1:00pm-5:00pm | Oct 21, 2015 (Wednesday)

2E	
Title:	**A Modern Approach to Modelling and Simulation of Micro-acoustic Devices**
Lecturer:	**Alireza Baghai-Wadji,** University of Cape Town, South Africa
Abstract:	High performance modelling and simulation of SAW and BAW devices continue to pose challenges to analysts and designers alike. To account for acoustic wave generation, transmission, scattering and interaction using 3D device models, numerous device features have to be considered in unison, including geometrical structures of varying scales, anisotropic piezoelectric materials, and finitely-thick finitely-conductive massive metallic electrodes and bus-bars. Extreme miniaturization of devices renders the analysis of electromagnetic interference and dissipative heat phenomena no longer a matter of choice. Rigorous modelling of higher-order effects in micro-acoustic devices, involving several hundreds to thousands of electrodes, with possibly varying aperture lengths, presents itself as an utterly complex multi-physics boundary value problem which calls for new modelling and simulation paradigms and computational methodologies. Thereby, a question arises: Are currently available sophisticated software packages not suitable to meet the above-mentioned partially conflicting design criteria? The answer remains far from being affirmative. Despite impressive advances made in recent decades, it is generally appreciated in the acoustics community that numerous computational challenges still remain to be tackled. With his uncompromising dedication, extending well over three decades, to solve some of the notoriously-difficult computational problems in micro-acoustics, the efforts of the course instructor have recently culminated in a succession of breakthroughs allowing him to remedy major debilitating shortcomings in computational acoustics and electromagnetics. It is the story of his life-long scholarly efforts which is shared in this short course. Along the way the course participant becomes acquainted, first hand, with a plethora of physical and computational insights, e.g., higher-order effects in SAW and BAW devices; 3D charge distributions on finitely-thick massive electrodes; 3D massive and finitely-thick bus-bars; dissipative loses in finitely-conductive electrodes; and coupled acoustic and electromagnetic radiation and scattering phenomena. Speaker's Universal Functions in conjunction with his work on the regularization of Green's functions will inform the course attendees from the most advanced computational technologies currently available in micro-acoustic device modelling. Also included are speaker's recent achievements in the area of finite difference method, as applied to the mass-loading effect. Thereby, it will be demonstrated that the edge- and corner points can be eliminated from the analysis at the outset – responding to an age-old problem in simulations! The presentation promises to be a comprehensive, up-to-date and pedagogically well-prepared short course - scintillating with novelty in each moment of instruction. A comprehensive manuscript will be handed out to the course participants.
Outline	• Higher-order effects in SAW- and BAW devices; • 2D- and 3D charge distributions on finitely thick massive electrodes; • 2D- and 3D massively and finitely thick bus-bars; • Dissipative loses in finitely-conductive electrodes; • Coupled acoustic and electromagnetic radiation and scattering phenomena; • Universal Functions (introduced by the instructor);

- Two recent developments in the regularization of Green's functions' singularities (accomplished by the instructor);
- Recent achievements in the area of finite difference method as applied to the mass-loading effect (carried out by the instructor and his research team);
- Conservative finite difference method;
- Fast and accelerated computational techniques;
- Design of novel physics-inspired analysing and synthesizing functions for modelling and simulation of microacoustic devices;
- Methods for joint time-frequency analysis.

Biography

Alireza Baghai-Wadji is currently professor of electronic and computational engineering, convener of the ECE- and design thinking programmes, and assistant dean (internationalisation) at University of Cape Town (UCT), Cape Town, South Africa. He received his MSc, PhD, and DSc in 1984, 1987 and 1994, respectively, from Vienna University of Technology (VUT), Vienna, Austria. In 2003 he was awarded DSc from Helsinki University of Technology (HUT), Helsinki, Finland. From 2005 to 2012 he was professor and discipline head with RMIT University, Melbourne, Australia, and an international representative of his university in the Far- and South East Asia, and the Middle East. From 1979 to 2005 he was with VUT: associate professor (1997-2005), docent (1994-1997), assistant professor (1988-1994), research fellow (1984-1988), and research associate (1979-1983). He has worked on five continents accumulating vast experience in academia, research institutions and high-tech industry: Distinguished visiting professor at Beijing Institute of Technology, visiting professor at HUT; visiting scientist at Max Planck Institute, Garching, Germany; consultant to EPCOS, Munich, Germany; Nokia fellow; visiting professor at Institute for High Performance Computing in Singapore; senior member of Institute for Mathematical Sciences in Singapore. He was three times a recipient of the Austrian Kurt Goedel research fellowship (1990, 1991, 1992). He was a visiting scientist at University of California, Irvine, USA; adjunct professor in Department of Statistics and Mathematics at Arizona State University, Arizona, USA; principal engineering consultant with Motorola, Arizona, USA; principal engineering consultant with CTS Albuquerque, New Mexico, USA; principal engineer consultant with Siemens Matsushita, Graz, Austria; consultant with Siemens, Munich, Germany. He was director of the Aerospace and Aviation Electronics Program at The Sir Lawrence Wackett Aerospace Centre, Melbourne, Australia. He is an honorary member and fellow of The Electromagnetics Academy, USA and has been listed in Who's Who in Electromagnetics, USA. Since 1997 he has been an associated editor for IEEE-UFFC Transactions. He was twice a guest editor for the IEEE-UFFC Transactions, editing special issues devoted to the Design, Modelling, Simulations and Optimization Techniques in Micro-acoustic Devices. He has over 180 publications in peer reviewed journals and conference proceedings, and has delivered over 110 invited speeches, key note, plenary speeches, and tutorials internationally. He is the owner of one patent in USA. He has a successful track record of instructing 28 very well received short courses sponsored by IEEE or ACES since 1994. Since 1979 he has been carrying out research in and contributing to computational engineering. In microacoustic community he is known for his original contributions to the theory, regularization and computation of Green's functions.