EECS Department Undergraduate Handbook

Bachelor of Science Degrees in:

ELECTRICAL ENGINEERING
COMPUTER ENGINEERING
COMPUTER SCIENCE

For students admitted
to the EECS Department in Fall 2006

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Electrical Engineering and Computer Science
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THE UNIVERSITY OF KANSAS
School of Engineering

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School of Engineering

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Is engineering or Computer Science for me?

To find out, ask yourself:

- Do I like to design and build things?
- Am I a creative thinker who likes to solve complex problems?
- Do I enjoy math and science?
- Am I curious about how things work?
- Am I precise in my work and study habits?
- Do I budget my time so I can finish all the work required of me?
- Do I have a history of performing well academically?
- Am I ready to enter a demanding curriculum?

What degrees are offered?

The School of Engineering offers Bachelor of Science (BS) degrees in 10 disciplines. They are aerospace engineering, architectural engineering, chemical engineering, civil engineering, computer engineering, computer science, electrical engineering, engineering physics, mechanical engineering, and petroleum engineering.

What can I do with an engineering or computer science degree?

Whatever your major, you will find many job opportunities. Most KU graduates earn more than the national average starting salary. Many companies and governmental agencies are aware of the high quality of KU graduates, so they are eager to hire them and pay premium salaries. The School's Career Services Center will help put you in touch with potential employers. The Center schedules interviews and conducts workshops on resumes, interviewing, and searching for either permanent or summer jobs.

What is the faculty like?

Engineering faculty members are nationally recognized leaders in education and research. KU faculty members are leaders in many engineering societies. Their work is widely published in professional journals. You will get the chance to interact with faculty members outside the classroom and lab. Engineering faculty members participate in a variety of activities with students.

Why is there an engineering fee?

You will pay a special fee in addition to regular tuition and fees for School of Engineering courses. The fee, which is on a per-credit-hour basis for all School of Engineering courses, helps the School maintain and operate lab equipment and computers and provide other student services. Because you will tend to take more School of Engineering courses each semester as you advance, the fee you pay will tend to increase each year.

How do I get into the School?

First-year students may enter the School of Engineering, but admission is selective. Applications are judged on several factors including, but not limited to, high school record, scores on national tests, academic record at college or

university level, and trend of grades. High school transcripts and ACT scores are required. Equivalent SAT scores may be substituted.
You must have graduated in the top half of your high school class and have a mathematics score of 28 or higher on the ACT exam (or be otherwise eligible to take Math 121) to be directly admitted into the EECS Department. You should take a standard college-preparatory curriculum in high school, including courses in chemistry, economics, English, physics, and mathematics (through trigonometry). If you already have some college credits and you have a cumulative grade-point average of 2.5 or higher, you may qualify to transfer into the School of Engineering.

Transfer Admission Standards

All applications from transfer students either from other KU units or from other institutions are evaluated on a case-by-case basis.

In general, students with grade-point averages under 2.5 are not considered for admission. Students must submit mathematics ACT or SAT scores or proof of competence in calculus for consideration.

Can I get a scholarship?

The School of Engineering offers scholarships to incoming freshman and transfer students with outstanding academic credentials. Entering first-year students should submit KU's Undergraduate Application for Admission and Scholarships, available online at *www.admissions.ku.edu*, to the University of Kansas Office of Admissions and Scholarships, KU Visitor Center, 1520 Iowa St., Lawrence, KS 66045, (785)864-3911. The office will see that applicants are considered for any scholarships for which they are eligible. The application deadline to be considered is January 15.

The Engineering Diversity Program also makes scholarships available to students who are African American, Hispanic American or Native American. Call the Diversity Director at 785/864-3620 for more information.

For more information about grants, loans, and other need-based financial aid, write or call the University of Kansas Office of Student Financial Aid, 50 Strong Hall, Lawrence, KS 66045-1920, 785/864-4700 or visit their website at *www.ku.edu/~osfa*.

Where can I get more information?

Write or call the University of Kansas School of Engineering, Robert Sorem, Associate Dean, 1520 West 15th Street, 1 Eaton Hall, Lawrence, KS 66045, (785)864-3881; or visit the website at *www.engr.ku.edu*.

With so many engineering and computer science programs available, why choose KU?

- **Program Quality**
  KU's undergraduate engineering programs are accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (EAC/ABET). The computer science program is accredited by the Computing Accreditation Commission of ABET.
- **Your Overall Education**
  The overall quality and breadth of your education is one great reason for coming to KU. The College of Liberal Arts and Sciences offers hundreds of courses and has excellent teachers. You will meet many international students and teachers who bring a cultural richness to campus and who will expose you to the diverse viewpoints and customs so important to your undergraduate education.
- **Student Organizations**
  Students can supplement and advance their academic programs by participating in student chapters of national engineering and computer science societies. The School has active support groups for women and minority students, and all student groups can participate in the annual Engineering Exposition, creating exhibits that describe and demonstrate principles of engineering and computer science.

Research Opportunities

Undergraduates can participate in KU's top-flight research programs in computer-aided aircraft design, architectural lighting and visibility, enhanced oil recovery, structural mechanics and stress analysis, telecommunications and information science, radar remote sensing, computer-integrated manufacturing, automatic control systems, and other fields.

Electrical Engineering and Computer Science

Costas Tsatsoulis, Chair

The technological advances that have made our modern 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 communications, cellular telephones, 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), home entertainment products, radar, defense electronics, artificial intelligence, and a wide variety of computer software.

The EECS Department offers three Bachelor of Science degrees: Electrical Engineering (BSEE), Computer Engineering (BSCoE), and Computer Science (BSCS). Each features a firm grounding in the fundamentals of mathematics, basic science, and computer science and/or engineering science, with advanced studies in the theory and design of systems of various kinds, as well as hands-on experience. All degree programs are accredited.

Electrical engineers work with a broad range of electrical and electronic devices and systems. Electrical engineers may work in the areas of circuit design, electronic devices, electrical and optical communications, control and automation, electromagnetics, instrumentation, energy and power, or signal processing. 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.

Electrical engineers find professional opportunities in a multitude of environments and locations both in this country and abroad. Many opportunities are obvious, such as the telecommunications and computer industries, but there are many other employers who need electrical engineers. For example, industries using technology seek the expertise of electrical engineers for developing microelectronic integrated circuits, electrical and electronic consumer products, electrical power generation and distribution, industrial instrumentation and control systems, and radar. Electrical engineers also provide expertise for incorporating equipment for communication, computer-aided manufacturing, control, and data acquisition.

Computer engineers focus on all aspects of computational devices and systems, including both hardware and software. Wherever computers can be found, computer engineers are needed. In addition to the computer system aspects of the electrical engineering and computer science areas listed, computer engineers may work in the areas of computer elements and architectures, very large scale integrated (VLSI) circuits for data processing and storage, embedded and real-time computer systems, or computer networking.

Computer engineering graduates can expect to find jobs in digital hardware design, software engineering, computer communications, the integration of hardware and software, and in developing microprocessors, personal computers, workstations, mainframe computers, software, and computer networks. As more industries come to rely on computers to carry out office automation, communications, manufacturing and robotics, process control, computer-aided design, and computer manufacturing, the demand for engineers to design and implement such systems will continue to rise.

Computer scientists focus on the theory and practice of computing. They may pursue the design, analysis, and implementation of computer algorithms, study the theory of programming methods and languages, or design and develop new programming languages and software systems. Computer scientists may also work in the areas of artificial intelligence, database systems, parallel and distributed computation, human-computer interaction, computer graphics, operating systems, or computer systems analysis.

Computer science graduates find jobs in a variety of industrial and governmental settings. As computer hardware and communications technologies have advanced, an explosive demand has emerged for software systems to exploit the ever-increasing potential. The need for software system design, development, and maintenance is not restricted to those companies whose main business is software development. Virtually every major company and governmental agency has found the need to develop and maintain specialized software for specific purposes. This trend is sure to continue in the future.

Career opportunities for electrical engineers, computer engineers, and computer scientists are available in many areas of specialization, in many industrial, commercial, academic, and government environments, and in many geographic locations in this country and abroad. Expertise in electrical engineering, computer engineering, and computer science is of vital importance to any high technology organization. Many such organizations actively recruit majors in all three disciplines. In addition, a Bachelor of Science degree in one of these three areas prepares a student for continued studies in graduate school or in other professional schools such as medicine or law.

The pages that follow outline the degree requirements for the BSEE, BSCoE, and the BSCS degrees.

Vision

The Vision of the EECS Department is to provide a stimulating and challenging intellectual environment:

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

Mission

The Mission of the EECS Dept. 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

Common Degree Requirements

Natural Science Electives

Courses satisfying natural science electives CS and CoE majors must be chosen from the following list: ASTR 391, BIOL 150, BIOL 152, CHEM 184, CHEM 188, GEOG (104+105), GEOG 304 or GEOL 101. To count as one elective both GEOG 104 and 105 must be taken.

General Electives

All majors may choose classes from the following list of approved technical, scientific, and professional classes:

- EECS: Any course except EECS 100, EECS 128, EECS 138, EECS 315, EECS 316, EECS 317, EECS 318, and EECS 498. Also, EECS 645 may not be used by CoE majors, EECS 461 may not be used by CS majors, and only one of EECS 643 and EECS 645 may be used to satisfy EE degree requirements.
- Engineering: Any course from any Engineering Department numbered 200 or above, except for ENGR 300, ENG 504, ME 208, ME 228 and CE 390.
- Natural Science: Any course designated as NB, NE, or NP by CLAS except PHSX 111, PHSX 112, PHSX 114, PHSX 115, PHSX 212 and CHEM 125 (if CHEM 184 or its equivalent was taken for Basic Science). If a science course used for the science elective exceeds the required science elective hours, then excess hours will be considered general elective hours.
- Math: Any MATH course numbered 500 or above, except MATH 701.
- Business: Any course from the School of Business, except statistics and computing.

Humanities/Social Science Electives

Humanities and Social Science (H/SS) Electives must be selected from the list of Principal Courses (or Honors Principal Courses) in the Humanities and Social Sciences. This list is found in the College of Liberal Arts and Sciences section of the Undergraduate Catalog. Any course designated "H" (humanities) or "S" (social sciences) which has a principal course as a prerequisite is also acceptable. Foreign language courses (other than English or a student's native language) may be used for up to 6 credit hours of H/SS electives. Additionally, all western civilization (HWC) courses and non-western culture courses (see Undergraduate Catalog) can count as humanities (H) courses.

Senior Electives

EE and CoE majors may choose any EECS course 400 or above. Also, EECS 645 may not be used by CoE majors, and only one of EECS 643 and EECS 645 may be used to satisfy EE degree requirements.

For CS Majors, EECS 638, 647,648, 649, 663, 665, 672, 690 and any EECS course 700 or above.

Under unusual circumstances other courses can be petitioned as Senior Electives, subject to departmental approval.

Departmental Honors

A student may graduate with departmental honors in any of the three majors by satisfying the requirements below. Most of the requirements for graduation with Honors are completed during the final two semesters of the program.

1. The student must file an application to graduate with Departmental Honors during the semester preceding the student's final two semesters (a summer semester may count as one of these). This must be done prior to enrolling in any EECS 498 course (see step 3 below). These forms are available in 2001Eaton Hall. Applicants must have an overall GPA of 3.25 or higher and an engineering GPA of 3.5 or higher. Applicants must identify a research topic and obtain consent of a faculty member to supervise the Honors research.
2. Applicants who receive preliminary approval must remain enrolled full-time and must maintain the above minimum cumulative overall and engineering GPAs until graduation.
3. Applicants who receive preliminary approval must enroll in EECS 498: Honors Research for one credit hour for his/her last two semesters (a summer semester may count as one of theses) under the supervision of the faculty member named in the Honors application. These credits are in addition to those required for the degree.
4. The student must complete an independent research project paper and oral presentation to a panel of three faculty members, including the research supervisor. This panel makes the recommendation concerning graduating with honors.

Electrical Engineering

Electrical engineers work with a broad range of electrical and electronic devices and systems. Electrical engineers may work in the areas of circuit design, electronic devices, electrical and optical communications, control and automation, electromagnetics/antennas/radar, instrumentation, energy and power, or signal processing. 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.

Program Educational Objectives for Electrical Engineering

As Electrical Engineers, BSEE graduates of The University of Kansas within three to five years following graduation:

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

Requirements for the degree of Bachelor of Science in Electrical Engineering

A total of 128 credit hours is required for the BSEE degree, as follows:

Electrical Engineering (63 credit hours)

EECS	140	Introduction to Digital Logic Design ♦	4
EECS	168	Programming I ♦	4
EECS	211	Circuits I	3
EECS	212	Circuits II	4
EECS	312	Electronic Circuits I	3
EECS	360	Signal & System Analysis	4
EECS	388	Computer Systems & Assembly Language	4
EECS	412	Electronics Circuits II	4
EECS	420	Electromagnetics II	4
EECS	443	Digital Systems Design	4
EECS	444	Control Systems	3
EECS	470	Electrical Devices & Properties of Materials	3
EECS	501	Senior Design Laboratory I	3
EECS	502	Senior Design Laboratory II	3
EECS	562	Introduction to Communication Systems	4
Senior electives ✪			9

Mathematics (18 credit hours)

MATH	121	Calculus I	5
MATH	122	Calculus II	5
MATH	220	Applied Differential Equations	3
MATH	290	Elementary Linear Algebra	2
EECS	461	Probability and Statistics	3

Basic Science (17 credit hours)

CHEM	184	Chemistry I	5
PHSX	211	Physics I	4
EECS	220	Electromagnetics I	4
PHSX	313	Physics III	3
PHSX	316	Physics lab	1

General Electives (6 credit hours) ❁

General Elective 1	3
General Elective 2	3

English (6 credit hours)

ENGL	101	Composition	3
ENGL	102	Creative Reading and Writing	3

Communications Elective (3 credit hours)

One of the following courses:			3
ENGL	362	Foundations of Technical Writing	
COMS	130	Speaker-Audience Communications	

Humanities/Social Science (15 credit hours) ❖

H/SS Elective 1 (Economics):			3
ECON	142	Principles of Microeconomics (preferred) or	
ECON	144	Principles of Macroeconomics	
H/SS Elective 2			3
H/SS Elective 3			3
H/SS Elective 4			3
H/SS Elective 5			3

♦ Students with even KUIDs (7 digit) take EECS 140 in fall and EECS 168 in spring. Those with odd KUIDs (7 digit) take EECS 168 in fall and EECS 140 in spring.

❖ Humanities and Social Science Electives are selected from the list of Principal Courses in the University Undergraduate Catalog (see page 6).

❁ Six hours of General Electives are chosen from a list of natural science, math, business or engineering courses (see page 6).

✪ Nine hours of Senior Electives are chosen from EECS courses at 400 level or above (see page 6).

Electrical Engineering Suggested Course Sequence

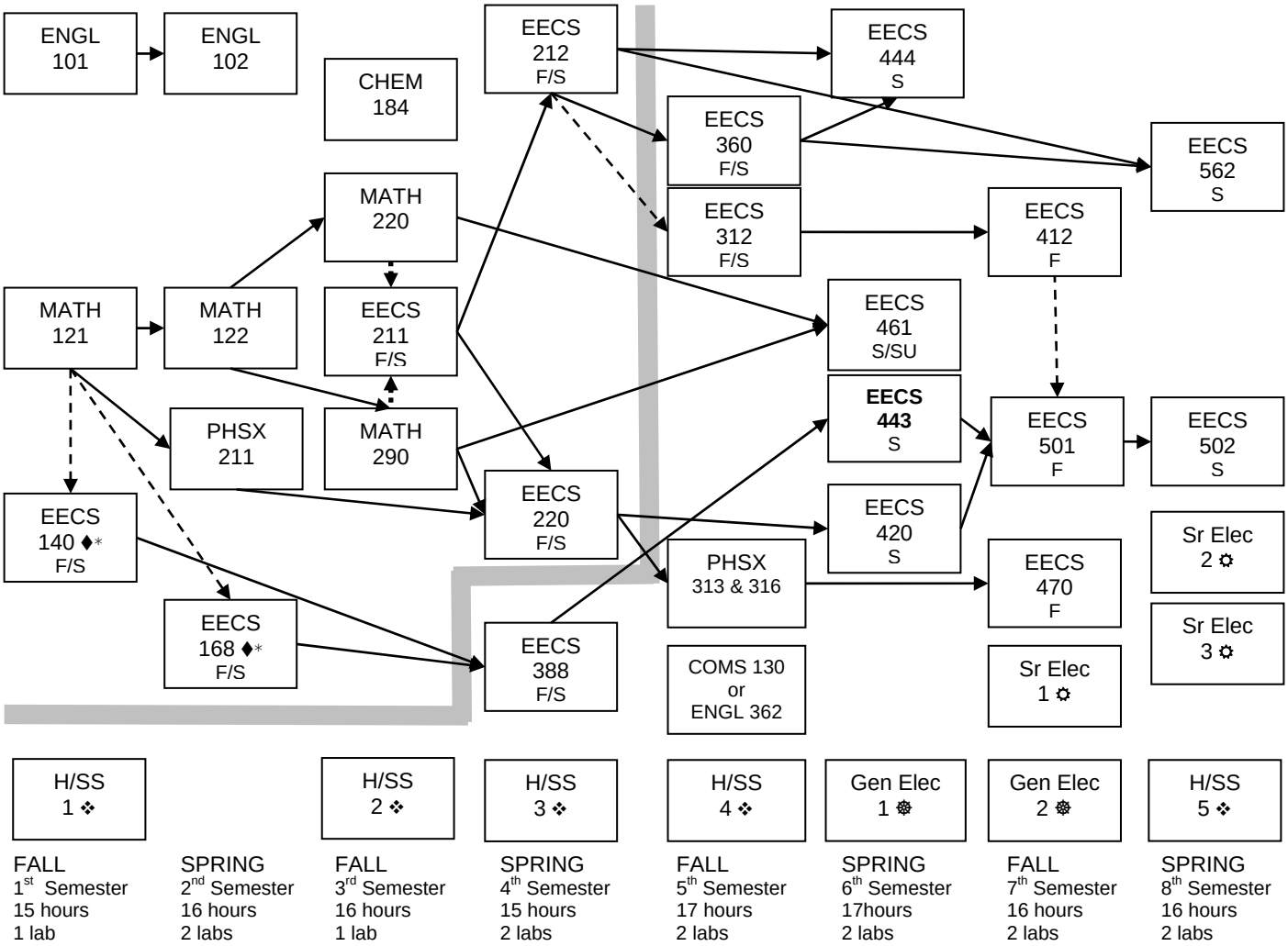
(Symbol key on previous page)

Fall 1st Semester		Spring 2nd Semester		Fall 3rd Semester		Spring 4th Semester	
				EECS 211	**3**		
ENGL 101	**3**	ENGL 102	**3**	MATH 220	**3**	EECS 212	**4**
MATH 121	**5**	MATH 122	**5**	MATH 290	**2**	EECS 220	**4**
EECS 140 or 168 ♦	**4**	PHSX 211	**4**	CHEM 184	**5**	EECS 388	**4**
H/SS 1 ❖	**3**	EECS 168 or 140 ♦	**4**	H/SS 2 ❖	**3**	H/SS 3 ❖	**3**
Total Hours	**15**	Total Hours	**16**	Total Hours	**16**	Total Hours	**15**

Fall 5th Semester		Spring 6th Semester		Fall 7th Semester		Spring 8th Semester	
EECS 312	**3**	EECS 420	**4**	EECS 412	**4**	EECS 502	**3**
PHSX 313 & 316	**4**	EECS 443	**4**	EECS 470	**3**	EECS 562	**4**
EECS 360	**4**	EECS 444	**3**	EECS 501	**3**	Sr. Elective 2 ✪	**3**
H/SS 4 ❖	**3**	EECS 461	**3**	Sr. Elective 1 ✪	**3**	Sr. Elective 3 ✪	**3**
COMS 130/ENGL 362	**3**	General Elective 1 ❁	**3**	General Elective 2 ❁	**3**	H/SS 5 ❖	**3**
Total Hours	**17**	Total Hours	**17**	Total Hours	**16**	Total Hours	**16**

Electrical Engineering Course Flow Chart

The following flow chart shows the prerequisite relationships among the technical portions of the BSEE program. This chart, the latest catalog, and your advisor should be consulted if deviations from the suggested course sequence are contemplated.



**Assumes even KUID.*

Upper Level Eligibility Established → Prerequisite - - - → Corequisite

BSEE Requirements Checklist

Name:

Advisor:

Course	SEM.	GRADE	MATH	SCIENCE	ENG TOPICS	GENERAL ED	OTHER	TOTAL HRS
Computer & Engineering Science and Design (63 hrs)								
EECS 140 Intro to Digital Logic and Design					4			**4**
EECS 168 Programming I					4			**4**
EECS 211 Circuits I					3			**3**
EECS 212 Circuits II					4			**4**
EECS 312 Electronic Circuits I					3			**3**
EECS 360 Signal & Systems Analysis					4			**4**
EECS 388 Computer Systems & Assembly Language					4			**4**
EECS 412 Electronic Circuits I					4			**4**
EECS 420 Electromagnetics II					4			**4**
EECS 443 Digital Systems Design					4			**4**
EECS 444 Control Systems					3			**3**
EECS 470 Electronic Devices and Prop of Materials					3			**3**
EECS 501 Senior Design Lab I					3			**3**
EECS 502 Senior Design Lab II					3			**3**
EECS 562 Intro to Communication Systems					4			**4**
Senior Electives (3 classes, 9 hrs)								
EECS					3			**3**
EECS					3			**3**
EECS					3			**3**
Mathematics (18 hrs)								
MATH 121 Calculus I			5					**5**
MATH 122 Calculus II			5					**5**
MATH 220 Applied Differential Equations			3					**3**
MATH 290 Elementary Linear Algebra			2					**2**
EECS 461 Probability and Statistics			3					**3**
Basic Science (17 hrs)								
CHEM 184 Chemistry I				5				**5**
PHSX 211 General Physics I				4				**4**
EECS 220 Electromagnetics I				4				**4**
PHSX 313 General Physics III				3				**3**
PHSX 316 Physics Lab				1				**1**
General Electives (6 hrs)								
							3	**3**
							3	**3**
English, Comms., Humanities & Social Science (24 hrs)								
ENGL 101 Composition						3		**3**
ENGL 102 Creative Reading and Writing						3		**3**
COMS Elective						3		**3**
ECON 14__						3		**3**
H&SS Elective (4 classes, 12 hrs)								
						3		**3**
						3		**3**
						3		**3**
						3		**3**
	TOTALS		**18**	**17**	**63**	**24**	**6**	**128**

Computer Engineering

Computer engineers focus on all aspects of computational devices and systems, including both hardware and software. Wherever computers can be found, computer engineers are needed. In addition to the computer system aspects of the electrical engineering and computer science, computer engineers may work in the areas of computer elements and architectures, very large scale integrated (VLSI) circuits for data processing and storage, embedded and real-time computer systems, or computer networking.

Program Educational Objectives for Computer Engineering

As Computer Engineers, BSCoEE graduates of The University of Kansas within three to five years following graduation:

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

Requirements for the Bachelor of Science in Computer Engineering Degree

A total of 128 credit hours is required for the BSCoE degree, as follows:

Computer Engineering (64 credit hours)

EECS	140	Introduction to Digital Logic Design ♦	4
EECS	168	Programming I ♦	4
EECS	211	Circuits I	3
EECS	212	Circuits II	4
EECS	268	Programming II	4
EECS	312	Electronic Circuits I	3
EECS	360	Signal & System Analysis	4
EECS	368	Programming Language Paradigms	3
EECS	388	Computer Systems & Assembly Language	4
EECS	443	Digital Systems Design	4
EECS	448	Software Engineering I	3
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	3
Senior electives ✪			9

Mathematics (22 credit hours)

MATH	121	Calculus I	5
MATH	122	Calculus II	5
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 (15 credit hours)

PHSX	211	Physics I	4
EECS	220	Electromagnetics I	4
PHSX	313	Physics III	3
PHSX	316	Physics lab	1
Natural Science Elective ⌘			3

General Electives (3 credit hours) ☸

General Electives			3

English (6 credit hours)

ENGL	101	Composition	3
ENGL	102	Creative Reading and Writing	3

Communications Elective (3 credit hours)

One of the following courses:			3
ENGL	362	Foundations of Technical Writing or	
COMS	130	Speaker-Audience Communications	

Humanities/Social Science (15 credit hours) ❖

H/SS Elective 1 (Economics):			3
ECON	142	Principles of Microeconomics (preferred) or	
ECON	144	Principles of Macroeconomics	
H/SS Elective 2			3
H/SS Elective 3			3
H/SS Elective 4			3
H/SS Elective 5			3

♦ Students with even KUIDs (7 digit) take EECS 140 in fall and EECS 168 in spring. Those with odd KUIDs (7 digit) take EECS 168 in fall and EECS 140 in spring.

❖ Humanities and Social Science Electives are selected from the list of Principal Courses in the University Undergraduate Catalog (see p. 6).

☸ Three hours of General Electives are chosen from a list of natural science, math, business, or engineering courses (see page 6).

⌘ Natural Science Elective is chosen from ASTR 391, BIOL 150, BIOL152, CHEM 184, CHEM 188, GEOG 104 and 105, GEOG 304, GEOL 101. Excess natural science hours count as General Elective hours.

✪ Nine hours of Senior Electives are chosen from EECS courses at 400 level or above (see page 6).

Computer Engineering Suggested Course Sequence

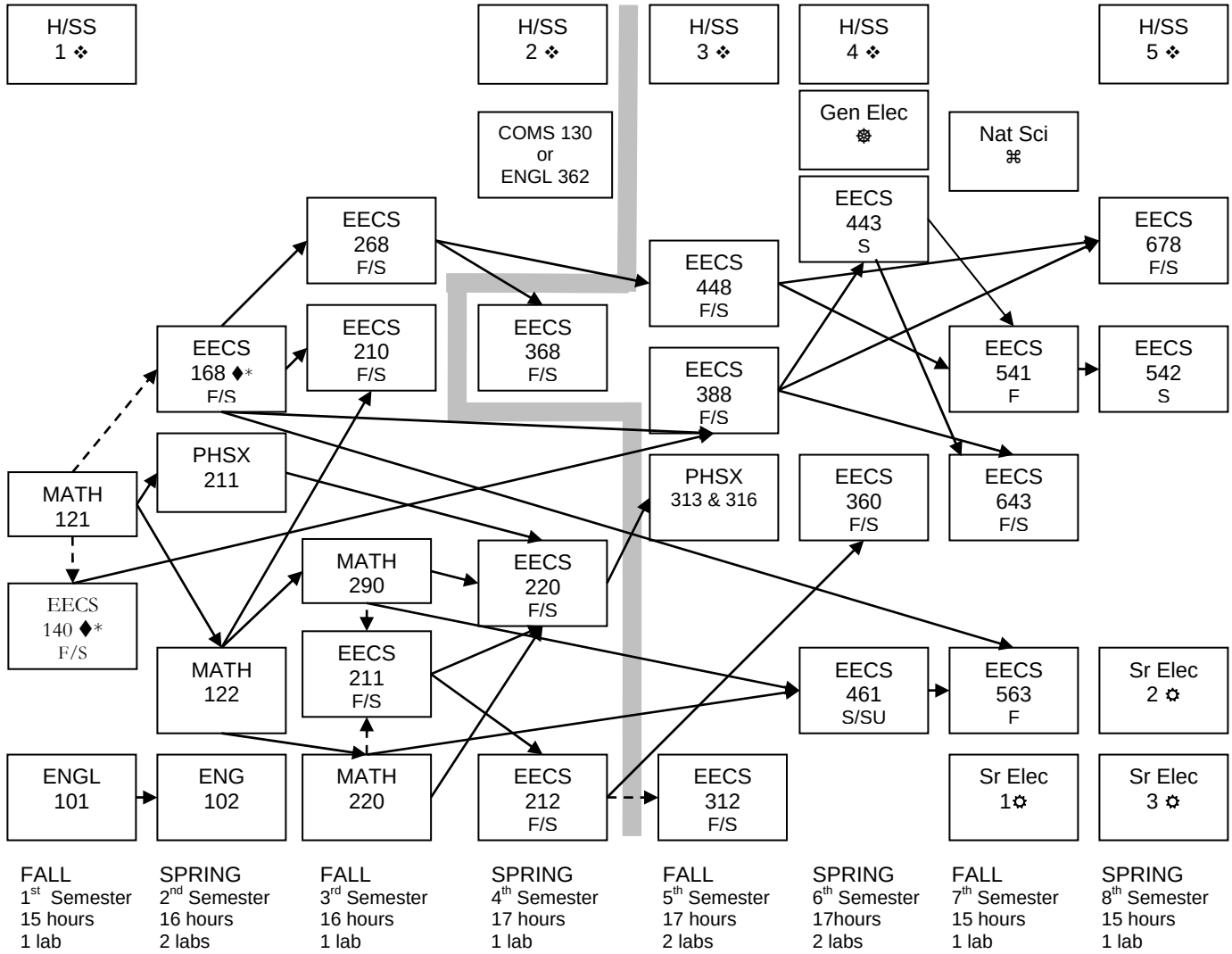
(Symbol key on previous page)

Fall 1st Semester		Spring 2nd Semester		Fall 3rd Semester		Spring 4th Semester	
				EECS 210	4	EECS 212	4
ENGL 101	3	ENGL 102	3	EECS 211	3	EECS 220	4
MATH 121	5	MATH 122	5	EECS 268	4	EECS 368	3
EECS 140 or 168 ♦	4	PHSX 211	4	MATH 220	3	COMS 130/ENGL 362	3
H/SS 1 ❖	3	EECS 168 or 140 ♦	4	MATH 290	2	H/SS 2 ❖	3
Total Hours	15	Total Hours	16	Total Hours	16	Total Hours	17

Fall 5th Semester		Spring 6th Semester		Fall 7th Semester		Spring 8th Semester	
EECS 312	3	EECS 360	4	EECS 541	3	EECS 542	3
EECS 388	4	EECS 443	4	EECS 643	3	EECS 678	3
EECS 448	3	EECS 461	3	EECS 563	3	Sr. Elective 2 ✪	3
PHSX 313 & 316	4	H/SS 4 ❖	3	Sr. Elective 1 ✪	3	Sr. Elective 3 ✪	3
H/SS 3 ❖	3	General Elective ☸	3	Natural Science ⌘	3	H/SS 5 ❖	3
Total Hours	17	Total Hours	17	Total Hours	15	Total Hours	15

Computer Engineering Course Flow Chart

The following flow chart shows the prerequisite relationships among the technical portions of the BSCoE program. This chart, the latest catalog, and your advisor should be consulted if deviations from the suggested course sequence are contemplated.



**Assumes even KUID*

Eligibility Established → Prerequisite - - - → Corequisite

BSCoE Requirements Checklist

Name:

Advisor:

Course	SEM.	GRADE	MATH	SCIENCE	ENG TOPICS	GENERAL ED	OTHER	TOTAL HRS
Computer & Engineering Science and Design (64 hrs)								
EECS 140 Intro to Digital Logic and Design					4			**4**
EECS 168 Programming I					4			**4**
EECS 211 Circuits I					3			**3**
EECS 212 Circuits II					4			**4**
EECS 268 Programming II					4			**4**
EECS 312 Electronic Circuits I					3			**3**
EECS 360 Signal & Systems Analysis					4			**4**
EECS 368 Programming Language Paradigms					3			**3**
EECS 388 Computer Systems & Assembly Language					4			**4**
EECS 443 Digital Systems Design					4			**4**
EECS 448 Software Engineering I					3			**3**
EECS 541 Computer Systems Design Lab I					3			**3**
EECS 542 Computer Systems Design Lab II					3			**3**
EECS 563 Introduction to Communication Networks					3			**3**
EECS 643 Advanced Computer Organization					3			**3**
EECS 678 Introduction to Operating Systems					3			**3**
Senior Electives (3 classes, 9 hrs)								
EECS					3			**3**
EECS					3			**3**
EECS					3			**3**
Mathematics (22 hrs)								
MATH 121 Calculus I			5					**5**
MATH 122 Calculus II			5					**5**
MATH 220 Applied Differential Equations			3					**3**
MATH 290 Elementary Linear Algebra			2					**2**
EECS 210 Discrete Structures			4					**4**
EECS 461 Probability and Statistics			3					**3**
Basic Science (15 hrs)								
PHSX 211 General Physics I				4				**4**
EECS 220 Electromagnetics I				4				**4**
PHSX 313 General Physics III				3				**3**
PHSX 316 Physics Lab				1				**1**
Natural Science				3				**3**
General Electives (3 hrs)								
							3	**3**
English, Communications, Humanities & Social Science (24 hrs)								
ENGL 101 Composition						3		**3**
ENGL 102 Creative Reading and Writing						3		**3**
COMS Elective						3		**3**
ECON 14__						3		**3**
H&SS Elective (4 classes, 12 hrs)								
						3		**3**
						3		**3**
						3		**3**
						3		**3**
	TOTALS		**22**	**15**	**64**	**24**	**3**	**128**

Computer Science

Computer scientists focus on the theory and practice of computing. They may pursue the design, analysis, and implementation of computer algorithms, study the theory of programming methods and languages, or design and develop software systems. Computer scientists may also work in the areas of artificial intelligence, database systems, parallel and distributed computation, human-computer interaction, computer graphics, operating systems, or computer systems analysis and administration.

Objectives of the Computer Science Program

Our program seeks to ensure that our graduates have the solid preparation necessary for a successful career or entry into a graduate degree program. To this end our objectives are to provide 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 communications,
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

Requirements for the Bachelor of Science in Computer Science Degree

A total of 127 credit hours is required for the BSCS degree, as follows:

Computer Science (55 credit 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 & Assembly Language	4
EECS	448	Software Engineering I	3
EECS	510	Introduction to the Theory of Computing	3
EECS	560	Data Structures	3
EECS	645	Computer Architecture	3
EECS	660	Fundamentals of Computer Algorithms	3
EECS	662	Programming Languages	3
EECS	665	Compiler Construction	3
EECS	678	Introduction to Operating Systems	3
Senior Electives ✪			12

Mathematics (22 credit hours)

MATH	121	Calculus I	5
MATH	122	Calculus II	5
MATH	223	Vector Calculus ♠	3
MATH	290	Elementary Linear Algebra ♠	2
MATH	526	Applied Mathematical Statistics I	3
EECS	210	Discrete Structures	4

Basic Science (14 credit hours)

PHSX	211	Physics I	4
PHSX	212	Physics II	4
Natural Science Electives (two courses) ⌘			6

General Electives (3 credit hours) ☸

General Electives	3

Communications (3 credit hours)

COMS	130	Speaker-Audience Communication	3

English (9 credit hours)

ENGL	101	Composition	3
ENGL	102	Creative Reading and Writing	3
ENGL	362	Foundations of Technical Writing or	3
ENGL	2XX	*	

*Foundations of Technical Writing: (ENGL 362) is strongly recommended as the third course when enrollment is possible.

Humanities/Social Science (21 credit hours) ❖

Ethics Course:			3
PHIL	375	Moral Issues in Computer Technology (offered fall semesters only)	
Three courses from Humanities (from at least two different departments)			9
Three courses from Social Sciences (from at least two different departments)			9

♦ Students with even KUIDs (7 digit) take EECS 140 in fall and EECS 168 in spring. Those with odd KUIDs (7 digit) take EECS 168 in fall and EECS 140 in spring.

❖ Humanities and Social Science Electives are three humanities courses and three social science courses that are identified as Principal Courses in the University Undergraduate Catalog (see page 6).

☸ Three hours of General Electives are chosen from a list of natural science, math, business, or engineering courses (see page 6).

⌘ Natural Science Electives (2 courses, 6 hours) are chosen from ASTR 391, BIOL 150, BIOL 152, CHEM 184, CHEM 188, GEOG 104 and 105, GEOG 304, GEOL 101. Excess natural science hours count as General Elective hours (see page 6).

✪ Twelve hours of Senior Electives are chosen from EECS 563, EECS 638, EECS 647, EECS 648, EECS 649, EECS 672, EECS 690, and any EECS course 700 level or above (see page 6).

♠ Honors MATH 143 is credited as both MATH 223 and MATH 290 and will satisfy these requirements.

Computer Science Suggested Course Sequence

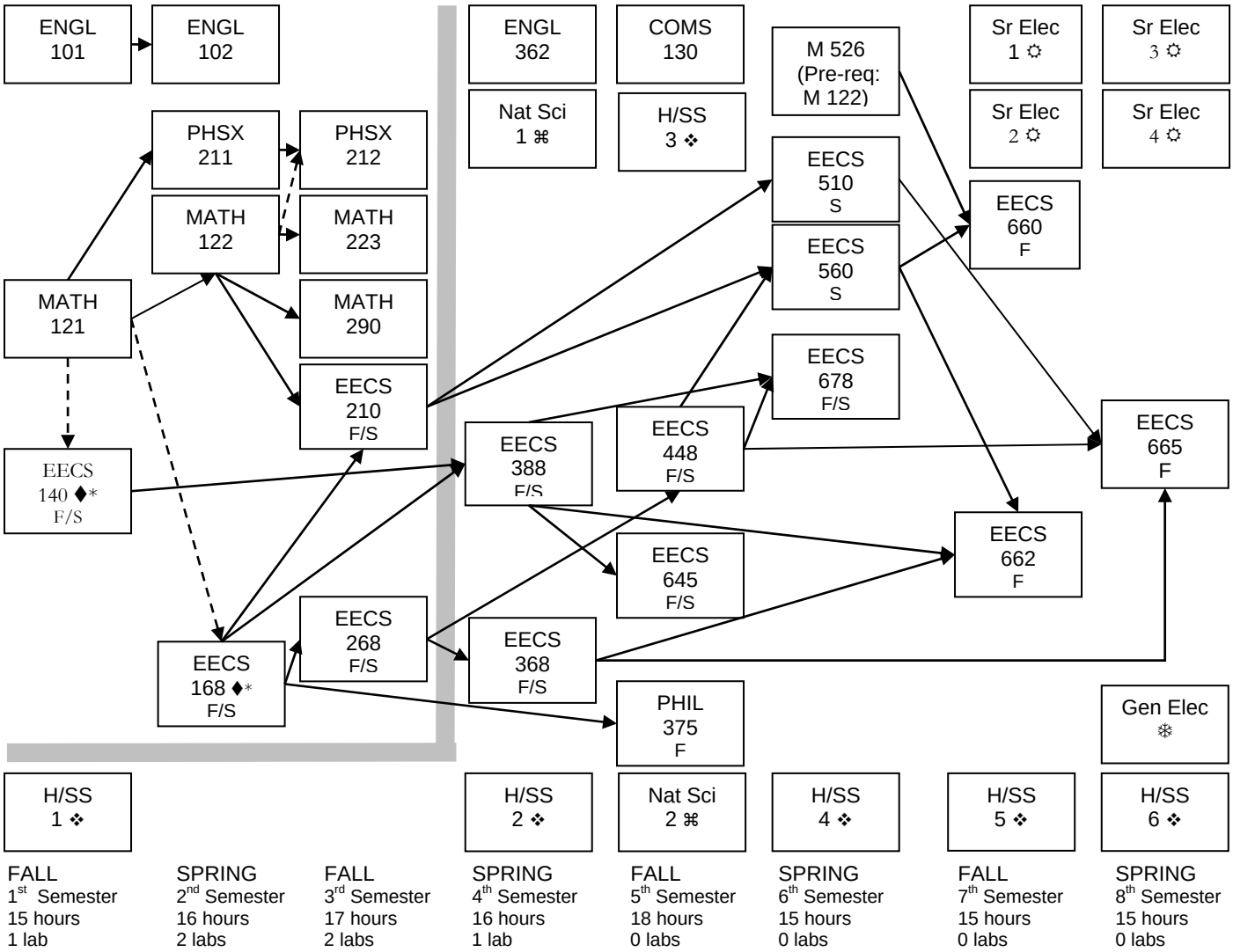
(Symbol key on previous page)

Fall 1st Semester		Spring 2nd Semester		Fall 3rd Semester		Spring 4th Semester	
				EECS 210	**4**	EECS 368	**3**
ENGL 101	**3**	ENGL 102	**3**	EECS 268	**4**	EECS 388	**4**
MATH 121	**5**	MATH 122	**5**	MATH 223	**3**	ENLG 362	**3**
EECS 140 or 168 ♦	**4**	PHSX 211	**4**	MATH 290	**2**	Natural Science 1 ⌘	**3**
H/SS 1 ❖	**3**	EECS 168 or 140 ♦	**4**	PHSX 212	**4**	H/SS 2 ❖	**3**
Total Hours	**15**	Total Hours	**16**	Total Hours	**17**	Total Hours	**16**

Fall 5th Semester		Spring 6th Semester		Fall 7th Semester		Spring 8th Semester	
EECS 448	**3**						
EECS 645	**3**	MATH 526	**3**	EECS 660	**3**	EECS 665	**3**
PHIL 375	**3**	EECS 510	**3**	EECS 662	**3**	Sr. Elective 3 ☼	**3**
COMS 130	**3**	EECS 560	**3**	H/SS 5 ❖	**3**	Sr. Elective 4 ☼	**3**
Natural Science 2 ⌘	**3**	EECS 678	**3**	Sr. Elective 1 ☼	**3**	General Elective ❁	**3**
H/SS 3 ❖	**3**	H/SS 4 ❖	**3**	Sr. Elective 2 ☼	**3**	H/SS 6 ❖	**3**
Total Hours	**18**	Total Hours	**15**	Total Hours	**15**	Total Hours	**15**

Computer Science Course Flow Chart

The following flow chart shows the prerequisite relationships among the technical portions of the BSCS program. This chart, the latest catalog, and your advisor should be consulted if deviations from the suggested course sequence are contemplated.



**Assumes even KUID.*

Eligibility Established → Prerequisite - - - → Corequisite

BSCS Requirements Checklist

Name:

Advisor:

Course	SEM.	GRADE	THEORETICAL FOUNDATIONS	ALGORITHMS	DATA STRUCTURES	SOFTWARE DESIGN	CONCEPT PROGRAM	COMPUTER ARCHITECTUR	TOTAL HOURS
Core Computer Science Classes (22hrs)									
EECS 140 Introduction to Digital Logic Design								4	**4**
EECS 168 Programming I				1	.5	1	1.5		**4**
EECS 268 Programming II				1	2		1		**4**
EECS 368 Functional Programming				.5	.5		2		**3**
EECS 388 Computer Systems & Assembly Language				1			1	2	**4**
EECS 448 Software Engineering									**3**
Total Core Accreditation Minima (16-24 hrs. required)				**3.5**	**3**	**4**	**5.5**	**6**	**22**
Advanced Computer Science Classes (33 hrs)									
EECS 510 Introduction to Theory of Computing			3						**3**
EECS 560 Data Structures				1	2				**3**
EECS 645 Computer Architecture								3	**3**
EECS 660 Fundamentals of Computer Algorithms				3					**3**
EECS 662 Programming Languages							3		**3**
EECS 665 Compiler Construction				1	.5	1.5			**3**
EECS 678 Introduction to Operating Systems				.5		.5		2	**3**
Senior Electives (4 classes, 12 hrs)									
EECS ____									**3**
EECS ____									**3**
EECS ____									**3**
EECS ____									**3**
Total Advanced Accreditation Minima (16-24 hrs required)			3	4.5	2	.5	3	5	**33**

Mathematics (22hrs)	SEM	GRADE	Math	Science	General	Other	HRS
MATH 121 Calculus I			5				**5**
MATH 122 Calculus II			5				**5**
MATH 223 Vector Calculus			3				**3**
MATH 290 Elementary Linear Algebra			2				**2**
MATH 526 Applied Mathematical Statistics I			3				**3**
EECS 210 Discrete Structures			4				**4**
Science (14hrs)							
PHSX 211 Physics I				4			**4**
PHSX 212 Physics II				4			**4**
Natural Science				3			**3**
Natural Science				3			**3**
Humanities, Social Science, English and Communications (33hrs)							
ENGL 101 Composition					3		**3**
ENGL 102 Creative Reading and Writing					3		**3**
ENGL __ 362 or 200 Level					3		**3**
PHIL 375 Moral Issues in Computer Technology					3		**3**
COMS 130 Speaker-Audience Communication					3		**3**
H&SS Electives (6 Classes)							
H:					3		**3**
H:					3		**3**
H:					3		**3**
SS:					3		**3**
SS:					3		**3**
SS:					3		**3**
General Electives (3 hrs.)							
						3	**3**
	TOTALS		**22**	**14**	**33**	**3**	**72**

Departmental Academic Policies

This section details department policies and procedures concerning completion of the curricula. In addition, each student is responsible for seeking out and complying with policies of the School of Engineering and the University. These are contained in the current Undergraduate Catalog of the University, or in sources referred to therein.

Transfer Credits

The University accepts and will place on the student's permanent KU record credits for all academic courses taken at an accredited college or university. Vocational and remedial courses are excluded.
Not all courses accepted by the University will apply toward a degree in engineering. A student will not receive engineering degree transfer credit for:

a. Courses in which the grade was lower than C, or which were graded credit/no-credit or pass/fail.
b. More than 64 hours from community or junior colleges.
c. Courses in advanced engineering sciences or engineering design unless they were taken in an engineering program accredited by ABET or CSAB.

To clearly document the application of engineering transfer course credits toward a specific degree in engineering, there is a "transfer contract" form, to be completed by the student and submitted for approval by the appropriate Department and School representatives. Copies of this form are available in the Department or School office. This process should normally be completed no later than the student's first semester in the Department.

In cases where it appears that a strong case can be made for transferring freshman or sophomore-level courses from a foreign school, or other school from which credits are not routinely accepted by the School of Engineering, a process called "Advanced Standing Credit by Validation" is available. Information about this process and the necessary forms are available from the Engineering Dean's office. All such validations should be petitioned during the student's first semester in the Department.

Academic Requirements

All School of Engineering undergraduates are subject to certain academic requirements (detailed in the Undergraduate Catalog) which call in part for maintaining a GPA of 2.0 or better, and which provide for academic probation and eventual dismissal from the School for failure to do so. You are expected to be familiar with these requirements.

Progress through the curriculum requires not just passing all courses required for a particular degree, but passing them at certain levels and/or in the proper sequence.

Course Prerequisites and Co-requisites

You must pass (at the appropriate grade level) all prerequisite courses for a given course **before** taking the follow-on course. If Course A is a co-requisite for Course B, Course A must be taken in the same semester as Course B *or* be completed prior to taking Course B.

Freshman-Sophomore Academic Requirements

In addition, EECS undergraduates are required to earn ***Upper Level Course Eligibility*** by attaining grades of C or better in each of the following courses:

EE Major *(13 courses)*
ENGL 101, 102
PHSX 211, CHEM 184
MATH 121, 122, 220, 290
EECS 140, 168, 211, 212, 220

CoE Major *(14 courses)*
ENGL 101, 102
PHSX 211
MATH 121, 122, 220, 290
EECS 140, 168, 210, 211, 212, 220, 268

CS Major *(12 courses)*
ENGL 101, 102
PHSX 211, 212
MATH 121, 122, 223, 290
EECS 140, 168, 210, 268

If you earn less than a C in any of the above listed courses, you must repeat the course at the next available opportunity and you must ***not*** take a course for which that course is a prerequisite. It is *your responsibility* to contact your advisor *before beginning the new semester* regarding any required repetitions and the associated enrollment adjustments (drops and adds).

Junior-Senior Academic Requirements

To enroll in *any* upper-level EECS course (numbered 300 and above), you must have fulfilled the ***Freshman-Sophomore Academic Requirements*** detailed above and thus acquired ***Upper Level Course Eligibility***. Exceptions: EECS 312, EECS 368 and EECS 388 may be taken in the same semester as you are completing your upper level eligibility. You may also petition for a *Partial Waiver of Upper Level Eligibility Requirements* by completing the appropriate petition, found in the EECS office or at www.eecs.ku.edu.

Graduation Requirements

In addition to completing each of the required and elective courses listed in the curriculum:

1. You must attain a cumulative grade-point average of at least 2.0 in courses applied toward the degree. You must also have a KU cumulative grade-point average of 2.0 whether or not all courses are being applied to the degree.
2. You must attain a cumulative grade-point average of at least 2.0 in all courses taken in the School of Engineering, including courses not applied toward a degree.
3. If you entered with advanced standing (transfer credit), you must attain a cumulative grade-point average of at least 2.0 in the resident courses applied toward the degree and at least a 2.0 in all courses taken in the school.
4. You must take the last 30 hours of credit toward the degree at KU and be officially enrolled in the School of Engineering during this time.

Scheduling Your Time

Obtaining a degree in Electrical Engineering, Computer Engineering, or Computer Science requires a commitment to organization and planning, as well as dedicating a large portion of time to in-class work, lab-work, and home-work.

Time is probably the most important factor when deciding how many classes to take each semester. If you have job or family commitments, you need to consider taking fewer courses in order to successfully proceed through the curriculum. The Department suggests planning for two to three hours out-of-class study time for every one hour spent in the classroom. Students are strongly discouraged from violating the following "60-hour rule". (Total-credit-hours x 3) + weekly-employment-hours ≤ 60 hours. If you are not closely following the Suggested Course Sequence for your degree, you should develop and keep current a complete plan of study for your chosen degree. This should be done at each semester's meeting with your faculty advisor (see below).

Advising and Enrollment

General Procedures

Each entering freshman or transfer student is encouraged to attend one of the University's summer orientation programs. At the summer orientation program, students are advised on course selection for the fall semester and given the opportunity to enroll. Students who cannot attend an orientation program confer with faculty advisors a day or two before the fall semester begins. Similar orientation programs are offered in January.

After the initial orientation advising, every EECS undergraduate is assigned a permanent faculty advisor. You should consult with your advisor at enrollment time and at any other time when questions or problems arise concerning your progress at the University or your professional future.

All continuing EECS students are to enroll during the regular enrollment periods that occur about half-way through a given semester for courses to be taken in the subsequent semester, i.e. in October/November for the following Spring semester, and in March/April for the following Summer session and Fall semester. Residual enrollment is only for new students and for continuing students who, for very good reasons, were unable to utilize the regular enrollment periods.

Each semester, a few days ahead of the start of enrollment itself, you are required to meet with your faculty advisor to plan your schedule and discuss other academic and career interests. You should watch for department notices informing you of the days set aside for advising by the EECS department. Prior to this advising period, you should sign up for an appointment on a sign-up sheet available at your advisor's office. At the time of the appointment you should bring an Academic Program Planning Form (available at the EECS office or at www.eecs.ku.edu) filled out with preliminary course selections. You should also arrive with definite notions (preferably written down so they will not be forgotten) about both (a) what you are sure of in terms of plans for the coming semester and about degree requirements in general, and (b) what you are unsure of that you need to discuss. This will make it possible for you and your advisor to deal effectively with whatever problems or concerns you have. You and our advisor must sign your Academic Program Planning Form before you will be allowed to enroll.

You are also encouraged to call on your advisor any time during the school year if you wish to change your schedule or discuss any other school or career related matters. Consultation with an advisor is strongly encouraged before making schedule changes.

There are a number of Department and School policies concerning course selection and enrollment in both engineering and non-engineering courses. Many of these are discussed below. For further information see the latest University catalog and check the EECS Department main bulletin boards at least weekly. The bulletin boards are located near 2001 Eaton Hall. Also, you should regularly check the EECS web site at www.eecs.ku.edu. Important notices regarding advising and enrollment are sent to your EECS student email account; make sure you check your EECS email account regularly or arrange to have your EECS account email forwarded to another account that you check regularly.

Auditors

A person enrolled at KU may, with permission of the instructor of the course involved, audit a course. Auditors may not take examinations, submit daily assignments, or use laboratory equipment if a laboratory is part of the course. When auditing is allowed, students enroll and pay tuition, but not fees. No University credit is awarded.

Change of Advisor

If for good reason (change of major, extreme conflict) you need to change advisor, you must seek permission of the person with whom you wish to be assigned. The new advisor must inform the department undergraduate records staff of their acceptance of an existing student as a new advisee. This must be done by e-mail or signed note.

Change of Major

If you wish to change majors within the School of Engineering, you must complete a Change of Major form available in the Engineering Dean's Office or the EECS Office or at www.eecs.ku.edu. Completed Change of Major forms should be turned in to the Engineering Dean's Office in 1 Eaton Hall.

If you wish to change your major to something other than engineering, you need to complete a Change of School Application form. Forms are available in the Engineering Dean's Office or at www.registrar.ku.edu. Completed forms should be turned in to the School in which you wish to change.

Curriculum Changes

When degree requirements are revised, students already admitted to that degree and making normal progress toward that degree generally have two options: (1) change to the revised curriculum, or (2) continue under the curriculum in effect when entering the degree program. If no additional time is needed for completion, it is generally advisable to choose the new curriculum.

Credit By Exam for EECS 168

If you feel that you have significant knowledge of programming and meet the requirements outlined below, you may attempt to obtain credit-by-exam for EECS 168. To get this credit, you must satisfactorily complete a comprehensive exam covering the materials for EECS 168.

Application Process

You must apply to take the test and be granted permission by the EECS department and by the University Registrar. The first step is to complete an application form at the Registrar's Office in 123 Strong Hall. Application to the department will include the following criteria:

1. You must meet the prerequisites for EECS 168, having received a "C" or better in each prerequisite course.
2. You must demonstrate that you have direct programming experience in C++, Java or C (others may be allowed as well) but the test will assume fluency in C++, and the follow-on course (EECS 268) assumes C++ fluency. The demonstration of experience must be accomplished in at least one of the following ways:
   a. You must have taken one or more programming courses in high school.
   b. You must have job experience in programming.
   c. You must be able to show that they have learned programming skills on your own by showing us code that you have written and explaining its operation.
3. You must not have taken any courses for which EECS 168 is a pre-requisite.
4. You are allowed to take the test once. If you do not pass, you will not be allowed to take the test again.

Official credit by exam application forms are available in the EECS office (2001 Eaton Hall). Endorsement by the department is required. Our endorsement will be given only if the criteria noted above are satisfied.

Frequency of Offering

The examination for credit in EECS 168 will be offered once immediately before the start of the fall and spring semesters. The application deadline is two weeks before the 1st day of classes. Students interested in taking the exam must take it at the single common time or wait until the next semester.

Test Contents and Structure

The test will be somewhat deeper than a comprehensive final examination over the entire contents of the EECS 168 course. It will be conducted in a lab with GTA proctors. Test questions will include:

- Several programming problems. This will be at least 60 percent of the total test points. Students will be required to read program specifications and then write, compile, and debug programs which meet the specifications.
- Definitions of key concepts.
- Short answers to questions.
- Multiple choice and true/false questions, if any, will not comprise more than 15 percent of the total test points.

Students will be allowed 3 1/2 hours to take the test.

Grading and Credit

The University allows either letter grades or credit ("CR") to be assigned. We will only award credit; we will not assign a letter grade. To receive credit, the student must earn an 80 percent score on the test.

Double Major

If you wish to double-major (earn two degrees), you must fulfill all the requirements for the degrees in question. You must also consult the Engineering Dean's office and the department and/or school of the second major to find out if there are any additional requirements.

Graduate Courses

Courses 700-999 are designed for graduate students. Undergraduates may NOT enroll in courses numbered 800-999. An undergraduate student may not enroll in an EECS course numbered 700-799 unless the student's engineering GPA is 3.0 or higher. In addition, it is strongly recommended that the student have a grade of B or higher in each prerequisite course.

Limitation on Enrollment in Engineering Courses

After the 5th day of classes, enrollment in a course offered by the School of Engineering is permissible only with approval of the instructor and special permission of the dean.

The School of Engineering reserves the right to deny admission to courses offered by the school to any student who is officially enrolled in another division of the university and who does not meet the standards established by the School of Engineering for admission or readmission.

Minimum and Maximum Enrollments

The maximum enrollment without the permission of the Dean of the School of Engineering is 19 hours in a semester and 9 hours in a summer session. There is no general minimum enrollment. However, for a particular student, a minimum enrollment requirement may be specified by the terms of a scholarship, student visa, or readmission agreement.

Substitutions

There are frequently times when it is necessary or desirable to make substitutions for a required course. This may occur when courses are transferred from another institution, or when there is a sound reason to substitute a course that lies outside the stated guidelines of the stated curriculum. Substitutions fall into one of the following five categories. Specific forms for cases 2, 3, and 4 are available from the EECS Office.

Case 1:

Courses transferred from another institution that automatically fulfill a course requirement. This occurs when the "ARTS" (Academic Requirements Tracking System) form transcript shows this course with the necessary KU course equivalent number. These courses should also appear in the appropriate slots at the top section of the ARTS form, but if they don't, have your advisor get this straight with the Dean's office. (The ARTS form is a computer generated form that shows all courses for which KU gives you credit hours and other pertinent information to track your progress as a student at KU).

Case 2:

Technical courses transferred from another accredited institution that clearly contain the appropriate course material for required courses, but do not appear on the ARTS form with the necessary KU course number. In this case, a *Transfer Contract* form should be filled out, signed by the advisor and then sent to the undergraduate committee and then the associate dean of engineering through the EECS Office.

Case 3:

Courses transferred from another institution or KU courses that may contain the appropriate course material for required courses, but this equivalence is not obvious. In this case, a *Course Substitution Petition* should be filled out, signed by the advisor, and then sent to the undergraduate committee and then the associate dean of engineering through the EECS office. If at all possible, these petitions are to be submitted for approval *before* the substituting courses are taken, and in any case at the earliest possible time.

Case 4:

Engineering courses which are not routinely transferred to the University of Kansas (for example, courses taken at a foreign university), but for which strong reasons can be advanced for their applicability toward degree requirements. In these cases, a petition for *Advanced Standing Credit by Validation* should be filled out. Case 4 applies only to 100- and 200-level (freshman and sophomore) courses.

Dropping a Course

General Information:

Dropping courses should be avoided, since dropping almost always carries consequences of some sort; it is better to plan carefully. During advising and enrollment students will be strongly discouraged from enrolling in more courses than they can realistically be expected to complete. The practice of over enrolling and dropping excess courses denies other students the opportunity to enroll in the first place. If a student is insistent about enrolling in more courses than the advisor believes is appropriate, the advisor may choose to approve 'with reservations', by recording these reservations on the Academic Program Planning Form.

Even with careful planning, however, you may at some point wish to drop a course that you have already enrolled in. Your advisor should always be consulted before making changes to your class schedule, but an advisor's signature is not required to drop a course.

Procedural Details:

Deadline dates and the latest information on dropping procedures and conditions for a given semester are available in the University academic calendar (currently available at www.registrar.ku.edu/calendar/academic.shtml) in effect for that semester. These rules have been in flux recently, and may change again in the future. As of the Fall 2006 semester, the general rules are:

1. During the first drop period of the semester, dropping a course erases the enrollment from your permanent record. Dropping a class during this first period may be done on-line and without any official approvals (but you should still consult with your EECS faculty advisor). If you do not drop before the first day of classes, there will be a financial penalty.
2. During the second drop period, the a "W" is recorded on your transcript. You may not drop on-line during this period.
3. During the third drop period, your class instructor must sign the drop card and assign either a W or an F for the course, which will appear on your transcript. Generally, you must be passing the course to receive a W.

Note: W means the student was earning at least a D at the time of dropping; the W has no effect on the GPA. F means the performance was not of passing quality; it is identical to an F at the end of the course and affects the GPA in precisely the same way.

Readmission

Under various circumstances a student may leave the School of Engineering. Depending upon the reason for leaving and the student's current status, there are different procedures to be followed to be reconsidered for a major in the Electrical Engineering and Computer Science Department.

1. If you leave the School of Engineering but remain a student in good standing at the University of Kansas and then wish to return to the School of Engineering, you would file an *Application for Change of School*. (Change of School Applications are available in the Engineering Dean's Office, 1 Eaton Hall or at: www.registrar.ku.edu).
2. If you leave the School of Engineering and the University of Kansas and then wish to return to the School of Engineering, you would file an *Application for Readmission.* (Applications are available at the Admissions Office, KU Visitors Center, 1402 Iowa Street or the School of Engineering Dean's Office, 1 Eaton Hall).
3. If you have been dismissed from the School of Engineering for poor scholarship, you must not only file the appropriate application mentioned in 1 or 2 above, but you must also file a *Petition for Reinstatement* to the School of Engineering. Petition forms are available from the School of Engineering Dean's office, 1 Eaton Hall. The signed petition must be turned in to the Dean's office for review and decision.

If you have completed additional course work since being dropped from the School of Engineering or leaving the University, you will need to include an up-to-date transcript or a combination of a previous transcript and grade reports for all subsequent work.

University Course Repeat Policy

You can replace up to five grades of D or F in your GPA calculation when you repeat a course and meet all eight (yes, 8) of the following criteria:

- The **original course** (must be graded D or F) has to be taken Fall 2001or later at KU.
- You must be an undergraduate.
- The original course must be taken in your first 60 college credit hours attempted or, if you have 60 or more attempted transfer hours, the original course must be taken in your first semester at KU.
- You cannot have previously repeated the course.
- The original grade cannot be the result of recorded academic or disciplinary misconduct.
- You cannot retake the course using the credit/no credit option.
- You must retake the course at KU.
- The repeated course must not be a prerequisite for a course you have already passed.

If you believe you meet the eight criteria you must file a course repeat petition form with the Engineering Dean's Office before the sixth week of classes. More information can be found at www.registrar.ku.edu.

Academic Misconduct

The EECS Department regards academic misconduct as a very serious matter. Students who violate conduct policies will be subject to severe penalties, up through and including dismissal from the School of Engineering. Please refer to the Student Handbook web site under Codes Policies, Laws & Guidelines at www.studenthandbook.ku.edu for specific guidelines about actions considered to be academic misconduct and the repercussions of such action.

These actions include, but are not limited to disruption of classes, threatening an instructor or fellow student in an academic setting; giving or receiving of unauthorized aid on examinations or in the preparation of notebooks, themes, reports or other assignments; knowingly misrepresenting the source of any academic work; unauthorized changing of grades; unauthorized use of University approvals or forging of signatures; falsification of research results; plagiarizing of another's work; violation of regulations or ethical codes for the treatment of human and animal subjects; or otherwise acting dishonestly in research.

Honors Programs

University and School of Engineering Honors

The School of Engineering encourages all qualified students to participate in the Honors Program. Students must meet with an engineering advisor every semester and may also meet with an honors program advisor. See the Honors Program section in the General Regulations chapter in the College of Liberal Arts and Sciences catalog.

Departmental Honors

A student may graduate with departmental honors in electrical engineering, computer engineering or computer science by satisfying the requirements listed on page 6. Most of the requirements for graduation with Departmental Honors are completed during the final two semesters of a student's undergraduate program.

Frequently Asked Questions

a. Is it OK for me to take the next course in a sequence, for example Math 122, at the same time I am repeating the prerequisite course, for example Math 121, to raise the grade to C or better?

Almost never -- for at least two reasons. First, the intent of the C-or-better policy is to get you to build solid foundations. This is not likely to happen if you haven't attained a C or better in the prerequisite course before taking the next course. Second, you may have an impossible examination schedule. For the example cited, Math 121-122, the Math department frequently schedules exams for both courses at the same time. If, in some unusual case, the *academic facts* convince your advisor that it would be appropriate for you to take the two courses at the same time, you should obtain the permission of the department(s) teaching the courses.

b. When and for what classes is the Credit/No Credit Option allowed?

Not recommended. Although the credit/no credit (CR/NC) option is allowed to fulfill English, humanities, social science, or oral communication courses, this option has the potential of lowering (not raising) your grade point average, since CR/NC courses are not included in GPA calculations.

c. I would rather put off taking English until my junior or senior year. Is that OK?

Definitely not! University regulations require that *all* students be *continuously* enrolled in English until the English requirements for their degree are completed. For the BSEE, BSCoE and BSCS degrees this means completion of ENGL 101 and 102 *with grades of C or better* to be eligible to take junior-senior courses. In the case of international students whose primary language is not English, this includes continuous enrollment in courses specified by the Applied English Center (AEC), followed immediately by continuous enrollment in ENGL 101 and 102.

d. What is the ROTC policy for electrical engineering, computer engineering, and computer science majors?

Students who are in training for a commission as a regular or reserve officer in the Reserve Officers Training Corps (ROTC) may petition to apply credit earned in technical courses in aerospace studies, military science, or naval science for graduation. Up to six hours may be petitioned to count toward the general elective requirement.

e. I was exempt from the speech requirement. Do I need to make up these hours?

Yes. EE and CoE students may make up these hours by taking ENGL 362 (if they haven't already taken the course to satisfy other requirements) or any other communications course which lists COMS 130 as a prerequisite. CS students may make up these hours by taking any other communications course which lists COMS 130 as a prerequisite.

f. I was given permission to take a higher level English course because my English ACT score was greater than 30. Are there any special requirements?

Yes! Students who have an ACT English score of 30 or higher may be allowed to take either take ENGL 102 (skipping ENGL 101) or ENGL 105 (honors equivalent of ENGL 102, again skipping ENGL 101). However, this does not give *credit* for ENGL 101. Students choosing to follow this path will need to make up these 3 hours of English *credit* with a higher level English course.

g. How do I locate computer science books, journals and conference proceedings in the KU libraries?

Print materials on computer science are housed in two different buildings at KU: **Anschutz Library,** 2nd floor (one floor below entry level), Call number QA 75.5-76.9. Anschutz covers mainly computer programming and software. Topics include general theory and application of computers, data processing, parallel processing, computer programming, programming languages, specific makes and models of computers and microprocessors, computer security, database and file management, etc. **Spahr Engineering Library,** 2nd floor, Call number TK 5100-7895. Spahr covers mainly computer engineering and hardware. Topics include telecommunication, signal processing, wireless, data transmission, computer networks, electronic circuits and apparatus, semiconductors, microelectronics, integrated circuits, microwaves, and computer hardware, components, and auxiliary equipment, etc. Sometimes there are materials on a topic in both Anschutz and Spahr.

h. What online publications are available?

The Spahr Engineering Library's web site provides online access to many computer science publications. These include the ACM Digital Library, the IEEE Xplore journals and proceedings since 1998, and many other electronic journals and databases. Online publications are accessible from anywhere on campus. Regardless of location, all computer science books, journals, and conference proceedings are listed in the library's online catalog. The same is true of all library materials at KU in every field of engineering. The catalog gives the location of each and every item.

Entry to the Profession

Job Search Assistance

The Engineering Career Center offers a comprehensive array of services to graduating students seeking permanent employment and to undergraduates seeking career-related summer or coop employment. These services include the on-campus interviewing program; a career fair each February and September; individual counseling and group workshops on resumes, interviewing, and job search strategies; resume-writing software; job postings from many employers not interviewing on campus; a library of employer and career literature; and mailing of student resumes to employers with job vacancies.

Although employment for engineering graduates depends on economic conditions, graduates from the KU School of Engineering consistently have been able to find responsible, high-paying positions in the profession. The Career Services Center does not guarantee employment to any graduate, but it makes every effort to help students who have initiated job searches. Services are available only to employers who support and implement the spirit and letter of state and federal laws in the matter of equal employment opportunity and nondiscriminatory practices.

Licensing

Engineering licensure laws vary from state to state, but, in general, to become a Professional Engineer (PE) an individual must be a graduate of an engineering program accredited by the Accreditation Board for Engineering and Technology, pass the Fundamentals of Engineering exam (usually taken during a student's senior year), gain four years of experience working under a PE, and pass the Principles and Practice of Engineering exam.

Student Activities/Organizations

Students in the School of Engineering are encouraged to supplement their academic programs by participating in professional activities offered by the school's student organizations.

Engineering Student Council

The Engineering Student Council, composed of elected representatives of the engineering student body, is the student governance organization for the School of Engineering. Engineering Student Council also sponsors an Engineering Exposition each year. Student groups and organizations plan and create exhibits that describe specialized areas of engineering and demonstrate engineering processes and resultant products. Awards are given for the best student displays.

Honor Societies

In their junior and senior years, outstanding engineering students may be invited to join one or more of the engineering honor societies on campus. These include Tau Beta Pi, all engineering disciplines; Eta Kappa Nu, electrical engineering and computer engineering; and Upsilon Pi Epsilon, computer science.

Minorities and Women

The **Engineering Diversity Program** encourages minority and women students to choose engineering as a career. It provides financial and academic support to its students, with retention as a main goal. Students may join chapters of the National Society of Black Engineers, American Indian Science and Engineering Society, the Society of Hispanic Professional Engineers, and/or the Society of Women Engineers. For further information, contact the Engineering Diversity Program director, 785/864-3620.

National Engineering Societies

Most national engineering societies have student chapters on campus. In EECS, the primary societies are the Association for Computing Machinery (ACM) and the Institute of Electrical and Electronics Engineers (IEEE).

Student Publication

Students in the School of Engineering publish a magazine, the *Kansas Engineer*, for distribution on campus and to alumni who subscribe.

Catalog Description of Courses Open to Undergraduates Offered by the EECS Department

EECS 128 Foundations of Information Technology (3). 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.

EECS 138 Introduction to Computing: ___ (3). 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 eligibility to enroll in MATH 115 or MATH 121.

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

EECS 141 Introduction to Digital Logic: Honors (4). An introductory course in digital logic 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.

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. 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. Co-requisite: MATH 104.

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.

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.

EECS 211 Circuits I (3). Analysis of linear electrical circuits: Kirchhoff'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. Co-requisites: MATH 220 and MATH 290.

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.

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

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.

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. Co-requisite: EECS 212.

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.

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.

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.

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.

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.

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.

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 141 and EECS 168 or 169 and upper-level EECS eligibility.

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.

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.

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.

EECS 443 Digital Systems Design (4). The design of computer systems from the 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.

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.

EECS 448 Software Engineering I (3). This course covers the systematic development of software products. It first outlines the problems encountered in large software systems and their life cycle. It then concentrates on the methods and techniques for specification, design, and implementation of software: requirements analysis and specification; systems planning on design; software design and design documentation; implementation techniques, unit testing, and integration; validation and verification; early preparation of documentation including user manuals. Prerequisite: EECS 268 and upper-level EECS eligibility.

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. Prerequisite: MATH 290, MATH 220 or MATH 223 and upper-level EECS eligibility.

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.

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.

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. Prerequisite: EECS 420. Corequisite: EECS 412.

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.

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.

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.

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.

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.

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.

EECS 560 Data Structures (3) Abstract data types and concrete data structures including their associated algorithms. Topics include sets, graphs, trees, priority queues, heaps, mergeable heaps, balanced tree structures, and advanced data structures on trees. Application to problem solving including consideration of trade-offs incurred in the

choice of implementation. Advanced sorting techniques. Efficiency of algorithms, big-oh, big-omega, worst case analysis, lower bounds on problem complexity. Basic techniques of algorithm design including divide and conquer, greedy, backtracking, and dynamic programming. Prerequisite: EECS 210 and EECS 448.

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; noise performance of analog modulation techniques. Prerequisite: EECS 212 and EECS 360.

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.

EECS 580 Electrical Energy Conversion (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. Prerequisites: EECS 212 or EECS 315 and EECS 220 or PHSX 212.

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.

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. Corequisites: EECS 420, EECS 461

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.

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.

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

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.

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.

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. Prerequisite: EECS 448. Student cannot receive credit for both EECS 647 and EECS 746.

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.

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.

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.

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, co-routines, and tasks. Run-time representation of program and data structures. Prerequisite: EECS 368, EECS 388 and EECS 560

EECS 665 Compiler Construction (3). Compilation of simple expressions and statements. Organization of a compiler including symbol tables, lexical scan, syntax scan, object code generation, error diagnostics, code optimization techniques, and overall design. Compilation techniques and run-time structures in a block-structured language such as PASCAL or B. Use of compiler writing languages and boot-strapping. Prerequisite: EECS 368, EECS 448 and EECS 510.

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, metallization, and plasma etching of thin films. (Same as C&PE 655) Prerequisite: senior standing in C&PE or EECS, or consent of instructor.

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

EECS 678 Introduction to Operating Systems (3). The purpose of the course is to provide the students with the concepts necessary to enable them to: (a) identify the abstract services common to all operating systems, and explore the many variations possible, (b) define the basic operating system components that carry out these machine independent abstractions, (c) understand how the entire system fits together, not merely how one or two important parts interact, and (d) understand the means by which fundamental problems in operating systems can be analyzed. Prerequisite: EECS 388 and EECS 448.

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.

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.

EECS 700 Special Topics ___ (1-5). Courses on special topics of current interest in electrical engineering, computer engineering, or computer science, given as the need arises. May be repeated for additional credit. Prerequisite: variable.

EECS 710 Information Security & Assurance (3). Identifying critical information assets; information security, integrity, and availability; security risks and risk avoidance; security models; access control mechanisms; computer viruses, worms, Trojan horses and other malicious login; encryption, cryptography, and key management technologies; operating systems security; database security; network security; e-commerce security; security policies; management and auditing. Prerequisite: Graduate standing in EECS.

EECS 711 Security Management and Audit (3). Administration and management of security of information systems and networks, intrusion detection systems, vulnerability analysis, anomaly detection, computer forensics, auditing and data management, risk management, contingency planning and incident handling, security planning, e-business and commerce security, privacy, traceability and cyber-evidence, legal issues in computer security. Prerequisite: EECS 710.

EECS 712 Network Security (3). Introduction to the basic concepts, components, protocols, and software tools to achieve secure communication in a public network. The concept of encryption, integrity, authentication, security models, and the robustness analysis. Emphasis on the application level protocols and vulnerabilities: firewalls, viruses, worm attack, Trojan horses, password security, secure multicast, biometrics, VPNs, internet protocols such as SSL, IPSec, PGP, and SNMP. The policies for access control, user privacy, and trust establishment and abuse in open environments such as eBay. Prerequisite: EECS 563 or EECS 780.

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 equivalent.

EECS 718 Graph Algorithms (3). This course introduces students to computational graph theory and various graph algorithms and their complexities. Algorithms and applications covered will include those related to graph searching, connectivity and distance in graphs, graph isomorphism, spanning trees, shortest paths, matching, flows in network, independent and dominating sets, coloring and covering, and Traveling Salesman and Postman problems. Prerequisite: EECS 560 or graduate standing with consent of instructor.

EECS 720 Electromagnetics for Communications and Radar (3). Topics in electromagnetics relevant to wireless communications, optics and fiberoptics, 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, and aperture antennas (arrays, reflectors, and lenses). Cylindrical and biconical antenna theory. Prerequisite: EECS 360, EECS 420, or EECS 720. Infrequently offered.

EECS 722 Mathematical Logic (3). Propositional Calculus. First order theories and model theory. Elementary arithmetic and Gödel'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 730 Introduction to Bioinformatics (3). This course provides an introduction to bioinformatics. It covers computational tools and databases widely used in bioinformatics. The underlying algorithms of existing tools will be discussed. Topics include: molecular biology databases, sequence alignment, gene expression data analysis, protein structure and function, protein analysis, and proteomics. Prerequisite: Data Structures Class equivalent to EECS 560, and Introduction to Biology equivalent to BIOL 150, or consent 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. Infrequently offered.

EECS 737 Computational Genomics (3). This course focuses on the computational analysis of genomes. Computational methods are studied in tandem with applied studies of genome structure, function, and evolution. Computational genomics topics include chromatin structure and function, genome architecture and evolution, roles of repeats, DNA composition analysis, and processes behind gene expressions; computational-methodology topics include sequence analysis and modeling, dynamic programming, formal language and linguistic methods, Markov chains and optimization methods, information theory, and molecular modeling. Prerequisite: EECS 730 or consent of instructor.

EECS 738 Machine Learning (3). This course introduces basic concepts and algorithms in machine learning. A variety of topics such as Bayesian decision theory, dimensionality reduction, clustering, neural networks, hidden Markov models, combining multiple learners, reinforcement learning, Bayesian learning, etc. will be covered. Prerequisite: Graduate standing in CS or CoE or consent of instructor.

EECS 739 Scientific Parallel Computing (3). This course is concerned with the application of parallel processing to problems in the natural sciences and engineering. State-of-the-art computing methodologies are studied along with contemporary applications. The course takes a performance-oriented applied approach, with attention to parallel algorithms, parallel architecture, compilation issues, and system evaluation. Prerequisite: Graduate standing or consent of instructor and experience with C, C++, or FORTRAN.

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-time representation of signals and systems, z-transform properties, signal/system correlation, sampling theory, analysis of linear time-invariant systems, filter implementation, digital filter design, discrete Fourier transform, and the fast Fourier transform. Prerequisite: EECS 360.

EECS 745 Implementation of Networks (3). Laboratory-focused implementation of networks. Topics include direct link networks (encoding, framing, error detection, reliable transmission, SONET, FDDL, network adapters, Ethernet, 802.11 wireless networks); packet and cell switching (ATM, switching hardware, bridges and extended LANs); internetworking (Internet concepts, IPv6, multicast, naming/DNS); end-to-end protocols (UDP, TCP, APIs and sockets, RPCs, performance); end-to-end data (presentation formatting, data compression, security); congestion control (queuing disciplines, TCP congestion control and congestion avoidance); high-speed networking (issues, services, experiences); voice over IP (peer-to-peer calling, call managers, call signaling, PBX and call attendant functionality). Prerequisite: EECS 563 or EECS 780.

EECS 746 Database Systems (3). Introduction to the concept of databases and their operations. Basic database concepts, architectures, and data storage structures and indexing. Though other architectures are discussed, focus is on relational databases and the SQL retrieval language. Normalization, functional dependencies, and multivalued dependencies also covered. Culminates in the design and implementation of a simple database with a web interface. Prerequisite: EECS 448 or consent of instructor. Students cannot receive credit for both EECS 647 and EECS 746.

EECS 747 Mobile Robotics (3). Design, construction, and programming of mobile robots. Topics include computational hardware, designing and prototyping, sensors, mechanics, motors, power, robot programming, robot design principals and current research in mobile robotics

EECS 749 Knowledge Based Systems (3). General concepts of intelligent problem solving, rule-based systems, distributed AI, reasoning under uncertainty, case-based reasoning, subsymbolic techniques. Prerequisite: At least one class in Artificial Intelligence.

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 766 Resource Sharing for Broadband Access Networks (3). Connections between network customers and the network come in many forms, wireless data systems, e.g., IEEE 802.16, wireless cellular systems, e.g. 3G, coax cable networks, e.g., DOSCIS, fiber optic communications systems, e.g., EPON, copper twisted pair, e.g., DSL, and powerline communications systems. All of these systems use various resource sharing strategies. The resource sharing strategy is matched to the necessities of specific systems as well as their operating environments. There are commonalities between these strategies as well as differences. This course will look at resource sharing from a general perspective and then examine specific systems to underscore their commonalities and differences. Systems to be studied in detail include, DOSCIS, IEEE 802.16/Wi-Max, WCDMA, HSDPA/HSUPA, EV-DO, EPON, ZigBee/IEEE 80215.4, and powerline networks. The use of cognitive radio communications technologies in future access networks will be introduced. Prerequisite: EECS 461 and EECS 563 or EECS 780.

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 the 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 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 applications 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 modeling representations and algorithms. Boolean set operations on solid models and the boundary evaluation algorithm. Geometric modeling systems architectures. Project developed in C. Prerequisite: EECS 672.

EECS 775 Visualization (3). Data representations, algorithms, filtering, and rendering techniques used in Scientific and Information Visualization with an emphasis on Scientific Visualization. Structured and unstructured grids. Interpolation. Contouring, volumetric rendering. Prerequisite: EECS 672 or instructor's permission.

EECS 780 Communication Networks (3). Comprehensive in-depth coverage to communication networks with emphasis on the Internet and the PSTN (wired and wireless). Extensive examples of protocols and algorithms will be presented at all levels, including: client/server and peer-to-peer applications; session control, transport protocols, and end-to-end arguments and end-to-end congestion control; network architecture, forwarding, routing, signaling, addressing, and traffic management; quality of service, basic queuing (basic M/M/1 and Little's law) and multimedia applications; LAN architecture, link protocols, access networks and MAC algorithms; physical media characteristics and coding; network security and information assurance; network management. Prerequisite: EECS 168 and EECS 461. Students cannot receive credit for both EECS 563 and EECS 780.

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 and 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.