

ECE Curriculum Guide

Classes of 2008-2011

Department of Electrical and Computer Engineering

University of Rochester

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ECE UNDERGRADUATE COORDINATOR

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**CURRICULUM CHANGES APPLICABLE
TO THE CLASSES OF 2011 AND BEYOND**

ECE 101 IS NOW A 2 CREDIT ELECTIVE SEMINAR COURSE. FRESHMAN ARE STRONGLY ADVISED TO TAKE THIS COURSE.

THE NORMAL FRESHMAN FALL SCHEDULE SHOULD INCLUDE ECE 112. HOWEVER, IF ECE 112 IS NOT TAKEN IN THE FIRST YEAR IT MAY BE TAKEN IN A SUBSEQUENT YEAR.

THERE IS NOW A GREATER FLEXIBILITY IN TAKING ECE COURSES. STUDENTS WHO HAVE AP CREDITS IN CALCULUS, OR WHO ARE UNSURE OF THEIR MAJORS, SHOULD CONSULT WITH THEIR ADVISOR IN DESIGNING A SUITABLE SELECTION OF COURSES.

Undergraduate Program Mission Statement

Our mission is to provide our students with the knowledge and skills that will enable them to build productive careers in the field of Electrical and Computer Engineering. We will teach our students the principles and good practices of modern basic and applied electrical and computer engineering. We will train them to solve problems systematically, yet to think creatively, and we will develop in them an awareness of the role of engineering in modern society.

Program Objectives

- Develop within our graduates a basic foundation of knowledge in six fundamental areas of electrical and computer engineering (circuits and systems, electromagnetics, microelectronics, digital systems, computer architecture, signals and communications) with additional depth and design experience in at least one area.
- Develop in our students the proficiency in engineering analysis and synthesis needed for the professional practice of electrical and computer engineering.
- Help our students to develop the skills necessary to function effectively on an engineering team.
- Develop within our graduates the ability to communicate effectively with the technical community and the general public.
- Instill in our graduates an appreciation of and enthusiasm for research, creativity and lifelong inquiry.
- Foster within our graduates an appreciation for the need to maintain the highest ethical standards in their professional lives.
- Provide our students with the breadth to pursue opportunities in non-traditional fields within or outside of electrical and computer engineering.

Program Educational Outcomes

- Students will acquire knowledge and skill in the mathematics underlying electrical and computer engineering analysis and design, including calculus, linear algebra, discrete mathematics, and probability.
- Students will develop a firm foundation in the physical sciences underlying electrical and computer engineering analysis and design, including fundamental physics and electricity and magnetism.
- In recognition of the broad choice of career paths within ECE and the societal impact of engineering, students will obtain knowledge of modern physics or other sciences such as biology, chemistry, or environmental science.
- Students will be able to use the tools of Electrical and Computer Engineering, including computer simulation, design and analysis software, and laboratory measurement equipment.
- Students will be able to design and conduct experiments, and analyze and correctly interpret data.
- Students will gain a sufficient foundation in the fundamental areas of electrical and computer engineering to understand problems in a broad context. These fundamental areas include: circuits and systems, electromagnetics, microelectronics, digital systems, computer architecture, signals and communications.
- Students will have the in-depth training in at least one fundamental ECE area to conduct detailed design and analysis and will develop the skills to bring a design project to successful completion.
- Students will gain the skills and general engineering knowledge necessary to function in an engineering project team.
- Students will be exposed to the issues of professionalism and ethical responsibility through examples.
- Students will be able to communicate effectively with their peers and the public in written, oral, and graphical forms.
- Students will start to understand the societal context and impact of engineering.
- Students will learn to appreciate the value of the creation and dissemination of new engineering knowledge and the need to engage in life-long learning.
- Students will broaden their education through exposure to the humanities and/or social sciences.

This Guide supplements information found in the 2006-2008 *Official Bulletin* of the University of Rochester for the Electrical and Computer Engineering degree program in the School of Engineering and Applied Science (SEAS). To plan a program of study meeting departmental requirements and satisfying one's objectives, each student must remain aware of applicable curricular requirements. When requirements are changed, the Department is obligated to communicate these changes to students through letters, announcements, and/or meetings. **It is the student's obligation to read and study this Curriculum Guide, to attend announced class meetings, and to meet with his or her advisor regularly.**

1) ABET PROGRAM ACCREDITATION

In the State of New York, engineering degrees must be registered for either professional or general purposes. All degrees conferred by the Department of Electrical and Computer Engineering at the University of Rochester are registered for professional purposes. In contrast, all degrees granted through the Inter-departmental Program are registered for general purposes.

The State will automatically register an engineering degree program for professional purposes if it is accredited by the Accreditation Board for Engineering and Technology (ABET). The current ABET accreditation criteria require that each electrical and computer engineering student complete a curriculum with the following **minimum** content:

(1)	Humanities & Social Science	1/2 year	(16 credit hours)
(2)	Mathematics & Basic Science	1 year	(32 credit hours)
(3)	Engineering Science and Design	1 1/2 year	(48 credit hours)

In the item (3) above, students should strive to achieve at least 1 year (32 credit hours) of Engineering Science and at least 1/2 year (16 credit hours) of Engineering Design content. Further, the program must culminate in a meaningful, major design experience. **The required courses in the ECE curriculum listed below guarantee satisfaction of ABET accreditation requirements.**

2) PROFESSIONAL REGISTRATION

The main difference between professional and general degrees is that students with the professional degree may sit for part A of the Professional Engineering Examination, also known as the Fundamentals of Engineering (FE) examination. This examination on fundamentals of engineering and science is the first step toward registration as a professional engineer. All ECE students should consider taking the FE examination in the spring of their senior year. Professional registration brings certain recognized benefits, furthermore, entry-level engineering jobs with the State of New York, as well as many junior level federal positions, require successful completion of the FE. In addition, private corporations such as Kodak and Xerox require a significant number of professionally registered engineers. Because the path that an engineer's career is likely to take is difficult to predict, the department encourages all students to sit for the FE examination.

3) RECOMMENDED CURRICULUM AND REQUIREMENTS

First Year – FALL

ECE101 – Freshman Seminar
ECE 112 – Logic Design
MTH 161 – Calc. I
CAS 105 – Writing Requirement
Elective (hum. or social science)³

Second Year – FALL

ECE 111 – Intro. Signals & Circuits
MTH 165¹ – Linear Algebra w/ Diff. Equations I
PHY 122² – Elec. & Magnetism
Elective (hum. or social science)³

Third and Fourth Years – FALL

ECE 221 – Elec. Devices & Circuits
ECE 241 - Signals
ECE 230 – Electromagnetic Waves

SPRING

ECE114 – Intro. Comp. & Prog.
MTH 162¹ – Calc. II
PHY 121² – Mechanics
Elective (hum. or social science)³

SPRING

ECE 113 – Circuits & Signals
MTH 164¹ – Multidimensional Calc.
PHY 123² – Waves & Modern Physics
or other Natural Science³
Elective (hum. or social science)³

SPRING

ECE 200 – Computer Org.
ECE 222 – Integrated Circuits
ECE 242 - Communications
ECE 216 – Microprocessors & Embedded
Microcontroller Sys.

Plus the following:

- MTH201 – Introduction to Probability⁴
- 1 ECE Advanced Elective course
- ECE 349 - Capstone Design course
- ECE 399 (2 credits) – Social and Ethical Aspects of Engineering
- ECE 398 (2 credits) – Engineering Design Seminar
- Free electives to complete the balance of 128 credit hours.

A total of 12 ECE courses, the ECE Capstone Design Course plus the two seminar courses, ECE 398 and ECE 399 are required for graduation.

ECE 399 should be taken in the junior year and ECE 398 must be satisfactorily completed, usually in the Fall term of the Senior year, prior to undertaking the Capstone Design course.

¹Acceptable alternative mathematics sequences: Honors math Sequence: MTH 171, 172, 173, 174, is perfectly appropriate for those with adequate mathematics background. The sequence MTH 141, 142, 143, 165, 164; is acceptable, **HOWEVER**, it is best to take MTH143 or an equivalent in the SUMMER between the 1st and 2nd years, in order to get back in sequence. Consult with your faculty and administrator to arrange your best sequence.

²Two physics courses, PHY 121 and PHY 122, are required of all ECE majors. In addition, it is strongly recommended that ECE students also complete PHY123. However selected other courses in natural science from among AST, BCS, BIO, CHM, EES, and PHY may also satisfy the ECE program's Natural Science requirement. Students must check with the ECE department undergraduate coordinator prior to taking any such course to confirm that the course will satisfy the ECE Natural Science requirement.

³In the ECE program a total of five courses in the humanities and social sciences is required. Three of these courses must constitute an approved Cluster in Humanities or Social Sciences and must be passed with a 2.0 average or better. See the Cluster Search Engine (<http://www.rochester.edu/College/CCAS/clusters>) and descriptions of clusters in the undergraduate bulletin.

⁴MTH 201, "Introduction to Probability", is required for all ECE majors. Students should normally take MTH201 concurrently with ECE241 but in any case MTH201 must be taken prior to taking ECE242.

For graduation, electrical and computer engineering majors must achieve a minimum cumulative grade-point average of 2.0 in the eleven required ECE core courses: specifically ECE 111, 112, 113, 114, 200, 216, 221, 222, 230, 241 and 242. In addition, 128 total credits are required for graduation with an overall cumulative grade point average of 2.0.

4) ADMISSION REQUIREMENTS

Students wishing to major in Electrical and Computer Engineering must file a completed "ECE Curriculum Planning Form" (See Appendix 1), along with the Concentration Approval Form, ordinarily during the fourth semester of study. This form constitutes application to the upper-division ECE program. The minimum requirements for admission to the ECE program are completion of the following: (*no student may be admitted to the major if on Academic Probation in the College*)

1. ECE 111, 112, 113 and 114 with a minimum cumulative GPA of 2.3 in these four courses
2. MTH161, 162, 165, 164 or the equivalent mathematics sequence
3. PHY121, 122, 123 (or other natural science course in place of PHY123)
4. University primary writing requirement, usually satisfied by taking CAS 105
5. A minimum GPA of 2.0 in all courses completed to date.

A submitted plan, though never binding, is very useful in helping students to focus their interests within the field of electrical and computer engineering. Before preparing and submitting a course plan, each student should study available written material and then discuss the alternatives fully with his or her faculty advisor or with other faculty. The Curriculum Planning Form, approved by the student's faculty advisor, will then be attached to a Concentration Approval form and submitted to the Dean of SEAS.

Under special circumstances, such as transfer from another institution or a change of intended major in the early years of study, students may not complete all the requirements for admission by the end of the sophomore year. Such circumstances might include lacking one of the three required ECE or seven freshman-sophomore courses in mathematics, physics, and physical sciences. Students in such a situation may qualify for **conditional admission** by submitting a form, available from the Undergraduate Coordinator in the ECE Office, to the ECE Undergraduate Committee along with an up-to-date ECE Curriculum Planning Form. The application must present a realistic plan, approved by the student's advisor, for completion of all ECE program admission requirements within one year. Failure to meet the requirements within one year will result in removal from the major.

Only the Administrative Committee of the School of Engineering and Applied Sciences can make exceptions from the general degree requirements published in the Official Bulletin of the University. Petition forms for Administrative Committee consideration may also be obtained from the Electrical and Computer Engineering Office.

5) ECE ADVANCED ELECTIVE AND CAPSTONE DESIGN

In planning a program of study each student must choose one advanced ECE elective course and the capstone design course ECE 349. This is the minimum requirement and students are encouraged to take as many advanced electives as they may fit into their schedule. This requirement assures that all majors devote some of their advanced level course-work to a specialization within ECE leading to a design project. Students may choose one of the specified design projects or they may define their own design project in consultation and with the approval of an ECE faculty member. In this case the student should petition the ECE Undergraduate Committee using the standard petition form available from the Undergraduate Coordinator in the ECE Office.

A listing of advanced electives for the various areas of specialization are given below. Multiple advanced electives are listed for most areas; please consult with your ECE advisor to make appropriate course selections. Refer to the undergraduate bulletin for course descriptions.

AREA	ADVANCED ELECTIVES	CAPSTONE DESIGN
Signals and Communications	244, 245, 246	349
VLSI and Electronics	261, 266	349
Computer Engineering	201	349
Waves, Fields and Devices	223, 226, 234, 235, 266	349

Students are also required to complete ECE398 (Engineering Design Seminar) prior to undertaking the Capstone Design Project; ECE398 normally will be completed in the fall of the Senior year.

6) PRE-MEDICAL

ECE students interested in preparing for medical school are urged to obtain related materials from the Health Professions Advisor at the Center for Academic Support, Lattimore 312. It is essential that such students begin program planning very early and involve both their ECE advisor and the Health Professions Advisor.

Some of the courses usually required for admission to medical school are readily accommodated within the BS ECE curricular requirements. These include two semesters of general physics, two semesters of general chemistry, two semesters of math, and two semesters of English. (The English requirement is accommodated by using one of the five H&SS courses over and above the University Primary Writing requirement.) Note that a laboratory in physics is usually required for medical school admission, although not for the ECE program. Only medical schools may decide whether ECE labs can be substituted.

Additional requirements for medical school admission include a year of biology with labs and a year of organic chemistry with labs. To accommodate these courses, an ECE student can use the free electives available in the ECE curriculum. Additional courses can only be accommodated by overloads, by use of summer courses, or by advanced placement credit.

Scheduling all of these courses with due regard for prerequisites may be complex and the workload demands strong commitment from the student. Thus, consultation with the Health Professions Advisor in Lattimore Hall and the ECE faculty advisor is essential. Freshman orientation is not too early to begin program planning!

7) INTERNSHIPS AND PRACTICUM

ECE majors are strongly encouraged to participate in internships with local or nationally based engineering firms. Only in a few cases can internship experiences be used for academic credit. Students who wish to obtain such credit for an internship must obtain prior approval from the ECE Undergraduate Committee.

The Engineering Practicum program, supervised jointly by the School of Engineering and Applied Sciences (SEAS) and the Center for Work and Career Development (CWCD), is a way to gain valuable work experience. A student in this program takes one semester and the summer preceding or following to work for a company. Academic credit is not granted, but the work experience and references obtained are valuable in later job searching. Typically graduation is delayed by one semester, but some students with Advanced Placement credit or summer classes can graduate on time. Additional information, including example programs, is available from the SEAS office in Lattimore Hall, or from the CWCD Office.

8) TRANSFER CREDITS

If a student wishes to take a course at another institution to satisfy an ECE degree requirement, **PRIOR APPROVAL** is required and proper supporting documentation about the course must be submitted to the ECE Department Undergraduate Coordinator. An "Undergraduate Transfer Credit Approval Form," available in the ECE Office is to be used for this purpose. Students are strongly advised to seek the advice of their advisor before registering for a course at another institution. Completed forms will be forwarded to the Undergraduate Committee for action.

9) FIVE-YEAR BS/MS PROGRAM

ECE juniors contemplating graduate work should consider the special five-year program offered by the Department. This program provides the advantage of a smooth transition between undergraduate and graduate study. Program enrollment is competitive and students must apply for admission in the spring of their junior year. Successful applicants begin their masters-level study in the Senior year. Through a special program initiated by the School of Engineering and Applied Science, students who have been formally accepted into the 3/2 program will be granted a 75% tuition scholarship for the fifth year of study (only after the BS degree has been awarded).

Students should consult the UR *Graduate Studies Official Bulletin* found at: (<http://www.rochester.edu/GradBulletin/>) for the MS degree requirements and they should meet with a faculty member to develop an integrated BS/MS program of study.

10) CERTIFICATE IN MANAGEMENT STUDIES

Many ECE students choose to pursue the Certificate in Management Studies, which requires 6 courses (see the Undergraduate Bulletin and the Interdepartmental/Social Science Cluster link for more details). With careful planning, it is possible for ECE students to obtain this certificate without overloading.

11) NROTC

A maximum of two NROTC courses (8 credits) may be taken as free electives toward the 128 credits required for graduation. Additional NROTC courses must be taken as overloads.

12) UPPER-LEVEL WRITING REQUIREMENT

It is vitally important for all students to be able to communicate effectively in writing. The University's **Upper-level Writing Requirement** applies to all majors. Within electrical and computer engineering the requirement will be met through writing assignments in ECE 111, 112, 113, and ECE 399. Students who transfer credit for any one or more of these courses from another institution to the UR must consult with the ECE Department's undergraduate coordinator to determine if their program satisfies the requirement.

13) Humanities & Social Science Requirement

All ECE majors must take a minimum of 5 humanities/social science (H&SS) courses. This includes the three courses taken to satisfy the University Cluster requirement. These five courses can be chosen from any recognized Humanities and/or Social Science field listed below. Courses in the business field may not be used to satisfy this requirement. Students also are expected to take some of these courses beyond the introductory level. Ordinarily, H&SS Clusters will count for three of the five required courses, but if questions arise, students should consult their advisors. Language courses at the 101 level are only accepted when followed by another, more advanced course in the same language.

Acceptable Humanities Courses: Any English course except for ENG101 or the course taken to satisfy the university primary writing requirement (usually CAS 105); any course in art or art history, foreign or comparative literature, a foreign language above 101 level, music theory or music history, philosophy, religious studies, or film studies courses cross-listed in a humanities department.

Acceptable Social Sciences Courses: Any course in anthropology, economics, history, linguistics, political science, psychology or sociology.

Notes:

- 1) No computer courses offered in humanities or social science fields may be used as a H/SS distribution course.
- 2) Ordinarily, courses taken at the University of Rochester to meet the 5 course requirement in H&SS are 4 credit hour courses. Consult your advisor concerning 2 or 3 credit courses (including transfer courses). You may need to petition the Undergraduate Committee to use such courses as credit toward the H&SS distribution requirement.

The following restriction applies to all courses used to satisfy the distribution requirement:

"The Faculty approved the Committee on Educational Policy motion that two 2-credit courses may be combined to fulfill one 4-credit distribution requirement only if both courses are from the same discipline; that two 2-credit courses from different disciplines may be substituted for a 4-credit free elective; and that no more than two courses may be combined to count toward either a distribution requirement or a free elective." From Summary of Minutes, School Faculty Meeting, September 23, 1977.

14) Natural Science Requirement

Courses that may satisfy the Natural Science requirement are:

Physics – PHY123 or higher

Astronomy – AST111 or higher

Chemistry – CHM103 or higher

Biology– BIO110 or higher (BIO115 1st Semester Freshman ONLY)

Earth & Environmental Science - EES101 or higher

Brain & Cognitive Sciences – BCS110 or higher

Appendix 1: ECE CURRICULUM PLANNING FORM

ECE students are required to maintain an up-to-date copy of this form in their advising folder, starting with the pre-registration that occurs in the spring of their second year. Additional copies of this form may be obtained from the ECE Office.

NAME _____ ID# _____ DATE _____

CAMPUS ADDRESS _____ PHONE _____ CLASS OF _____

NOTE: Indicate in the extreme right column: TC=transfer credit, SR=summer course, AP=advanced placement

	<u>Fall semester</u>	<u>Spring semester</u>	<u>Summer or Transfer</u>
First year:	_____	_____	_____
_____	_____	_____	_____
Acad. year	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
Second year:	_____	_____	_____
_____	_____	_____	_____
Acad. year	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
Third year:	_____	_____	_____
_____	_____	_____	_____
Acad. year	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
Fourth year:	_____	_____	_____
_____	_____	_____	_____
Acad. year	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

Advisor _____ date _____

UG Program Coordinator _____ date _____

UNDERGRADUATE ADVISORS

Undergraduate Committee Chairman

Prof. Jack Mottley	HPN306	5-4308	mottley@ece.rochester.edu
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Undergraduate Committee

Prof. Paul Ampadu	CSB 417	3-5753	ampadu@ece.rochester.edu
Prof. Vic Derefinko	HPN305	5-9402	derefink@ece.rochester.edu
Prof. Wendi Heinzelman	HPN 307	5-4053	wheinz@ece.rochester.edu
Prof. Gaurav Sharma	HPN417	5-7313	sharma@ece.rochester.edu

Undergraduate Program Coordinator

Barbara A. Dick	HPN 205	5-5719	barbd@ece.rochester.edu
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Class Advisors

CLASS 2011

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W. Heinzelman	HPN 307	5-4053	heinzelman@ece.rochester.edu
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H. Wu	CSB 416	5-2112	hwu@ece.rochester.edu
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Z. Ignjatovic	HPN 341	5-3790	ignjatov@ece.rochester.edu

BASIC GUIDE TO ECE UNDERGRADUATE REQUIREMENTS

REQUIREMENTS FOR ADMISSION TO THE CONCENTRATION

ECE111	Curriculum Planning Form
ECE112	Course Approval Form
ECE113	(Forms filed 2 nd sem. Soph. Year)
ECE114 or CSC171	2.3 GPA or Higher
CAS105 (must obtain a C or better)	

NEED TO GRADUATE

CAS105 (must obtain a C or better)	CREDIT
	4

ECE CORE COURSES

ECE111	4
ECE112	4
ECE113	4
ECE114 or CSC171	4
ECE200	4
ECE216	4
ECE221	4
ECE222	4
ECE230	4
ECE241	4
ECE242	4
ECE398	2
ECE399	2

ADVANCED ELECTIVE

ECE Concentrations	Required (one)
Computer Engineering	201
Signals/Communications	245, 246
VLSI/Electronics	261
Waves,Fields and Devices	223, 226, 234, 235
* Concentration chosen must be courses not taken before.	

CAPSTONE DESIGN (ECE349)	<u>4</u>	(60)
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BASIC SCIENCE AND MATH

MTH141 (If you take 141, Must take all three in the 14X sequence)		
MTH161/142	4	
MTH162/143	4	
MTH164	4	
MTH165/163	4	
MTH 201	4	
PHY121/141	4	
PHY122/142	4	
NAT.SCI - (CHOOSE ONE)	<u>4</u>	(32)
AST111 or higher		
CHM103 or higher		
BIO101 or higher		
EES101 or higher		
BCS 110 or higher		
PHY123 or higher		

DISTRIBUTION COURSES – (At least one cluster required) *Must maintain a 2.0 GPA

** (See UR Cluster site <http://www.rochester.edu/College/CCAS/clusters/>)

Cluster	4	
Cluster	4	
Cluster	4	
H/SS	4	
H/SS	<u>4</u>	(20)

FREE ELECTIVES – any Humanities or social sciences courses		(16)
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TOTAL CREDITS 128