PROPOSAL TO THE SENATE COMMITTEE ON EDUCATIONAL POLICY

TITLE OF THE PROPOSAL:

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

SPONSOR:

Professor N. Narayana Rao
Associate Head for Instructional and Graduate Affairs
Department of Electrical and Computer Engineering
153 Everitt Laboratory
MC-702

Phone: (217) 333-3302
Fax: (217) 244-7075
E-mail: rao@ece.uiuc.edu

BRIEF DESCRIPTION:

The primary goals of this revision include:

1. update the Computer Engineering content of the Curriculum
2. provide a unified treatment of computer engineering, from low level design to high level programming
3. eliminate duplication of topics in sequence of core courses

JUSTIFICATION:

The Computer Engineering Curriculum was introduced in 1971 in the ECE Department, then known as the Department of Electrical Engineering (EE). The name of the department was changed from EE to ECE in the mid 1980's. Since 1971, the Computer Engineering Curriculum has undergone only incremental changes over the years. While the fundamental material in the EE part of the curriculum remains relevant and current, the discipline of Computer Engineering has changed significantly in the last decade, both in terms of underlying concepts and in terms of existing pedagogy. As a guiding principle for the curriculum, we believe that computer engineers should understand computing from the low level to the high level.

Specific topics that should be understood by all computer engineers include:

1. Basic engineering mathematics and sciences (including probability and statistics)

2. Electricity and magnetism
3. Semiconductors, transistors
4. Implementation of digital logic devices
5. Basic logic (Boolean algebra, propositional logic) and logic design
6. Digital systems
7. Computer architecture
8. Algorithm design and analysis
9. Data structures
10. Machine-level programming
11. High-level (including object-oriented) programming
12. Bridge between high-level programming and low-level programming
13. Operating systems

The proposed revisions aim to realign the CE Curriculum with the goals and guiding principles outlined above.

Strong overlaps of this revised CE Curriculum with the EE Curriculum (also being revised, as described in a companion proposal, submitted for approval) address items 1-4 above. 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i. MATH 242 (3 hours) has been replaced by MATH 243 (4 hours) which provides additional treatment of vector calculus.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) and MATH 415 have been replaced by MATH 386 (4 hours) which provides adequate treatment of both differential equations and linear algebra.
iii. STAT 400 has been replaced by STAT 410 as an option in place of ECE 413.
iv. The basic science requirement is replaced by a requirement to take one course from the departmentally approved list of technical elective other than ECE or CS (see Appendix A).

Gaps in the present curriculum with respect to algorithm analysis in item 8 above will be filled by revised versions of Math 213 and CS 173. Students may take either course.

The newly introduced required courses ECE 190 and ECE 391 address gaps in the present curriculum with respect to items 10, 12, and 13. 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), and is required for computer engineering majors.

The remaining items above are adequately addressed by the present curriculum.

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 changes that will affect this department are: (1) switching from the present requirement of Math 213 to an option between CS 173 and Math 213, and (2) switching from CS 125 to ECE 190. The CS Department has indicated that they have no reservations about the proposed changes and they will reallocate resources to manage any net changes in course enrollments when the revised curriculum becomes effective. See letter attached.

Mathematics Department. The changes that will affect this department are: (1) changing the required calculus sequence by replacing Math 242 by Math 243, and Math 385 by Math 386; (2) switching from the present requirement of Math 213 to an option between CS 173 and Math 213; and (3) dropping the requirement of Math 415, since the linear algebra content in Math 386 is considered to be sufficient, eliminating the need for a separate three-hour course on the subject. The Mathematics Department has indicated that they are able and willing to adjust resources to manage any net impact of these changes. 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 revisions will bring the curriculum in line with the changes in the discipline of computer engineering in the last decade, both in terms of underlying concepts and in terms of existing pedagogy, as explained under "Justification."

STATEMENT FOR PROGRAMS OF STUDY CATALOG:

See attached.

PROPOSED EFFECTIVE DATE: Fall 2006

CLEARANCES:

N. Narayana Rao Date: 10/19/05

Sponsor

Date: Oct 19, 2005

Department of Electrical and Computer Engineering

Date: 10/27/05

College of Engineering

Date: _____

Office of the Provost

Appendix A

Departmentally Approved Technical Electives List for ECE Programs

ABE:	All 200, 300, 400 level(*) (Agri. Biol. Eng.)
AE:	311, 402, 407, 412, 413, 416, 433, 434, 435, 481 (Aerospace Eng.)
ASTR:	404, 405, 414 (Astronomy)
ATMS:	300, 401, 402, 410, 421 (Atmospheric Sci.)
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(*) (Chem. Biomolecular Eng.)
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 Sci.)
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 (Elect. Comp. Eng.)
GE:	411, 420, 424, 424 (General Eng.)
GEOL:	452, 454, 471 (Geology)
IB:	150/151(+), all 200, 300, 400 level(*) (Integrative Biology)
IE:	310, 330 (Industrial Eng.)
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 Cell 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 Sci. Eng.)
NPRE:	402, 421, 423, 431, 435, 441, 446, 447, 448, 455 (Nucl. Plasma Radiol. Eng.)
PHYS:	325, 326, 402, 403, 427, 460, 470, 485, 486, 487 (Physics)
TAM:	211, 212, 251, 324, 335, 412, 435, 445, 451 (Theoretical Applied Mech.)

- * excepting seminars and special topics courses
- + AP hours in marked courses cannot be used as technical elective hours

Appendix B

Title of Course: *Computer Systems Engineering*

Text: Course notes prepared by Prof. Steve Lumetta

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

www.ece.uiuc.edu
Department of Electrical and Computer Engineering
155 Everitt Laboratory
1406 West Green Street
Urbana IL 61801
217-333-2300

For the Degree of Bachelor of Science in Computer Engineering

Computer engineering is a discipline that applies principles of physics and mathematics to the design, implementation, and analysis of computer and communication systems. The discipline is broad, spanning topics as diverse as radio communications, coding and encryption, computer architecture, testing and analysis of computer and communication systems, vision, and robotics. A defining characteristic of the discipline is its grounding in physical aspects of computer and communication systems. Computer engineering concerns itself with development of devices that exploit physical phenomena to store and process information, with the design of hardware that incorporates such devices, and with software that takes advantage of this hardware's characteristics. It addresses problems in design, testing, and evaluation of system properties, such as reliability, and security. It is an exciting area to work in, one that has immediate impact on the technology that shapes society today.

Educational Objectives and Outcomes

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

- **Depth**. To provide students with an understanding of the fundamental knowledge prerequisite for the practice of or for advanced study in computer 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 computer 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 computer engineering
- Knowledge of mathematics, and basic and engineering sciences, necessary to carry out analysis and design appropriate to computer engineering
- Knowledge of discrete mathematics.

The CompE 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 computer/electrical 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 Computer Engineering (CompE) Curriculum

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

The computer engineering core curriculum focuses on fundamental computer engineering knowledge: circuits (ECE 110), systems (ECE 210), electromagnetics (ECE 329), computer engineering (ECE 190, ECE 290, ECE 385, ECE 390, ECE 411), solid state electronics (ECE 440), and computer science (CS 225). The rich set of ECE elective courses permits students to concentrate in any sub-discipline of computer engineering including: computer systems; electronic circuits; networks; engineering applications; software, languages, and theory; and algorithms and mathematical tools.

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. Engineering design, communication, and teamwork are integrated throughout the curriculum, including the beginning required courses, Introduction to Electrical and Computer Engineering (ECE 110), Introduction to Computing Systems (ECE 190), and Introduction to Computer Engineering (ECE 290), as well as Computer Systems Engineering (ECE 391), Digital Systems Laboratory (ECE 385), and Computer Organization and Design (ECE 411), which are taken in the third year. Further design experiences occur in the elective courses.

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 advisors, 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 Undergrad Research Symposium. The department offers thesis courses and project opportunities for students wishing to graduate with Highest Honors.

Grade-Point Average Requirements

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 76 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 to 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

Computer Engineering Core

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

Hours	
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

(Rev. 11/9/05)

2	ECE 385—Digital Systems Laboratory
3	ECE 391—Computer Systems Engineering
4	ECE 411—Comp Organization & Design
3	ECE 440—Solid State Electronic Devices
4	CS 225—Data Structure & Softw Prin
34	Total

Advanced Mathematics

These courses provide additional sophistication for the computer engineer. The probability and statistics course lays the groundwork for understanding problems ranging from communications engineering to data analysis in diverse areas such as medicine and manufacturing.

Hours	
3	CS 173 – Discrete Structures or MATH 213—Basic Discrete Mathematics
3	ECE 413—Probability with Engrg Applic **or** STAT 410—Statistics and Probability II
6	Total

Composition I

This course teaches fundamentals of expository writing.

Hours	
4	RHET 105—Principles of Composition

Technical Electives

These courses stress the rigorous analysis and design principles practiced in the major concentration areas of computer engineering.

Hours	
22	One course must not be either ECE or CS. The remainder are electives in electrical and computer engineering and in computer science. All are to be chosen from the Departmentally Approved List of Technical Electives.

Social Sciences and Humanities

The social sciences 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	
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	
12	Free electives

Campus General Education Requirements

Students must select courses that satisfy both the College of Engineering's social sciences and humanities requirement and the campus requirements in social and behavioral sciences and in humanities and the arts. Proper 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 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
3	CS 173* - Discrete Structures or MATH 213*—Basic Discrete Mathematics
4	MATH 243*—Calculus III Plus
4	PHYS 212*—Univ Physics, Elec & Mag
3	Elective in social sciences or humanities[2]
18	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	Free elective
18	Total

Third Year

Hours	First Semester
4	CS 225—Data Structure & Softw Prin
3	ECE 329—Intro Electromagnetic Fields
2	ECE 385—Digital Systems Laboratory

3	Technical elective[3]
3	Elective in social sciences or humanities[2]
15	Total

Hours	Second Semester
3	ECE 391 – Computer Systems Engineering
3	ECE 413—Probability with Engrg Applic or STAT 410 Statistics and Probability II
3	ECE 440—Solid State Electronic Devices
3	Technical elective[3]
3	Elective in social sciences or humanities[2]
15	Total

Fourth Year

Hours	First Semester
4	ECE 411—Comp Organization & Design
5	Technical electives[3]
3	Elective in social sciences or humanities[2]
3	Free elective
15	Total

Hours	Second Semester
11	Technical electives[3]
3	Free elective
14	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.. One course must not be either ECE or CS. The remaining classes are ECE and CS electives. All are to be chosen from the Departmentally Approved List of Technical Electives.