



## LECTURE INVITATION

# SOUND QUALITY OF AUDIO SYSTEMS – MODELLING, MEASUREMENT AND CONTROL

The University course will be presented as a block seminar

PRESENTED BY: Prof. Dr. Wolfgang Klippel  
Institute of Acoustics and Speech Communication,  
Dresden University of Technology, Germany

DATE: **4<sup>th</sup> to 6<sup>th</sup> November, 2019**  
9:00 a.m. – 5:00 p.m.

LOCATION: Feng Chia University, Taichung, Taiwan  
No. 951, Sec. 1, Dongda Rd, Taichung

LANGUAGE: English

REGISTRATION FEE: NTD6,000 (Students NTD1,000)

PARTICIPANTS: Engineers of the audio industry active in research & development,  
manufacturing and quality control  
students in the graduate program of the Electro-Acoustics

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## ABSTRACT:

The lecture addresses the evaluation of sound reproduction systems using physical and perceptive measurement techniques. The generation of signal distortion is modelled by linear, nonlinear and time-variant systems with lumped and distributed parameters. New measurement techniques based on those models are presented using test signals and music. The relationship between symptoms and physical causes of the distortion is made more transparent, and the impact on the perceived sound quality by combining listening tests, auralization techniques with physical methods is discussed. This knowledge is important for designing and manufacturing small, light and cost-effective transducers that reproduce the sound at high efficiency and sufficient sound quality and for using new control techniques (smart amplifiers).

## New topics addressed this year in the lecture:

Higher-Modal Analysis applied to headphones diaphragms

- What are the root cause analysis of the rocking modes (mass, stiffness or BI imbalances)?
- Why generates the diaphragm significant intermodulation distortion?
- How to use FEA to find the optimum shape of the diaphragm

Comprehensive evaluation of audio systems with arbitrary signals

- How to separate the distortion in reproduced music signals
- How to assess the audibility of the distortion
- How to assess impact on the reproduced sound quality

Fast loudspeaker measurement in a non-anechoic environment

- Limitations of traditional techniques (windowing of the impulse response)
- Complete compensation of the room influence by inverse filtering
- How to provide accurate reference data
- Generation of a room correction curve valid for multiple speakers

Active control of electro-acoustical transducer

- How to improve maximum output, sound quality and efficiency
- Transducers need active protection, equalization, linearization and stabilization
- DSP provides new freedom for passive transducer design

## CONTENT:

ELECTRO-ACOUSTICAL MODELLING:

- Fundamentals - transduction, vibration, radiation
- Abstraction - models with lumped and distributed parameters
- Small Signal Performance - linear approximation and transfer function
- Large Signal Performance - thermal dynamics and nonlinearities
- Time-varying properties - influence of climate and aging

MEASUREMENTS AND ANALYSIS:

- Persistent excitation - artificial and natural stimuli
- Monitored signals - electrical, mechanical and acoustical sensors
- Complex structures - digital and analogue components
- Sound field - measurements in the near and far field
- Interaction with the room - direct and diffuse sound part
- Measurement time - ultra-fast and long-term (power) testing
- Distortion analysis - linear and nonlinear components
- System identification - optimal fitting and parameter estimation
- Transformations - Fourier, wavelet and perceptual modelling
- Data compression - separation of unique and redundant information

INTERPRETATION AND DIAGNOSTICS:

- Interpretation - measured symptoms and physical causes
- Perception - audibility and impact on perceived sound quality
- Evaluation - selection of optimal drive units for system design
- Specification - minimal but comprehensive set of data
- Tolerances - variation of parameters and influences

**Prof. Klippel will address other topics in his lecture which are important for your work. Please send your wish list or detailed question to [henry.liou@somaacoustic.com.tw](mailto:henry.liou@somaacoustic.com.tw).**

## MORE on Loudspeakers, Smart Amplifiers and DSP:

### Attend the Master-class on “Software Complements Hardware in Active Loudspeakers” on November 8<sup>th</sup> 2019 in Shenzhen / China!

The three-day lecture at the Feng-Chia University covers the basic terms, fundamental and theoretical concepts and practical diagnostic methods that are required for the design and evaluation of modern audio systems. Most of the new techniques are illustrated on woofers and other common cone loudspeakers to simplify the interpretation of the measurement results.

This knowledge is used for the development of active loudspeaker systems using adaptive, nonlinear control, which can be implemented in DSP and smart amplifiers at low cost. This new technology, opportunities and practical applications in modern audio products are discussed in a separate **Master-class on “Software Complements Hardware in Active Loudspeakers”** that will be presented on **8<sup>th</sup> of November 2019** in Shenzhen (main land China) just before the 7<sup>th</sup> International Symposium on ElectroAcoustic Technologies (ISEAT 2019). It is strongly recommended to use the three-day lecture as a warm up for the following Master-class.

#### **Contact Information:**

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