

The University of Kansas

Department of Electrical Engineering & Computer Science

Graduate Level Course Descriptions

EECS 501 Senior Design Laboratory I (3).
EECS 502 Senior Design Laboratory II (3).
EECS 510 Introduction to the Theory of Computing (3).
EECS 512 Electronic Circuits III (3).
EECS 541 Computer Systems Design Laboratory I (3).
EECS 542 Computer Systems Design Laboratory II (3).
EECS 546 Integrated Circuit Design (3).
EECS 560 Data Structures (3).
EECS 562 Introduction to Communication Systems (4).
EECS 580 Electrical Energy Conversion (3).
EECS 603 Information Processing with C++ (3).
EECS 611 Noise Reduction in Electronic Systems (3).
EECS 622 Microwave and Radio Transmission Systems (3).
EECS 625 Introduction to Radar (3).
EECS 628 Fiber Optic Communication Systems (3).
EECS 638 Fundamentals of Expert Systems (3).
EECS 644 Introduction to Digital Signal Processing (3).
EECS 645 Computer Architecture (3).
EECS 647 Introduction to Database Systems (3).
EECS 649 Introduction to Artificial Intelligence (3).
EECS 660 Fundamentals of Computer Algorithms (3).
EECS 662 Programming Languages (3).
EECS 663 Introduction to Communication Networks (3).
EECS 665 Compiler Construction (3).
EECS 670 Introduction to Semiconductor Processing (3).
EECS 672 Introduction to Computer Graphics (3).
EECS 678 Introduction to Operating Systems (3).
EECS 690 Special Topics: — (1-3).
EECS 692 Directed Reading (1-3).
EECS 700 Special Topics — (1-5). Courses on special topics of current interest in electrical engineering and computer science, given as the need arises. May be repeated for additional credit. Prerequisite: variable.
EECS 713 High Speed Digital Circuit Design (3). Basic concepts and techniques in the design and analysis of high-frequency digital and analog circuits. Topics include: transmission lines, ground and power planes, layer stacking, substrate materials, terminations, vias, component issues, clock distribution, cross-talk, filtering and decoupling, shielding, signal launching. Prerequisite: EECS 312 and senior or graduate standing. EECS 420 recommended.
EECS 716 Formal Language Theory (3). Formal language generation by grammars, recognition by automata (finite and pushdown automata, Turing machines), and equivalence of these formulations; elementary containment and closure properties. Emphasis on context-free, deterministic context-free and regular languages. Prerequisite: EECS 510 or *EECS 805* or equivalent.
EECS 720 Electromagnetics for Communications and Radar (3). Topics in electromagnetics relevant to wireless communications, optics and fiber optics, radar and remote sensing. Subjects covered include space waves, guided waves, radiation and antennas, scattering, electromagnetic properties of materials, and optics. Prerequisite: EECS 420 or equivalent.
EECS 721 Antennas (3). Gain, Pattern, and Impedance concepts for antennas. Linear, loop, helical, & aperture antennas (arrays, reflectors, and lenses). Cylindrical & biconical antenna theory. Prerequisite: EECS 360, EECS 420, or EECS 720.
EECS 722 Mathematical Logic (3). Propositional Calculus. First order theories and model theory. Elementary arithmetic and Godel's incompleteness theorems. (Same as MATH 722) Prerequisite: MATH 765 or MATH 791, or equivalent evidence of mathematical maturity.

EECS 723 Microwave Engineering (3-4). Survey of microwave systems, techniques, and hardware. Guided-wave theory, microwave network theory, active and passive microwave components. The four-hour version of the course includes a laboratory. Prerequisite: EECS 420.
EECS 724 Computability Theory (3). Effective computability of functions and sets in terms of Turing machines and other computation models; universal machines and unsolvability of the halting problem; the Church-Turing thesis and formal proofs of the equivalence of Turing machines, systems of recursion equations, Post canonical systems; mathematical properties of the classes of recursive functions, recursive and recursively enumerable sets. Prerequisite: EECS 510.
EECS 730 Artificial Intelligence (3). An introduction to "creative" information processing systems including examples of individual and coordinated human behavior, and artificially intelligent computer programs. Elementary systems analysis, simulation techniques, and heuristic programming as needed to study cognitive processes. Construction and validation of a simulation of some "intelligent" information processing system. Prerequisite: EECS 368 or EECS 807 or permission of instructor.
EECS 735 Automated Theorem Proving (3). Computer-based theorem-proving methods for selected domains such as plane geometry, symbolic integral calculus, and propositional calculus are reviewed. Mechanical theorem-proving procedures for the first-order predicate calculus are studied in depth. Includes resolution, semantic resolution, hyper-resolution, linear resolution, and paramodulation. Applications of these procedures to areas such as proofs of program correctness, deductive question answering, problem solving, and program synthesis. Prerequisite: EECS 730 and a knowledge of mathematical logic equivalent to that supplied by EECS 210.
EECS 740 Digital Image Processing (3). This course gives a hands on introduction to the fundamentals of digital image processing. Topics include: image formation, image transforms, image enhancement, image restoration, image reconstruction, image compression, and image segmentation. Prerequisite: EECS 672 or EECS 744.
EECS 741 Computer Vision (3). This course gives a hands on introduction to the fundamentals of computer vision. Topics include: image formation, edge detection, image segmentation, line-drawing interpretation, shape from shading, texture analysis, stereo imaging, motion analysis, shape representation, object recognition. Prerequisite: EECS 672 or EECS 744.
EECS 742 Digital Video for Multimedia Systems (3). An introduction to digital video for multimedia systems. Topics include basics of digital video, capture and non-linear editing, video feature detection (temporal segmentation, motion estimation), content based video classification, video compression techniques and standards (MPEG-1, 2, 4, 7), video streaming, and multimedia applications. Digital video tools and techniques will be utilized in several programming projects. Prerequisite: EECS 740 or equivalent.
EECS 744 Digital Signal Processing I (3). Discrete fourier transforms, design of digital filters, fast fourier transform algorithms, and its application to signal processing, description of DSP chips and introduction to quantization error. Prerequisite: EECS 360.
EECS 745 High Performance Integrated Networks (3). Processing requirements for integrated networks and associated applications. Principles of VLSI architectures. Overview of selected network functions, including scrambling & descrambling, synchronization, cell switching, routing, bandwidth shaping and policing, encryption, and decryption. Implementation of network functions using high performance special-purpose architectures. Examples of processors for high

speed networks. Prerequisite: EECS 546 and EECS 663. Co-requisite: EECS 863.

EECS 749 Knowledge Based Systems (3). General concepts of intelligent problem solving, rule-based systems, reasoning under uncertainty, associative networks, model-based reasoning blackboards, object-oriented systems, case-based reasoning, induction, neural networks. Students may not earn credit in both EECS 749 and CE 792. Prerequisite: EECS 649 or EECS 730 or equivalent.

EECS 750 Operating System (3). An analytical treatment of the structures and theoretical foundations of operating systems and related systems, and of their design and implementation. Cooperating and distributed processes, memory and store management strategies, resource sharing and queuing, concurrency control, and system protection and security. Other topics such as design methodologies, fault tolerance, languages for distributed programming, and communication protocols will also be discussed. Prerequisite: EECS 678 and one of EECS 461, MATH 526, or MATH 627.

EECS 752 Concurrent Software Systems (3). Introduction to design and implementation of concurrent (multi-threaded, parallel, or distributed) software systems. The course examines problems and solutions common to all concurrent software, including interference, deadlock, consensus, resource allocation, coordination, global predicate evaluation, ways of expressing concurrency, concurrent I/O, debugging, fault tolerance, and heterogeneity. Prerequisite: EECS 448 and EECS 678.

EECS 753 Embedded and Real Time Computer Systems (3). This course will cover emerging and proposed techniques and issues in embedded and real time computer systems. Topics will include new paradigms, enabling technologies, and challenges resulting from emerging application domains. Prerequisite: EECS 645 and EECS 678.

EECS 755 System Requirements Modeling and Analysis (3). Modern software engineering techniques for modeling and analyzing software systems. Course coverage concentrates on pragmatic, formal modeling techniques that support predictive analysis.

EECS 761 Programming Paradigms (3). An investigation of alternative programming paradigms and their representative effect on programming expressiveness and style. Emphasis is on a comparative understanding of a spectrum of programming paradigms, with some facility in the use of at least one typical language representative of each paradigm studied. The course will review and investigate as appropriate imperative, functional, object-oriented, parallel, and logical programming paradigms, plus additional paradigms as relevant. Prerequisite: EECS 662 or EECS 807 or equivalent.

EECS 762 Programming Language Foundation (3). Relationship between syntactic, static-semantic, and semantic structures. Attribute grammars as models for static-semantic information processing. Survey of formal semantic models, including operational, denotational, and axiomatic examples. Related static-semantic, semantic, and programming language issues. Prerequisite: EECS 662 or EECS 807 or equivalent.

EECS 764 Analysis of Algorithms (3). Models of computations and performance measures; asymptotic analysis of algorithms; basic design paradigms including divide-and-conquer, dynamic programming, backtracking, branch-and-bound, greedy method and heuristics; design and analysis of approximation algorithms; lower bound theory; polynomial transformation and the theory of NP-Completeness; additional topics may be selected from arithmetic complexity, graph algorithms, string matching, and other combinatorial problems. Prerequisite: EECS 660 or EECS 805 or equivalent.

EECS 767 Information Retrieval (3). The objective of this course is to give students a hands on introduction to information retrieval systems. Classic textual information retrieval systems are studied, followed by presentation of current research in area. Topics include: file structures, term-weighting schemes, text preprocessing, World Wide Web search engines, multimedia retrieval systems, artificial

intelligence applications. Prerequisite: EECS 647 or Permission of instructor.

EECS 772 Interactive Graphics Systems (3). The principles of interactive graphics from the systems point of view. Program structures and schemata, with emphasis on interaction control. High performance device architectures. Graphic languages and software architecture. Human factors of interaction and interaction design. Projective geometry and surface modeling. Software management techniques. Algorithms. Group projects. Prerequisite: EECS 672

EECS 773 Advanced Graphics (3). Advanced topics in graphics and graphics systems. Techniques for scientific visualization and photorealistic rendering. Ray tracing; radiosity; volumetric rendering; antialiasing; animation. Specialized modeling techniques like particle systems and recursive constructions. Collaborative interaction and visualization. Prerequisite: EECS 672.

EECS 774 Geometric Modeling (3). Introduction to the representation, manipulation, and analysis of mathematical models of physical objects with application to mechanical computer-aided design and manufacturing (CAD/ CAM). Basic geometric analysis tools. Implicit and parametric representations of curves and surfaces. Curve and surface design and display techniques. Curve and surface intersections. Solid modelling representations and algorithms. Boolean set operations on solid models and the boundary evaluation algorithm. Geometric modeling system architectures. Project developed in C. Prerequisite: EECS 672.

EECS 781 Numerical Analysis I (3). Finite and divided differences. Interpolation, numerical differentiation, and integration. Gaussian quadrature. Numerical integration of ordinary differential equations. Curve fitting. (Same as Math 781). Prerequisite: Math 320 and knowledge of a programming language.

EECS 782 Numerical Analysis II (3). Direct & interactive methods for solving systems of linear equations. Numerical solution of partial differential equations. Numerical determination of eigenvectors and eigenvalues. Solution of nonlinear equations. (Same as MATH 782) Prerequisite: EECS 781.

EECS 800 Special Topics: _____ (1-5). Advanced courses on special topics of current interest in electrical engineering and computer science given as the need arises. May be repeated for additional credit. Prerequisite: variable.

EECS 801 Directed Graduate Readings (1-3). Graduate level directed readings on a topic in electrical engineering and computer science, mutually agreed-on by the student and instructor. May be repeated for credit on another topic. Prerequisite: Consent of Instructor.

EECS 802 EECS Colloquium (.2). A colloquium series featuring speakers from industry, government, other universities, and research organizations on the university campus presenting talks on various topics related to electrical engineering, computer engineering, and computer science. Course will be graded Satisfactory/Fail. No prerequisite.

EECS 803 Introduction to Research (3). Introduction to research methods and resources for conducting research including methods of effectively tapping library resources, preparation of literature surveys, and presentation of results. EECS faculty and advanced graduate students will give regular presentations of current research projects to the class. Students will write papers on the presentations or on particular topics of interest. The students will also give their own presentation of a topic. Prerequisite: Graduate standing in the EECS department.

EECS 804 Algorithmic Problem Solving (4). Fundamental stages of software development are covered: problem specification, implementation, testing, and documentation. Introduction to object-oriented programming using Java: implementing classes, specifying and implementing interfaces, inheritance, polymorphism. Introduction to fundamental data types such as arrays, stacks, queues, and trees. Introduction to algorithmic complexity for understanding algorithm

cost. Prerequisite: Admission to the EECS Fast-Path Program. Does not count towards required credit hours for any EECS degree.

EECS 805 Mathematical Foundations (4). Fundamental stages of software development are covered: This course includes topics from discrete mathematics and language theory. The topics include logic and proof techniques, relations and partial orders, graphs and trees, solution of recurrence relations, advanced counting techniques, regular and context-free languages and their grammars, finite and pushdown automata, Turing machines, and the limits of computation. Prerequisite: Admission to the EECS Fast-Path Program. Does not count towards required credit hours for any EECS degree.

EECS 806 Machine Organization and Programming (4). Fundamental stages of software development are covered: This Internal organization or microprocessors, programming in assembly language, the structure of computing systems, instruction sets, pipelined functional units, memory hierarchies, performance evaluation. Prerequisite: Admission to the EECS Fast-Path Program. Does not count towards required credit hours for any EECS degree.

EECS 807 Programming Language Foundations (3). Introduction to programming language semantics, including translators, interpreters, and compilers. Also included is an introduction to functional programming. Topics include: semantic models of evaluation, environments and closures, continuations, functions as first class objects, macros, exception handling, scope, typing, encapsulation, and message-passing and polymorphism. Prerequisite: Admission to the EECS Fast-Path Program. Does not count towards required credit hours for any EECS degree.

EECS 808 Data Structures and Software Engineering (3). This course develops techniques appropriate for design, development, and maintenance of intermediate to large software systems. Included is a study of the software life cycle and the development and use of sophisticated abstract data types. Advanced data structures are introduced and motivated in terms of software engineering and issues related to large system development. Prerequisite: Admission to the EECS Fast-Path Program. Does not count towards required credit hours for any EECS degree.

EECS 821 Adaptive Antenna Arrays for Communications and Radar (3). Description and analysis of antenna arrays that have dynamically adjustable patterns. Topics include phased array antennas, digital beamforming in element and beam space; adaptive beamforming algorithms; error effects; relationship between multiple access schemes such as FDMA, TDMA, CDMA, and SDMA; mobile, satellite, indoor, and radar applications; and current antenna, transceiver, and DSP technology. Prerequisite: EECS 420, EECS 461, and EECS 744 or equivalent.

EECS 823 Microwave Remote Sensing (3). Description and analysis of basic microwave remote sensing systems including radars and radiometers as well as the scattering and emission properties of natural targets. Topics covered include plane wave propagation, antennas, radiometers, atmospheric effects, radars, calibrated systems, and remote sensing applications. Prerequisite: EECS 420 and EECS 622.

EECS 825 Radar Systems (3). Description and analysis of radars of various types. Resolution in angle, range, and speed. Ambiguities. Return from point and area targets. Detection in the presence of noise and fading. Tracking and MTI. Amplitude measurement. Imaging radars. Prerequisite: EECS 360, 420, and EECS 461.

EECS 828 Advanced Fiber-Optic Communications (3). An advanced course in fiber-optic communications. The course will focus on various important aspects and applications of modern fiber-optic communications, ranging from photonic devices to systems and networks. Topics include: advanced semiconductor laser devices, external optical modulators, optical amplifiers, optical fiber nonlinearities and their impact in WDM and TDM optical systems, polarization effect in fiber-optic systems, optical receivers and high-speed optical system performance evaluation, optical soliton systems,

lightwave analog video transmission, SONET & ATM optical networking and advanced multi-access lightwave networks. Prerequisite: EECS 628 or equivalent.

EECS 830 Advanced Artificial Intelligence (3).

A detailed examination of computer programs and techniques that manifest intelligent behavior, with examples drawn from current literature. The nature of intelligence and intelligent behavior. Development of, improvement to, extension of, and generalization from artificially intelligent systems, such as theorem-provers, pattern recognizers, language analyzers, problem-solvers, question answerers, decision-makers, planners, and learners. Prerequisite: EECS 730.

EECS 833 Neural Networks and Fuzzy Systems (3).

Fundamental theory of adaptive systems, Introduction to Artificial Neural Networks (ANN) and learning algorithms, neural computers, pattern classification, using neural networks, Hop-field networks, Introduction to fuzzy sets and fuzzy relations, fuzzy-model-based classification and control, fusion of fuzzy models with neural networks, applications of fuzzy-neural networks in engineering problems. Prerequisite: Permission of the instructor.

EECS 837 Data Mining (3). Extracting data from data bases to data warehouses. Preprocessing of data: handling incomplete, uncertain and vague data sets. Discretization methods. Methodology of learning from examples: rules of generalization, control strategies. Typical learning systems: ID3, AQ, C4.5, and LERS. Validation of knowledge. Visualization of knowledge bases. Learning from observation, conceptual clustering. Data mining using neural nets. Genetic algorithms. Data mining under uncertainty, using approaches based on probability theory, fuzzy set theory and rough set theory. Prerequisite: EECS 638.

EECS 843 Fault Tolerant Systems (3). The fundamental principles of fault tolerant system architecture. Analysis of dependability and fault tolerance of systems. Fault detection and correction methods, including error correction and detection coding, module redundancy, faulty containment, protocols, reconfiguration, and system recovery. Examples of the application of these methods to implementation of computers, networks, and processors. Prerequisite: EECS 645 and EECS 663.

EECS 844 Digital Signal Processing for Communications and Radar (3). This course focuses on the design and implementation of communication and radar systems using digital signal processing algorithms. Subjects include digital filters, modulation and demodulation algorithms, subsampling techniques, adaptive algorithms for filters and antennas, DSP microprocessors, and other software radio principles. Prerequisite: EECS 744 or permission of instructor.

EECS 846 High Performance Digital Signal Processing (3)*. The fundamental principles of VSLI architectures and the physical factors motivating those principles. Computationally difficult DSP and image processing algorithms. Mapping of algorithms to special-purpose parallel architectures. Application of these methods to implementation of high performance signal processors, including use of current CAD tools. Examples of general-purpose and special-purpose digital signal processors. Prerequisite: EECS 546 and EECS 744.

EECS 848 Software Engineering II (3). This course is a continuation of the material presented in EECS 448 on the design and specification phase for production software. It includes a major project which will be carried out as a group effort. Students will be required to specify, design and document, and implement a major component of a combined project. Prerequisite: EECS 448 or equivalent.

EECS 850 Advanced Operating Systems (3). A study of current research topics in operation systems. Topics such as design methodologies, synchronization and communication, resource management, multicomputer and parallel computer control, supercomputer control, languages for distributed computing, resource management, network operating systems, system modeling, and performance evaluation. Prerequisite: EECS 750.

EECS 861 Random Signal Theory (3). An extension of probabilistic modeling introducing random processes and spectral representation. Special emphasis on filtering and estimation including Wiener, Kalman, matched, pre and de emphasis filtering. Prerequisite: EECS 360 and EECS 461.

EECS 862 Principles of Digital Communication Systems (3). A study of communication systems using noisy channels. Principal topics are: information and channel capacity, baseband data transmission, digital carrier modulation, error control coding, & digital transmission of analog signals. The course includes a laboratory/computer aided design component integrated into the study of digital communication systems. Prerequisite: EECS 562. Co-requisite: EECS 861.

EECS 863 Analysis of Communication Networks (3). Modeling and analysis for performance prediction of communication networks. Topics include: an introduction to queueing theory; analysis of TDM systems; modeling and analysis of networks of queues; analysis of congestion and flow control algorithms; analysis of routing algorithms; analysis of bus and ring networks. Prerequisite: EECS 562 and EECS 861.

EECS 864 Multiwavelength Optical Networks (3). Introduce methodologies for multiwavelength optical network analysis, design, control and survivability. Prerequisite: EECS 663.

EECS 865 Wireless Communication Systems (3). The theory and practice of the engineering of wireless telecommunication systems. Topics include cellular principles, mobile radio propagation (including indoor and outdoor channels), radio links calculations, fading (including Rayleigh, Rician, and other models), packet radio, equalization, diversity, error correction coding, spread spectrum, multiple access techniques (including time, frequency, and code), & wireless networking. Current topics of interest will be covered. Corequisite: EECS 861.

EECS 868 Statistics of Random Processes (3). An introduction to the theory and practice of estimating the models and parameters of stochastic models used in communications and pattern recognition. Prerequisite: EECS 861.

EECS 888 Internet Routing Architectures (3). A detailed study of routing in IP networks. Topics include evolution of the Internet architecture, IP services and network characteristics, an overview of routing protocols, the details of common interior routing protocols and interdomain routing protocols, and the relationship between routing protocols and the implementation of policy. Issues will be illustrated through laboratories based on common routing platforms. Prerequisite: EECS 745.

EECS 891 Graduate Problems (1-5). Directed studies of advanced phases of electrical engineering and computer science not covered in the regular graduate courses, including advanced laboratory work, special research or library reading. Prerequisite: Consent of Instructor

EECS 899 Master's Thesis or Report (1-6). Original investigation satisfying thesis requirements for the Master of Science degree.

EECS 900 Seminar (0.5-3). Group discussion of selected topics and reports on the progress of original investigations.

EECS 962 Advanced Modulation and Coding (3). Study of coding subsystems and techniques within a digital communication system. Analysis of the effects of combined modulation and coding. Commercial and military applications of spread spectrum modulation for interference suppression.

Prerequisite: EECS 862.

EECS 963 Integrated Telecommunication Networks (3). Description and analysis of telecommunication networks designed to integrate different types of traffic and provide different user services. Integrated Services Digital Network (ISDN), Broadband ISDN and Asynchronous Transfer Mode (ATM). "Fast packet" transport of speech, image, video. Source modeling, performance analysis, and congestion control techniques for integrated networks. Prerequisite: either EECS 863 or EECS 663.

EECS 964 Simulation of Communication Systems (3). This course will cover both fundamental and advanced concepts of simulation based analysis and design of communication systems. Monte Carlo simulation principles, modeling techniques, and performance estimation procedures will be discussed. Case studies in simulation satellite, optical and digital microwave links will be presented and the students will be exposed to state of the art simulation packages. Prerequisite: EECS 861 and EECS 862.

EECS 965 Detection and Estimation (3). Detection of signals in the presence of noise and estimation of signal parameters. Narrowband signals, multiple observations, signal detectability and sequential detection. Structure and performance of the receiver. Discrete-time processing and filtering. Prerequisite: EECS 861.

EECS 967 Mathematical Optimization with Communications Applications (3). A mathematical study of various methods for minimizing (or maximizing) functions. Optimization problem formulation. Linear, nonlinear, integer, dynamic programming. Conditions for optimal points. Convergence of algorithms. Stochastic optimization. Application to communications network design, error control coding, system modeling, etc. Prerequisite: Graduate standing in the School of Engineering and EECS 861.

EECS 998 Post-Master's Research (1-6).

EECS 999 Doctoral Dissertation (1-10).