**EEL 6935/ COT 6930 - Biologically Inspired Architecture**

**Fall 2014 – Live/Distance Learning Sections**

**Syllabus:**Biological and engineering architectures and mappings between them; Concepts of parallel and distributed sensing, processing and control; robust, adaptive and optimized system; and nonlinear dynamics; system diagnostics, security, and intelligent system.   Applications from artificial sensors and organs to autonomic computing and cellular automata

**Prerequisites:** Graduate status in engineering (biomedical/computer / electrical/mechanical) and computer science.

**Additional information:**This is a cross-disciplinary course. You are not expected to have all the background; and you may not be able to apply all of many of the concepts covered in the class. However, as a graduate student, you are expected to be aware of fundamentals in your field. There will be opportunities to communicate your discipline-specific concepts to others from different backgrounds.

**Instructor:** Dr. Ravi Shankar, Professor, Engineering and Computer Science, [shankar@fau.edu](https://exchange.fau.edu/owa/redir.aspx?C=bPR8OLEnKkaEgnfFUcZtLBVtYRcNWtEITpi3ImTtH5B2SvMXIm3nYJFpZeMMO1H3hqfJWxUFBjM.&URL=mailto%3ashankar%40fau.edu), (561) 297-3470/ (561) 306-5625

**Schedule:** MWF 12 to 12.50 PM. Lectures will be recorded with Echo. Live class students are encouraged to attend MW classes. They will be waived off two quizzes in return for class participation. **Friday’**s class will be recorded without student participation and will be a review session. All students are encouraged to watch this review session before the following week’s lectures.

**Goals:** The human body is a highly evolved, sophisticated and complex system. It is a system to be held in awe and emulated. This is also true of human engineered systems, but not to the same extent. Advances have been made in mapping at system, subsystem, component, and lower levels between the two domains. Much has been learned about the human system; innovative technologies have evolved that address engineering problems by mimicking the human system, and vice-versa.  Applications are vast and varied, from microelectronics, computer architectures, and software agents in engineering,  to robotic aids and artificial sensors and organs in medicine.   Dr. Shankar has applied the concepts of nonlinear dynamics, a fundamental construct in physiological and natural complex systems,   advantageously to fields as diverse as medical diagnostics, mobile computing, engineering design productivity, and STEM education. The goal of this course is to expose the students to fundamental concepts, technological mappings, and engineering & medical applications in a variety of fields. The student will develop a fresh research and development perspective that is grounded in highly evolved biological systems. This should help find innovative solutions in many domains. Dr. Shankar has background and expertise in biomedical, electrical, electronics, and computer engineering, and computer science, VLSI and MEMS. He has 7 US patents based on these concepts, some of which have been commercialized.

**References:**  There is no text book for this course. However, each topic will have specified references.  Secure access to one or two books. ·         Pool,  R.,  Beyond Engineering - How Society Shapes Technology, Oxford University Press, 1997

·         Barrett, K.E., et al., Ganong’s  Review of Medical Physiology, McGraw-Hill,  a recent edition

·         Mead, C., Analog and VLSI Neural Systems, Addison-Wesley, 1989,

·         Jackson, E. A., Perspectives of Nonlinear Dynamics, Cambridge University Press, 1995

·         Batty, M., Cities and Complexity: Understanding Cities with Cellular Automata, Agent-Based Models, and Fractals, MIT Press, 2007

·         Wolfram, S.  A New Kind of Science, Wolfram Media, 2002

·         Lalanda, P, et al., Autonomic Computing, Springer, 2014

·         Northrop, R., Introduction to Complexity and Complex Systems, CRC Press, 2011

**Topics:**

·         Complex systems - human, natural, and engineered systems.  Characteristics and challenges

·         Nonlinear Dynamics - Chaos and Fractals, Chus’s circuit and other oscillators.  Productivity challenges and successes. Applications in diagnostics, computation, productivity, and education.

·         Sensors - Analog Neural VLSI for vision and hearing; sub-threshold and low power design.

·         Parallel and Distributed Architecture  - SIMD/MIMD architecture, Network on a Chip,   Internet of Things,  and sensor networks

·         Hierarchical System - Object Oriented Design,  Engineering Design Automation, Network protocols, system health monitoring, HL7, and wearable computing

·         Seamless Integration - semantic web and  UMLS (unified medical language system)

·         Cellular Automata - Game of Life, Cryptography, Systolic Arrays,

·         Organic Computing - self-principles (organization, configuration, optimization, healing, protection, and explanation).  Nearly modular architectures, highly reliable organizations, cyber-physical systems.

·         Diagnostics - patterns, data analytics, cognitive/behavioral l models, and big data.

·         Systems Biology - Emergent Systems, Bioinformatics, and computational models

·         Genomics -  DNA Chip and  Sequencing

·         Synthetic Biology -  intersection of biology and engineering; biosafety and biosecurity

·         System variability - Sensitivity analysis and early prediction of system failure

·         Intelligent systems - AI, smart software agents, Robotics, and health assist devices

**Grading:**  Assignments (choose 5 out of 10) – 25%; Wiki site (create/edit) on one of the above topics – 50%; and Project (prototype, model, program, simulate, or build) – 25%.