**EAE 298 Aeroacoustics, Fall Quarter 2016**

**Mid-Term Exam   
(Closed Note)**

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|  | **Name :** |  |

1. [2 points] 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. [3 points] 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.

3. [3 points] 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)

4. [2 points] 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

5. [2 points] What is the blank in the equation, where SPL is the sound pressure level and is the reference pressure, which is ?

Ans.:

6. [3 points] What is the ‘retarded time’? Do you remember the equation?

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

7. [2 points] 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.

8. [3 points] 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.