Certificate: Control Systems

Control systems are the critical center of any vehicle system. Examples of control systems are numerous and multifaceted: climate control for passenger comfort in an automobile, automatic cruise control, engine control and pollution control are some typical illustrations. Design of control systems for practical applications requires a through understanding of physical models of the process, mathematical modeling techniques, transient behavior of systems and dynamic characteristics of a physical system.

The Control Systems certificate program will introduce the participants to mathematical techniques of system analysis, use of software, such as Matlab, to enhance the student's experience, system modeling, continuous and discrete time control techniques, including analog and digital PID controllers, digital control, fuzzy logic control, neural network controller, etc. At the next level, participants will be introduced to multivariable control (control of several interacting variables of a physical process) and design strategies for multivariable processes. Finally, the program will introduce some basic concepts in non-linear control and simple design techniques. Several case studies will be presented to enhance the learning experience. Group design projects will be assigned to ensure that the participants understand the design process. (12 credit hours)

ECE 560 Modern Control Theory
3 credits
Introduction to linear spaces and operators; mathematical description input/output systems; state variables and state transition matrix; controllability and observability and its application to irreducible realization of transfer function matrices; state variable estimation; controller syntheses by state feedback; stability of linear systems; analysis of composite systems.

ECE 565 Digital Control Systems
3 credits
Mathematical representation of digital control systems; z-transform and difference equations; classical and state space methods of analysis and design; direct digital control of industrial processes.

ECE 567 Nonlinear Control Systems
3 credits
A study of nonlinearities in control systems, phase plane analysis, isoclines, equilibrium points, limit cycles, optimum systems; heuristic methods; harmonic balance, describing function, frequency response and jump phenomena. Oscillations in relay systems, state space, optimum relay controls, stability, and Liapunov's method are also covered.

ECE 583 Neural Networks
3 credits
Computational characteristics of the brain, learning and self-organization, neural network architectures, e.g., single-layer nets, multi-layer nets, recurrent neural nets, ART, Boltzman. Self-organizing feature maps. Back-propagation, feed-forward, center-

propagation and other learning techniques; hardware implementation examples and applications.

ECE 552 Fuzzy Systems
3 credits
A study of the concept of fuzzy set theory including operations on fuzzy sets, fuzzy relations, fuzzy measures, and fuzzy logic, with an emphasis on engineering applications. Topics include fuzzy set theory, application to image processing, pattern recognition, artificial intelligence, computer hardware design and control systems.

ECE 512 Active Filter Design
3 credits
This course deals with the analysis and design of continuous-time (analog) and switched-capacitor filters. Students will learn how to analyze and design analog filter, whether they are passive, active or switched-capacitor filters. Effect of tolerances of circuit elements on the performance of the circuit behavior will be discussed. Also, students will learn how to use simulation tools to design filters and verify circuit performance.