Directions: No books or notes may be used during this exam.

Multiple-choice Questions. 10 points each. CIRCLE THE LETTER corresponding to your answer for each question. If you don’t know the answer, then make your best guess.

1. The Nyquist Theorem is a way to determine
   (A) the fundamental frequency of a musical instrument
   (B) the minimum digital sampling rate
   (C) the maximum digital sampling rate
   (D) the amount of digital distortion
   (E) none of the above.

2. The spectrum of a sound wave is a graph of
   (A) amplitude vs. frequency
   (B) amplitude vs. time
   (C) amplitude vs. position
   (D) amplitude vs. pressure
   (E) none of the above.

3. The quality of a sound that distinguishes it from others of the same pitch and volume is called
   (A) reverberation
   (B) intensity
   (C) frequency
   (D) absorption
   (E) none of the above.

4. Pressure is defined as
   (A) mass times acceleration
   (B) mass per unit length
   (C) mass per unit volume
   (D) force per unit length
   (E) force per unit area
   (F) force per unit volume.

5. The speed of a wave can be found using
   (A) intensity and amplitude only
   (B) frequency and wavelength only
   (C) intensity and intensity level only
   (D) harmonic number and density only
   (E) all of the above.
Definitions. 10 points each. For full credit, use proper grammar, spelling and complete sentences. (A complete sentence has both a subject and a predicate.)

6. Define reverberation time.

The reverberation time is the amount of time that it takes for the sound intensity to decrease to 1/1,000,000 of its maximum intensity.

7. Define diatonic scale.

The diatonic scale of Pythagoras is where each octave is divided into twelve semitones.

8. Define frequency just noticeable difference.

This occurs when the two notes are played at different times, i.e. sequentially.


The Doppler Effect is when the observed frequency (and wavelength) changes due to relative motion between the source and/or observer and the medium which is carrying the sound wave.

10. Define waveform.

Waveform is the amplitude vs. time graph of a wave.
Short Answers. 10 points each. For full credit, use proper grammar, spelling and complete sentences. (A complete sentence has both a subject and a predicate.)

11. What did you find most interesting about the LaSells Stewart Center?

12. What is Faraday's Law of Induction?

Faraday's Law of Induction states that when there is relative motion between a wire and a magnetic field, a current and voltage will be created in the wire.

13. What is the difference between analog and digital?

Analog is continuous while digital is discrete.

14. What are Fletcher-Munson Curves (also called Curves of Equal Loudness)?

Fletcher-Munson Curves are graphs of intensity and intensity level vs. frequency where each point on any curve has the same loudness as perceived by a random selection of people.

15. What is the difference between sound and hearing?

Sound is regions of higher and lower pressure and density that travel through some material. Hearing is the perception of sound waves by a living organism.
Numerical Problems. 10 points each. If the temperature is not given, then assume that the speed of sound in air is 345 m/sec. If the answer is incorrect, then partial credit may be awarded.

16. The frequency of a simple sound wave in base ten is 250 Hz. Convert this frequency to binary.
\[ 250 - 128 = 122, \quad 122 - 64 = 58, \quad 58 - 32 = 26, \quad 26 - 16 = 10, \quad 10 - 8 = 2 \]
\[ 128, 64, 32, 16, 8, 4, 2, 1 \]
\[ 1 \quad 1 \quad 1 \quad 1 \quad 0 \quad 1 \quad 0 \]
\[ 250_{10} = 11111010_2 \]

17. A rectangular room measures 10 ft. x 20 ft. x 30 ft. and the material in the room has an average absorption coefficient of 0.1 ft/sec. Calculate the reverberation time of this room.
\[ V = LWH = (10)(20)(30) = 6000 \text{ ft}^3 \]
\[ A = \alpha (2A_1 + 2A_2 + 2A_3) = (0.1)(2(100) + 2(200) + 2(300)) \]
\[ A = 0.2(200+400+300) = 220 \text{ ft}^3/\text{sec} \]
\[ T_R = \frac{0.05V}{A} = \frac{(0.05)(6000)}{220} = 1.36 \text{ sec} \]

18. The frequency of a sound wave is 875 Hz. Calculate the wavelength of the wave.
\[ \lambda = \frac{V}{f} \]
\[ \lambda = \frac{345}{875} = 0.394 \text{ meters} \]

19. The smallest frequencies produced by a wind instrument are 120 Hz, 360 Hz, 600 Hz, 840 Hz, etc. What is the effective length of this instrument?
\[ f_1 = 120 \text{ Hz}, \quad f_3 = 3f_1 \quad (\text{closed}) \quad f_N = \frac{NV}{4L} \quad f_1 = \frac{V}{4L} \]
\[ L = \frac{V}{4f_1} = \frac{345}{(4)(120)} = \frac{345}{480} = 0.719 \text{ meters} \]

20. One person (the instructor) is talking during a lecture. How much does the sound intensity level increase when all fifty people in the room talk at the same time? Assume that each person talks equally loudly.
\[ \Delta B = 10 \log_{10} \left( \frac{I_2}{I_1} \right) \]
\[ I_2 = 50I_1 \]
\[ \Delta B = 10 \log_{10} 50 = 17.0 \text{ dB} \]

If you have extra time, then check over your answers and make sure that you have printed your name, signed your name and printed your student ID # on the first page. Thanks.

I hope that you all have a good spring break.