SPEECH ACOUSTICS
Budapest University of Technology and Economics
Spring 2009

Preliminary Syllabus

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This is a new and innovative course for students interested in speech communication. In the first half of the course we will focus on the physics of speech production, including current cutting-edge research. Understanding of key concepts will be stressed rather than mathematical rigor. The second half of the course will focus on various topics of current interest, including speech perception, phonetics, and speech technology. Students who participate in the course will be able to apply their knowledge of speech in a variety of contexts. The language of instruction is English. Office hours will be held weekly.

Prerequisites:

Speech Information Systems (Beszéd-információs rendszerek) or Speech Communication (Beszédkommunikáció), or equivalent, or special permission from the lecturer
Basic familiarity with phonetic transcription and speech analysis will be assumed.
Proficiency in English.

Class meetings:

Mon & Thu 3:15-5pm, Room 205, BME Stoczek building
Both the time and location of the class meetings may be changed.
If you plan to attend the classes (either for credit or not), please contact the teaching assistant.

Grade in this subject is calculated approximately as follows:

Theme Reports (3)	45
Term paper (1)	55
	100

Out of six possible theme reports, only the top three will be counted in determining the grade. Students will choose their themes at the beginning of the semester. One paper for each theme will be required reading for all students (in **bold** below). Theme reports and in-class discussions will be based on two or three additional papers. Additional homework problems and lab assignments will be provided, but they are entirely optional. If students complete them, the lecturer will give feedback, but they will not count toward the final grade.

COURSE OUTLINE

Feb 9 (Monday) Introduction and background. Phonetic transcriptions. Survey of speech anatomy, respiratory system, airflows and pressures. Auditory system and human response to sound. Some basic acoustics of resonators and sources, source-filter concepts.

Feb 12 (Thursday) Navier-Stokes equations. Conceptual understanding of N-S equations. Derivation of the one-dimensional wave equation. Solution of the wave equation. Analogy to electrical circuits. Simple modeling of speech with acoustical circuits.

Feb 16 (Monday) Theme 1 Lecture: Frication and aspiration sound sources; aeroacoustics of periodic and noisy sound source production; airflow and vortices.
Readings: Stevens (1971); Shadle (1991); ***Krane (2005)***

Feb 19 (Thursday) Application of the wave equation to a uniform tube. Natural frequencies. Coupled resonators and impedance matching. Simple examples from speech. Helmholtz resonators and lumped elements. Definition of acoustic impedance: inertance, compliance, and resistance.

Feb 23 (Monday) Theme 2 Lecture: Glottal aerodynamics. Flow separation. Coanda effect. Effects on vocal fold vibration.
Readings: Pelorson et al (1994); Alipour and Scherer (1995); ***Erath and Plesniak (2006)***

Feb 26 (Thursday) Catching up.

Mar 2 (Monday) *Theme 1 Reports due. Discussion of Theme 1 papers.*

Mar 5 (Thursday) Speech sources lab.

Mar 9 (Monday) *Theme 2 Reports due. Discussion of Theme 2 papers.*

Mar 12 (Thursday) Poles and zeros. Nasals, liquids, laterals. All-pole model of vowel production. Glottal sound source. Vocal tract transfer function. Examples from vowels and nasals.

Mar 16 (Monday) Theme 3 Lecture: Source-tract interation.
Readings: Bickley and Stevens (1986); Zang et al (2006); Drechsel and Thomson (2008); ***Titze (2008)***

Mar 19 (Thursday) Subglottal acoustics. Pole-zero pairs in vowels. Noisy sources. Relation of periodic and noisy sources to N-S equations. Transfer functions with noisy sources.

Mar 23 (Monday) Catching up.

Mar 26 (Thursday). Speech analysis lab.

Mar 30 (Monday) Theme 3 Reports due. *Discussion of Theme 3 papers.*

Apr 2 (Thursday) Theme 4 Lecture: Three-dimensional modeling of speech production.
Readings: Selbie et al (2002); Takemoto et al (2006); Sidlof et al (2007)

Apr 6 (Monday) Catching up.

Apr 9 (Thursday) Theme 5 Lecture: Coarticulation and variation in speech.
Readings:

Apr 13 (Monday) No class. Easter holiday.

Apr 16 (Thursday) Theme 4 Reports due. *Discussion of Theme 4 papers.*

Apr 20 (Monday) Knowledge-based speech technologies.

Apr 23 (Thursday) Theme 5 Reports due. *Discussion of Theme 5 papers.*

Apr 27 (Monday) Speech technology lab.

Apr 30 (Thursday) Theme 6 Lecture: Child speech development
Readings: Kent

May 4 (Monday) Speech perception I.

May 7 (Thursday) Speech perception II.

May 11 (Monday) Speech perception lab.

May 14 (Thursday) Theme 6 Reports due. *Discussion of Theme 6 papers.* Last day of class.

June 19 (Friday) Final project due.

Bibliography

Alipour, F., R. C. Scherer (1995). *Pulsatile airflow during phonation: An excised larynx model*. Journal of the Acoustical Society of America 97(2):1241-1248.

Bickley, C. A., K. N. Stevens (1986). *Effects of a vocal tract constriction on the glottal source: Experimental and modeling studies*. Journal of Phonetics 14:373-382.

Drechsel, J. S., S. L. Thomson (2008). *Influence of supraglottal structures on the glottal jet exiting a two-layer synthetic, self-oscillating vocal fold model.* Journal of the Acoustical Society of America 123(6):4434-4445.

Erath, B. D., M. W. Plesniak (2006). *The occurance of the Coanda effect in pulsatile flow through static models of the human vocal folds*. Journal of the Acoustical Society of America 120(2):1000-1011.

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Titze, I. R. (2008). *Nonlinear source-filter coupling in phonation: Theory*. Journal of the Acoustical Society of America 123(5):2733-2749.

Zhang, Z., J. Neubauer, D. A. Berry (2006). *The influence of subglottal acoustics on laboratory models of phonation*. Journal of the Acoustical Society of America 120(3):1558-1569.