyover), and approach (landing). EPNL(dB) is the metric of aircraft noise certification

7. How is the dominant noise source different for take-off and approach?

Ans.: Engine noise is dominant for take-off and airframe noise is dominant for approach

8. What are the main aircraft engine fan noise sources?

Ans.: Fan wake and OGV interaction noise and fan shock noise

9. Describes (at least three) types of airframe noise?

Ans.: Landing gear noise, slat noise, flap noise, spoiler

10. How does hybrid-wing-body (HWB) aircraft reduce noise significantly?

Ans.: Engines are installed over the wing and the noise is shielded by the fuselage

11. What is the dominant wind turbine noise source? What is the physical mechanism of the noise?

Ans.: Trailing edge noise. Hydrodynamic energy within the turbulent boundary layer is scattered by a sharp trailing edge

**Class #2**

1. What is the blank in the equation, , where f is frequency and c is the speed of sound?

Ans.: Wavelength ()

2. What is the audible frequency range? What frequency range is the human ear sensitive to?

Ans.: Audible frequency range is 20 and 20,000Hz. The human ear is most sensitive to sound in 1 to 5 kHz range.

3. What is the blank in the equation, where SPL is the sound pressure level and is the reference pressure, which is ?

Ans.:

**Class #3**

1. What is the blank in the equation,

Ans.: where is the speed of sound

2. For a point source, what are the wave fronts?

Ans.: Spheres

3. For a monopole source, a sound field depends only on \_\_\_\_\_\_\_.

Ans.: radial distance, r, from the source

**Class #4**

1. What is the ‘free field’?

Ans.: The sound field of a source in unbounded homogeneous. The atmosphere is ‘unbounded’ if there are no boundaries and the atmosphere is ‘homogenous’ if the sound speed is constant.

2. What is the ‘far-field’ assumption?

Ans.: or

3. What is ‘geometrical attenuation’?

Ans.: represents the attenuation of a spherical sound wave with increasing distance from the source as a consequence of the spherical spreading of acoustic intensity.

4. What is the purpose of generating one-third or octave band frequency sound pressure levels?

Ans.: To reduce a large number of spectra levels to much smaller number of levels

**Class #5**

1. What is the ‘retarded time’? Do you remember the equation?

Ans.: The time when source emits the sound or sound is generated.

2. Is a dipole more efficient or less efficient than a monopole in terms of sound generation? Why is that?

Ans. It is less efficient. Because a dipole involves sources of opposite sign there is some cancellation of the acoustic field.

**Class #6**

1. Do you remember the Doppler factor for a moving point source?

Ans.:

2. For a subsonic case, how many does exist for a given observer )?

Ans.: Only one

3. What does mean?

Ans.: component of the source velocity in the direction of the observer, , where is the source Mach number vector and is the unit vector in the direction from the source to the observer observer.

**Class #7**

1. According to the dimensional analysis of Lighthill’s acoustic analogy, how does the acoustic energy vary with respect to Mach number in subsonic case?

Ans.: It increases with the eight power of Mach number.

**Class #8**

1. What is the difference between Lighthill’s equation and Lilley’s equation?

Ans.: In the Lighthill equation, the interaction between the sound field and mean flow (convection and refraction of sound by the flow) must be accounted for by adjusting the source term. In the Lilley’s equation, these effects have been moved from the source term to the wave operator part of the equation and can therefore be calculated as part of the solution.

**Class #9**

1. What are three basic sources in supersonic jet noise?

Ans.: Turbulent mixing noise, broadband shock-associated noise, screetch tone noise

2. What are two mixing noise sources in jet noise?

Ans.: Large scale turbulence and fine scale turbulence

**Class #10**

1. What is the difference between the time average and ensemble average?

Ans.: Time averaging is the averaged quantity of a single system over a certain time interval and ensemble averaging is the averaged quantity of many identical systems at a certain time instance.

2. How do you call the system in which the ensemble averaging becomes the same as the time averaging?

Ans.: The system is ergonic ensemble or statistically stationary system

**Class #11**

1. Which region radiates more jet noise, mixing region or developed region?

Ans.: The mixing region generates about six times larger noise than the developed region.

2. According to Tam and Auriault’s theory, what is a true noise source for fine-scale turbulence noise?

Ans.: where