TKK Department of Signal Processing and Acoustics
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S-89.2300 Sound and Voice Technology
Examination June 9th, 2008
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You have max three (3) hours for answering the questions. You may leave after the first hour but not before. Allowed/Required accessories: pens, calculator, student card. Paper is available from the supervisors of the examination. No books, notes, laptop computers/PDAs or conversation. Turn off your mobile phone. The results may be expected to appear one month after examination on the course web pages and information board.

At the ECE-department, it is customary to gather feedback from the courses. You can send your (voluntary) feedback to the course e-mail. **All feedback is appreciated!**

- **Answer only to five (5) questions.** If you answer 6, only the worst five will be taken into account.

- Express yourself punctually: for engineers it is not enough to define concepts "something like that" but exactly and unambiguously.

- Answer clearly (both contentswise and handwriting): According to Murphy's law, if an answer can be misinterpreted, it will be misinterpreted.

- Everyone has to leave a paper, even if it contained only your name and student number! Also remember to sign the participation list!

Good luck with the examination!

1. Explain the following concepts with a few words. If needed, include a mathematical formula or definition or drawing.
   (a) critical band
   (b) temporary hearing loss
   (c) CD-quality
   (d) microphone
   (e) loudness level
   (f) semitone

2. Write an essay of the following topic: The acoustics of woodwind instruments.
   (1-2 pages long, well organized answer gives the best result)

3. Write an essay of the following topic: Environmental noise, noise control and the effects of noise on hearing
   (1-2 pages long, well organized answer gives the best result)

4. Sound producer is recording a band of 4 girls in his studio. The dimensions of the studio are: width 4 m, lenght 6 m and height 2.4 m. All walls and ceiling have been covered with acoustical absorpent. The absorption coefficient for the floor is 0.1 and reverberation time 0.4 s when the 4 girls are singing background vocals at the same time.
   (a) What is the absroption coefficient of the absorpents?

   The record company decides to sack one of the singers, which means that the producer has to record the background vocals again.
   (b) What is the reverberation time of the studio during a new singing session?

   Without a doubt, by sacking one of the singers, the record company wants to save money.
   (c) How much money does the producer save, when he destroys the original solo vocal tracks by the dismissed member from his hard disk? There were total of 3 minutes 15 seconds of material recorded with 24 bits and 96 kHz sampling rate. Hard disk capacity costs 1,73 € per gigabyte.

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5. (a) Persons A and B are sitting at a terrace of a lake sauna with Helmholtz resonators in their hands. By blowing to the resonator, person A produces a 260 Hz fundamental frequency. However, when person B does the same, we will hear a 7 Hz beating. How much liquid should person B remove from his/her resonator so that the "orchestra" would play in unison, i.e. play exactly the same note?

   The dimensions of the neck of the resonator are:

   - length: 4 cm
   - diameter: 1,8 cm

   (b) Let's assume that the resonators are equal both in terms of tuning and phase, one resonator produces sound pressure level of 70 dB at 1 meter distance and the terrace represents an acoustical free field. What is the sound pressure level for a listener standing 4 meters away from both players?

6. Answer the following questions (a)-(f) by selecting the best alternative (A, B, C, D, E, or F). An adequate answer is the correct sequence of letters, that is, 6 capital letters in the right order. Note! Verify that you have chosen the alternative you want (the letter is always before the value).

   (a) The average length of a male vocal tract is 17 cm. The fundamental frequency of a male speech is in average
   (A) 1 Hz (B) 10 Hz (C) 17 Hz (D) 110 Hz (E) 506 Hz (F) 1520 Hz

   (b) When storing a sound signal with 24 bits (using linear quantization), the dynamics is
   (A) 24 dB (B) 69 dB (C) 96 dB (D) 108 dB (E) 124 dB (F) 144 dB

   (c) Audio signal taken from an audio-CD-record, is MP3-encoded using 192 kbit/s bitrate. The compression ratio is
   (A) 1:192 (B) 1:11 (C) 1:10 (D) 1:7 (E) 1:2 (F) 1:0,192

   (d) The (theoretical) sound pressure level caused by two coherent sound sources, if they have a 180 degree phase shift and the sound pressure level of them is 0 dB each, is
   (A) $-\infty$ dB (B) -6 dB (C) 0 dB (D) 3 dB (E) 6 dB (F) ∞ dB

   (e) The (theoretical) sound pressure level caused by two incoherent sound sources, if they have a 180 degree phase shift and the sound pressure level of them is 0 dB each, is
   (A) $-\infty$ dB (B) -3 dB (C) 0 dB (D) 3 dB (E) 6 dB (F) ∞ dB

   (f) In a room with reverberation time 1 s and volume 1000 m^3, the absorption area is
   (A) 1610 m^2 (B) 621.12 m^2 (C) 600 m^2 (D) 401 m^2 (E) 161 m^2 (F) 16.1 m^2