Certificate: Digital Signal Processing

Digital Signal Processing (DSP) deals with the manipulation and shaping of signals whose values are only defined at discrete instants in time. Discrete signals are a natural consequence of measuring physical and process variables at discrete intervals in time. Continuous signals are often sampled by Analog-to-Digital Converters (A/D) for direct storage in a computer. Signals stored in a computer can be processed for many practical applications. Examples include speech synthesis, speech coding, digital audio and video, digital control of industrial processes, digital filtering for shaping signal characteristics including noise suppression, etc.

The DSP certificate program will introduce the participants to basic theoretical and practical concepts of DSP. Applications of digital filtering, speech processing, real-time processing, and FFT analysis will be discussed. Case studies of typical DSP applications will be presented. (12 credit hours)

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; and direct digital control of industrial processes are presented.

ECE 581 Architectures for Digital Signal Processing
3 credits
Overview of digital electronics, digital signal processing and VLSI design methods to design signal processing hardware from algorithms. Topics include: VLSI technology, algorithms, systolic arrays, wave front arrays, mapping methods for formalizing specific algorithms to hardware implementations, classification schemes (SIMD/MISD/SIMD/MIMD), associative processing, bit-serial pipelined architectures, DSP architectures, interconnection networks, related topics in wafer-scale integration and neural networks.

ECE 583 Neural Networks
3 credits
Computational characteristics of the brain, learning and self-organization; neural network architectures, e.g., single-layer nets, multilayer 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 584 Speech Processes
3 credits
Basic physical principles, physiological models, speech analysis and synthesis models, linear prediction models, synthesis by analysis, synthesis by rule, spectral analysis. Format estimation, vocoders, speech coding, speech and speaker recognition.

ECE 512 Active Filter Design
3 credits
Introduction of OP AMP and application, bilinear transfer functions and frequency characteristics, first order and biquad circuits, Butterworth, Chebyshev and Cauer filters, frequency transformations, ladder design with simulated elements, leapfrog simulation, full and partial impendence scaling simulations, switched-capacitor filters, sensitivity analysis.

ECE 580 Digital Signal Processing
3 credits
Introduction to continuous and discrete time systems, z-transform, discrete fourier transform, the fast fourier transform and its implementation, fast convolution, design and implementation of digital filters, architecture for digital signal processors, quantization efforts.

ECE 582 Statistical Signal Processing
3 credits
A review of discrete-time signals and systems, introduction of discrete-time random signals and variables, linear signal models, nonparametric power spectrum estimation, least-squares filtering and prediction, signal modeling and parametric spectral estimation, and selected topics are presented.

ECE 589 Multidimensional Signal Processing
3 credits
Topics include multidimensional signal analysis methodologies, signal representation, 2-D FIR filter, 2-D recursive systems and IIT filters, spectral estimation and methods, multidimensional signal restoration, applications in 2-D image processing and 3-D image processing, reconstruction, and feature estimation.

ECE 576 Information Engineering
3 credits
This course will cover the fundamental concepts of information engineering including computation, storage, communication, and application. Examples of topics are multimedia data such as video, audio, image and text, multimedia transmission through local & wide area networks, multimedia data representations, storage & compression. Information engineering applications will be discussed and students are expected to complete a project in a selected application.

ECE 579 Intelligent Systems
3 credits
Representative topics include: Elements of AI, searching techniques, language paradigms, knowledge representation, reference techniques, object-oriented techniques, engineering applications of intelligent systems using production rules, and fuzzy logic networks.

ECE 5802 Mulitrate Signal Processing with Applications
3 credits
The purpose of this course is to provide an introduction to multirate digital signal processing and their typical applications in different fields of engineering (speech processing, communications, instrumentation, measurements, signal compression, etc). Thus the first part of this course will focus on laying the theoretical foundation for all aspects of multirate digital signal processing. Once the fundamentals are well established, we move on to the second part of the course, which deals with the modern applications of multirate digital signal processing. These, applications include: design of efficient multirate filter banks, using the wavelets transforms in order to efficiently encode signals for signal compression purposes, spectral analysis and synthesis of signals, etc. A final part of the course is devoted to teaching students the necessary software tools to analyze, design and simulate multirate digital signal processing systems.