ENCS COURSE DESCRIPTIONS

ENCS 5300. FUNDAMENTALS OF NANOMATERIALS (3): This course focuses on the chemical, physical and mathematical concepts that describe and explain the properties of matter at the nano-scale. It will emphasize the fundamental chemistry, physics, and mathematics needed to understand the molecular driving forces underlying self-assembly processes and the methods used to characterize the resulting nanomaterials. It will also cover applications of nanomaterials.

ENCS 6010. ADVANCED APPLIED MATHEMATICS (3): This course covers advanced mathematical topics including linear algebra, numerical methods, Fourier Analysis, discrete mathematics, probability and statistics, and algebraic structures, with special emphasis on applications in engineering and computational sciences.

ENCS 6020. ADVANCED COMPUTING (3): This course provides fundamental knowledge, skills, and tools for the computation undertaken on high-end computers, computer networks, or personal computers. The topics include: programming and programming languages; data structures, algorithms and computational complexity; high performance computing; distributed computing; optimizations; statistical data analysis; computational error analysis. Selected engineering applications of advanced computing techniques will also be covered.

ENCS 6030. MODELING AND SIMULATION OF CYBER PHYSICAL SYSTEMS (3): The principles of modeling, simulation and design, including establishment of specifications and conducting analysis of cyber-physical systems consisting of devices communicating with one another and interacting with the physical world via sensors and actuators are studied. Topics include synchronous and asynchronous models as well as timed model, safety and liveness requirements, and real-time scheduling. Some aspects of modeling and simulation of dynamics systems and hybrid systems are also studied.

ENCS 6110. ADVANCED ROBOTIC SYSTEMS (3): This course primarily presents a review of robot transformations, kinematics, dynamics, differential motion, motion and path planning, manipulation and mobility control. Advanced topics include: multi-robot system cooperative and collaborative task planning and execution, robotic sensors interfacing and integration, passive and active sensing, processing, and reasoning. Student will have opportunity to learn about robotic software, sensors, and hardware thru laboratory hands-on projects.

ENCS 6120. MECHATRONICS SYSTEMS DESIGN (3): This course is aimed to cover from preliminary knowledge of mechatronics theories to a project-based mechatronic system design. The multidisciplinary content of this course include: mechanisms, electronics, sensors, control strategies with software, firmware, and hardware in the control loop. This course also discusses techniques and skills related to integrating mechatronics systems with sensors, robotics systems, programmable logic controller (PLC), and man-machine interfaces. Students who successfully complete this course should be able to tackle multidisciplinary engineering design projects requiring tight integration of mechatronics components and sub-components in support of embedded electromechanical mechanism and control systems.

ENCS 6200. ENGINEERING DESIGN OPTIMIATION (3): Computerized design methods for optimization techniques. Formulation of optimization problems using design variables and constraints. Problem solving with mathematical models, deterministic optimization methods in operations research, linear programming models, simplex method, duality and sensitivity in linear programming. Nonlinear optimization and multi-objective function optimization, constrained and unconstrained problems.

ENCS 6210. ENGINEERING MANAGEMENT AND QUALITY CONTROL (3): This course is an introduction to the engineering management strategies applied on the project and organization level in different engineering fields such as construction, manufacturing and energy management. It also introduces traditional methodologies and techniques applied in quality control of engineering projects.

ENCS 6260. ENGINEERING STATISTICS AND PROBABILITY (3): The course discusses and applies rigorous and systematic statistical methods for solving applied science problems**,** identification of the empirical setting of the research problem and methodology**,** data management, choice of statistical, and analysis mechanics and ability of student to use statistical analysis tools for solving engineering problems. Different statistical modeling approaches will be covered (linear, categorical, generalized, time series, survival models, etc.) using statistical analysis software packages and interpreting statistical results.

ENCS 6280. FINITE SYSTEM ANALYSIS (3): Theoretical basis of finite element method. The physical and mathematical modeling using various element types. Application to various engineering problems. Application of commercial FAE software to solving complex engineering problems.

ENCS 6300. MICRO- AND NANO-FABRICATION AND CHARACTERIZATION TECHNIQUES (3): This course presents the fundamental principles and techniques used in fabricating micro- and nano-scale structures and devices including lithography, oxidation, diffusion, ion implantation, and methods of film deposition and etching. Further, an overview of the characterization of materials and micro-/nano-scale structures, measurement techniques, and packaging will also be covered. Future trends and challenges in micro-/nano-device manufacturing will also be discussed.

ENCS 6410. TRANSPORTATION FACILITIES EVALUATION AND DESIGN (3): Analysis of quantity, capacity, quality and accessibility of transportation systems, concepts and applications of transportation facilities. Public and non-motorized transportation, decision-making techniques in transportation planning and economic analysis of transportation systems. Design, construction, maintenance and management of transportation structures.

ENCS 6420. TRANSPORTATION AND ENVIRONMENTAL SUSTAINABILITY (3): Evaluation of transportation and environmental engineering relationship; transportation impact to land use and growth management; transportation and environmental impacts, equity and policies; the role of non-motorized and transit transportation to sustainability; environmental justice; alternative fuel; autonomous and connected vehicles; complete streets, environmental and energy policies; air pollution and vehicle emission estimation models; green-house gases and climate change.

ENCS 6430. PAVEMENT, ENVIRONMENTAL AND GROUND WATER DESIGN (3): Analysis and design of flexible and rigid pavements, construction materials. Theory and design of structures for collection, purification, distribution, and disposal of water and wastewater. Hydro mechanics of confined and unconfined flow of water through soil; foundation engineering, potential theory, application to design of earth dams and retaining structures.

ENCS 6440. ENVIRONMENTAL AND TRANSPORTATION RISK ANALYSIS (3): Statistical Applications for Transportation Safety and Environmental Risk Assessment. Statistical methods used to determine the nature and extent of the problem, evaluate the potential environmental risks; theory, evaluation, analytic and techniques for quantifying the potential effects on transportation and environmental impact risks.

ENCS 6530. ANALYSIS OF MODERN ENERGY CONVERSION AND CONSERVATION SYSTEMS (3): This course will cover energy needs; Energy sources – Fossil Fuel, Nuclear Energy, Coal; Green and Renewable Energy sources – Hydrogen, Solar energy, Wind, Geothermal, Biomass and Ethanol. Energy conversion systems – photovoltaic power conversion, wind turbine generators, fuel cells, battery storage systems, and power electronics. Energy saving methods and analysis. Smart power grid design and analysis will also be presented.

ENCS 6620. DATA MINING (3): This course will expose the students to the principles of data mining and data analytics. The fundamentals of data warehousing and architectures, multidimensional data model, statistical and machine learning techniques and implementations will be covered. Data mining and data analysis approaches such as classification, estimation, prediction, clustering, data visualization, statistical inference and learning, and database management will also be discussed. Students will learn the use of a statistical or mathematical programming language for the purpose of performing the tasks in data mining and data analysis. Prerequisites: ENCS 6010

ENCS 6800. INTRODUCTION TO CYBER SECURITY (3): This course introduces cyber security, focusing on the interdisciplinary aspects of the field from theory to practical implications. The course presents the growth from information security, cyber security theory. It will present the relationships of cyber security to people, societies, organizations and countries. Various technologies and tools will be presented for a basis for analysis of cyber threats and their mitigation. Case studies at various levels of impact will be discussed.

ENCS 6960. DIGITAL AND COMPUTER COMMUNICATIONS (3): This course provides an in-depth understanding of the modern digital and computer communications for wired and wireless applications. The topics include channel characterization; baseband and passband data transmission; optimum transmitter-receiver design; synchronous and asynchronous data exchange; synchronization and detection; spread spectrum; multiplexing; diversity; multiple antennas and space-time communications; digital signaling; channel capacity; error-control codes; Open System Interconnection models; cellular concept and implementation; modern wired and wireless communications standards; and protocols such as TCP/IP and UDP. Prerequisite: EECE 3500 or equivalent.

ENCS 7100. ARTIFICIAL INTELLIGENCE ROBOTICS (3): The principles of artificial intelligent robotics are studied. Topics include; theory of robot autonomy, robot hierarchical functional decomposition, and robot biologically-inspired intelligent control schemes such as: reflexive, reactive, deliberative and hybrid, visual and remote sensing, world and task perception modeling and learning, and applications of embedded intelligence systems. Hands on laboratory projects are required. Prerequisite: ENGR 5070 or equivalent courses.

ENCS 7110. PRINCIPLES OF CYBER PHYSICAL SYSTEMS (3): An introduction to the principles of design, including: specification, modeling, and analysis of cyber-physical systems consisting of computing devices communicating with one another and interacting with the physical world via sensors and actuators. Topics include synchronous and asynchronous models as well as timed model, safety and liveness requirements, and real-time scheduling. Some aspects of dynamics systems and hybrid systems are also studied.

ENCS 7200. ESTIMATION THEORY AND SYSTEM IDENTIFICATION (3): This course provides an introduction to estimation theory and system identification including: estimation methods; hypothesis testing; method of moment's estimators; Least squares estimators; Maximum likelihood estimators and; Bayesian estimators. Introduction to the system identification; non-parametric and parametric models for identification; parametric estimation and prediction;

identification of parametric time series models; AR, MA, ARMA models and, input-output models. Identification of state-space models; Kalman filter and subspace identification methods.

ENCS 7300. SOLID STATE PHYSICS AND DEVICES (3): Introduces the physical principles of semiconductor materials and devices. Presents the semiconductor device operation based on energy bands and carrier statistics. Describes the operation of p-n junctions and metal semiconductor junctions. Extends this knowledge to descriptions of bipolar and field effect transistors, and other microelectronic devices. PREREQUISITES: EECE 3300 Electronics or Permission of Instructor.

ENCS 7700. HIGH-PERFORMANCE COMPUTING APPLICATIONS (3): This course is a graduate-level application and algorithm design for High-Performance Scientific Computing. The topics include computing in multiple-core computer, distributed computing, solving non-trivial n-body problems, dense linear algebra on multi processors, parallel tree search and efficiency/scalability/performance of parallel algorithms. The practical application of this course is the implementation of the parallel algorithms and techniques into programming models, such as OpenMP, CUDA, Pthreads and MPI and try these applications in a real super computer. Prerequisite: COMP 4700 (Algorithms) and COMP 5520 Introduction High Performance Computing.

ENCS 7800. GRAPHY THEORY AND NETWORKS ANALYSIS (3): This course provides an introduction to graph theory and network analysis. The topics include Introduction to graph theory and graph concepts; Representations of graphs and graph isomorphism; Trees as a Special case of graphs; Connectivity, covering, matching, and coloring in graphs; Directed graphs and Planar graphs; and the application of graph theory in the analysis of Internet, social networks, and information networks.

ENCS 7900. COMPUTER VISION (3): This course discusses computer vision techniques for image and video processing. Topics include: image color spaces, color, binary and color image processing, image features quantization and extraction, weak and strong features mitigation and integration, object detection and matching, object motion estimation and tracking, object classification, stereo imaging, and scene understanding. Student will develop strong intuitions and sound mathematical background for adaptive computer vision learning and this ability will be reinforced thru multiple practical class projects.

ENCS 7930. APPLIED SIGNAL PROCESSING (3): This project-based course provides students with the opportunity to develop and implement signal processing algorithms to various deterministic or stochastic signal systems. This course incorporates advanced topics from applied speech, audio, image, video and communications signal processing. Topics include: discrete and continuous Fast Fourier Transforms, analysis of stochastic signals, statistical pattern recognition, application of discrete wavelet transform (Haar wavelets, Daubechies wavelets), and applications of fast and low-complexity signal processing and data fusion.

ENCS 7060, 7061, 7062. SPECIAL TOPICS (3): Covers topics of specific area interest including special research topics. To be approved by advisor and program director.

ENCS 7070. PROFESSIONAL DEVELOPMENT AND ETHICS (0): This course will introduce PhD students to ethical issues related to the research enterprise and the responsible conduct of research, it will also cover topics related to professional development and preparation for careers in academia, research, and industry.

ENCS 7080. PHD SEMINAR(0): This course exposes students to the most recent research developments in the areas of Data Sciences, Cyber-Security, Networking, and Engineering

Systems Design, Modeling, and Manufacturing. Students attend weekly seminars delivered by invited engineers, computer scientists, and other professionals.

ENCS 7090. ENCS PHD DISSERTATION (3-9): Research in an area of specialization to be carried out under the direction of the Advisory Committee. Variable credit course.