Electrical Engineering: Signal Processing & Communications

EESC 6340 Introduction to Telecommunications Networks (3 semester credit hours) Circuit, message and packet switching. The hierarchy of the ISO-OSI Layers. The physical layer: channel characteristics, coding, and error detection. The data link control layer: retransmission strategies, framing, multiaccess protocols, e.g., Aloha, slotted Aloha, CSMA, and CSMA/CD. The network layer: routing, broadcasting, multicasting, flow control schemes. Corequisite: EESC 6349. (3-0) Y

EESC 6341 Information Theory (3 semester credit hours) Entropy and mutual information, lossless compression, channel capacity for discrete memoryless channels and Gaussian channels, capacity under fading and multiple-input multiple-output (MIMO) channels, the multiple-access channel, the broadcast channel, the Slepian-Wolf problem. Prerequisite: ENGR 3341. (3-0) R

EESC 6343 Detection and Estimation Theory (3 semester credit hours) Parameter estimation. Least-squares, mean-square-error, and minimum-variance estimators. Maximum A Posteriori (MAP) and Maximum-Likelihood (ML) estimators. Bayes estimation. Cramer- Rao lower bound. BLUE estimator and Wiener filtering. Hypothesis testing and data-driven classification algorithms. Prerequisite: EESC 6349. (3-0) R

EESC 6344 Coding Theory (3 semester credit hours) Fundamentals of linear block codes, Hamming and Reed-Muller codes, LDPC codes and message passing decoding, cyclic codes, BCH and Reed-Solomon codes, convolutional codes, introduction to coded modulation. Prerequisite: EE 4360. (3-0) R

EESC 6349 (MECH 6312) Probability, Random Variables, and Statistics (3 semester credit hours) Probability theory, random variables, functions of random variables, random vectors, whitening transformation, law of large numbers, sample-mean estimator, confidence interval, likelihood ratio test, Chi-square test. (3-0) Y

EESC 6350 Signal Theory (3 semester credit hours) Signal processing applications and signal spaces, vector spaces, matrix inverses and orthogonal projections, four fundamental subspaces, least squares and minimum norm solutions, the SVD and principal component analysis, subspace approximation, infinite dimensional spaces, linear operators, norms, inner products and Hilbert spaces, projection theorems, spectral properties of Hermitian operators, Hilbert spaces of random variables, linear minimum variance estimation and the Levinson-Durbin algorithm, general optimization over Hilbert spaces, methods and applications of optimization. Prerequisite: EE 3302 or equivalent. (3-0) R

EESC 6352 Digital Communication Systems (3 semester credit hours) This course covers basic principles of digital communications. The topics include introduction to source coding, signal representations, various digital modulation and transmission schemes, demodulators and detectors, error performance evaluations, introduction to channel coding, link budget, channel capacity and system design considerations. Overviews of various communication systems and their applications are also presented Prerequisite: ENGR 3341 or equivalent. (3-0) Y

EESC 6353 Broadband Digital Communication (3 semester credit hours) Characterization of broadband wireline and wireless channels. MAP and ML detection. Intersymbol Interference (ISI) effects. Equalization methods to mitigate ISI including single- carrier and multi-carrier techniques. Multi-Input Multi-Output (MIMO) communication systems. Implementation issues including complexity, channel estimation, bias and decision delay. Real-world case studies from Digital Subscriber Lines (DSL) and wireless systems. Students work individually or in small teams on a project and present their findings to the class. Prerequisites: EESC 6349 and knowledge of MATLAB. (3-0) T

EESC 6360 Digital Signal Processing I (3 semester credit hours) Analysis of discrete time signals and systems, Z-transform, discrete Fourier transform, fast Fourier transform, analysis and design of digital filters. Prerequisite: EE 4361 or equivalent. (3-0) Y

EESC 6361 Digital Signal Processing II (3 semester credit hours) Continuation of EESC 6360. Includes advanced topics in signal processing such as: Digital filter structures, digital filter design and implementation methods, multirate digital signal processing, linear prediction and optimum filtering, spectral analysis and estimation methods. Prerequisite: EESC 6360. (3-0) T

EESC 6362 Introduction to Speech Processing (3 semester credit hours) Introduction to the fundamentals of speech signal processing and speech applications. Speech analysis and speech synthesis techniques, speech enhancement and speech coding techniques including ADPCM and linear-predictive based methods such as CELP. Prerequisite: EESC 6360. (3-0) Y

EESC 6363 Digital Image Processing (3 semester credit hours) Image formation, image sampling, 2D Fourier transform and properties, image wavelet transform, image enhancement in spatial and frequency domains, image restoration, color image processing, image segmentation, edge detection, morphological operations, object representation and description, introduction to image compression. Prerequisites: EE 4361 or equivalent and knowledge of C or MATLAB. (3-0) T

EESC 6364 Machine Learning and Pattern Recognition (3 semester credit hours) This course covers basic concepts and algorithms for pattern recognition and machine learning. Bayesian decision theory, parametric learning, non-parametric learning, linear regression, linear classifiers and support vector machine, kernel methods, data clustering, mixture models, component analysis, multilayer neural networks, deep learning with convolutional neural networks. Prerequisites: Knowledge of probability and knowledge of MATLAB or C. (3-0) T

EESC 6365 Adaptive Signal Processing (3 semester credit hours) Adaptive signal processing algorithms learn the properties of their environments. Transversal and lattice versions of the Least Mean Squares (LMS) and Recursive Least Squares (RLS) adaptive filter algorithms and other modern algorithms will be studied. These algorithms will be applied to network and acoustic echo cancellation, speech enhancement, channel equalization, interference rejection, beam forming, direction finding, active noise control, wireless systems, and others. Prerequisites: EESC 6349 and EESC 6360 and knowledge of matrix algebra. (3-0) T

EESC 6366 Speech and Speaker Recognition (3 semester credit hours) Introduction to concepts in automatic recognition methods for speech applications; the primary emphasis is for automatic speech recognition and speaker identification techniques. Topics include speech features for recognition, hidden Markov models (HMMs) for acoustic and language applications (speech recognition, dialect/language recognition), Gaussian mixture models (GMMs) for speaker characterization, robustness issues to address noise and channel conditions for automatic recognition. (3-0) Y

EESC 6367 Applied Digital Signal Processing (3 semester credit hours) Implementation of signal processing algorithms, real-time signal processing, fixed-point versus floating-point implementation, architecture of processors used for signal processing, software development tools, code optimization, application project. Lab fee of $30 required. Prerequisites: EE 4361 or equivalent and knowledge of C. (2-3) T

EESC 6368 (CE 6368) Multimodal Deep Learning (3 semester credit hours) Theory and applications in the field of multimodal deep learning. Robustness and performance of systems by considering cross-modal integration. Deep learning methods used for representation, translation, alignment, fusion, and co-learning of multimodal content. Multimodal embeddings and their applications. Use of deep learning solutions such as convolutional neural network (CNN), Long short-term memory (LSTM), and attention models to process multimodal data. Recommended Corequisite: EESC 6349. Prerequisite: ENGR 3341 or equivalent. (3-0) T

EESC 6389 Wireless Communications Laboratory (3 semester credit hours) This lecture and lab course covers the fundamentals of wireless communication from the perspective of digital signal processing (DSP). Physical layer concepts such as linear modulation, demodulation, and orthogonal frequency division multiplexing; synchronization, channel estimation, equalization, and MIMO will be translated into practice with the help of software defined radio platforms. Lab fee of $30 required. Prerequisite: EE 3350 or equivalent. (2-3) Y

EESC 6390 Introduction to Wireless Communication Systems (3 semester credit hours) Principles, practice, and system overview of mobile systems. Modulation, demodulation, coding, encoding, and multiple-access techniques. Performance characterization of mobile systems. Prerequisite: EE 3350 or equivalent. (3-0) Y

EESC 6391 Signaling and Coding for Wireless Communication Systems (3 semester credit hours) Study of signaling and coding for wireless communication systems. Topics which will be covered include digital modulation schemes, digital multiple access technologies, their performance under wireless channel impairments, equalization, channel coding, interleaving, and diversity schemes. Prerequisites: EESC 6352 and EESC 6390. (3-0) T

EESC 6392 Propagation and Devices for Wireless Communications (3 semester credit hours) Mobile communication fundamentals, models of wave propagation, simulation of electromagnetic waves in the cellular environment, multipath propagation, compensation for fading, mobile and cell antenna designs, problems of interference and incompatibility, design of active and passive cellular components, comparison of analog and digital cellular designs. Prerequisites: EE 4301 or equivalent, and EESC 6390. (3-0) R

EESC 6395 Wireless Sensor Systems and Networks (3 semester credit hours) Sensor mote architecture and design. Sensor network types, architecture and protocol stack. Studies on and design of physical layer, data link layer, network layer, transport layer, and application layer. Time synchronization, localization, topology, mobility and task management issues in wireless sensor networks. Security and privacy issues. Case studies on applications. Recommended prerequisite: (CE 4390 or CS 4390) or equivalent. (3-0) T

EESC 7V85 Special Topics in Signal Processing (1-6 semester credit hours) May be repeated for credit as topics vary (9 semester credit hours maximum). ([1-6]-0) R

EESC 7V86 Special Topics in Wireless Communications (1-6 semester credit hours) May be repeated for credit as topics vary (9 semester credit hours maximum). ([1-6]-0) R