EECS 225d: Midterm 1, March 7, 1997

Name:

For multiple choice questions, also write a brief (1-2 sentence) explanation of why the answer is correct. The parenthesized numbers after each question number give the relative point value of each question.

1. (2) The excitation model for the Voder was

   a) a pulse generator

   b) a collection of sin generators

   c) wide band noise

   d) (some other answer - specify your choice).

2. (2) A range of different vowels can be synthetically produced by

   a) exciting a single uniform tube with periodic pressure pulses.

   b) exciting a multi-tube structure with the sum of sine waves.

   c) exceptionally smart single-cell animals

   d) (some other answer - specify your choice).

3. (2) An acoustic tube closed at both ends and excited at its midpoint will resonate at frequencies

   a) higher than

   b) lower than

   c) equal to

   that of an acoustic tube open at one end and excited at the other end.

4. (2) In response to pure sinusoidal tones, an auditory nerve will spike at different rates, depending on the frequency of the stimulus. These rates are predominantly determined by

   a) the properties of the hair cell stereocilia

   b) the basilar membrane vibration in the vicinity of the hair cell

   c) the specific parameters of the neuron

   d) the strength of the dollar in European markets

5. (2) Ignoring air absorption, frequency dependencies, nonlinearities, or spatial dependencies, what is the effect on the reverberation time (e.g., RT60) of doubling the absorption coefficient of a room's surfaces?

   a) increase the reverberation time for quiet sounds and decrease it for loud sounds

   b) double the reverberation time

   c) halve the the reverberation time

   d) reduce the reverberation time by a factor of 4.

6. (2) Three tones (100 Hz, 2000 Hz, and 7000 Hz) are presented monaurally over wideband headphones (40Hz -16 kHz $\pm$ 1 dB) to a young adult subject with normal hearing. In each case, the Sound Pressure Level (SPL) at the subject's ear is 40 dB. What would be the expected order of loudness for the tones, going from the loudest to the least loud?

   a) 100, 2000, 7000

   b) 2000, 100, 7000

   c) 2000, 7000, 100

   d) All would have roughly the same loudness.

7. (2) Dynamic programming has been applied to speech recognition for many years. One major advantage to this approach (as it has been commonly used) is

   a) The effects of different vocal tract lengths are normalized

   b) The effects of different durations for the same sounds are normalized

   c) The effects of different loudnesses for the same sounds are normalized

   d) The effects of post-nasal drip are normalized

8. (2) A classifier is trained on a set of examples that are labeled for class membership. The resulting classifier is used to estimate the class of each example in the training set, and is correct 90% of the time. The same classifier is then tested on a new set of examples that were not used in the training. For real-world data, the most likely result would be

   a) The test set performance would be at most 90%

   b) The test set performance would be at least 90%

   c) The test set performance would be close to zero

   d) The test set performance would depend on the eye of the beholder

9. (6) Consider a digital filter consisting of two cascaded sections:

Section 1 is defined by the equation

$$v(n) = x(n) - x(n-K)$$

Section 2 is defined by the equation

$$y(n) = 2cos(\theta)y(n-1) - y(n-2) + v(n)$$

a) Sketch the filter's poles and zeros for $K = 12$ and $\theta = 60$ degrees

b) Sketch the frequency response, i.e. the amplitude of Y(z) evaluated on the unit circle, vs. ωT.

10. (4) Define the following terms (1 sentence per definition):

a) interval histogram

b) efferent

c) stapes

d) oval window

11. (4) Show that the constraint u(x,t) = w(x)v(t) can be applied to the 1-D wave equation, and that exponentials are a solution to the resulting form. Recall that the 1-D wave equation is

$$c^2\left(\frac{\partial^2 u}{\partial x^2}\right) = \frac{\partial^2 u}{\partial t^2}$$

12. (4) Give two dimensions of difficulty for a speech recognition task. For each dimension, describe an easier and a harder example, and explain (in one sentence) the difference in difficulty.

13. (6) Let $\mathbf{x}$ be a discrete random variable, and let a and b be two classes that examples corresponding to $\mathbf{x}$ can belong to. Further, let the 2 class-conditional densities be known:

$$p(\mathbf{x}|a) = \begin{cases} \frac{1}{8} & \text{for } 1 \leq \mathbf{x} \leq 8 \\ 0 & \text{elsewhere} \end{cases}$$

and

$$p(\mathbf{x}|b) = \begin{cases} \frac{1}{4} & \text{for } 7 \leq \mathbf{x} \leq 10 \\ 0 & \text{elsewhere} \end{cases}$$

Finally, the class priors are also known, and are $p(a) = \frac{3}{4}$ and $p(b) = \frac{1}{4}$. Find the optimal decision rule to decide on class a or b given $\mathbf{x}$.