February 3, 2004

TO: General Bulletin 2004 - 2006 Coordinators or Department Chairpersons

FROM: Lynne Ford, Secretary of the University Faculty

RE: Proof Copy of Course Listings

We are sending you copies of the courses listed for your department or departments as they are now entered in the University Registrar's data base, corrected according to the blue colored sheets you returned over the past weeks. Please review and return these white sheets to Carolyn Wilson Loveless in the Office of the Dean by Monday, February 16th. If we do not receive anything from you by that time, we will assume it is correct as distributed and they will go into the Bulletin as is.

We appreciate your assistance in meeting this deadline. Thank you.

Frank: 2/5/04 Return to Annette with corrections by 2/15/04 Thanks Annette

cc: Heidi Emick

Course	Short title (maximum 30 characters)	Hours
Bulletin Title (maximum 70 characters)		
Description		

EECS 212 **INTR TO SIG SYS AND CONT** **(3)**

Signals, Systems, and Control

Characterization of continuous-time signals and systems. Laplace transforms, constant coefficient differential equations. Modeling of dynamical systems. Introduction to control system analysis and design. Prereq: MATH 224.

EECS 214 **SIGNALS AND SYSTEMS LAB** **(1)**

Signals, Systems, and Control Laboratory

A laboratory course based on the material in EECS 212. Analysis and simulation using MATLAB/Simulink. Laboratory experiments involving signal processing and control. Coreq: EECS 212.

EECS 216 **FUNDAMENTAL SYSTEM CONCEPTS** **(3)**

Fundamental System Concepts

Develops framework for addressing problems in science and engineering that require an integrated, interdisciplinary approach, including the effective management of complexity and uncertainty. Introduces fundamental system concepts in an integrated framework. Properties and behavior of phenomena regardless of the physical implementation through a focus on the structure and logic of information flow. Systematic problem solving methodology using systems concepts. Prereq: MATH 224.

EECS 233 **INTRO DATA STRUCTURES** **(4)**

Introduction to Data Structures

The programming language C++; pointers, files, variant records, and recursion. Representation and manipulation of data: one-way and circular linked lists, doubly linked lists; the available space list. Different representations of stacks and queues. Representation of binary trees, trees and graphs. Hashing; searching and sorting. Laboratory. Prereq: ENGR 131.

EECS 245 **ELECTRONIC CIRCUITS** **(4)**

Electronic Circuits

Analysis of time-dependent electrical circuits. Dynamic waveforms and elements: inductors, capacitors, and transformers. First- and second-order circuits, passive and active. Analysis of sinusoidal steady state response using phasors. Laplace transforms and pole-zero diagrams. S-domain circuit analysis. Two-port networks, impulse response, and transfer functions. Introduction to nonlinear semiconductor devices: diodes, BJTs, and FETs. Gain-bandwidth product, slew-rate and other limitations of real devices. SPICE simulation and laboratory exercises reinforce course materials. Prereq: ENGR 210. Coreq: MATH 224.

EECS 246 **SIGNALS AND SYSTEMS** **(4)**

Signals and Systems

The sinusoidal steady state and phasor analysis. Bode plots and their relationship to the frequency domain representation of signals. Gain-bandwidth product, slew-rate and other limitations of real devices. Filter design. Frequency domain considerations including Fourier series and Fourier transforms. Sampling theorem. The Discrete Fourier Transform. The z-transform and digital signal processing. Accompanying laboratory exercises which reinforce classroom lectures. Prereq: ENGR 210 and MATH 224.

Course	Short title (maximum 30 characters)	Hours
Bulletin Title (maximum 70 characters)		
Description		

EECS 251 **NUMERICAL METHODS I** **(3)**

Numerical Methods

Introduction to basic concepts and algorithms used in the numerical solution of common problems including solving non-linear equations, solving systems of linear equations, interpolation, fitting curves to data, integration and solving ordinary differential equations. Computational error and the efficiency of various numerical methods are discussed in some detail. Most homework requires the implementation of numerical methods on a computer. Prereq: ENGR 131 and MATH 122.

EECS 281 **LOGIC DESIGN AND COMPUTER ORG** **(4)**

Logic Design and Computer Organization

Fundamentals of digital systems in terms of both computer organization and logic level design. Organization of digital computers; information representation; boolean algebra; analysis and synthesis of combinational and sequential circuits; datapaths and register transfers; instruction sets and assembly language; input/output and communication; memory. Prereq: ENGR 131.

EECS 285 **ENGR IN COMMUNITY SERVICE II** **(3)**

Engineering in Community Service II

Project-oriented course; students work on "real" engineering projects of benefit to the community and in partnership with community "customers." Project teams consists of a mix of sophomores, juniors, and seniors. Students perform engineering design tasks as appropriate to their technical background. Emphasis on teamwork, communication skills, customer awareness, and professional responsibility. Prereq: Sophomore standing in EECS.

EECS 290 **SPECIAL TOPICS** **(1-18)**

Special Topics

Limited to sophomores and juniors. Prereq: Consent of instructor.

EECS 301 **DIGITAL LOGIC LABORATORY** **(2)**

Digital Logic Laboratory

This course is an introductory experimental laboratory for digital networks. The course introduces students to the process of design, analysis, synthesis and implementation of digital networks. The course covers the design of combinational circuits, sequential networks, registers, counters, synchronous/asynchronous Finite State Machine, register based design, and arithmetic computational block. Prereq: EECS 281.

EECS 304 **CONT ENGR I WITH LAB** **(3)**

Control Engineering I with Laboratory

Analysis and design techniques for control applications. Linearization of nonlinear systems. Design specifications. Classical design methods: root locus, bode, nyquist. PID, lead, lag, lead-lag controller design. State space modeling, solution, controllability, observability and stability. Modeling and control demonstrations and experiments single-input/single-output and multivariable systems. Control system analysis/design/implementation software. Prereq: EECS 212.

Course	Short title (maximum 30 characters)	Hours
Bulletin Title (maximum 70 characters)		
Description		

EECS 305 **CONTROL ENGINEERING LAB I** **(1)**

Control Engineering I Laboratory

A laboratory course based on the material in EECS 304. Modeling, simulation, and analysis using MATLAB. Physical experiments involving control of mechanical systems, process control systems, and design of PID controllers. Prereq: EECS 212 or equivalent. Coreq: EECS 304.

EECS 306 **CONT ENGR II WITH LAB** **(3)**

Control Engineering II with Laboratory

Advanced techniques for control of dynamic systems. State-space modeling, analysis, and controller synthesis; introduction to nonlinear control systems: phase plane methods, bang-bang control, time-optimal control; describing functions analysis and design techniques; discrete time systems and controllers. Advanced control design methods implementation. Prereq: EECS 304.

EECS 309 **ELECTROMAGNETIC FIELDS I** **(3)**

Electromagnetic Fields I

Maxwell's integral and differential equations, boundary conditions, constitutive relations, energy conservation and Pointing vector, wave equation, plane waves, propagating waves and transmission lines, characteristic impedance, reflection coefficient and standing wave ratio, in-depth analysis of coaxial and strip lines, electro- and magneto-quasistatics, simple boundary value problems, correspondence between fields and circuit concepts, energy and forces. Prereq: MATH 223 and PHYS 122. Coreq: MATH 224.

EECS 310 **ELECTROMECHANICAL ENERGY CONV** **(4)**

Electromechanical Energy Conversion

Electromechanical dynamics, modeling and control. Forces in quasistatic magnetic systems. Energy conversion properties of rotating machines. Analysis and control of DC servomotors, AC servomotors, reluctance machines, inductance machines, and magnetic bearing. Analysis of electromagnetic sensors. Electronic communication, torque linearization through computer controls and flux-vector control. Electromechanical properties are measured in the lab and high-performance controls are constructed and tested. Prereq: EECS 309.

EECS 311 **ELECTROMAGNETIC FIELDS II** **(3)**

Electromagnetic Fields II

Boundary value problems, guided electromagnetic waves, rectangular and circular waveguides, strip lines, losses in waveguiding structures, scattering, wave optics and wave propagation in anisotropic media, ferrites and plasmas, resonant systems, cavities, microwave networks, multiport networks, scattering matrix formulation, radiation and antennas, radiation from dipoles, apertures and simple arrays. Prereq: EECS 309.

EECS 313 **SIGNAL PROCESSING** **(3)**

Signal Processing

Fourier series and transforms. Analog and digital filters. Fast-Fourier transforms, sampling, and modulation for discrete time signals and systems. Consideration of stochastic signals and linear processing of stochastic signals using correlation functions and spectral analysis. Prereq: EECS 246.

Course	Short title (maximum 30 characters)	Hours
Bulletin Title (maximum 70 characters)		
Description		

EECS 314 **COMPUTER ARCHITECTURE** **(3)**

Computer Architecture

This course provides students the opportunity to study and evaluate a modern computer architecture design. The course covers topics in fundamentals of computer design, performance, cost, instruction set design, processor implementation, control unit, pipelining, communication and network, memory hierarchy, computer arithmetic, input-output, and an introduction to RISC and super-scalar processors. Prereq: EECS 281.

EECS 315 **DIGITAL SYSTEMS DESIGN** **(4)**

Digital Systems Design

This course gives students the ability to design modern digital circuits. The course covers topics in logic level analysis and synthesis, digital electronics: transistors, CMOS logic gates, CMOS lay-out, design metrics space, power, delay. Programmable logic (partitioning, routing), state machine analysis and synthesis, register transfer level block design, datapath, controllers, ASM charts, microsequencers, emulation and rapid protyping, and switch/logic-level simulation. Prereq: EECS 281.

EECS 316 **COMPUTER DESIGN** **(3)**

Computer Design

Methodologies for systematic design of digital systems with emphasis on programmable logic implementations and prototyping. Laboratory which uses modern design techniques based on hardware description languages such as VHDL, CAD tools, and Field Programmable Gata Arrays (FPGAs). Prereq: EECS 281; EECS 315 or consent of instructor.

EECS 317 **COMPUTER DESIGN LABORATORY** **(2)**

Computer Design Laboratory

Sequence of laboratory projects provide practical experience in computer-aided design techniques for computer and digital system design. Hardware system modeled and simulated at register transfer and switching transistor level.

EECS 318 **VLSI/CAD** **(4)**

Computer-Aided Design

With Very Large Scale Integration (VLSI) technology there is an increased need for Computer-Aided Design (CAD) techniques and tools to help in the design of large digital systems that deliver both performance and functionality. Such high performance tools are of great importance in the VLSI design process, both to perform functional, logical and behavioral modeling and verification to aid the testing process. This course discusses the fundamentals in behavioral languages, both VHDL and Verilog, with hands-on experience with state-of-the-art computer-aided design tools. Prereq: EECS 281 and EECS 321.

EECS 321 **SEMICONDUCT ELECTRONIC DEVICES** **(4)**

Semiconductor Electronic Devices

Energy bands and charge carriers in semiconductors and their experimental verifications. Excess carriers in semiconductors. Principles of operation of semiconductor devices that rely on the electrical properties of semiconductor surfaces and junctions. Development of equivalent circuit models and performance limitations of these devices. Devices covered include: junctions, bipolar transistors, Schottky junctions, MOS capacitors, junction gate and MOS field effect transistors, optical devices such as photodetectors, light-emitting diodes, solar cells and lasers. Laboratory experiments to characterize some of the above devices. Prereq: EECS 309.

Course	**Short title (maximum 30 characters)**	**Hours**
Bulletin Title (maximum 70 characters)		
Description		

EECS 322 **INTEGRATED CIRC/ELECT DEVICES** **(3)**

Integrated Circuits and Electronic Devices

Technology of monolithic integrated circuits and devices, including crystal growth and doping, photolithography, vacuum technology, metalization, wet etching, thin film basics, oxidation, diffusion, ion implantation, epitaxy, chemical vapor deposition, plasma processing, and micromachining. Basics of semiconductor devices including junction diodes, bipolar junction transistors, and field effect transistors. Prereq: EECS 321.

EECS 324 **SIMULATION TECHNIQUES IN ENGR** **(3)**

Simulation Techniques in Engineering

Discrete event systems and simulation concepts. Discrete event simulation with batch and interactive languages. Coreq: ENGL 398.

EECS 329 **DESIGN OBJECT-ORIENTED SYSTEMS** **(3)**

Design of Object-Oriented Systems

This course provides an opportunity to gain an understanding of the concepts and technology of object-oriented systems and learn system design techniques that take full advantage of this technology. Students also develop competence in programming with the object-oriented features of C++. Prereq: EECS 233.

EECS 337 **SYSTEMS PROGRAMMING** **(4)**

Systems Programming

Lexical analyzers; symbol tables and their searching; assemblers, one-pass and two-pass, conditional assembly, and macros; linkers and loaders; interpreters, pcodes, threaded codes; introduction to compilation, grammar, parsing, and code generation; preprocessors; text editors, line-oriented and screen-oriented; bootstrap loaders, ROM monitors, interrupts, and device drivers. Laboratory. Prereq: EECS 233 and EECS 281.

EECS 338 **INTRO TO OPERATING SYSTEMS** **(4)**

Introduction to Operating Systems

CPU scheduling, memory management, concurrent processes, semaphores, monitors, deadlocks, secondary storage management, file systems, protection, UNIX operating system, fork, exec, wait, UNIX System V IPCs, sockets, remote procedure calls, threads. Must be proficient in "C" programming language. Prereq: EECS 337.

EECS 340 **ALGORITHMS & DATA STRUCTURES** **(3)**

Algorithms and Data Structures

Efficient sorting algorithms, external sorting methods, internal and external searching, efficient string processing algorithms, geometric and graph algorithms. Prereq: EECS 233 and MATH 304.

EECS 341 **INTRO TO DATABASE SYSTEMS** **(3)**

Introduction to Database Systems

Relational model, ER model, relational algebra and calculus, SQL, OBE, security, views, files and physical database structures, query processing and query optimization, normalization theory, concurrency control, object relational systems, multimedia databases, Oracle SQL server, Microsoft SQL server. Prereq: EECS 233.

Course	Short title (maximum 30 characters)	Hours
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Description		

EECS 342 **INTRODUCTION TO GLOBAL ISSUES** **(3)**

Introduction to Global Issues

This systems course is based on the paradigm of the world as a complex system. Global issues such as population, world trade and financial markets, resources (energy, water, land), global climate change, and others are considered with particular emphasis put on their mutual interdependence. A reasoning support computer system which contains extensive data and a family of models is used for future assessment. Students are engaged in individual, custom-tailored, projects of creating conditions for a desirable or sustainable future based on data and scientific knowledge available. Students at CWRU will interact with students from fifteen universities that have been strategically selected in order to give global coverage to UNESCO'S Global-problematique Education Network Initiative (GENIe) in joint, participatory scenario analysis via the internet.

EECS 343 **THEORETICAL COMPUTER SCIENCE** **(3)**

Theoretical Computer Science

Introduction to mathematical logic, different classes of automata and their correspondence to different classes of formal languages, recursive functions and computability, assertions and program verification, denotational semantics. Prereq: MATH 304. Cross-listed as MATH 343.

EECS 344 **ELECTRONIC ANALYSIS & DESIGN** **(3)**

Electronic Analysis and Design

The design and analysis of real-world circuits. Topics include: junction diodes, non-ideal op-amp models, characteristics and models for large and small signal operation of bipolar junction transistors (BJTs) and field effect transistors (FETs), selection of operating point and biasing for BJT and FET amplifiers. Hybrid-pi model and other advanced circuit models, cascaded amplifiers, negative feedback, differential amplifiers, oscillators, tuned circuits, and phase-locked loops. Computers will be extensively used to model circuits. Selected experiments and/or laboratory projects. Prereq: EECS 245.

EECS 345 **PROGRAMMING LANGUAGE CONCEPTS** **(3)**

Programming Language Concepts

This course studies important concepts underlying the design, definition, implementation and use of modern programming languages including syntax, semantics, names/scopes, types, expression, assignment, subprograms, data abstraction, and inheritance. Imperative, object-oriented, concurrent, functional, and logic programming paradigms are discussed. Illustrative examples are drawn from a variety of popular languages, such as C++, Java, Ada, Lisp, and Prolog. Prereq: EECS 233, EECS 337.

EECS 346 **ENGINEERING OPTIMIZATON** **(3)**

Engineering Optimization

Optimization techniques including linear programming and extensions; transportation and assignment problems; network flow optimization; quadratic, integer, and separable programming; geometric programming; and dynamic programming. Nonlinear optimization topics: optimality criteria, gradient and other practical unconstrained and constrained methods. Computer applications using engineering and business case studies. Prereq: MATH 201.

Course	Short title (maximum 30 characters)	Hours
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Description		

EECS 347 **NETWORK SYNTHESIS** **(3)**

Network Synthesis

Design techniques for the construction of filters, delayors, predictors, analog computer networks, and necessary and sufficient requirements for the realization of practical networks. Prereq: EECS 246 or equivalent.

EECS 348 **COMMUNICATION ELECTRONIC CIR** **(4)**

Communication Electronic Cir

EECS 350 **INDUST & PRODUCTION SYS ENGR** **(3)**

Industrial and Production Systems Engineering

Time and motion study, human factors and safety engineering, man-machine systems, quality control and reliability, project management, scheduling, sequencing, inspection and maintenance of industrial processes.

EECS 351 **COMMUNICATIONS & SIGNAL ANALYS** **(3)**

Communications and Signal Analysis

Fourier transform analysis and sampling of signals. AM, FM and SSB modulation and other modulation methods such as pulse code, delta, pulse position, PSK and FSK. Detection, multiplexing, performance evaluation in terms of signal-to-noise ratio and bandwidth requirements. Prereq: EECS 246 or equivalent.

EECS 352 **ENGR ECON AND DEC MAKING** **(3)**

Engineering Economics and Decision Analysis

Economic analysis of engineering projects, focusing on financial decisions concerning capital investments. Present worth, annual worth, internal rate of return, benefit/cost ratio. Replacement and abandonment policies, effects of taxes, and inflation. Decision making under risk and uncertainty. Decision trees. Value of information.

EECS 354 **DIGITAL COMMUNICATIONS** **(3)**

Digital Communications

Fundamental bounds on transmission of information. Signal representation in vector space. Optimum reception. Probability and random processes with application to noise problems, speech encoding using linear prediction. Shaping of base-band signal spectra, correlative coding and equalization. Comparative analysis of digital modulation schemes. Concepts of information theory and coding. Applications to data communication. Prereq: EECS 351 recommended.

EECS 355 **RF COMMUNICATIONS** **(3)**

RF Communications

Coverage of modern communications circuits and systems with a particular emphasis upon mobile communications. Cellular communications, modulation methods, user access schemes. Individual system components: tuned small signal amplifiers and power amplifiers, mixers, detectors, and frequency synthesizers. Low-power design considerations. Prereq: EECS 351.

Course	Short title (maximum 30 characters)	Hours
Bulletin Title (maximum 70 characters)		
Description		

EECS 356 **MICROWAVE ENGINEERING** **(3)**

Microwave Engineering

Transmission lines and circuit analysis, waveguides, modes of propagation, impedance matching techniques, scattering matrix, waveguide components, striplines, resonators, microwave theory, filters, microwave solid state devices. Prereq: EECS 311.

EECS 358 **DOMAIN THEORETIC METH FOR A.I.** **(3)**

Domain Theoretic Methods for Artificial Intelligence

Resolution for propositional logic and completeness via Zorn's Lemma, Domain theory and topology through three-value logic. Default reasoning and extensions. Clausal logic for Scott domains and Smyth power domains. Power defaults theory and the semantics of nonmonotonic reasoning and disjunctive logic programming. Prereq: EECS 343, EECS 391, MATH 307, or PHIL 306. Cross-listed as MATH 350.

EECS 360 **MFG OPERATIONS & AUTOMATED SYS** **(3)**

Manufacturing, Operations, and Automated Systems

Introduction to design, modeling, analysis, and optimization of production, automation computer-integrated, and manufacturing systems. Topics include, design of products and processes, statistical quality control: confirming design, design of location/spatial problems, transportation and assignment problems, product-oriented layout (including assembly line balancing), process oriented layout (including quadratic assignment problem and steepest descent exchange heuristics), group technology and clustering, cellular and network flow layouts, machining supervisions optimization and numerical control. Tools for analysis for each of the above problems include: optimization, multiple criteria decision-making (MCDM), and heuristics for combinatorial problems. Applications to computer science and engineering problems are also covered. Prereq: Junior or senior level standing in engineering or consent of instructor.

EECS 375 **AUTONOMOUS ROBOTICS** **(3)**

Autonomous Robotics

Introduction to the design, construction and control of autonomous mobile robots. The first half of the course consists of focused exercises on mechanical construction with LEGO, characteristics of sensors, motors and batteries, and control strategies for autonomous robots. In the second half of the course, students design, build and program their own complete robots that participate in a public competition. All work is performed in groups. Biologically-inspired approaches to the design and control of autonomous robots are emphasized throughout. Prereq: Consent of instructor. Cross-listed as BIOL 375.

EECS 381 **HYBRID SYSTEMS** **(3)**

Hybrid Systems

Today, the most interesting computer code and microprocessor designs are "embedded" and hence interact with the physical world, producing a mixture of digital and analog domains. The class studies an array of tools for understanding and designing these "hybrid systems." Topics include: basics of language and finite state automata theory, discrete-event dynamic systems, Petri nets, timed and hybrid automata, and hybrid dynamical systems. Simulation, verification, and control concepts and languages for these models. Prereq: MATH 224 and either EECS 246 or MATH 304.

Course | **Short title (maximum 30 characters)** | **Hours**
Bulletin Title (maximum 70 characters)
Description

EECS 382 | **MICROPROCESSOR - BASED DESIGN** | **(3)**

Microprocessor-Based Design

Microprocessor architectures, memory design, timing, polled and interrupt driven I/O, microprocessor support devices, microcontrollers, integrated hardware/software design considerations. Prereq: ENGR 210 and EECS 281.

EECS 383 | **MICROPROCESSOR APPL TO CONTROL** | **(3)**

Microprocessor Applications to Controls

Digital control and its implementation using microprocessors. Z-transforms. Time response characteristics, steady-state error, mapping from the s-plane to the z-plane. Digital controller design-stability testing methods, gain and phase margins, PID controllers, digital filter structures. Prereq: EECS 246 or equivalent.

EECS 385 | **ENGR IN COMMUNITY SERVICE IV** | **(3)**

Engineering in Community Service IV

Project-oriented course; students work on "real" engineering projects of benefit to the community and in partnership with community "customers." Project teams consists of a mix of sophomores, juniors, and seniors. Students perform engineering design, project specification, and technical research as appropriate to their technical background. Emphasis on project planning and organization, teamwork, project management, communication skills, customer awareness, and professional responsibility. Prereq: Junior or Senior standing in EECS.

EECS 391 | **INTRO ARTIFICIAL INTELLIGENCE** | **(3)**

Introduction to Artificial Intelligence

Overview of artificial intelligence, knowledge representation, search, game-playing, logic rule-based systems, AI programming languages, learning, neural networks, evolutionary algorithms, natural language understanding, planning, robotics. Prereq: ENGR 131.

EECS 396 | **COMP GRAPHICS FOR SIMULATION** | **(3)**

Computer Graphics for Engineering Simulation

Basic computer graphics including geometrical transformations, homogeneous coordinates, perspective and projective transformations, hidden surface algorithms, rendering including shaded models, color and lighting, reflection, transparency. Real-time rendering and physical modeling for engineering simulation. Prereq: EECS 233 or permission of instructor.

EECS 396L | **SPECIAL TOPICS** | **(1-6)**

Special Topics

(Credit as arranged.) Limited to juniors and seniors.

EECS 396M | **SPEC TOP: COMPUTER SCIENCE** | **(1-9)**

Special Topics: Computer Science

EECS 396N | **SPECIAL TOPICS** | **(1-18)**

Special Topics

Course	Short title (maximum 30 characters)	Hours
Bulletin Title (maximum 70 characters)		
Description		

EECS 397L **SPEC TOPICS IN ELECTRICAL ENGR** **(1-6)**

Special Topics in Electrical Engineering

(Credit as arranged.) Limited to juniors and seniors. Prereq: Consent of instructor.

EECS 398L **SENIOR PROJECT IN ELEC ENGR I** **(4)**

Senior Project in Electrical Engineering I

EECS 398M **SOFTWARE ENGINEERING** **(3)**

Software Engineering

Issues in the development of complex software systems. Software lifecycle models. Software engineering methodology, requirements, analysis and specification design implementation, validation, and maintenance. Team development of a significant applications program. Prereq: EECS 337.

EECS 398N **ENGINEERING PROJECTS I** **(4)**

Engineering Projects I

Project experience in the application of course material to practical systems engineering problems. Identification of project, literature review, and proposal preparation for EECS 399. Prereq: Senior standing.

EECS 399L **SENIOR PROJ IN ELEC ENGR II** **(4)**

Senior Project in Electrical Engineering II

Prereq: EECS 398L (or concur).

EECS 399M **COMPUTER ENG DESIGN PROJECT** **(4)**

Computer Engineering Design Project

Capstone course for computer engineering seniors. Material from previous and concurrent courses used to solve hardware and/or software design problems. Formal presentations of the projects scheduled during last week of classes. Prereq: Senior standing.

EECS 399N **ENGINEERING PROJECTS II** **(4)**

Engineering Projects II

Elective projects with emphasis on engineering design. Capstone engineering project. Prereq: Senior standing.

EECS 400T **GRADUATE TEACHING I** **(0)**

Graduate Teaching I

This course will provide the Ph.D. candidate with experience in teaching undergraduate or graduate students. The experience is expected to involve direct student contact but will be based upon the specific departmental needs and teaching obligations. This teaching experience will be conducted under the supervision of the faculty member who is responsible for the course, but the academic advisor will assess the educational plan to ensure that it provides an educational experience for the student. Students in this course may be expected to perform one or more of the following teaching related activities: grading homeworks, quizzes, and exams, having office hours for students, tutoring students. Prereq: Ph.D. student in EECS department.

Course	Short title (maximum 30 characters)	Hours
Bulletin Title (maximum 70 characters)		
Description		

EECS 401 **DIGITAL SIGNAL PROCESSING** **(3)**

Digital Signal Processing

Characterization of discrete-time signals and systems. Fourier analysis: the Discrete-time Fourier Transform, the Discrete-time Fourier series, the Discrete Fourier Transform and the Fast Fourier Transform. Continuous-time signal sampling and signal reconstruction. Digital filter design: infinite impulse response filters, finite impulse response filters, filter realization and quantization effects. Random signals: discrete correlation sequences and power density spectra, response of linear systems. Prereq: EECS 313.

EECS 404 **DIGITAL CONTROL SYSTEMS** **(3)**

Digital Control Systems

Analysis and design techniques for computer based control systems. Sampling, hybrid continuous-time/discrete-time system modeling; sampled data and state space representations, controllability, observability and stability, transformation of analog controllers, design of deadbeat and state feedback controllers; pole placement controllers based on input/output models, introduction to model identification, optimal control and adaptive control. Prereq: EECS 304.

EECS 405 **DATA STRUCTURES & FILES** **(3)**

Data Structures and File Management

Fundamental concepts: sequential allocation, linked allocation, lists, trees, graphs, internal sorting, external sorting, sequential, binary, interpolation search, hashing file, indexed files, multiple level index structures, btrees, hashed files. Multiple attribute retrieval; inverted files, multi lists, multiple-key hashing, hd trees. Introduction to data bases. Data models. Prereq: EECS 233 and MATH 304.

EECS 408 **INTRO TO LINEAR SYSTEMS** **(3)**

Introduction to Linear Systems

Analysis and design of linear feedback systems using state-space techniques. Review of matrix theory, linearization, transition maps and variations of constants formula, structural properties of state-space models, controllability and observability, realization theory, pole assignment and stabilization, linear quadratic regulator problems, observers, and the separation theorem. Prereq: EECS 304.

EECS 409 **DISCRETE EVENT SYSTEMS** **(3)**

Discrete Event Systems

A broad range of system behavior can be described using a discrete event framework. These systems are playing an increasingly important role in modeling, analyzing, and designing manufacturing systems. Simulation, automata, and queuing theory have been the primary tools for studying the behavior of these logically complex systems; however, new methods and techniques as well as new modeling frameworks have been developed to represent and to explore discrete event system behavior. The class will begin by studying simulation, the theory of languages, and finite state automata, and queuing theory approaches and then progress to examining selected additional frameworks for modeling and analyzing these systems including Petrinets, perturbation analysis, and Min-Max algebras.

Course	Short title (maximum 30 characters)	Hours
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Description		

EECS 411 **INTRO TO LOGIC PROGRAMMING** **(3)**

Introduction to Logic Programming

Basic constructs of logic programs, terms, facts, rules, queries. Logic programs for manipulating recursive data structures. Unification and the logic programming computation model. How Prolog realized the abstract computational mode. Arithmetic, structure inspection, metalogical and extralogical techniques in Prolog. Advanced programming techniques: nondeterminism, difference structures, DCGS, meta-interpreters. Applications. Prereq: EECS 233.

EECS 412 **ELECTROMAGNETIC FIELDS III** **(3)**

Electromagnetic Fields III

Maxwell's equations, macroscopic versus microscopic fields, field interaction with materials in terms of polarization vectors P and M. Laplace's and Poisson's equations and solutions, scalar and vector potentials. Wave propagation in various types of media such as anisotropic and gyrotropic media. Phase and group velocities, signal velocity and dispersion. Boundary value problems associated with wave-guide and cavities. Wave solutions in cylindrical and spherical coordinates. Radiation and antennas.

EECS 413 **NONLINEAR SYSTEMS I** **(3)**

Nonlinear Systems I

This course will provide an introduction to techniques used for the analysis of nonlinear dynamic systems. Topics will include existence and uniqueness of solutions, phase plane analysis of two dimensional systems including Poincare-Bendixson, describing functions for single-input single-output systems, averaging methods, bifurcation theory, stability, and an introduction to the study of complicated dynamics and chaos. Coreq: EECS 408.

EECS 414 **COMPLEX SYS MODELING & ANALY** **(3)**

Complex Systems Modeling and Analysis

The concept of a complex system as a relationship of identifiable subsystems. Modeling of large-scale systems by aggregation, perturbation, via system identification and by the use of fuzzy logic. The structural properties of large-scale systems. A hierarchical, multi-level approach to large-scale systems analysis and synthesis. Coordination by the interaction balance and by interaction prediction principles. Decentralized decision making and control of large-scale systems. Near optimum system design. Structure and stability of fuzzy control systems.

EECS 415 **INTEGR CIRCUIT TECHNOLOGY I** **(3)**

Integrated Circuit Technology I

Review of semiconductor technology. Device fabrication processing, material evaluation, oxide passivation, pattern transfer technique, diffusion, ion implantation, metallization, probing, packaging, and testing. Design and fabrication of passive and active semiconductor devices. Prereq: EECS 322.

EECS 416 **OPTIMIZATION THEORY & TECHNIQ** **(3)**

Optimization Theory and Techniques

Underlying theory of linear, nonlinear, multilevel, and multiobjective optimization. Techniques include linear programming and extensions, quadratic programming, dynamic programming, decomposition coordination schemes for multilevel optimization. Methods for generating Pareto optimal solutions in multiobjective optimization. Applications to engineering problems. Prereq: MATH 201 or equivalent.

Course	**Short title (maximum 30 characters)**	**Hours**

Bulletin Title (maximum 70 characters)
Description

EECS 417 **INTRO TO STOCHASTIC CONTROL** **(3)**

Introduction to Stochastic Control

Analysis and design of controllers for discrete-time stochastic systems. Review of probability theory and stochastic properties, input-output analysis of linear stochastic systems, spectral factorization and Weiner filtering, minimum variance control, state-space models of stochastic systems, optimal control and dynamic programming, statistical estimation and filtering, the Kalman-Bucy theory, the linear quadratic Gaussian problem, and the separation theorem. Prereq: EECS 408.

EECS 418 **SYS IDENT & ADAPTIVE CONTROL** **(3)**

System Identification and Adaptive Control

Parameter identification methods for linear discrete time systems: maximum likelihood and least squares estimation techniques. Adaptive control for linear discrete time systems including self-tuning regulators and model reference adaptive control. Consideration of both theoretical and practical issues relating to the use of identification and adaptive control.

EECS 419 **COMPUTER SYSTEM ARCHITECTURE** **(3)**

Computer System Architecture

Interaction between computer systems hardware and software. Pipeline techniques - instruction pipelines - arithmetic pipelines. Instruction level parallelism. Cache mechanism. I/O structures. Examples taken from existing computer systems. Prereq: EECS 338.

EECS 420 **SOLID STATE ELECTRONICS I** **(3)**

Solid State Electronics I

Quantum mechanics and solid state physics. Crystal structures, electrons in periodic structures, band structures, transport phenomenon, nonequilibrium process, lattice dynamics, scattering mechanisms, surface and interface physics; physics of semiconductor electronic devices. Prereq: EECS 321.

EECS 421 **OPTIMIZATION OF DYNAMIC SYST** **(3)**

Optimization of Dynamic Systems

Fundamentals of dynamic optimization with applications to control. Variational treatment of control problems and the Maximum Principle. Structures of optimal systems; regulators, terminal controllers, time-optimal controllers. Sufficient conditions for optimality. Singular controls. Computational aspects. Selected applications. Prereq: EECS 408. Cross-listed as MATH 434.

EECS 422 **SOLID STATE ELECTRONICS II** **(3)**

Solid State Electronics II

Advanced physics of semiconductor devices. Review of current transport and semiconductor electronics. Surface and interface properties. P-N junction. Bipolar junction transistors, field effect transistors, solar cells and photonic devices.

EECS 423 **DISTRIBUTED SYSTEMS** **(3)**

Distributed Systems

Introduction to distributed systems; system models; network architecture and protocols; interprocess communication; client-server model; group communication; TCP sockets; remote procedure calls; distributed objects and remote invocation; distributed file systems; file service architecture; name services; directory and discovery services; distributed synchronization and coordination; transactions and concurrency control; security; cryptography; replication; distributed multimedia systems. Prereq: EECS 338.

EECS 424 **INTRODUCTION TO NANOTECHNOLOGY** **(3)**

Introduction to Nanotechnology

(See EMAE 424.) Cross-listed as EMAE 424.

EECS 425 **COMPUTER COMMUNICATION NETWORK** **(3)**

Computer Communications Networks

Covers computer network architecture. Topics include: network applications; types of networks; network architecture; OSI, TCP/IP and ATM reference models; transmission media; the telephone system; ISDN and ATM error detection and correction; data link protocols; channel allocation; LAN protocols; bridges; routing; congestion control; internetworking; transport services and protocols; TCP/IP and ATM protocols; socket programming; security; Domain Name System; Simple Network Management Protocol; email, WWW; Java; Corba; distributed multimedia. Prereq: EECS 338.

EECS 426 **MOS INTEGRATED CIRCUIT DESIGN** **(3)**

MOS Integrated Circuit Design

Design of digital and analog MOS integrated circuits. IC fabrication and device models. Logic, memory, and clock generation. Amplifiers, comparators, references, and switched-capacitor circuits. Characterization of circuit performance with/without parasitics using hand analysis and SPICE circuit simulation. Prereq: EECS 344 and EECS 321.

EECS 427 **MEMS FOR SENSING AND COMMUNICA** **(3)**

MEMS for Sensing and Communication

This course covers basic MEMS fabrication technologies and device operating principles of MEMS resonators and inertial sensors such as accelerometers and gyroscopes. Critical issues regarding sensing resolution and low noise interface electronics design will be discussed. MEMS applications such as low noise oscillators, filters, switches, etc. for wireless communications will also be covered.

EECS 428 **COMPUTER COMM NETWORKS II** **(3)**

Computer Communications Networks II

Introduction to topics and methodology in computer networks and middleware research. Traffic characterization, stochastic models, and self-similarity. Congestion control (Tahoe, Reno, Sack). Active Queue Management (RED, FQ) and explicit QoS. The Web: overview and components, HTTP, its interaction with TCP, caching. Overlay networks and CDN. Expected work includes a course-long project on network simulation, a final project, a paper presentation, midterm, and final test. Prereq: EECS 425 or permission of instructor.

Course	Short title (maximum 30 characters)	Hours
Bulletin Title (maximum 70 characters)		
Description		

EECS 429 **RISK & RELIAB ANALYS FOR ENGR** **(3)**

Risk and Reliability Methods for Engineers

Probabilistic models and methods for risk, reliability, and quality engineering; Markov decision processes; stochastic dynamic programming; stochastic programming and other methods for risk analysis; failure models; qualitative fault analysis; reliability analysis of systems; life data analysis and accelerated life testing; design of experiments for quality engineering; statistical quality control; and acceptance sampling for quality control.

EECS 430 **OBJECT-ORIENTED SOFTWARE DEVLP** **(3)**

Object-Oriented Software Development

Covers advanced methodology for the design of large software systems. Topics include: object-oriented analysis and design; encapsulation; inheritance; subtype and parametric polymorphism; object-oriented programming languages; design patterns; application frameworks; software architecture; user-interfaces; concurrent and distributed objects. Prereq: EECS 337 or consent of instructor.

EECS 431 **SOFTWARE ENGINEERING** **(3)**

Software Engineering

Design of software systems working from specifications; top-down decomposition using stepwise refinement; object-oriented methods; prototyping. Software metrics and testing; software quality and reliability; maintenance; human factors. Homework involves working in teams on large software projects. Prereq: EECS 337.

EECS 432 **COMPILER CONSTRUCTION** **(3)**

Compiler Construction

Top-down and bottom-up recognizers for context-free grammars; LR(k) parsers, error recovery, semantic analysis, storage allocation for block structured languages, optimization, code generation. Homework involves writing a compiler for a block structured language. Prereq: EECS 337.

EECS 433 **DATABASE SYSTEMS** **(3)**

Database Systems

Basic issues in file processing and database management systems. Physical data organization. Relational databases. Database design. Relational Query Languages, SQL. Query languages. Query optimization. Database integrity and security. Object-oriented databases. Object-oriented Query Languages, OQL. Prereq: EECS 341 and MATH 304.

EECS 434 **MICROFABRICAT SILICON ELE SYS** **(3)**

Microfabricated Silicon Electromechanical Systems

Topics related to current research in microelectromechanical systems based upon silicon integrated circuit fabrication technology: fabrication, physics, devices, design, modeling, testing, and packaging. Bulk micromachining, surface micromachining, silicon to glass and silicon-silicon bonding. Principles of operation for microactuators and microcomponents. Testing and packaging issues. Prereq: EECS 322 or EECS 415.

Course	Short title (maximum 30 characters)	Hours
Bulletin Title (maximum 70 characters)		
Description		

EECS 435 **DATA MINING** **(3)**

Data Mining

Data Mining is the process of discovering interesting knowledge from large amounts of data stored either in databases, data warehouses, or other information repositories. Topics to be covered includes: Data Warehouse and OLAP technology for data mining, Data Preprocessing, Data Mining Primitives, Languages, and System Architectures, Mining Association Rules from Large Databases, Classification and Prediction, Cluster Analysis, Mining Complex Types of Data, and Applications and Trends in Data Mining. Prereq: EECS 341 or equivalent.

EECS 436 **ADVANCES IN DATABASES** **(3)**

Advances in Databases

Advanced topics in databases will be covered in this course. Query optimization in object-oriented databases, temporal databases, issues in multimedia databases, databases and Web, graphical query interfaces. Basic knowledge in databases is required. Prereq: EECS 433.

EECS 438 **BIOMEDICAL MICRODEVICES** **(3)**

Biomedical Microdevices

EECS 440 **AUTOMATA AND FORMAL LANGUAGES** **(3)**

Automata and Formal Languages

(See MATH 410.) Cross-listed as MATH 410.

EECS 444 **COMPUTER SECURITY** **(3)**

Computer Security

General types of security attacks; approaches to prevention; secret key and public key cryptography; message authentication and hash functions; digital signatures and authentication protocols; information gathering; password cracking; spoofing; session hijacking; denial of service attacks; buffer overruns; viruses, worms, etc., principles of secure software design, threat modeling; access control; least privilege; storing secrets; socket security; RPC security; security testing; secure software installation; operating system security; database security; web security; email security; firewalls; intrusions. Prereq: EECS 337.

EECS 445 **FORMAL VERIFICATION** **(3)**

Formal Verification

Introduction and survey of principles and methodologies in formal specification and verification of systems (hardware, software, hybrid). Prereq: EECS 345 or graduate standing.

EECS 450 **PRODUCTION & OPERATION SYSTEMS** **(3)**

Production and Operations Systems

Fundamental theories and techniques, decision making, and artificial intelligence for solving production/manufacturing problems. Formulation, modeling, planning, and control of production problems at three levels: strategic, tactical, and operational (long term, medium, and short term). Specific problems include aggregate planning, project planning, scheduling, line balancing, sequencing, and machine set-up. Special emphasis will be given on decomposition and control of computer integrated systems, on-line and off-line supervisory planning, and man/machine systems.

Course	Short title (maximum 30 characters)	Hours
Bulletin Title (maximum 70 characters)		
Description		

EECS 452 **RANDOM SIGNALS** (3)

Random Signals

Fundamental concepts in probability. Probability distribution and density functions. Random variables, functions of random variables, mean, variance, higher moments, Gaussian random variables, random processes, stationary random processes, and ergodicity. Correlation functions and power spectral density. Orthogonal series representation of colored noise. Representation of bandpass noise and application to communication systems. Application to signals and noise in linear systems. Introduction to estimation, sampling, and prediction. Discussion of Poisson, Gaussian, and Markov processes.

EECS 454 **ANALYSIS OF ALGORITHMS** (3)

Analysis of Algorithms

This course presents and analyzes a number of efficient algorithms. Problems are selected from such problem domains as sorting, searching, set manipulation, graph algorithms, matrix operations, polynomial manipulation, and fast Fourier transforms. Through specific examples and general techniques, the course covers the design of efficient algorithms as well as the analysis of the efficiency of particular algorithms. Certain important problems for which no efficient algorithms are known (NP-complete problems) are discussed in order to illustrate the intrinsic difficulty which can sometimes preclude efficient algorithmic solutions. Prereq: MATH 304 and (EECS 340 or EECS 405). Cross-listed as OPRE 454.

EECS 455 **WIRELESS COMMUNICATIONS** (3)

Wireless Communications

Cellular telephone systems, wireless networks, receiver architectures, noise characterization, error-correction coding, digital modulation, multiple-access technologies, multipath fading. Prereq: STAT 332 and EECS 351 or consent of instructor.

EECS 456 **MICROWAVE ENGINEERING** (3)

Microwave Engineering

Transmission line theory, propagation in waveguides, coaxial lines, striplines. Circuit theory of microwave systems, multi-port circuits, equivalent circuits. Foster's Reactance Theorem. Scattering matrix. Smith Charts, impedance matching and transformation using stub tuners and transformers. Electromagnetic resonators. Prereq: EECS 412.

EECS 458 **INTRO TO BIOINFORMATICS** (3)

Introduction to Bioinformatics

Fundamental algorithmic methods in computational molecular biology and bioinformatics discussed. Sequence analysis, pairwise and multiple alignment, probabilistic models, phylogenetic analysis, folding and structure prediction emphasized. Prereq: EECS 340, EECS 233.

EECS 459X **DOMAIN THEORETIC METH FOR A.I.** (3)

Domain Theoretic Methods for Artificial Intelligence

(See EECS 358.) Cross-listed as MATH 450.

Course	Short title (maximum 30 characters)	Hours
Bulletin Title (maximum 70 characters)		
Description		

EECS 460 MFG OPERATIONS & AUTOMATED SYS (3)

Manufacturing, Design, and Automated Systems

The course is designed primarily for graduate engineering students who wish to know about the fundamentals and modeling of production/automation/manufacturing systems. The course provides a survey of various topics in production automation and computer-aided and integrated manufacturing with emphasis on decision making, optimization, and modeling. Topics include computerized process planning, on-line and off-line supervisory computer control, computerized discrete production systems, numerical control, monitoring and planning, flexible manufacturing systems, group technology, materials handling systems, man/machine systems and requirements, design and analysis of assembly systems, and computerized facility layout design problems. The course presents a step-by-step and cohesive account of concepts, theories, and procedures for solving modern manufacturing and production problems with emphasis on computer applications. Prereq: Consent of instructor.

EECS 463 TECHNIQ OF MODEL-BASED CNTRL (3)

Techniques of Model-based Control

Strategies of process control centered around the use of process models in the control system. Topics include single loop, feed forward, cascade and multivariable internal model control. Tuning controllers to accommodate process uncertainty. Treatment of control effect and output constraints in model predictive control and modular-multivariable control. Prereq: EECS 304. Cross-listed as ECHE 463.

EECS 466 COMPUTER GRAPHICS (3)

Computer Graphics

Theory and practice of computer graphics: object and environment representation including coordinate transformations image extraction including perspective, hidden surface, and shading algorithms; and interaction. Covers a wide range of graphic display devices and systems with emphasis in interactive shaded graphics. Laboratory. Prereq: EECS 233.

EECS 473 MULTIMEDIA AND WEB COMPUTING (3)

Multimedia and Web Computing

Multimedia is an important application area that will be at the center for next-generation computer systems and software design. It is a fast-changing technology, and, already, in the industry, there is a significant demand for computer scientists/engineers with multimedia system design knowledge. The objective of EECS 473 is to present design issues for multimedia systems from specification to software implementation and testing. This will include multimedia basics, data capture/models/compression, synchronization models, multimedia servers, OS support for multimedia, multimedia communication systems, and multimedia user interfaces. There will be a project about designing and implementing a multimedia system. Students are expected to know Unix systems programming (System V IPCs, fork, exec, etc.), RPC, thread and socket programming. Prereq: ENGR 131, EECS 233, and EECS 338.

Course	Short title (maximum 30 characters)	Hours
Bulletin Title (maximum 70 characters)		
Description		

EECS 475 **AUTONOMOUS ROBOTICS** **(3)**

Autonomous Robotics

Introduction to the design, construction and control of autonomous mobile robots. The first half of the course consists of focused exercises on mechanical construction with LEGO, characteristics of sensors, motors and batteries, and control strategies for autonomous robots. In the second half of the course, students design, build and program their own complete robots that participate in a public competition. All work is performed in groups. Biologically-inspired approaches to the design and control of autonomous robots are emphasized throughout. Prereq: Consent of instructor. Cross-listed as BIOL 475.

EECS 477 **DYNAMICS OF ADAPTIVE BEHAVIOR** **(3)**

The Dynamics of Adaptive Behavior

Introduction to embodied, situated, and dynamical approaches to the design and analysis of autonomous agents and animals. Topics include recurrent neural networks, coupled neural/body/environment systems, and evolution and analysis of neural circuits. Behavior studied include examples from motor control, perception, learning, and cognition. Prereq: ENGR 131 and MATH 224. Cross-listed as BIOL 477.

EECS 478 **COMPUTATIONAL NEUROSCIENCE** **(3)**

Computational Neuroscience

Computer simulation of neurons and neural circuits, and the computational properties of nervous systems. Students are taught a range of models for neurons and neural circuits, and are asked to implement and explore the computational and dynamic properties of these models. The course introduces students to dynamical systems theory for the analysis of neurons and neural circuits, as well as to cable theory, passive and active compartmental modeling, numerical integration methods, models of plasticity and learning, models of brain systems, and their relationship to artificial neural networks. Term project required. Two lectures per week. Cross-listed as BIOL 478, EBME 478, and NEUR 478.

EECS 479 **SEM:COMPUTATIONAL NEUROSCIENCE** **(3)**

Seminar in Computational Neuroscience

Readings and discussion in the recent literature on computational neuroscience, adaptive behavior, and other current topics. Cross-listed as BIOL 479.

EECS 483 **DATA ACQUISITION AND CONTROL** **(3)**

Data Acquisition and Control

Data acquisition (theory and practice), digital control of sampled data systems, stability tests, system simulation digital filter structure, finite word length effects, limit cycles, state-variable feedback and state estimation. Laboratory includes control algorithm programming done in assembly language.

EECS 484 **COMPUTATIONAL INTELLIGENCE I** **(3)**

Computational Intelligence I: Basic Principles

This course is concerned with learning the fundamentals of a number of computational methodologies which are used in adaptive parallel distributed information processing. Such methodologies include neural net computing, evolutionary programming, genetic algorithms, fuzzy set theory, and "artificial life." These computational paradigms complement and supplement the traditional practices of pattern recognition and artificial intelligence. Functionalities covered include self-organization, learning a model or supervised learning, optimization, and memorization.

Course	Short title (maximum 30 characters)	Hours
Bulletin Title (maximum 70 characters)		
Description		

EECS 485 **VLSI SYSTEMS** **(3)**

VLSI Systems

Basic MOSFET models, inverters, steering logic, the silicon gate, nMOS process, design rules, basic design structures (e.g., NAND and NOR gates, PLA, ROM, RAM), design methodology and tools (spice, N.mpc, Caesar, mkpla), VLSI technology and system architecture. Requires project and student presentation, laboratory.

EECS 486 **RES IN VLSI DESIGN AUTOMATION** **(3)**

Research in VLSI Design Automation

Research topics related to VLSI design automation such as hardware description languages, computer-aided design tools, algorithms and methodologies for VLSI design for a wide range of levels of design abstraction, design validation and test. Requires term project and class presentation.

EECS 488 **EMBEDDED SYSTEM DESIGN** **(3)**

Embedded Systems Design

Objective: to introduce and expose the student to methodologies for systematic design of embedded system. The topics include, but are not limited to, system specification, architecture modeling, component partitioning, estimation metrics, hardware software codesign, diagnostics.

EECS 489 **ROBOTICS I** **(3)**

Robotics I

(See EMAE 489.) Prereq: EMAE 181. Cross-listed as EMAE 489.

EECS 490 **COMPUTER PROCESSING OF IMAGES** **(3)**

Computer Processing of Images

Introduction of computer vision methodologies. Includes the images systems: optics and detectors and geometric relationships between scene and image, 3-D scene scanning and imaging techniques including stereovision and laser rangefinders. Digital signal processing in 2-D and optical preprocessing of images. Real-time digital signal transmission of dynamic images and HDTV. Hardware issues in processing of vision information. Prereq: EECS 322, EBME 310, EMAE 325 or equivalent or consent of instructor.

EECS 491 **INTELLIGENT SYSTEMS I** **(3)**

Intelligent Systems I

Artificial intelligence and programming techniques used in design and implementation of intelligent systems. Problem solving and game playing by computer, different representation of problems and games, and their associated solution methods. Knowledge representation: logic, semantic networks frames. Programming in LISP and Prolog.

EECS 500 **EECS COLLOQUIUM** **(0)**

EECS Colloquium

Seminars on current topics in Electrical Engineering and Computer Science.

Course **Short title (maximum 30 characters)** **Hours**
Bulletin Title (maximum 70 characters)
Description

EECS 500T **GRADUATE TEACHING II** **(0)**

Graduate Teaching II

This course will provide the Ph.D. candidate with experience in teaching undergraduate or graduate students. The experience is expected to involve direct student contact but will be based upon the specific departmental needs and teaching obligations. This teaching experience will be conducted under the supervision of the faculty member who is responsible for the course, but the academic advisor will assess the educational plan to ensure that it provides an educational experience for the student. Students in this course may be expected to perform one or more of the following teaching related activities: grading homeworks, quizzes, and exams, having office hours for students, running recitation sessions, providing laboratory assistance. Prereq: Ph.D. student in EECS department.

EECS 516 **LARGE SCALE OPTIMIZATION** **(3)**

Large Scale Optimization

Concepts and techniques for dealing with large optimization problems encountered in designing large engineering structure, control of interconnected systems, pattern recognition, and planning and operations of complex systems; partitioning, relaxation, restriction, decomposition, approximation, and other problem simplification devices; specific algorithms; potential use of parallel and symbolic computation; student seminars and projects. Prereq: EECS 416.

EECS 518 **ANALYSIS OF NONLINEAR SYSTEMS** **(3)**

Nonlinear Systems: Analysis and Control

Mathematical preliminaries: differential equations and dynamical systems, differential geometry and manifolds. Dynamical systems and feedback systems, existence and uniqueness of solutions. Complicated dynamics and chaotic systems. Stability of nonlinear systems: input-output methods and Lyapunov stability. Control of nonlinear systems: gain scheduling, nonlinear regulator theory and feedback linearization. Prereq: EECS 408 and EECS 421.

EECS 519 **DIFFERENTIAL GEO NONLINEAR** **(3)**

Differential Geometric Nonlinear Control

This advanced course focuses on the analysis and design of nonlinear control systems, with special emphasis on the differential geometric approach. Differential geometry has proved to be an extremely powerful tool for the analysis and design of nonlinear systems, similar to the roles of the Laplace transformation and linear algebra in linear systems. The objective of the course is to present the major methods and results of nonlinear systems and provide a mathematical foundation, which will enable students to follow the recent developments in the constantly expanding literature. This course will also benefit those students from Electrical, Mechanical, Chemical and Biomedical Engineering, who are doing research in the fields that involve nonlinear control problems. Prereq: EECS 408 or equivalent.

EECS 526 **MIXED-SIGNAL SYSTEMS** **(3)**

Integrated Mixed-Signal Systems

Mixed-signal (analog/digital) integrated circuit design. D-to-A and A-to-D conversion, applications in mixed-signal VLSI, low-noise and low-power techniques, and communication sub-circuits. System simulation at the transistor and behavioral levels using SPICE. Class will design a mixed-signal CMOS IC for fabrication by MOSIS. Prereq: EECS 426.

Course	**Short title (maximum 30 characters)**	**Hours**
Bulletin Title (maximum 70 characters)		
Description		

EECS 527 **ADVANCED SENSORS** **(3)**

Advanced Sensors: Theory and Techniques

Sensor technology with a primary focus on semiconductor-based devices. Physical principles of energy conversion devices (sensors) with a review of relevant fundamentals: elasticity theory, fluid mechanics, silicon fabrication and micromachining technology, semiconductor device physics. Classification and terminology of sensors, defining and measuring sensor characteristics and performance, effect of the environment on sensors, predicting and controlling sensor error. Mechanical, acoustic, magnetic, thermal, radiation, chemical and biological sensors will be examined. Sensor packaging and sensor interface circuitry. Prereq: EECS 322 or EECS 415 and EECS 434.

EECS 531 **COMPUTER VISION** **(3)**

Computer Vision

Geometric optics, ray matrics, calibration of monocular and stereo imaging systems. Adaptive camera thresholding and image segmentation, morphological and convolutional image processing. Selected topics including edge estimation and industrial inspection, optimal filtering, model matching, CAD-based vision and range image processing. Neural-net image processing. Model-based computer vision for scene interpretation and autonomous systems. Prereq: EECS 490 or equivalent.

EECS 550 **NEUROMECHANICS SEMINAR** **(0)**

Neuromechanics Seminar

(See EBME 550.) Cross-listed as EBME 550.

EECS 589 **ROBOTICS II** **(3)**

Robotics II

Survey of research issues in robotics. Force control, visual servoing, robot autonomy, on-line planning, high-speed control, man/machine interfaces, robot learning, sensory processing for real-time control. Primarily a project-based lab course in which students design real-time software executing on multi-processors to control an industrial robot. Prereq: EECS 489.

EECS 591 **INTELLIGENT SYSTEMS II** **(3)**

Intelligent Systems II

EECS 600 **SPECIAL TOPICS** **(1-18)**

Special Topics

EECS 600T **GRADUATE TEACHING III** **(0)**

Graduate Teaching III

This course will provide Ph.D. candidate with experience in teaching undergraduate or graduate students. The experience is expected to involve direct student contact but will be based upon the specific departmental needs and teaching obligations. This teaching experience will be conducted under the supervision of the faculty member who is responsible for the course, but the academic advisor will assess the educational plan to ensure that it provides an educational experience for the student. Students in this course may be expected to perform one or more of the following teaching related activities running recitation sessions, providing laboratory assistance, developing teaching or lecture materials presenting lectures. Prereq: Ph.D. student in EECS department.

Course	Short title (maximum 30 characters)	Hours
Bulletin Title (maximum 70 characters)		
Description		
EECS 601	**INDEPENDENT STUDY**	**(1-18)**
Independent Study		
EECS 602	**ADVANCED PROJECTS LAB**	**(1-18)**
Advanced Projects Laboratory		
EECS 620	**SPECIAL TOPICS**	**(1-18)**
Special Topics		
EECS 621	**SPECIAL PROJECTS**	**(1-18)**
Special Projects		
EECS 649	**PROJECT (M.S.)**	**(1-9)**
Project M.S.		
EECS 651	**THESIS M.S.**	**(1-18)**
Thesis M.S.		
EECS 701	**DISSERTATION PH.D.**	**(1-18)**
Dissertation Ph.D.		
EECS 703	**DISSERTATION FELLOWSHIP**	**(1-8)**
Dissertation Fellowship		