CE 761 Matrix Analysis of Framed Structures (3).
CE 762 Behavior of Reinforced Concrete Members (3).
CE 763 Design of Prestressed Concrete Structures (3).
CE 764 Advanced Design of Reinforced Concrete Structures (3).
CE 765 Advanced Steel Design - Building Structures (3).
CE 766 Advanced Steel Design - Bridge Structures (3).
CE 767 Introduction to Fracture Mechanics (3).
CE 770 Concepts of Environmental Chemistry (2).
CE 771 Environmental Chemical Analysis (1).
CE 772 Physical Principles of Environmental Engineering Processes (3).
CE 773 Biological Principles of Environmental Engineering (3).
CE 774 Chemical Principles of Environmental Engineering Processes (3).
CE 775 Marine Pollution (3).
CE 777 Industrial Water and Wastes (3).
CE 778 Air Quality (3).
CE 779 Water Quality (3).
CE 781 Traffic Engineering I: (Traffic Characteristics and Studies) (3).
CE 785 Terrain Analysis (3).
CE 787 Advanced Soil Mechanics (3).
CE 788 Geotechnical Engineering Testing (3).
CE 789 Pavement Management Systems (3).
CE 791 Waste Facility Siting and Design (3).
CE 792 Knowledge-based/Expert Systems in Engineering (3).
CE 793 Advanced Concepts in CADD (3).
CE 794 Environmental Graduate Student Orientation (1).
CE 795 Scanning Electron Microscopy and X-ray Microanalysis (3).

■ Construction Management Courses

CMGT 357 Engineering Economics (3). Analysis of design alternatives and investment opportunities based on the time value of money. Topics include financial statements and accounting concepts related to economic analysis, time value of money and cash flow equivalence, cost of capital and minimum attractive rate of return (MARR), defining mutually exclusive alternatives, developing alternative after-tax cash flows, performing investment and replacement studies, and methods for addressing uncertainty and risk. Prerequisite: Junior and senior standing in the School of Engineering or the School of Architecture and Urban Design. LEC

CMGT 500 Construction Engineering (3). An introduction to the construction industry, construction project management, and construction operations. Topics include project participant roles and responsibilities; project delivery systems; procurement of construction services; sustainable construction; contracts, bonds, and insurance; equipment selection and use; constructability and value engineering; estimating and bidding; planning and scheduling; operations management; safety; and project commissioning and closeout. Prerequisite: Junior or Senior standing in the School of Engineering or the School of Architecture and Urban Design. LEC

CMGT 609 International Construction Management (3). An Introduction to the management of international construction projects. This course focuses on areas where international construction project management differs from the management of domestic construction projects. Topics include project delivery systems including build-operate-transfer (BOT) and other systems unique to international construction contracts; the impact of the host country's language, demographics, laws, political structure, geography, economics, culture, and customs on project delivery; currency transfer and risk; procurement and expediting; designing construction means and methods that optimize available labor, material, and equipment; participant roles and responsibilities; among other topics. Prerequisite: CMGT 400 or consent of instructor. LEC

CMGT 700 Construction Project Management (3).
CMGT 701 Construction Planning and Scheduling (3).
CMGT 702 Construction Equipment and Methods (3).
CMGT 703 Construction Quality, Productivity, and Safety (3).
CMGT 704 Construction Estimating and Bidding (3).
CMGT 705 Construction Contracts, Bonds, and Insurance (3).
CMGT 790 Construction Seminar: _____ (3).

Electrical Engineering and Computer Science

Chair: Costas Tsatsoulis
Eaton Hall, 1520 West 15th St., Room 2001
Lawrence, KS 66045-7621
www.eecs.ku.edu, (785) 864-4620, fax: (785) 864-3226

The technological advances that have made our society what it is today are due largely to the efforts of electrical engineers, computer engineers, and computer scientists. Among these advances are radio, television, telephones, wireless and mobile communications, personal computers, workstations, mainframe computers, aircraft avionics, satellite electronics, automobile electronics, office machinery, medical electronic equipment, video games, electric power generation and distribution systems, telecommunications, computer networks (including the Internet), personal entertainment products, radar, defense electronics, artificial intelligence, and a wide variety of computer software.

The department offers three Bachelor of Science degrees: Electrical Engineering (B.S.E.E.), Computer Engineering (B.S.Co.E.), and Computer Science (B.S.C.S.). Each features a firm grounding in mathematics, basic science, computer and engineering science, and advanced studies in the theory and design of various systems as well as hands-on experience. All degree programs are accredited.

Vision and Mission

The vision of the EECS department is to provide a stimulating and challenging intellectual environment.

- To have classes populated by outstanding students.
- To be world class in an increasing number of selected areas of research.
- To have faculty members with high visibility among their peers.

The mission of the EECS department is

- To educate the next generation of electrical engineers, computer engineers, and computer scientists.
- To discover, apply, and disseminate knowledge.
- To be an asset to the community and to society.

Departmental Honors Program

A student may graduate with departmental honors in electrical engineering, computer engineering, or computer science by graduating with a minimum grade-point average requirement while maintaining full-time status. In addition, students must enroll in EECS 498 Honors Research for their last two semesters and must complete an independent research project paper and oral presentation to a panel of three judges.

Electrical Engineering Program

Electrical engineers work with a broad range of electrical and electronic devices and systems. While computers are involved in many of these areas, either as components or as design/analysis tools, an electrical engineer's work often extends beyond the computing aspects of a problem or system.

Educational Objectives. As electrical engineers, B.S.E.E. graduates of KU

1. Will have demonstrated success in the practice of electrical engineering based on the ability to use fundamental scientific and engineering principles, use modern laboratory and computing tools, and design electrical components and complex systems.
2. Will have demonstrated team skills to function in multidisciplinary environments, made technical contributions to and/or provided technical leadership in a diverse and changing global society, demonstrated proficiency in technical communications, and utilized ethical and professional principles in all career decisions.

First- and Second-year Preparation. The following are recommended enrollments for the first two years:

First semester (15 hrs.): MATH 121, ENGL 101, EECS 140, humanities/social sciences elective.
Second semester (16 hrs.): MATH 122, ENGL 102, PHSX 211, EECS 168.
Third semester (16 hrs.): EECS 211, MATH 220, MATH 290, CHEM 184, humanities/social science elective.
Fourth semester (15 hrs.): EECS 212, EECS 220, EECS 388, humanities/social sciences elective.

Requirements for the Bachelor of Science Degree in Electrical Engineering. A total of 128 credit hours is required for the B.S.E.E. degree, as follows:

Electrical Engineering (63 hours)
- EECS 211 and EECS 212 Circuits I and II 7
- EECS 140 Introduction to Digital Logic Design 4
- EECS 168 Programming I 4
- EECS 312 Electronic Circuits I 3
- EECS 360 Signal and System Analysis 4
- EECS 388 Computer Systems and Assembly Language 4
- EECS 412 Electronic Circuits II 4
- EECS 420 Electromagnetics II 4
- EECS 443 Digital Systems Design 4
- EECS 444 Control Systems 3
- EECS 470 Electronic Devices and Properties of Materials 3
- EECS 501 and EECS 502 Senior Design Laboratory I and II 6
- EECS 562 Introduction to Communication Systems 4
- Senior electives 9
  (Any EECS course numbered 400 or above. Under unusual circumstances other courses can be considered but only with an accompanying petition.)

Requirements for EECS Honors (2 hours)
- EECS 498 Honors Research 2
  (Refer to the *EECS Undergraduate Handbook* for full requirements for graduation with departmental honors.)

Mathematics (18 hours)
- MATH 121 and MATH 122 Calculus I and II 10
- MATH 220 Applied Differential Equations 3
- MATH 290 Elementary Linear Algebra 2
- EECS 461 Probability and Statistics 3

Basic Science (17 hours)
- CHEM 184 Foundations of Chemistry I 5
- PHSX 211 General Physics I 4
- EECS 220 Electromagnetics I 4
- PHSX 313 General Physics III 3
- PHSX 316 Intermediate Physics Laboratory I 1

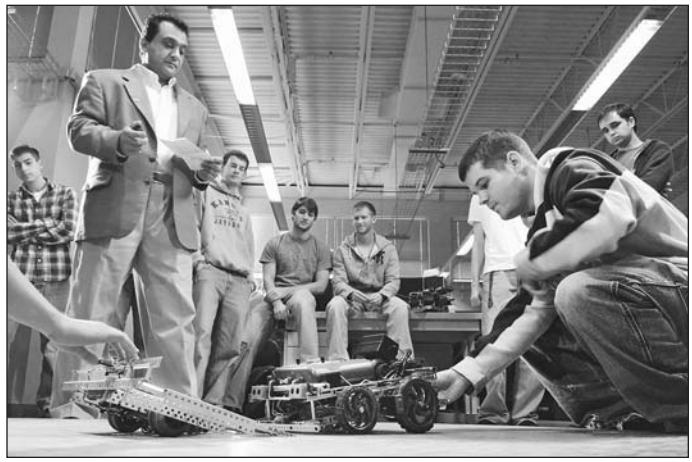
Professional Electives (6 hours)
- Two courses from the following list of approved technical, scientific, and professional courses: 6
  - EECS: Any course except EECS 128, EECS 138, EECS 315, EECS 316, EECS 317, EECS 318, EECS 498. Only one of EECS 643 or EECS 645 may be used.
  - Engineering: Any course from any engineering department numbered 200 or above, except ENGR 300, ENGR 504, ME 208, ME 228, and CE 390.
  - Natural science: Any course designated NB, NE, or NP by the College of Liberal Arts and Sciences, except PHSX 111, PHSX 112, PHSX 114, PHSX 115, PHSX 212, CHEM 125 (if CHEM 184 or the equivalent was taken to meet Basic Science requirements). If a science course used for the science elective exceeds the required science elective hours, the excess hours will be considered professional elective hours.
  - Mathematics: Any MATH course numbered 500 or above, except MATH 701.
  - Business: Any course from the School of Business except statistics or computing.

English (6 hours)
- ENGL 101 Composition 3
- ENGL 102 Critical Reading and Writing 3

Communication (3 hours)
- One of the following courses: 3
  ENGL 362 Foundations of Technical Writing (3)
  COMS 130 Speaker-Audience Communication (3)

General Education Component (15 hours)
- Economics elective 3
  ECON 142 Principles of Microeconomics (3) (preferred) **or**
  ECON 144 Principles of Macroeconomics (3)
- Humanities/social sciences electives 12
  Selected from the list of Principal Courses or Honors Principal Courses in humanities and social sciences. See *http://collegesas.ku.edu/advising/principal_courses.shtml*. Any course designated H or S with a principal course as a prerequisite is also acceptable. Western civilization (HWC) and non-Western culture courses also count as humanities courses.

Credit for ROTC Courses. Up to 6 hours of ROTC may be petitioned to count toward the professional elective requirement.



Credit for Foreign Language. Foreign language courses (other than English or a student's native language) may be used for up to 6 credit hours of humanities/social sciences electives.

Professional Opportunities. Electrical engineers may work in circuit design, electronic devices, electrical and optical communications, control and automation, electromagnetics, instrumentation, energy and power, or signal processing. Electrical engineers typically work in telecommunications, consumer electronics, utilities firms, government, and defense or consulting firms.

Computer Engineering Program

Computer engineers focus on all aspects of computational devices and systems, including both hardware and software. Wherever computers are found, computer engineers are needed.

Educational Objectives. As computer engineers, B.S.Co.E. graduates of KU

1. Will have demonstrated success in the practice of computer engineering based on the ability to use fundamental scientific and engineering principles, use modern laboratory and computing tools, and design computer components and complex software systems.

2. Will have demonstrated team skills to function in multidisciplinary environments, made technical contributions to and/or provided technical leadership in a diverse and changing global society, demonstrated proficiency in technical communications, and utilized ethical and professional principles in all career decisions.

First- and Second-year Preparation. The following are recommended enrollments for the first two years:

First semester (15 hrs.): MATH 121, ENGL 101, EECS 140, humanities/social sciences elective.
Second semester (16 hrs.): MATH 122, ENGL 102, PHSX 211, EECS 168.
Third semester (16 hrs.): EECS 210, EECS 211, EECS 268, MATH 220, MATH 290.
Fourth semester (17 hrs.): EECS 212, EECS 220, EECS 368, COMS 130 or ENGL 362, humanities or social science elective.

Requirements for the Bachelor of Science Degree in Computer Engineering. A total of 127 credit hours is required for the B.S.Co.E. degree, as follows:

Computer Engineering (66 hours)
- EECS 211 and EECS 212 Circuits I and II 7
- EECS 140 Introduction to Digital Logic Design 4
- EECS 168 and EECS 268 Programming I and II 8
- EECS 312 Electronic Circuits I 3
- EECS 360 Signal and System Analysis 4
- EECS 368 Programming Language Paradigms 3
- EECS 388 Computer Systems and Assembly Language 4
- EECS 443 Digital Systems Design 4

The Department of Electrical Engineering and Computer Science offers courses and programs in electrical engineering, computer engineering, and computer science.

Principal courses are online at *http://collegesas.ku.edu/advising/principal_courses.shtml*.

EECS 448 Software Engineering I 4
EECS 541 Computer Systems Design Laboratory I 3
EECS 542 Computer Systems Design Laboratory II 3
EECS 563 Introduction to Communication Networks 3
EECS 643 Advanced Computer Organization 3
EECS 678 Introduction to Operating Systems 4
Senior electives 9
(Any EECS course numbered 400 or above except EECS 645. Under unusual circumstances other courses can be considered but only with an accompanying petition.)

Requirements for EECS Honors (2 hours)
EECS 498 Honors Research 2
(Refer to the *EECS Undergraduate Handbook* for full requirements for graduation with departmental honors.)

Mathematics (22 hours)
MATH 121 and MATH 122 Calculus I and II 10
MATH 220 Applied Differential Equations 3
MATH 290 Elementary Linear Algebra 2
EECS 210 Discrete Structures 4
EECS 461 Probability and Statistics 3

Basic Science (12 hours)
PHSX 211 General Physics I 4
EECS 220 Electromagnetics I 4
PHSX 313 General Physics III 3
PHSX 316 Intermediate Physics Laboratory I 1

Professional Elective (3 hours)
To be taken from the list of approved technical, scientific, and professional courses (same as for electrical engineering) 3

English (6 hours—same as electrical engineering)

Communication (3 hours—same as electrical engineering)

General Education Component (15 hours—same as electrical engineering)

Credit for ROTC Courses. Up to 6 hours of ROTC may be petitioned to count toward the professional elective requirement.

Credit for Foreign Language. Foreign language courses (other than English or a student's native language) may be used for up to 6 credit hours of humanities/social sciences electives.

Professional Opportunities. Computer engineers may work in computer elements and architectures, very large-scale integrated circuits for data processing and storage, embedded and real-time computer systems, or computer networking. Computer engineers work in the computer industry, telecommunications, government and defense, software companies or consulting firms.

Computer Science Program

Computer scientists focus on the theory and practice of computing.

Educational Objectives. The program gives graduates the solid preparation necessary for a successful career or entry into a graduate degree program. It provides the student with

1. An understanding of the fundamental concepts in basic sciences and mathematics and how these concepts can be applied to the solution of science and engineering problems.
2. Meaningful studies in the humanities and social sciences, including an appreciation of ethical issues in the use of technology.
3. A solid foundation in oral and written communication.
4. Experience with the design, maintenance and implementation of software systems.
5. An understanding of computer hardware and software architectures and the ability to design software systems that run efficiently on conventional computing systems.

First- and Second-year Preparation. The following are recommended enrollments for the first two years:

First semester (15 hrs.): MATH 121, ENGL 101, EECS 140, humanities/social sciences elective.
Second semester (16 hrs.): MATH 122, ENGL 102, PHSX 211, EECS 168.
Third semester (17 hrs.): EECS 210, EECS 268, PHSX 212, MATH 223, MATH 290.
Fourth semester (16 hrs.): EECS 368, EECS 388, ENGL 362, humanities/social science elective, natural science elective.

Requirements for the Bachelor of Science Degree in Computer Science. A total of 128 credit hours is required for the B.S.C.S. degree, as follows:

Computer Science (59 hours)
EECS 140 Introduction to Digital Logic Design 4
EECS 168 Programming I 4
EECS 268 Programming II 4
EECS 368 Programming Language Paradigms 3
EECS 388 Computer Systems and Assembly Language 4
EECS 448 Software Engineering I 4
EECS 510 Introduction to the Theory of Computing 3
EECS 560 Data Structures 4
EECS 645 Computer Architecture 3
EECS 660 Fundamentals of Computer Algorithms 3
EECS 662 Programming Languages 3
EECS 665 Compiler Construction 4
EECS 678 Introduction to Operating Systems 4
Senior electives 12
(EECS 563, EECS 638, EECS 647, EECS 648, EECS 649, EECS 672, EECS 690, and any EECS course numbered 700 or above. Under unusual circumstances other courses can be considered but only with an accompanying petition.)

Requirements for EECS Honors (2 hours)
EECS 498 Honors Research 2
(Refer to the *EECS Undergraduate Handbook* for full requirements for graduation with departmental honors.)

Mathematics (22 hours)
MATH 121 and MATH 122 Calculus I and II 10
MATH 223 Vector Calculus 3
MATH 290 Elementary Linear Algebra 2
EECS 210 Discrete Structures 4
MATH 526 Applied Mathematical Statistics I 3

Basic Science (11 hours)
PHSX 211 and PHSX 212 General Physics I and II 8
Science elective (one course, minimum of 3 hours) chosen from the following list: 3
ASTR 391, BIOL 150, BIOL 152, CHEM 184, CHEM 188, GEOG 104 **and** GEOG 105 (together count as one course), GEOG 304, GEOL 101

English (9 hours)
ENGL 101 Composition 3
ENGL 102 Critical Reading and Writing 3
ENGL 362 Foundations of Technical Writing (3) **or**
A 200-level English course (3) 3
(ENGL 362 is strongly recommended as the third course when enrollment is possible.)

Communication (3 hours)
COMS 130 Speaker-Audience Communication 3

Ethics (3 hours)
PHIL 375 Moral Issues in Computer Technology 3

Humanities/Social Science Electives (18 hours)
Three humanities courses selected from at least two different departments .. 9
Three social sciences courses selected from at least two different departments ... 9
Selection options are the same as for electrical engineering.

Professional Electives (3 hours)
To be taken from the list of approved technical, scientific, and professional courses (same as for electrical engineering) 3

Credit for ROTC Courses. Up to 6 hours of ROTC may be petitioned to count toward the professional elective requirement.

Credit for Foreign Language. Foreign language courses (other than English or a student's native language) may be used for up to 6 credit hours of humanities/social sciences electives.

Professional Opportunities. Computer scientists may pursue the design, analysis, and implementation of computer algorithms; study the theory of programming methods and languages; or design and develop software systems. They also may work in artificial intelligence, database systems, parallel and distributed computation, human-computer interaction, computer graphics, operating systems, or computer systems analysis and administration. Computer scientists work for software companies, computer systems analysis, government and defense, telecommunications, or consulting firms.

■ Electrical Engineering and Computer Science Courses

EECS 128 Foundations of Information Technology: _____ (3). NM Introduction to information technology and the computer as a general tool processing information. Topics include internet tools (including browsers, search engines and Web page construction), networking, computer organization, algorithms, programming languages, data representation and manipulation, binary numbers and Boolean logic, system and application software (including word processors, spreadsheets and presentation software), operating systems, databases, artificial intelligence, social and ethical issues in computing, information security, and mobile computing. Prerequisite: MATH 101 or MATH 104 or eligibility to enroll in MATH 115 or MATH 121. LEC

EECS 138 Introduction to Computing: _____ (3). NM Algorithm development, basic computer organization, syntax and semantics of a high-level programming language, including testing and debugging. Concept of structure in data and programs, arrays, top-down design, subroutines and library programs. Abstract data types. System concepts such as compilation and files. Nature and scope of computer science. Not open to students who have taken EECS 805. Prerequisite: MATH 101 or MATH 104, or meeting the requirements to enroll in MATH 115 or MATH 121. LEC

EECS 140 Introduction to Digital Logic Design (4). An introductory course in digital logic circuits covering number representation, digital codes, Boolean Algebra, combinatorial logic design, sequential logic design, and programmable logic devices. Corequisite: MATH 104. LEC

EECS 141 Introduction to Digital Logic: Honors (4). An introductory course in digital logic circuits covering number representation, digital codes, Boolean algebra, combinatorial logic design, sequential logic design, and programmable logic devices. This course is intended for highly motivated students and includes honors-level assignments. Co-requisite: MATH 121, plus either acceptance into the KU Honors Program or consent of instructor. LEC

EECS 168 Programming I (4). Problem solving using a high level programming language and object oriented software design. Fundamental stages of software development are discussed: problem specification, program design, implementation, testing, and documentation. Introduction to programming using an object oriented language: using classes, defining classes, and extending classes. Introduction to algorithms and data structures useful for problem solving: arrays, lists, files, searching, and sorting. Student will be responsible for designing, implementing, testing, and documenting independent programming projects. Professional ethics are defined and discussed in particular with respect to computer rights and responsibilities. Corequisite: MATH 104. LEC

EECS 169 Programming I: Honors (4). Problem solving using a high level programming language and object oriented software design. Fundamental stages of software development are discussed: problem specification, program design, implementation, testing, and documentation. Introduction to programming using an object oriented language: using classes, defining classes, extending classes. Introduction to algorithms and data structures useful for problem solving: arrays, lists, files, searching, and sorting. Students will be responsible for designing, implementing, testing, and documenting independent programming projects. Professional ethics are defined and discussed in particular with respect to computer rights and responsibilities. This course is intended for highly motivated students and includes honors-level assignments. Co-requisite: MATH 121, plus either acceptance into the KU Honors Program or consent of instructor. LEC

EECS 210 Discrete Structures (4). Mathematical foundations including logic, sets and functions, general proof techniques, mathematical induction, sequences and summations, number theory, basic and advanced counting techniques, solution of recurrence relations, equivalence relations, partial order relations, lattices, graphs and trees, algorithmic complexity, and algorithm design and analysis. Throughout there will be an emphasis on the development of general problem solving skills including algorithmic specification of solutions and the use of discrete structures in a variety of applications. Prerequisite: EECS 168 or 169 (or equivalent) and MATH 122. LEC

EECS 211 Circuits I (3). Analysis of linear electrical circuits: Kirchoff's laws; source, resistor, capacitor and inductor models; nodal and mesh analysis; network theorems; transient analysis; Laplace transform analysis; steady-state sinusoidal analysis; computer-aided analysis. Prerequisite: Co-requisite: Math 220 and MATH 290. LEC

EECS 212 Circuits II (4). Continued study of electrical circuits: Steady-state power analysis, three-phase circuits, transformers, frequency response, and two-port network analysis. Prerequisite: EECS 211. LEC

EECS 220 Electromagnetics I (4). Vector analysis. Electrostatic and magnetostatic fields in a vacuum and material media. Electromagnetic fields and Maxwell's equations for time-varying sources. The relationship between field and circuit theory. Simple applications of Maxwell's equations. Prerequisite: MATH 220, MATH 290, PHSX 211, and EECS 211. LEC

EECS 268 Programming II (4). This course continues developing problem solving techniques by focusing on the imperative and object-oriented styles using Abstract Data Types. Basic data structures such as queues, stacks, trees, and graphs will be covered. Recursion. Basic notions of algorithmic efficiency and performance analysis in the context of sorting algorithms. Basic Object-Oriented techniques. An associated laboratory will develop projects reinforcing the lecture material. Three class periods and one laboratory period per week. Prerequisite: EECS 168 or EECS 169. LEC

EECS 312 Electronic Circuits I (3). Introduction to diodes, BJTs and MOSFETs, and their use in electronic circuits, especially digital circuits. Prerequisite: Upper-level eligibility. Corequisite: EECS 212. LEC

EECS 315 Electric Circuits and Machines (3). Introduction to DC and AC electrical circuit analysis techniques, AC power calculations, transformers, three-phase systems, magnetic circuits, and DC and AC machines with a focus on applications. Not open to electrical or computer engineering majors. Prerequisite: A course in differential equations and eight hours of physics. LEC

EECS 316 Circuits, Electronics, and Instrumentation (3). Introduction to DC and AC electrical circuit analysis, operational amplifiers, semiconductors, digital circuits and systems, and electronic instrumentation and measurements with a focus on applications. Not open to electrical or computer engineering majors. Students may not receive credit for both EECS 316 and EECS 317. Prerequisite: A course in differential equations and eight hours of physics. LEC

EECS 317 Electronics and Instrumentation (2). Introduction to operational amplifiers, semiconductors, digital circuits and systems, and electronic instrumentation and measurements with a focus on applications. Not open to electrical or computer engineering majors. Students may not receive credit for both EECS 316 and EECS 317. Prerequisite: EECS 315. LEC

EECS 318 Circuits and Electronics Lab (1). Laboratory exercises intended to complement EECS 315, EECS 316 and EECS 317. Experiments include DC circuits, analog electronics, and digital electronics. Not open to electrical or computer engineering majors. Co-requisite: EECS 316 or EECS 317. LAB

EECS 360 Signal and System Analysis (4). Fourier signal analysis (series and transform); linear system analysis (continuous and discrete); Z-transforms; analog and digital filter analysis. Analysis and design of continuous and discrete time systems using MATLAB. Prerequisite: EECS 212 and upper level EECS eligibility. LEC

EECS 368 Programming Language Paradigms (3). The course is a survey of programming languages: their attributes, uses, advantages, and disadvantages. Topics include scopes, parameter passing, storage management, control flow, exception handling, encapsulation and modularization mechanism, reusability through genericity and inheritance, and type systems. In particular, several different languages will be studied which exemplify different language philosophies (e.g., procedural, functional, object-oriented, logic, scripting). Prerequisite: EECS 268 and upper-level EECS eligibility. LEC

EECS 388 Computer Systems and Assembly Language (4). Internal organization of microprocessor and microcontroller systems; programming in assembly language; input and output system; controlling external devices. The course will focus on one or two specific microprocessors and computer systems. Prerequisite: EECS 140 or EECS 141, EECS 168 or EECS 169, and upper-level EECS eligibility. LEC

EECS 399 Projects (1-5). An electrical engineering, computer engineering, or computer science project pursued under the student's initiative, culminating in a comprehensive report, with special emphasis on orderly preparation and effective composition. Prerequisite: Upper-level EECS eligibility and consent of instructor. IND

EECS 412 Electronic Circuits II (4). Discrete and integrated amplifier analysis and design. Introduction to feedback amplifier analysis and design. Introduction to feedback amplifiers. Prerequisite: EECS 312 and upper-level EECS eligibility. LEC

EECS 420 Electromagnetics II (4). This course applies electromagnetic analysis to high frequency devices and systems where wave propagation effects cannot be neglected. Topics covered include transmission lines, space waves, waveguides, radiation, and antennas. Laboratory experiments include transmission line, waveguide, and antenna measurements and characterizations. 3 hours lecture, 1 hour laboratory. Prerequisite: EECS 220 and upper-level EECS eligibility. LEC

EECS 443 Digital Systems Design (4). The design of computer systems from hardware point of view. The implementation of functional and control units. Introduction to VHDL, and its use in modeling and designing digital systems. Prerequisite: EECS 388. LEC

EECS 444 Control Systems (3). An introduction to the modeling, analysis, and design of linear control systems. Topics include mathematical models, feedback concepts, state-space methods, time response, system stability in the time and transform domains, design using PID control and series compensation, and digital controller implementation. Prerequisite: EECS 212 and EECS 360. LEC

EECS 448 Software Engineering I (4). This course is an introduction to software engineering, and it covers the systematic development of software products. It outlines the scope of software engineering, including life-cycle models, software process, teams, tools, testing, planning, and estimating. It concentrates on requirements, analysis, design, implementation, and maintenance of software products. The laboratory covers CASE tools, configuration control tools, UML diagrams, integrated development environments, and project specific components. Prerequisites: EECS 268 and upper-level EECS eligibility. LEC

EECS 461 Probability and Statistics (3). Introduction to probability and statistics with applications. Reliability of systems. Discrete and continuous random variables. Expectations, functions of random variables and linear regression. Sampling distributions, confidence intervals, and hypothesis testing. Joint, marginal, and conditional distributions and densities. Prerequisites: MATH 290, MATH 220, and upper-level EECS eligibility. LEC

EECS 470 Electronic Devices and Properties of Materials (3). An introduction to crystal structures, and metal, insulator, and semiconductor properties. Topics covered include the thermal, electric, dielectric, and optical properties of these materials. A significant portion of this course is devoted to the properties of semiconductors and semiconductor devices. Prerequisite: PHSX 313 and upper-level EECS eligibility. LEC

KU's total research expenditures in fiscal year 2007 for all projects, including sponsored research, training, and service grants in all fields, were $289 million.

EECS 498 Honors Research (1-2). Arranged to allow students to satisfy the independent research requirement for graduation with departmental honors. Prerequisite: Consent of instructor and upper-level EECS eligibility. IND

EECS 501 Senior Design Laboratory I (3). A lecture/laboratory course involving the design and implementation of prototypes of electrical and computer type products and systems. The project specifications require consideration of ethics, economics, manufacturing, and safety. 2 hours lecture, 1 hour laboratory. Prerequisite: EECS 420. Corequisite: EECS 412. LEC

EECS 502 Senior Design Laboratory II (3). A lecture/laboratory course involving the design and implementation of prototypes of electrical and computer type products and systems. The project specifications require consideration of ethics, economics, health, manufacturing, and safety. Prerequisite: EECS 501. LEC

EECS 510 Introduction to the Theory of Computing (3). Finite state automata and regular expressions. Context-free grammars and pushdown automata. Turing machines. Models of computable functions and undecidable problems. The course emphasis is on the theory of computability, especially on showing limits of computation. May be taken for graduate credit. (Same as MATH 510.) Prerequisite: EECS 210 and upper-level EECS eligibility. LEC

EECS 512 Electronic Circuits III (3). Feedback amplifier circuit analysis, power amplifiers, analog IC op-amp techniques and analysis, filter approximation and realization, oscillators, wave generators and shapers. Prerequisite: EECS 412. LEC

EECS 541 Computer Systems Design Laboratory I (3). A two semester lecture/laboratory course involving the specification, design, implementation, analysis, and documentation of a significant hardware and software computer system. Laboratory work involves software, hardware, and hardware/software trade-offs. Project requirements include consideration of ethics, economics, manufacturing, safety, and health aspects of product development. Can be taken only during the senior year. Prerequisite: EECS 443 and EECS 448. LEC

EECS 542 Computer Systems Design Laboratory II (3). A two semester lecture/laboratory course involving the specification, design, implementation, analysis, and documentation of a significant hardware and software computer system. Laboratory work involves software, hardware, and hardware/software trade-offs. Project requirements include consideration of ethics, economics, manufacturing, safety, and health aspects of product development. Can be taken only during the senior year. Prerequisite: EECS 541. LEC

EECS 546 Integrated Circuit Design (3). The design, analysis, simulation, and layout of integrated circuit systems using CMOS technology. Students will carry out a design from initial concept through mask layout. The use of computer aided design tools is emphasized. Prerequisite: EECS 312 and EECS 470. LEC

EECS 560 Data Structures (4). Data abstraction and abstract data types. Topics include the design and implementation of dictionary, priority queues, concatenated queue, disjoint set structures, graphs, and other advanced data structures based on balanced and unbalanced tree structures. Special emphasis will be placed on the implementations of these structures and their performance tradeoffs. Both asymptotic complexity analysis and experimental profiling techniques will be introduced. Labs will be used to provide students with hands-on experience in the implementations of various abstract data types and to perform experimental performance analysis. Prerequisites: MATH 210 and EECS 448. LEC

EECS 562 Introduction to Communication Systems (4). A first course in communications, including lectures and integrated laboratory experiments. After a review of spectral analysis and signal transmission, analog and digital communications are studied. Topics include: sampling, pulse amplitude modulation, and pulse code modulation; analog and digital amplitude, frequency, and phase modulation; frequency and time division multiplexing; and noise performance of analog modulation techniques. Prerequisite: EECS 212 and EECS 360. LEC

EECS 563 Introduction to Communication Networks (3). An introduction to the principles used in communication networks is given in this course. Topics include a discussion of the uses of communications networks, network traffic, network impairments, standards, layered reference models for organizing network functions. Local Area Network technology and protocols are discussed. Link, network, transport layer protocols, and security are introduced. TCP/IP networks are stressed. VoIP is used as an example throughout the course. Basic concepts of network performance evaluation are studied, both analytical and simulation techniques are considered. Prerequisite: EECS 168 and either EECS 461 or MATH 526. LEC

EECS 580 Electrical Power Systems (3). An introductory course on electric power generation and transmission. Topics will include: electric power system components; environmental impact; renewable energy sources; power system networks and flow; synchronous generators; transformers; high voltage transmission systems; power quality; stability; blackouts. Prerequisite: EECS 212 or EECS 315 and EECS 220 or PHSX 212. LEC

EECS 611 Electromagnetic Compatibility (3). A study of unwanted generation and reception of radio-frequency radiation from analog and digital electronic systems and how these emissions/receptions can be reduced. Topics covered include sources of radiation, grounding, shielding, crosstalk, electrostatic discharge, and practical design and layout schemes for reducing unwanted radiation and reception. Also covered are the major governmental electromagnetic compatibility (EMC) regulations and standards that apply to commercial electronic devices and systems. Prerequisite: EECS 220 and EECS 312. LEC

EECS 622 Microwave and Radio Transmission Systems (3). Introduction to radio transmission systems. Topics include radio transmitter and receiver design, radiowave propagation phenomenology, antenna performance and basic design, and signal detection in the presence of noise. Students will design radio systems to meet specified performance measure. Corequisite: EECS 420 and EECS 461. LEC

EECS 628 Fiber-optic Communication Systems (3). Description and analysis of the key components in optical communication systems. Topics covered include quantum sources, fiber cable propagation and dispersion characteristics, receiver characteristics, and system gain considerations. Prerequisite: EECS 220 and PHSX 313 or equivalent and upper-level EECS eligibility. LEC

EECS 638 Fundamentals of Expert Systems (3). Basic information about expert systems: architecture of an expert system, building expert systems, uncertainty in expert systems, taxonomy of expert systems. Knowledge representation: first order logic, production systems, semantic nets, frames. Uncertainty in expert systems, one-valued approaches: probability theory, systems using Bayes' rule, and systems using certainty theory; two-valued approaches: systems using Dempster-Shafer theory and system INFERNO; set-valued approaches: systems using fuzzy set theory and systems using rough set theory. Prerequisite: EECS 560 or consent of instructor. LEC

EECS 643 Advanced Computer Organization (3). Principles and techniques of instruction level parallelism, Tomasulo's algorithm, branch prediction, reservation stations, recorder buffers, memory hierarchies. Parallel and scalable architectures, global directory caches, synchronization primitives, memory consistency, multithreading. Only one of EECS 643 and EECS 645 may be used to satisfy EECS degree requirements. Prerequisite: EECS 443. LEC

EECS 644 Introduction to Digital Signal Processing (3). Discrete time signal and systems theory, sampling theorem, z-transforms, digital filter design, discrete Fourier transform, FFT, and hardware considerations. Prerequisite: EECS 360. LEC

EECS 645 Computer Architecture (3). The structure and design of computing systems. Examination and analysis of computing systems. Examination and analysis of instruction set architectures, pipelined control and arithmetic units, vector processors, memory hierarchies, and performance evaluation. Prerequisite: EECS 388. LEC

EECS 647 Introduction to Database Systems (3). Introduction to the concept of databases and their operations. Basic concepts, database architectures, storage structures and indexing, data structures: hierarchical, network, and relational database organizations. Emphasis on relational databases and retrieval languages SQL, QBE, and ones based on relational algebra and relational calculus; brief description of predicate calculus. Theory of databases, normal forms, normalization, candidates keys, decomposition, functional dependencies, multi-valued dependencies. Introduction to the design of a simple database structure and a data retrieval language. Student cannot receive credit for both EECS 647 and EECS 746. Prerequisite: EECS 448. LEC

EECS 648 Software Engineering Tools (3). This course focuses on the software engineering tools and practices currently in use in the industry, supporting the complete software development lifecycle. The course provides hands-on experience with current software development tools. Topics include software engineering artifacts, team structure and roles, work contracts, requirements elicitation and analysis, specifications, supplementary specifications, use-case models, activity diagrams, use-case specifications, traceability, technical design, design review meetings, coding standards, code quality, code reviews, and modern software engineering tools. Prerequisite: EECS 448. LEC

EECS 649 Introduction to Artificial Intelligence (3). General concepts, search procedures, two-person games, predicate calculus and automated theorem proving, nonmonotonic logic, probabilistic reasoning, rule based systems, semantic networks, frames, dynamic memory, planning, machine learning, natural language understanding, neural networks. Corequisite: EECS 368. LEC

EECS 660 Fundamentals of Computer Algorithms (3). Basic concepts and techniques in the design and analysis of computer algorithms. Models of computations. Simple lower bound theory and optimality of algorithms. Computationally hard problems and the theory of NP-Completeness. Introduction to parallel algorithms. Prerequisite: EECS 560 and either EECS 461 or MATH 526. LEC

EECS 662 Programming Languages (3). Formal definition of programming languages including specification of syntax and semantics. Simple statements including precedence, infix, prefix, and postfix notation. Global properties of algorithmic languages including scope of declaration, storage allocation, grouping of statements, binding time of constituents, subroutines, coroutines, and tasks. Run-time representation of program and data structures. Prerequisite: EECS 368 and EECS 388 and EECS 560. LEC

EECS 665 Compiler Construction (4). Compilation of simple expressions and statements. Organization of a compiler including symbol tables, lexical analysis, syntax analysis, intermediate and object code generation, error diagnostics, code optimization techniques and run-time structures in a block-structured language such as PASCAL or C. Programming assignments include using tools for lexer and parser generator, and intermediate, and object code generation techniques. Laboratory exercises will provide hands-on experience with the tools and concepts required for the programming assignments. Prerequisites: EECS 368, EECS 448, EECS 510. LEC

EECS 670 Introduction to Semiconductor Processing (3). An overview of various processes to fabricate semiconductor devices and integrated circuits. Topics covered include crystal growth, oxidation, solid-state diffusion, ion implantation, photolithography, chemical vapor deposition, epitaxial growth, metalization, and plasma etching of thin films. (Same as C&PE 655.) Prerequisite: Senior standing in C&PE or EECS, or consent of instructor. LEC

EECS 672 Introduction to Computer Graphics (3). Foundations of 2D and 3D computer graphics. Structured graphics application programming. Basic 2D and 3D graphics algorithms (modeling and viewing transformations, clipping, projects, visible line/surface determination, basic empirical lighting, and shading models), and aliasing. Prerequisite: EECS 448. LEC

EECS 678 Introduction to Operating Systems (4). The objective of this course is to provide the students with the concepts necessary to enable them to: a) identify the abstract services common to all operating systems, b) define the basic system components that support the operating system's machine independent abstractions on particular target architectures, c) consider how the design and implementation of different systems components interact and constrain one another, not merely how

one or two important parts work in isolation, and d) understand the means by which fundamental problems in operating systems can be analyzed and addressed. Programming assignments address topics including process creation, inter-process communication, system call implementation, process scheduling and virtual memory. Laboratory exercises primarily focus on use of tools and concepts required for the programming assignments but include a small number of independent topics. Prerequisites: EECS 388 either EECS 448. LEC

EECS 690 Special Topics: _____ (1-3). Arranged as needed to present appropriate material to groups of students. May be repeated for additional credit. Prerequisite: Upper-level EECS eligibility and consent of instructor. LEC

EECS 692 Directed Reading (1-3). Reading under the supervision of an instructor on a topic chosen by the student with the advice of the instructor. May be repeated for additional credit. Consent of the department required for enrollment. Prerequisite: Upper-level EECS eligibility and consent of instructor. IND

EECS 700 Special Topics: _____ (1-5).

EECS 710 Information Security and Assurance (3).

EECS 711 Security Management and Audit (3).

EECS 712 Network Security (3).

EECS 713 High-speed Digital Circuit Design (3).

EECS 716 Formal Language Theory (3).

EECS 718 Graph Algorithms (3).

EECS 720 Electromagnetics for Communications and Radar (3).

EECS 721 Antennas (3).

EECS 722 Mathematical Logic (3).

EECS 723 Microwave Engineering (3-4).

EECS 725 Introduction to Radar Systems (3).

EECS 728 Fiber-optic Measurement and Sensors (3).

EECS 730 Introduction to Bioinformatics (3).

EECS 735 Automated Theorem Proving (3).

EECS 737 Computational Genomics (3).

EECS 738 Machine Learning (3).

EECS 739 Scientific Parallel Computing (3).

EECS 740 Digital Image Processing (3).

EECS 741 Computer Vision (3).

EECS 742 Digital Video for Multimedia Systems (3).

EECS 743 Static Analysis (3).

EECS 744 Digital Signal Processing I (3).

EECS 745 Implementation of Networks (3).

EECS 746 Database Systems (3).

EECS 747 Mobile Robotics (3).

EECS 749 Knowledge-based Systems (3).

EECS 750 Advanced Operating Systems (3).

EECS 752 Concurrent Software Systems (3).

EECS 753 Embedded and Real Time Computer Systems (3).

EECS 755 Software Modeling and Analysis (3).

EECS 761 Programming Paradigms (3).

EECS 762 Programming Language Foundation I (3).

EECS 763 Introduction to Multiprocessor Systems on Chip (3).

EECS 764 Analysis of Algorithms (3).

EECS 766 Resource Sharing for Broadband Access Networks (3).

EECS 767 Information Retrieval (3).

EECS 773 Advanced Graphics (3).

EECS 774 Geometric Modeling (3).

EECS 775 Visualization (3).

EECS 780 Communication Networks (3).

EECS 781 Numerical Analysis I (3).

EECS 782 Numerical Analysis II (3).

Engineering

No undergraduate program is offered in this area, but some ENGR courses may be taken to count toward undergraduate degrees in engineering.

Engineering Courses

ENGR 108 Introduction to Engineering (2). An introductory level course with emphasis on engineering problem definition, methods simulation, and solution, including approaches to engineering design; engineering units and terminology; engineering disciplines and career areas, and engineering code of ethics. LEC

ENGR 180 Introduction to Naval Ships Systems I (3). The concept of weapons systems and the systems approach are explored. The techniques of linear analysis of ballistics and weapons are introduced. The dynamics of the basic components of weapons control systems are investigated and stated as transfer functions. This course provides the tools for the future development in the student's understanding of the basic principles that underlie all modern naval weapons systems. Approved for degree credit in the College of Liberal Arts and Sciences effective fall 1971. Such courses count within the limit of 25 hours accepted from other schools and divisions. (Same as NAVY 180.) Prerequisite: MATH 002. LEC

ENGR 184 Introduction to Naval Ships Systems II (3). The concept of weapons systems and the systems approach are explored. The techniques of linear analysis of ballistics and weapons are introduced. The dynamics of the basic components of weapons control systems are investigated and stated as transfer functions. This course provides the tools for the future development in the student's understanding of the basic principles that underlie all modern naval weapons systems. Approved for degree credit in the College of Liberal Arts and Sciences effective Fall 1971. Such courses count within the limit of 25 hours accepted from other schools and divisions. (Same as NAVY 184.) LEC

ENGR 300 Cooperative Engineering Education Experience (1). Engineering work experience with a recognized engineering organization. The work must be professional in nature and not merely routine. A final summary report must be submitted to the student's major department at the conclusion of each continuous period of employment and may cover more than one sequential semester or summer session. Credit for this course cannot be used toward graduation requirements. Prerequisite: Permission of major department. FLD

ENGR 301 Navigation and Operations I (3). First semester juniors. Three hours classroom and two and one-half hours laboratory per week. A comprehensive study of the theory, principles, and procedures of ship navigation in coastal and open ocean environment. Includes piloting, triangulation, ocean and tidal currents, navigational astronomy, spherical trigonometry, sight reduction, publications and logs; an introduction to electronic navigation, including theory of wave propagation, hyperbolic and azimuthal systems, doppler, inertial, and satellite systems. (Same as NAVY 300.) LEC

ENGR 304 Technology: Its Past and Its Future (3). An examination of the role of technology and its influence on society. The historical development of technology will be traced up to modern times with an emphasis on its relations to the humanities. Attention will be given to the future of different branches of technology and alternative programs for their implementation. (Same as HIST 404.) LEC

ENGR 305 Navigation and Operations II (3). Second semester juniors. Three hours classroom and two and one-half hours laboratory per week. A study of laws for the prevention of ship collisions; tactical formations and dispositions, relative motion, and maneuvering board. Major portion of the semester is devoted to operations research and analysis, with an introduction to discrete probability theory, game theory, measures of effectiveness, active and passive sonar equations, and review of systems analysis and cost effectiveness. (Same as NAVY 304.) Prerequisite: MATH 111 or higher. LEC

ENGR 360 Special Topics: _____ (1-5). Courses on special topics of current interest to engineers, such as ethics, engineering economics, engineering practice, communications, teamwork, and professional and career development. Prerequisite: Approval of the instructor. FLD

ENGR 504 Technical Writing for Engineers (1-3). The process of planning, organizing, initiating, drafting, and editing engineering documents. Writing, editing, and publishing the Kansas Engineer magazine. Graded on satisfactory/unsatisfactory basis. Prerequisite: ENGL 102. FLD

ENGR 515 Verbal Communications in Engineering (1). Meets one hour per week. Planning, preparing, and presenting speeches on a variety of topics throughout the semester. Includes preparing speeches, spontaneous speeches and the evaluation of speeches by other students. Prerequisite: Two English courses and at least junior or senior standing in engineering or consent of instructor. FLD

Engineering management courses are offered on the Edwards Campus, 12600 Quivira Rd., Overland Park, KS 66213-2402, phone (from Lawrence): 864-8400 or (913) 897-8400, *http://emgt.ku.edu*.

Engineering physics courses are offered in cooperation with the Department of Physics and Astronomy in the College of Liberal Arts and Sciences.