

## STUDY QUESTIONS FOR THE FINAL EXAM (August 8, 2008)

## A. ACOUSTIC PHONETICS: INTRODUCTION TO BASIC ACOUSTICS

1. What is sound? Give *three* definitions, and explain. Why is it difficult to describe sound?
2. What are the two types of wave motion? Which one is relevant to sound propagation?
3. Describe the air pressure fluctuations caused by a source, from the point of view of (i) particle movement, (ii) wave movement.
4. What is a waveform?
5. List and define the physical dimensions of waves.
6. List and define the temporal dimensions of waves.
7. What are the psychological dimensions of waves?
8. Periodic and aperiodic waves: define and give examples.
9. Fourier theorem: explain.
10. Sinusoidal waves and complex waves: define and give examples.
11. Complex waves are of two types: which are they? Define.
12. Give brief definitions of the following basic acoustic terms:
  - a. transverse and longitudinal waves
  - b. cycle
  - c. period
  - d. frequency
  - e. pure tone
  - f. compression and rarefaction
  - g. force, elasticity, inertia
  - h. amplitude
  - i. wavelength
  - j. velocity
  - k. phase
  - l. fundamental frequency
  - m. harmonics
  - n. line spectrum
  - o. transient and continuous aperiodic complex signals
13. Explain the relationship between frequency and period. Give the algebraic formula and provide *one* example.
14. Explain the relationship between wavelength, velocity and frequency. Give the algebraic formula and provide *one* example.
15. Reflection: define and explain the properties of the reflected waves with giving an example.
16. Standing waves: explain by referring to the concepts *nodes* and *antinodes*.
17. Resonance: discuss, and give examples.
18. Acoustic resonator: define.
19. Discuss the concepts *resonance curve* and *bandwidth*. Illustrate your discussion with examples.
20. What is the lowest resonance frequency of the vocal tract? Why?
21. Resonant frequencies of the vocal tract: why do only the odd number multiples of the  $F_0$  resonate?
22. What are *poles* and *zeros*?

## **B. SOURCE-FILTER THEORY OF SPEECH PRODUCTION**

1. Briefly summarize the basic aspects of the source-filter theory of speech production. Illustrate your discussion with examples.
2. Draw the spectrum of a typical glottal air flow (100 Hz). Explain (i) the relationship between the  $F_0$  and its harmonics, (ii) the relationship between frequency and amplitude of the harmonics.
3. Explain the supralaryngeal filter concept. Discuss the transfer function of the supralaryngeal airway for the vowel [ə].
4. Formant lowering and vocal tract length: Discuss the two ways in which the length of the vocal tract can be increased. How does the increase of the length of the vocal tract affect formant frequencies?
5. Summarize the predictions of the effects of constriction of the vocal tract on the frequencies of  $F_1$ ,  $F_2$  and  $F_3$ .

## **C. ACOUSTIC PRINCIPLES APPLIED TO THE VOCAL TRACT: THE CONSONANTS**

1. What are the acoustic correlates of the three components of stop articulation? Discuss and give examples.
2. Explain the concept *locus*. Illustrate your discussion with examples.
3. Which are the acoustic cues important for (i) distinguishing between voiced and voiceless stops, and (ii) distinguishing between stops of different places of articulation?
4. What are the acoustic characteristics of fricatives? Discuss with reference to the distinction between (i) voiced and voiceless fricatives, and (ii) fricatives of different places of articulation.
5. What are the acoustic correlates of (i) the glides, and (ii) liquids?
6. What are the acoustic correlates of nasals?
7. What are the acoustic correlates of (i) the glottal stop, and (ii) the glottal fricatives?
8. What are the acoustic correlates of (i) the flaps, and (ii) trills?

## **D. SPECTROGRAPHY**

Define the following terms relevant to the interpreting of spectrograms:

1. Define the concept of *spectrograms*.
2. Wide-band filtering: define and explain its most common application.
3. Narrow-band filtering: define and explain its most common application.
4. Define the relationship between time resolution and frequency resolution. What are the implications of the relationship between time resolution and frequency resolution?

## E. SPEECH PERCEPTION

### 1. Hearing: How do we hear sounds?

- a. Explain the change in mode of the transmission of sounds as they travel through the outer ear, middle ear and inner ear.
- b. The outer ear: name and describe its parts and refer to their functions.
- c. Explain the mechanism of how the external auditory meatus boosts the high frequencies of sounds.
- d. The middle ear: name and describe its parts and refer to their functions.
- e. What is *impedance*? Describe the two mechanisms which the middle ear employs in order to minimize the effect of mismatch in impedance.
- f. What is the function of the *eustachian tube*? Explain, and give an example.
- g. The inner ear: name and describe its parts, and refer to their functions.
- h. What is the traveling wave theory?

### 2. The perception of frequency and intensity

#### (i) The perception of frequency

- a. Is the human auditory system equally responsive to all frequency changes? Discuss.
- b. Define the concept *mel*. How do you interpret the following frequency values: 500 mel, 2000 mel?
- c. What is the relationship between the increase of frequency in cycles per second (Hz) and the increase of mels (pitch)?

#### (ii) The perception of intensity

- a. What is the relationship between intensity and loudness? Discuss.
- b. Discuss the concept *absolute threshold of audibility*.
- c. A *phon* is a unit of equal loudness. Define the concept *phon curves*. Interpret the following loudness level curves: 20-phon line; 70-phon line.
- d. Explain the relationship between frequency and intensity at low loudness levels and at higher loudness levels.
- e. What is the unit of loudness? Define.

## F. PRACTICAL EXERCISES

1. Identify the spectrograms of the vowels [i], [u] and [ɑ].
2. Identify the spectrograms of the diphthongs [aj] and [au].
3. Identify the spectrograms of stops, fricatives, nasals, approximants, flaps and trills (only by their *manner* of articulation).
4. Distinguish between spectrograms of
  - i. voiced and voiceless stops
  - ii. voiced and voiceless fricatives
  - iii. stops and nasals
  - iv. glides and liquids
  - v. lateral and rhotic liquids
5. Transcription of *connected speech* as practiced in home assignments.

## **READINGS:**

### **FROM CUSTOM COURSEWARE:**

1. MacKay, Ian. 1987. *Phonetics: The Science of Speech Production*. Chapter 10.
2. Denes, P. and E. Pinson: *The Speech Chain*. Chapter 5.
3. Appendix 6-26.
3. Lecture notes.