

## **Candidacy Oral Exam Questions**

**Created: February 21, 2004**

**Last Update: March 04, 2004**

- 1) ANYTHING YOU SCREWED UP ON THE WRITTEN EXAM (an oldie but a goodie!!)**
- 2) Derive the Wave Equation.**
  - a) What are the 3 equations?**
  - b) For the Momentum Equation ... get from  $F=ma$  to the momentum equation. Draw the sum of the forces.**
  - c) How big is a “parcel of fluid”?**
- 3) How are two coherent sources summed? Two incoherent sources?**
- 4) Write down the simple source relations for Power, Pressure, Velocity and Intensity. How does the density and speed of sound, of the medium, affect each of these.**
- 5) Know the equations for a mass/spring/dashpot system. What is the resonant frequency vs. the Forcing function?**
- 6) Helmholtz Resonator. What is the Hooke’s Law relationship for the resonator and how is it used to compute the resonance frequency.**
- 7) Define Snell’s Law, boundary conditions and critical angle.**
- 8) What is the cutoff frequency?**
- 9) Define a pressure release and a rigid condition.**

- 10) What is the definition of resonance and when does it occur?
- 11) What is Velocity Potential? Derive how it is related to Pressure.
- 12) What is Reciprocity?
- 13) Given  $F = ma$ , derive the universe. Give three examples.
- 14) What is a Dipole? How does it radiate sound power compared to a monopole?
- 15) What is a wavenumber?
- 16) Draw the 3<sup>rd</sup> order mode for a string. What is the wavenumber in terms of the length of the string?
- 17) Draw the 3<sup>rd</sup> order mode of transverse waves of a bar.
- 18) How many equations are required to solve the wave equation for transverse waves in a bar? Why?
- 19) What is Radiation Efficiency?
- 20) What is Radiation Impedance? How is it related to the Farfield Sound Power radiated by a source?
- 21) What are the constraints in the boundary conditions for transverse vibrations of a beam? What can be described independently of what else?
- 22) Consider a pulse on a string. What does the reflection look like if the reflecting surface is rigid?

- 23) Consider a Plane Acoustic Wave impinging on a rigid surface. What are the wave characteristics at the surface (i.e. pressure, particle velocity, etc ...).**
- 24) What is the impedance of a mass/spring/dashpot system?**
- 25) In a SHO, what terms are dominant at low frequencies, frequencies near resonance and at high frequencies?**
- 26) What effect does adding mass have on the resonance frequency?**
- 27) What effect does damping have on the resonance frequency?**
- 28) What is the Fourier Transform? Derive the Inverse Fourier Transform?**
- 29) What is the Coincidence Frequency? Why is it important?**
- 30) Give an example of a Dispersive Wave?**
- 31) What is a Dispersive Medium?**
- 32) What is the Mass Conservation Equation? What does it mean physically? Using this relationship, what is the equality between change in density and change in volume?**
- 33) Using the Linearized Equation of State, derive the relationship between Stress and Strain.**
- 34) What is another name for the operator Del?**
- 35) What is the meaning of Instantaneous Intensity?**

- 36) For a periodic signal, what are the two relationships for the time average intensity?**
- 37) If a signal is not periodic, how is the intensity computed?**
- 38) What are the definitions of Specific Acoustic Impedance, Mechanical Impedance and Acoustic Impedance? How are these interrelated?**
- 39) Derive the roots of a complex number and plot them in the complex plane.**
- 40) What is the quality factor? How is it related to the loss factor?**
- 41) What is Doppler?**
- 42) Take a position for or against the truth. Prove the validity of your position.**
- 43) Derive the Pressure Reflection Coefficient.**
- 44) What are the boundary conditions for a simply supported beam?**
- 45) What are the boundary conditions for a fixed beam?**
- 46) If the radiation impedance is purely imaginary, what is the radiate sound power?**
- 47) How many Pascals are in an atmosphere?**
- 48) What is buoyancy? How is the equation derived from the Conservation of Momentum Equation?**

- 49) If a pipe is open at  $x=L$ , what is the impedance at  $x=L$ ?  
What is the input impedance?**
- 50) Define orthogonality. How is it used to solve for coefficients in a normal mode solution?**
- 51) What is the relationship between sound speed and Tension, Young's Modulus and Bulk Modulus?**
- 52) What is Radiation Impedance?**

**Added on 04 March, 2004**

- 53) Derive the linear equation of state in an ideal gas.**
- 54) Describe the physical relationship between speed of sound, pressure and density.**
- 55) How does the sound speed relate to the average particle velocity?**
- 56) How is sound speed related to temperature in an ideal gas?**
- 57) What is energy density? What do the terms mean?**
- 58) What are the units of Energy Density? Units of Energy?**
- 59) For a plane wave, what is the maximum energy? Is this result true for any other type of wave?**
- 60) Two people stand on the moon 50m apart. Halfway between them is a barrier 3x5m. One person claps. Describe the propagation of the acoustic wave from one person to the other.**
- 61) Know what is and isn't a solution to the wave equation.**
- 62) Considering only a 1-D mass/spring system, know how to determine the number of modes.**
- 63) What is the difference between a homogeneous and isotropic medium?**
- 64) Construct a dipole using only one source.**

- 65) How can absorption be included into an already lossless solution?**
- 66) Draw the radiation plot for a simple dipole in the farfield.**
- 67) Where are the sources located in a dipole pattern?**
- 68) What causes the pattern of a dipole to go to zero?**
- 69) Draw the radiation pattern for a circular piston.**
- 70) What causes the nulls in a spherical radiator's pattern?**
- 71) How does the main lobe of a piston source change as the radius changes?**
- 72) How do sound waves behave when they interact with a high temperature object.**
- 73) What is the bracketed term in the wave equation?**
- 74) What is Newton's 2<sup>nd</sup> Law?**
- 75) Plot  $y = 2 \cdot \cos(ct - x)$  on the complex plane.**
- 76) Is intensity a vector?**
- 77) Can impedance be a negative number?**
- 78) How do you compute the velocity from a pressure wave?**
- 79) How are pressure and velocity related if the boundary is neither rigid or pressure release but instead the boundary is complex.**

**80) If the forcing function of a LDE is  $3x^2 + 2x$ , what is the Constant Coefficient Solution and why?**

**81) Be able to recognize an Euler, Legendre and Bessel polynomial.**

**82) Why use a Frobenius solution instead of a power series?**