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PROPOSAL TO THE SENATE COMMITTEE ON EDUCATIONAL POLICY

TITLE OF THE PROPOSAL:

Revised Curriculum for the Bachelor of Science Degree in Electrical Engineering (EE) in the Department of Electrical and Computer Engineering (ECE)

SPONSOR:

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BRIEF DESCRIPTION:

The primary goals of this revision include:

1. update constraints on technical electives. Specifically:
35 hours selected from a Departmentally approved list (see Appendix A), to include at least:
 - i. 6 hours of non-ECE courses
 - ii. 3 of the following 5 courses:
ECE 410, ECE 442 and 443, ECE 450, ECE 391 or CS 225, ECE 430
 - iii. 2 ECE Lab Courses as indicated on the tech elective list
 - iv. 22 hours of ECE courses

2. increase the depth and rigor of the mathematics content of the curriculum. Specifically:
 - i. MATH 242 (3 hours) has been replaced by MATH 243 (4 hours) which provides additional treatment of vector calculus
 - ii. MATH 385 (3 hours) has been replaced by MATH 386 (4 hours) which provides additional treatment of linear algebra
 - iii. STAT 400 has been replaced by STAT 410 as an option in place of ECE 413.

3. improve understanding of computing systems. Specifically:

- i. ECE 190 replaces CS 125 as the required course in introduction to computing systems and programming. This new course represents the "bits-to-C" approach to the subject matter.
- ii. ECE 390 is replaced by ECE 391, a new course on operating systems (see Appendix B). ECE 391 is required for computer engineering majors and is in the *3-of-5 list* (see 1.ii. above) for electrical engineering majors.

JUSTIFICATION:

1. The present curriculum includes a fairly complicated set of constraints that govern the selection of 15 hours of Technical Electives in addition to 22 hours of Advanced ECE Electives. These rules were developed many years ago, primarily to enforce engineering breadth in our students. In the revised curriculum, Technical Electives and Advanced ECE Electives are merged into a single category of 35 hours of Technical Electives recognizing the fact that many students will go on to careers in non-traditional engineering areas, e.g., bioengineering, law, medicine, management, and entrepreneurship. The new technical elective requirement will enforce rigor while allowing many variations in focus. The new rule will allow up to 13 hours of non-ECE Technical Electives, with no additional constraints on how those 13 hours are used.
2. The changes in the mathematics requirement ensure that all EE students will have exposure to concepts in linear algebra (presently not required) along with a treatment of vector calculus, essential for advanced study in EE.
3. ECE 190 is being used to replace CS 125, which is currently a required course for ECE undergraduates. The proposed course is more appropriate for ECE undergraduates because of its bottom-up, systems orientation, and also because it provides exposure and motivation for many subdisciplines of Electrical and Computer Engineering. ECE 391 covers core material in operating systems, device-driver programming, etc. that are essential for modern computer engineering applications.

BUDGETARY AND STAFF IMPLICATIONS:

The revised curriculum primarily affects three departments in terms of course-enrollment shifts. These are the Department of Computer Science, the Department of Mathematics, and the Department of Statistics.

Department of Computer Science (CS). The change that will affect this department is: switching from CS 125 to ECE 190. The CS Department has indicated that they have no reservations about the proposed changes and, taken together with the changes associated with the proposed revisions to the Computer Engineering Curriculum (submitted for approval along with this Proposal), they will reallocate resources to manage any net changes in course enrollments when the revised curricula become effective. See letter attached.

Mathematics Department. The change that will affect this department is: (1) changing the required calculus sequence by replacing Math 242 by Math 243, and Math 385 by Math 386. The Mathematics Department has indicated that they are able and willing to adjust resources to manage any net impact of these changes, taken together with the changes associated with the proposed revisions to the Computer Engineering Curriculum (submitted for approval along with this Proposal). See letter attached.

Department of Statistics. The change that will affect this department is: replacement of the current option of allowing Stat 400 in place of ECE 413 by the option of allowing Stat 410 in place of ECE 413, that is, replacing Stat 400 by Stat 410. The Statistics Department supports this change and there appear to be no budgetary and staff implications. See letter attached.

GUIDELINES FOR UNDERGRADUATE EDUCATION:

Relative to the present curriculum, the revised curriculum more strongly meets the Senate's guidelines for undergraduate education. As in the present curriculum, students develop the ability to write and think clearly, the desire and ability to be lifelong learners, and appreciation for our own and other cultures. In terms of professional preparation, the revised curriculum will enforce rigor while allowing many variations in focus in the choice of technical electives, as stated under "Justification."

STATEMENT FOR PROGRAMS OF STUDY CATALOG:

See attached.

PROPOSED EFFECTIVE DATE: Fall 2006

CLEARANCES:

N. Narayana Rao Date: 10/19/05

Sponsor

Roshan E. Bhatt Date: Oct 19, 2005

Department of Electrical and Computer Engineering

Jesamine A. ... Date: 10/27/05

College of Engineering

_____ Date: _____

Office of the Provost

APPENDIX A

Departmentally Approved Technical Electives List for EE and Comp E

Rubric	Courses	Dept. / Program Name
ABE	All 200, 300, 400 level*	Agricultural & Biological Engineering
AE	311, 402, 407, 412, 413, 416, 433, 434, 435, 481	Aerospace Engineering
ASTR	404, 405, 414	Astronomy
ATMS	300, 401, 402, 410, 421	Atmospheric Science
BIOC	All 200, 300, 400 level*	Biochemistry
BIOE	All 200, 300, 400 level*	Bioengineering
BIOP	All 200, 300, 400 level*	Biophysics
CEE	330, 447	Civil Environmental Eng.
CHBE	All 200, 300, 400 level*	Chemical & Biomolecular Engineering
CHEM	104/105, all 200, 300, 400 level*	Chemistry
CS	225, 257, 273, 411, 414, 418, 419, 421, 422, 423, 424, 426, 427, 431, 433, 437, 446, 450, 455, 458, 459, 473, 475, 476	Computer Science
ECE	All non-required courses except for 205, 206, 211, 216, 317. Lab Courses: 326, 395, 412, 415, 420, 431, 435, 443, 444, 447, 451, 453, 460, 463, 469, 470, 486, 496	Electrical & Computer Engineering
GE	411, 420, 424, 424	General Engineering
GEOL	452, 454, 471	Geology
IB	150/151, all 200, 300, 400 level*	Integrative Biology
IE	310, 330	Industrial Engineering
MATH	213, 380, 402, 412, 413, 414, 415, 417, 418, 423, 432, 442, 444, 446, 447, 448, 453, 466, 481, 484, 489	Mathematics
MCB	103, 150/151, all 200, 300, 400 level*	Molecular & Cellular Biology
ME	300, 310, 320, 330, 350, 400, 401, 402, 403, 404, 410, 411, 420, 430, 431, 450, 471, 472	Mechanical Eng.
MSE	All 200, 300, 400 level*	Material Science & Engineering
NPRE	402, 421, 423, 431, 435, 441, 446, 447, 448, 455	Nuclear, Plasma, Radiological Engineering
PHYS	325, 326, 402, 403, 427, 460, 470, 485, 486, 487	Physics
TAM	211, 212, 251, 324, 335, 412, 435, 445, 451	Theoretical & Applied Mechanics

* excepting seminars and special topics courses

Note: AP credit for only one course may be used toward tech elective hours

Appendix B

Title of Course: *Computer Systems Engineering*

Text: *Course notes prepared by Prof. Steve Lumetta*

<u>Topical Outline</u>	<u>Hours</u>
<i>review of computer organization and representations</i>	2
<i>x86 assembly: review of basic constructs and structures, interfacing C to assembly, macros, stack frame and calling convention</i>	4
<i>simple data structures: queues, heaps, stacks, lists</i>	2
<i>synchronization: primitives, memory semantics, mutual exclusion, semaphores, scheduling, and race conditions</i>	5
<i>interrupts: controlling generation and handling, chaining, cleanup code, interactions with device functionality</i>	5
<i>resource management: virtualization and protection, virtual memory and hardware support</i>	4
<i>exceptions and signals: exceptions due to instructions, memory accesses, and floating-point operations; signal semantics and delivery</i>	4
<i>device programming: basic abstractions, character and block devices</i>	3
<i>file system abstractions: disk layout, access control lists and capabilities, log-structured and traditional filesystems as design problem</i>	5
<i>I/O interface: file descriptors, buffering, control operations, memory mapping</i>	4
<i>networking programming: socket abstractions, basics of low-level network protocols, relationship to kernel I/O abstractions</i>	5
<i>midterms</i>	2
Total	45

Statement for Programs of Study Catalog

Note for Reviewers: In the online version of this document the Departmentally Approved List of Technical Electives cited in this document will be hyperlinked to a Departmental web site URL. It is Appendix A at the end of this document for review purposes.

Curriculum In Electrical Engineering

www.ece.uiuc.edu

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For the Degree of Bachelor of Science in Electrical Engineering

A list of the twenty greatest engineering achievements of the twentieth century compiled by the National Academy of Engineering includes ten achievements primarily related to the field of electrical engineering: electrification, electronics, radio and television, computers, telephone, internet, imaging, household appliances, health technologies, and laser and fiber optics. The remaining achievements in the list – automobile, airplane, water supply and distribution, agricultural mechanization, air conditioning and refrigeration, highways, spacecraft, petroleum/petrochemical technologies, nuclear technologies, and high-performance materials – also require knowledge of electrical engineering to differing degrees. In the twenty-first century the discipline of electrical engineering continues to be one of the primary drivers of change and progress in technology and standards of living around the globe.

Educational Objectives and Outcomes

The Electrical Engineering (EE) curriculum is administered by the Department of Electrical and Computer Engineering (ECE). There are four educational objectives of the EE curriculum:

- **Depth.** To provide students with an understanding of the fundamental knowledge prerequisite for the practice of or for advanced study in electrical engineering, including its scientific principles, rigorous analysis, and creative design.
- **Breadth.** To provide students with the broad education, including knowledge of important current issues in engineering, with emphasis on electrical engineering,

necessary for productive careers in the public or private sectors or for the pursuit of graduate education.

- **Professionalism.** To develop skills for clear communication and responsible teamwork and to inculcate professional attitudes and ethics so that students are prepared for the complex modern work environment and for lifelong learning.
- **Learning Environment.** To provide an environment that enables students to pursue their goals in an innovative program that is rigorous and challenging, open and supportive.

The following educational outcomes are expected for each graduating student:

- Ability to apply knowledge of mathematics, science, and engineering
- Ability to design and conduct experiments as well as analyze and interpret data
- Ability to design a system to meet desired needs
- Ability to function on multidisciplinary teams
- Ability to identify, formulate, and solve engineering problems
- Understanding of professional and ethical responsibility
- Ability to communicate effectively
- Broad education necessary to understand impact of engineering solutions in a global/societal context
- Recognition of the need for and ability to engage in lifelong learning
- Knowledge of contemporary issues
- Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
- Knowledge of probability and statistics, including applications to electrical engineering
- Knowledge of mathematics, and basic and engineering sciences, necessary to carry out analysis and design appropriate to electrical engineering
- Knowledge of advanced mathematics.

The EE program objectives and outcomes detailed above are consistent with the Engineering Criteria 2000 (EC2K) of the Accreditation Board for Engineering and Technology (ABET).

The Importance of the First-Year ECE Experience

First-year students take Introduction to Electrical and Computer Engineering (ECE 110), a four-credit-hour class combining theory, laboratory measurement, and design. Not only do beginning students get a substantive course in their major, they also gain a better appreciation for the basic science and mathematics courses that are taken during the first two years of study. Students gain first-hand experience in the activities of a professional electrical/computer engineer and are better able to make the important decision as to whether they have chosen the major best suited to them.

Intellectual Content of the Electrical Engineering (EE) Curriculum

Student involvement in the EE discipline increases during each year of the program. Most of the core electrical engineering courses are taken in the fourth and fifth semesters. During the last three semesters, the student chooses electives to define a curriculum to meet specific educational and career needs.

The electrical engineering core curriculum focuses on fundamental electrical engineering knowledge: circuits (ECE 110), systems (ECE 210), electromagnetics (ECE 329), solid state electronics (ECE 440), computer engineering (ECE 190, ECE 290, ECE 385), and design (ECE 445). The rich set of ECE elective courses permits students to select from collections of courses in the seven areas of electrical and computer engineering: bioengineering, acoustics, and magnetic resonance engineering; circuits and signal processing; communication and control; computer engineering; electromagnetics, optics, and remote sensing; microelectronics and quantum electronics; power and energy systems.

Methods of Instruction and Design Experience

Instruction is given using a combination of lecture, discussion, laboratory, and project methodologies of the highest quality. The large number of laboratory courses and superb access to advanced computer facilities provide excellent practical experience in the field. Laboratory and design work are emphasized throughout the curriculum beginning with Introduction to Electrical and Computer Engineering (ECE 110). The sophomore year includes design experience in Computer Engineering (ECE 190 and ECE 290) and the Digital Systems Laboratory (ECE 385). During the junior and senior years, students gain further design experience in elective courses, including at least two laboratory courses, in their chosen sub-discipline. In the Senior Design Laboratory (ECE 445), students learn to combine all phases of an engineering project including design, analysis, construction, teamwork, and reporting.

Honors Activity

Students wishing to do honors work are encouraged to apply to the James Scholar Program administered jointly by the College of Engineering and the ECE Department. In consultation with departmental honors advisers, students create and carry out honors activity contracts. They must also participate in the ECE Honors Seminar and are encouraged to participate in the yearly Undergraduate Honors Symposium. The department offers thesis courses and project opportunities for students wishing to graduate with Highest Honors.

Grade-Point Average Requirements

(Rev. 11/14/05)

A student must have a grade-point average of at least 2.0 in ECE courses in order to remain in good standing and to graduate. To qualify for registration for the ECE courses shown in the third year of the curriculum, a student must have completed, with a combined 2.25 grade-point average, the mathematics, physics, and electrical and computer engineering courses shown in the first two years.

Overview of Curriculum Requirements

The curriculum requires 128 hours for graduation and is organized as follows:

Required Courses

Required courses total 62 hours.

Basic Sciences and Mathematics

These courses stress the scientific principles upon which the engineering discipline is based.

Hours	
5	MATH 220—Calculus I
3	MATH 230—Calculus II
4	MATH 243—Calculus III Plus
4	MATH 386—Intro Differential Eq Plus
4	PHYS 211—Univ Physics, Mechanics
4	PHYS 212—Univ Physics, Elec & Mag
2	PHYS 213—Univ Physics, Thermal Physics
2	PHYS 214—Univ Physics, Quantum Phys
3	CHEM 102—General Chemistry I
1	CHEM 103—General Chemistry Lab I
32	Total

Electrical Engineering Core

These courses stress fundamental electrical engineering concepts and basic laboratory techniques that encompass the common intellectual understanding of all electrical engineering.

Hours	
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4	ECE 110—Intro Elec & Comp Engrg
4	ECE 190—Intro to Computing Systems
4	ECE 210—Analog Signal Processing
3	ECE 290—Computer Engineering, I
3	ECE 329—Intro Electromagnetic Fields
2	ECE 385—Digital Systems Laboratory
3	ECE 440—Solid State Electronic Devices
2	ECE 445—Senior Design Project Lab
25	Total

Probability and Statistics

This course lays the ground work for understanding problems ranging from communications engineering to data analysis in diverse areas such as medicine and manufacturing.

Hours	
3	ECE 413—Probability with Engrg Applic or STAT 410—Statistics and Probability II
3	Total

Composition I

This course teaches fundamentals of expository writing.

Hours	
4	RHET 105—Principles of Composition

Technical Electives

These courses are chosen from the Departmentally Approved List of Technical Electives that includes courses in ECE, other engineering departments, and the basic sciences and mathematics departments. This elective requirement gives each student freedom to define a technical course of study in electrical engineering of considerable breadth and focus. The Advanced Core ECE Electives are introductory to major specialty areas of electrical

engineering. Choices should be made with care, planning, and consultation with an advisor. Consult also the advising materials for all the sub-disciplines of electrical engineering.

35 hours to include <i>at least</i> :	Selected from the Departmentally Approved <u>List of Technical Electives</u>
(i) 6 hours	Non-ECE courses
(ii) 3 courses	Selected from the following list of Advanced Core ECE electives:
3-4 hours	ECE 391—Computer Systems Engineering or CS 225—Data Structure & Softw Prin
4 hours	ECE 410—Digital Signal Processing, I
3 hours	ECE 430—Power Circuits & Electromechanics
4 hours	ECE 442—Electronic Circuits and ECE 443—Electronic Circuits Laboratory
3 hours	ECE 450—Lines, Fields, and Waves
(iii) 2 courses	ECE labs identified in the <u>List of Technical Electives</u>
(iv) 22 hours	ECE courses

Social Sciences and Humanities

The social science and humanities courses, as approved by the College of Engineering, ensure that students have exposure in breadth and depth to areas of intellectual activity that are essential to the general education of any college graduate.

Hours	Requirements
18	Social sciences and humanities courses approved by the College of Engineering and satisfying the campus general education requirements for social sciences and humanities.

Free Electives

These unrestricted electives give the student the opportunity to explore any intellectual area. This freedom plays a critical role in helping students to define research specialties or to complete minors such as bioengineering, technology and management, or languages. At least seven hours must be taken for a grade.

Hours	Requirements
11	Free electives

Campus General Education Requirements

Students must select courses that satisfy both the college social sciences and humanities requirement and the campus requirements in social and behavioral sciences and in

humanities and the arts. Careful choices will assure that these courses also satisfy the campus requirements in the areas of Western and non-Western cultures. Many of these courses satisfy the campus General Education Advanced Composition requirement, which assures that the student has the advanced writing skills expected of all college graduates. The campus requirements in Composition I, natural sciences and technology, and quantitative reasoning are met by required courses. Beginning with the class that entered in fall 2000, students must complete a third-level college language course. Most students satisfy this requirement by completing three years of high school instruction in a single language.

Suggested Sequence

First Year

Hours	First Semester
3	CHEM 102—General Chemistry I
1	CHEM 103—General Chemistry Lab I
0	ENG 100—Engineering Lecture
5	MATH 220—Calculus I
4	RHET 105—Principles of Composition or ECE 110*—Intro Elec & Comp Engrg ¹
3	Elective in social sciences or humanities ²
16	Total

Hours	Second Semester
4	ECE 110*—Intro Elec & Comp Engrg or RHET 105—Principles of Composition ¹
3	MATH 230*—Calculus II
4	PHYS 211*—Univ Physics, Mechanics
3	Elective in social sciences or humanities ²
3	Free elective
17	Total

Second Year

Hours	First Semester
4	ECE 190—Intro to Computing Systems
4	MATH 243*—Calculus III Plus
4	PHYS 212*—Univ Physics, Elec & Mag
3	Elective in social sciences or humanities ²
2	Free elective
17	Total

Hours	Second Semester
4	ECE 210*—Analog Signal Processing
3	ECE 290*—Computer Engineering, I
4	MATH 386*—Intro Differential Eq Plus
2	PHYS 213*—Univ Physics, Thermal Physics
2	PHYS 214*—Univ Physics, Quantum Phys
3	Elective in social sciences or humanities ²
18	Total

Third Year

Hours	First Semester
3	ECE 329—Intro Electromagnetic Fields
2	ECE 385—Digital Systems Laboratory
3	ECE 413—Probability with Engrg Applic or STAT 410—Statistics and Probability II
4	Technical elective ³
3	Elective in social sciences or humanities ²

15	Total
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Hours	Second Semester
3	ECE 440—Solid State Electronic Devices
10	Technical electives ³
3	Free elective
16	Total

Fourth Year

Hours	First Semester
2	ECE 445—Senior Design Project Lab
9	Technical electives ³
3	Elective in social sciences or humanities ²
14	Total

Hours	Second Semester
12	Technical electives ³
3	Free electives
15	Total

* 2.25 GPA rule courses

1. RHET 105 may be taken in the first or second semester of the first year as authorized. The alternative is ECE 110.

2. Each student must satisfy the 18-hour social sciences and humanities requirements of the College of Engineering and the campus general education requirements for social sciences and humanities.

3. A minimum of 35 hours chosen from the Departmentally Approved List of Technical Electives. Of these, at least three courses are to be chosen from the ECE advanced core electives and two courses from the list of ECE laboratory electives; 22 hours must be ECE coursework, six hours non-ECE coursework, and the remaining hours may be chosen from the entire List.