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- TEACHING AND SERVICE STATEMENT -

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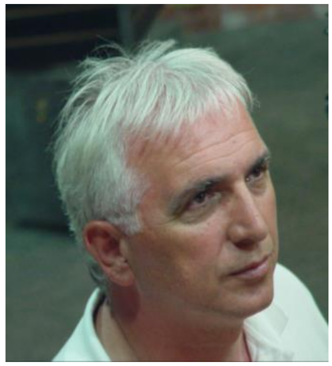

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II. TEACHING STATEMENT

i) Teaching Philosophy. Teaching is a dynamical process that involves two parts, the teacher and the student. Every time I teach a course, or give a series of lectures, I think of new ways to get the message across, always taking into account the level of and feedback from the audience. Such an adaptive and iterative process has subsequently helped me review the material of a course at several quantitative and qualitative levels. That is why I always think of teaching as a learning and dynamic process for the student and the teacher. I also believe that the out-of-class interaction of the teacher with the students is a very important element in the teaching process, and always try to make myself available either through official office hours, e-mail, phone or appointment.

ii) Teaching Program. The following areas of my teaching expertise have been developed at the University of Michigan Ann Arbor, University of Florida, Gainesville, Arizona State University, Tempe, and Louisiana Tech University: i) Electrical Biophysics and Physiology of the Nervous System; ii) Biomedical Signal Processing; iii) Neural Computation; iv) Biomedical Instrumentation and Design; v) Nonlinear Dynamics; vi) Linear and Nonlinear Systems Theory and Applications; vii) Advanced Digital Signal Processing; viii) Control Theory and Biomedical Applications; Information Theory. I also have taught entry-level undergraduate courses with students from all departments of the School of Engineering. Needless to say that, although the teaching of those courses did not require any specific expertise, it requires full attention to the details and design, as well as special teaching skills, since the audience is typically neither motivated nor oriented yet. Hands-on experience is a must for our engineering students and it is reflected in their course and teaching instructor evaluations.

iii) More Detailed Description of Areas of Teaching Interest

- Electrical biophysics of nerve cells and tissues (laws of resting and action potential generation, propagation of AP, synaptic action and statistics, mathematical modeling of axon, active transport of ions, neuromuscular junction, cell interactions and memory, mathematics of neurons). From neuron to macroscopic electrical and magnetic activity of the nervous system (EEG, MEG).
- Biomedical instrumentation and design for recording, amplification and filtering of biological signals. Principles of biological transducers (e.g. electrodes for measurement of bioelectric and biomagnetic events, pressure, volume flow and velocity, temperature). Therapeutic and prosthetic devices (e.g. brain electric and magnetic stimulators, cardiac pacemakers, defibrillators). Medical Imaging Systems (principles of radiography, thermography, nuclear medicine, ultrasonic scanning, computer-assisted tomography)
- Physiological basis and mathematical analysis of evoked responses (VEP, BAEP, SSEP). Applying systems theory to model various functions of the sensory and cognitive pathways of the central and peripheral nervous system.
- Digital processing of *deterministic* (linear and nonlinear) and *stochastic* (stationary and nonstationary) signals and images. Subareas: system identification, information theory, orthogonal transforms, time-frequency transforms, optimal filtering, pattern recognition
- Linear & nonlinear systems theory and modeling, chaos theory, control theory.
- Stability and complexity of networks of systems or of systems of spatial extent. Crises (seizures) in networks. Bifurcation analysis of their phase transitions. Synchronization of information transfer as a means for communication of the different parts of a system. Application of these principles to intelligent machines and rehabilitation.
- Information theory and its applications to the analysis of biomedical signals and images has been a recent area of teaching interest to me. It was developed from my research collaboration with Cleveland Clinic on analysis of MRI images and MEG signals from epilepsy patients for localization of the epileptogenic focus via information flow in the brain networks.

iv) Courses taught

1. Graduate Biomedical Instrumentation (BIEN 510, Winter 2013, Louisiana Tech University)
2. Biomedical Signals and Systems (BIEN 225, Fall 2013, Louisiana Tech University)
3. Applications of Information Theory to the Analysis of Biomedical Signals (BIEN 557, Spring 2013, Louisiana Tech University)
4. Fundamentals of Applied Neural Control via Bioelectromagnetism (BME 524, Spring 2011, Arizona State University)
5. The ASU experience (ASU101, Fall 2009, Arizona State University)
6. Microcomputer Applications in Bioengineering (BME370, Spring 2009, Arizona State University)
7. Computational Neuroscience (BME598, Spring 2008, Spring 2010, Arizona State University)
8. Scientific Communication (BME598, Fall 2007, Arizona State University)
9. Bioengineering Transport Phenomena, Fluids (BME331, Fall 2005, Arizona State University)
10. Introduction to Engineering Design (BME 100, Fall 2007; Arizona State University)
11. Biodynamics (BME598P, Fall 2001; Fall 2002, Arizona State University)
12. Advanced Physiology for Bioengineers (BME 598E/494, Spring 2001 to 2005; 5 times), Arizona State University)
13. Advanced Neural Signal Analysis and Processing (BME598A, Spring 2001, Arizona State University)
14. Intro to Signals and Systems for Bioengineers (BME350; 2002-2010; 9 times, Lectures and Lab, Arizona State University)
15. Intro to Bioengineering (ECE 100, Fall 2003; Arizona State University)
16. Basic Neurophysiology, Modeling of Neuron, CNS (**University of Florida**)
17. Intra-operative Monitoring of Evoked Potentials, Evoked Responses and Biomedical Instrumentation (Neurology Service, VA Medical Center**, University of Florida**)
18. Lectures on Brain Dynamics and Signal Processing of the EEG (**University of Florida**)
19. Biomedical Instrumentation and Design, Ad Hoc Lectures and laboratory (**University of Michigan, Ann Arbor**)
20. Basic and Advanced Digital Signal Processing courses, Ad Hoc Lectures (**University of Michigan, Ann Arbor**)

v) New Courses and Course Material Developed

Applications of Information Theory to the Analysis of Biomedical Signals (BIEN 557): New course at LA Tech, Spring 2013

This graduate course was designed to introduce graduate students of engineering to the fundamentals of probability and information and their employment in the analysis of stochastic signals, especially the ones encountered in complex networks and the noisy environment of multi-sensor recordings from the brain. Concepts of entropy, mutual information, information flow, channel capacity were developed and applied to real biomedical signals like EEG, MEG, ECG, as well as simulation spike data in neural networks. The students acquired a deep understanding of the concepts of a probabilistic signal and information channels, and the significance of their application to quantify the linear and nonlinear interactions between the components of complex deterministic and stochastic networks like the ones in the highly interconnected and interacting neural systems in the brain.

Fundamentals of Applied Neural Control via Bioelectromagnetism (BME524): New course at ASU, Spring 2011

This graduate course was designed to introduce graduate and senior undergraduate students in the fundamental principles of feedforward and feedback control and guide them in its application to biological systems. Topics include classical control (transfer functions, Bode plots), modern control (state-space, digital), robust control (hybrid), measures of performance of control (gain and phase margins), stability, observability, controllability, PID control circuits, design and implementation of controllers, bioelectric and biomagnetic aspects of membrane biophysics, ion channels, action potentials and impulse propagation, electrical tissue impedance theory and measurement, volume conductor theory, electrical and magnetic stimulation of excitable tissue, design of a controller for control of spiking of a neuron and neuronal networks (simulation studies), and a number of special topics as student term projects. At the conclusion of this course students are well prepared to independently analyze and appreciate problems in control, bioelectricity, biomagnetism and signal processing in neuroengineering.

Computational Neuroscience (BME598): New course at ASU, Spring 2008

This is a recently designed graduate course for the core of Neural Engineering in bioengineering. It includes topics on several established models of neurons, neuron networks, and advanced signal processing for detection and analysis of spatio-temporal information in neural networks in the brain. Linear (AR) and nonlinear (ARMAX) modeling of systems is reviewed. Concepts from information theory (e.g., Kolmogorov entropy, Kullback-Leibnitz entropy, mutual information) and advanced transforms (e.g., principal component and other orthogonal transforms, time-frequency analysis) are introduced and students have the opportunity to work with simulations and with real biological signals, typically the ones they generate in their laboratories for their MS and/or PhD.

Intro to Signals and Systems for Bioengineers (BME350; ASU)

This is an undergraduate course I modified and established as a core course for the undergraduate program in Bioengineering. It is an introductory course to signals and systems with applications to simulated and real biological signals (e.g. EEG, EMG, ECG). The students learn the basic definitions and principles of signals and systems (e.g. properties of causality, stability, convolution, time invariance), as well as their analysis via Fourier series, Fourier transforms, Laplace Transforms and their corresponding discrete counterparts DFTs, Z-transforms. The lectures were complemented with homework problems, midterm, final exams and two Lab hands-on projects in the Brain Dynamics Lab. The projects showed the effect of the sampling frequency of continuous signals (Nyquist criterion) and the application of DFT and Z to convolution and filter design.

Advanced Physiology for Engineers (BME 598E/494; ASU)

This is a graduate course. I was given the liberty to redesign the Neurophysiology part of the course (about 1/3 of the total) by including more engineering material with medical applications. Copies of transparencies and typed text with references to book chapters and papers were given out. This part was complemented with visits to Barrow Neurological Institute (BNI), where students had hands-on experience with cell recordings (e.g. using the patch clamp technique), Evoked Auditory, Visual and Somatosensory Potentials (EP) and electroencephalographic (EEG) recordings on an outpatient basis, and monitoring of neurophysiological recordings in the operating room (OR) for various kinds of neurological surgeries (e.g. brain, spinal cord) at a time. In their evaluations, students were particularly excited and gratified with these visits to BNI. Almost everyone thought had benefited from them a lot. The future plan is that recordings of EPs and EEGs be performed on site at ASU, most probably the Brain Dynamics Lab. In this case the BDL will become a teaching and a research Lab. Finally, the visits to BNI were complemented with assignment of related papers from the literature and oral presentations by the students.

Advanced Neural Signal Analysis and Processing (BME598A; ASU)

This is a graduate course. This course was developed in collaboration with Prof. Kipke. The goal was to introduce the students to a strict mathematical analysis of recorded electrical signals from the microscopic and the macroscopic level of CNS. Cell membrane nonlinear models of production of the action potential trains, axon propagation and synaptic models were discussed in the first part. The second part included the fundamentals of neural networks and the production of the EEG. In the last part, selective, advanced algorithms of signal processing (e.g. KL transforms, Wavelet Transforms, Nonlinear Stability measures) were taught for the EEG analysis. The lectures were accompanied with homework problems, midterm and final, including two projects on real EEG data (epileptic data in humans and mice).

Biodynamics (BME598P): New Course at ASU, Fall 2001

This is a graduate course. The dynamical aspects of signals and systems were investigated. Transition and steady states and the measures that characterize their stability (e.g. Lyapunov exponents) and complexity (e.g. correlation dimension, Kolmogorov entropy) were investigated. Homework problems with computer applications on simulation and real (e.g. EEG, EKG) data were performed. Control of steady states (fixed points, limit cycles, quasiperiodic, chaotic) was shown. Term papers with presentations were required.

vi) Teaching Evaluation

My teaching at LaTech has received high marks by the students. The evaluation of instruction over the 2 classes I taught so far is 3.8 out of a maximum of 4.0.

My teaching at ASU has received high marks by the students. The evaluation of instruction over the 22 classes I taught so far is 4.6 out of a maximum of 5.0. In addition, I felt very honored with my nomination by the student body for the “2003 University’s Last Lecture” award (see CV).

vii) Mentorship

Over the years I have provided mentorship and supported financially 11 post-doctoral fellows (1 at LA Tech, 7 at ASU, 3 at UF), 35 graduate students (3 at LA Tech, 14 at ASU, 18 at UF) and 11 undergraduate students (2 at LA Tech, 8 at ASU, 3 at UF). I have chaired or co-chaired 8 Ph.D. dissertations, been a member in 13 additional Ph.D. committees, chaired 14 M.S. theses and been a member in 6 additional M.S. committees, chaired 25 undergraduate Senior Design projects and 7 Honors Theses. (See the corresponding portions of the CV for details and student placement information.)

III. SERVICE STATEMENT

My service to our academic community spans a broad spectrum of activities.

At the international level, I have been an Associate Editor of IEEE TBME, member of the editorial board of Epilepsia, an Associate Editor of the Int. J. Neural systems, an Associate Editor of Annals of Bioengineering, co-Editor of 2 books, Guest Editor of 5 special journal issues, and ad hoc reviewer for 35 journals.

At the national level, I have been a member of the organizational / advisory committees for 13 conferences / meetings, chaired or co-chaired 12 conference sessions of professional societies and organizations, and have been a reviewer of research proposals for 10 organizations: NIH, NSF, Epilepsy Foundation of America, CURE (Citizens United for Research in Epilepsy), US Civilian Research and Development Foundation, Center for Integration of Medicine and Innovative Technology (CIMIT), Austrian Science Fund, Czech Science Foundation (GACR), Medical Research Council (MRC - United Kingdom) and the National Medical Research Council (Singapore).

At the local level, I have served in multiple departmental committees, including the P&T and Faculty Search Committees and chairing the Biomedical Engineering Graduate Committee for 3 years, 7 college committees and 3 university committees. As a member in one of the three University committees (Task Force for the "Arizona's Bioscience Roadmap to Success"), I assisted the Battelle Memorial Institute and the Flinn Foundation with the development of a roadmap for Biosciences in Arizona.

I have given 46 invited talks in conferences and meetings, including NSF and NIH workshops, the Council for the Advancement of Science Writing, and the American Society for the Advancement of Science (AAAS), and participated in the ASU President's "Community Enrichment Outreach Program" in 2002 and 2005. My research has frequently (at least on 22 occasions) been cited at the national and local press, including the Discover magazine and the New York Times. I am currently a member of 6 professional societies. Please refer to my Curriculum Vitae for more details on my academic service.