

# **ELECTRICAL ENGINEERING**

## **CURRICULUM GUIDE**

**UNIVERSITY OF MINNESOTA  
2008 - 2009**

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## 1.0. INTRODUCTION

This Curriculum Guide supplements the Institute of Technology Bulletin regarding the Electrical Engineering Curricula. It is prepared annually to reflect the department's changing courses and curricula. Students are urged to keep an up-to-date edition on hand and to become familiar with the organization and content of the guide.

### 1.1. Electrical Engineering Curricula

This EE Curriculum Guide reflects the requirements and suggested electives related to the EE Degree. The actual degree is entitled the Bachelor of Electrical Engineering (B.E.E.). Section 8 of this guide contains the requirements for the EE program that applies to those students entering the program prior to Fall 2006, entering Fall 2006 or entering Fall 2007.

Beginning Fall Quarter 1997, the Electrical and Computer Engineering and Computer Science and Engineering Departments began offering a new undergraduate degree called the Computer Engineering Degree (Bachelor of CompE.). (A separate curriculum guide is available for CompE.)

In addition to this Electrical Engineering Curriculum Guide, further information about Electrical Engineering and the Institute of Technology is contained in the

- Institute of Technology Undergraduate Program Information
- Institute of Technology Student Survival Guide and

These are available in hard copy from the IT Student Affairs Office, 105 Lind Hall. This information is also available on the web.

### 1.2. Further Information

Many other individuals and organizations at the University of Minnesota are available to help you. Foremost is the Faculty Academic Advising Committee with whom you should have frequent contact. Other offices and individuals are:

ECE Administrative Office: 625-3300 EE/CS 4174

ECE Department Head:  
David Lilja 625-0720 EE/CS 4178D lilja@umn.edu

ECE Associate Department Head:  
William Robbins 626-6722 EE/CS 4178D robbins@umn.edu

ECE Director Undergraduate Studies:  
Larry Kinney 625-4359 EE/CS 6121 kinney@umn.edu

ECE Academic Advisor & Co-op Coordinator:  
Kathleen Propp 625-4327 EE/CS 4178J propp@ece.umn.edu  
Kyle Dukart 624-2285 EE/CS 4174 kdukart@umn.edu

ECE Co-op Committee  
Ted Higman 624-4170 EE/CS 6125 higma001@umn.edu  
Website: <http://www.me.umn.edu/education/coop/about%20co-op.shtml>

ECE Senior Honors Course:  
Ahmed Tewfik 625-6024 EE/CS 6177 tewfik@umn.edu  
David Lilja 625-0720 EE/CS 4178D lilja@umn.edu

ECE Upper Division Latin Honors:  
Larry Kinney 625-4359 EE/CS 6121 kinney@umn.edu

ECE Scholastic Standards:  
Larry Kinney 625-4359 EE/CS 6121 kinney@umn.edu

ECE Graduate Information & Applications:  
Linda Jagerson 625-3564 EE/CS 4174C jager001@umn.edu

ECE Director Graduate Studies:  
Keshab Parhi 624-4116 EE/CS 6181 parhi@umn.edu

IT Student Services: 624-8504 130 Lind Hall

Liberal Ed. Requirements: 624-8504 105 Lind Hall studentaff@itdean.umn.edu

I.T. Career Services: 624-4090 Lind Hall 50 itcs@tc.umn.edu

I.T. Honors Program:  
Jeanne Anderegg 625-2800 Lind Hall 136 anderegg@umn.edu

Study Abroad - I.T. Student Affairs:  
Adam Pagel 624-8013 107 Lind Hall pagel@tc.umn.edu

Study Abroad - Global Campus:  
626-9000 230 Heller Hall [www.UMabroad.umn.edu](http://www.UMabroad.umn.edu)

Student Financial Aid Office:  
624-1111 200 Fraser Hall helpingu@umn.edu

International Student & Scholar Services:  
626-7100 190 Humphrey Center, West Bank

(The area code for all telephone numbers is 612.)

## 2.0. ADMISSIONS

Initially, all freshmen engineering and science students are admitted to I.T. and not to a specific major. Students are encouraged to designate a major by the end of the first year. Designation of EE as a proposed major does not assure admission to the Upper Division in EE. There is no minor available for Electrical Engineering.

With the completion of 60 credits, each I.T. student is obliged to make formal application in room 130 Lind Hall for admission to the Upper Division. The requirements for admission to Upper Division in Electrical Engineering are

- I.T. Technical Grade-point Average of 2.3.
- The following courses must be completed:
  - a) Math 2373
  - b) Phys 1302
  - c) EE 1301\*
  - d) EE 2001
  - e) At least one of EE 2011, 2301/301, and 2361/361

(\* or CSci 1113 for students entering prior to Fall 2006)

Students in the Coordinate Campus I.T. program at UMD or UMM are considered for Upper Division admission to I.T. under the same criteria as for I.T. students.

Students who apply for transfer from other institutions are generally considered under different criteria for admission when applying directly to Upper Division Electrical Engineering.

Upper Division status is required to enroll in third-year EE courses; overrides are not to be anticipated.

Electrical and Computer Engineering Department policy requires the completion of required EE 3XXX-level courses before registration for any 4XXX- or 5XXX-level courses required for graduation; waiver of this rule requires written prior approval of the Electrical and Computer Engineering Department Director of Undergraduate Studies.

## 3.0 REGISTRATION AND ADVISING

### 3.1. Entering I.T.

When a student is admitted to I.T., he or she is assigned a faculty adviser from I.T. Student Services. Before each semester's registration, a student must meet with the assigned adviser and receive approval of the intended registration.

Any student who has questions about the EE program is welcome to contact any ECE Undergraduate Advising Committee Member, the ECE Director of Undergraduate Studies, or the ECE Undergraduate Academic Adviser.

### 3.2. Upper Division EE

After admission to EE Upper Division, a student will meet with a member of the Undergraduate Advising Committee. Each upper division student must prepare a One-Year Plan (OYP) of course work in consultation with a Faculty Adviser at least once a year. The OYP lists the courses the student plans to take for the next semester or two; the OYP must be approved by a member of the Undergraduate Advising Committee.

A hold called a "Departmental Stamp (DS)" hold is always in effect on a student's registration. (Holds appear under Service Indicators on transcripts.) The DS hold blocks registration for a particular semester and following semesters. The semester to which a DS hold applies is found under a student's 'Holds' on One Stop. To move the DS hold to a future semester, a student must file an approved OYP plan in the ECE Dept Office that includes the planned courses for that semester and, ideally, the following semester. To file a OYP, a student must schedule an appointment with a member of the Undergraduate Advising Committee with the Receptionist in the ECE Dept Office (4-174 EE/CS Bldg, 625-3300). The signed OYP Plan must be returned to ECE Dept Office to have the DS hold changed. A copy of the OYP can be obtained at this time.

**You are responsible for your student copy of the One-Year Plan. Retain it and have it available when needed.**

### 3.3. Graduation Paperwork

Prepare your One-Year Plan for your senior year, and have it signed by a member of the ECE Undergraduate Advising Committee in the usual manner. When you are near the end of the next to last semester before your anticipated graduation, prepare an Application for Degree Form. This form is available on the web (<http://www.onestop.umn.edu/onestop/graduating.html>). It is an essential step in qualifying for graduation since it will inform the Degree-Clearance Office what must be completed to earn the degree. Please turn in the completed form to the Registrar's Office in 200 Fraser Hall. For more information, see Section 11.

### 3.4. Class Reservation and Waiting List

To accelerate the organization of classes under high-enrollment conditions and to reduce uncertainty about class size, the following policy will be enforced: **a student registered for an EE or CSci course must attend the first meeting of the class to retain the reservation.** If the first class is not attended, the student's place will be transferred to an attending student on the waiting list. The University Wait List site is on the registration panel.

Further, any student not enrolled but desiring admission to the class must also attend the first meeting to be considered.

## 4.0. ECE PROGRAMS AND ACTIVITIES

### 4.1. Engineering Co-op Program

#### 4.1.1 General Information

The Department of Electrical and Computer Engineering participates in an Engineering Co-op Education Program for junior and senior level undergraduate students who are either EE or CompE majors. This program allows students to participate in hands-on experience in various companies and government agencies involved in the engineering and technical fields. Both companies and students participating in this program find this a rewarding experience. Many companies have been a part of the Co-op Program for many years because of their positive experiences.

Students are encouraged to apply to the program late in their sophomore year for work experience in their junior and senior years. Upon acceptance into the Co-op Program, students interview with participating companies on a competitive basis. Students are paid at the going salary rate for the position in the company. Employers are expected to assign meaningful engineering tasks to the students, and to arrange for them to experience as many facets of the organization's operations as possible. Students are encouraged to interact with other professionals within the organization and improve their technical and personal communication skills.

#### 4.1.2 Engineering Co-op Program Fall 2006 and Later

Starting Fall 2006 the Electrical and Computer Engineering co-op program combined with the Mechanical Engineering co-op program. The program will operate the same as the ME program except EE students will register for EE co-op courses rather than ME co-op courses. EE co-op students receive credits for the three co-op assignments by registering for EE 3041 (2 cr), EE 4043W (4 cr) and EE 4044 (2 cr); these apply to the non-major technical elective category. At least the first two co-op assignments must be completed to receive credit.

See <http://www.me.umn.edu/education/coop/about%20co-op.shtml> for more information about the co-op program.

### 4.2. I.T. Honors Program

The Electrical and Computer Engineering Department participates in the I.T. Honors Program. During their Senior Year, qualified students may elect to participate in the Senior Honors Design Courses instead of the Senior Design Project course. This is a two-semester, two-credit per semester design course performed under the direction of a faculty adviser and Professors A. Tewfik and D. Lilja. Advance permission from Professor Tewfik or Lilja is required to register for this sequence.

In addition, a student may graduate with Latin honors (cum laude, magna cum laude, summa cum laude) by obtaining the required grade point average, completing the

required honors experiences, and completing an honors thesis. Contact the I.T. Honors Office in 136 Lind Hall, or Professor L. Kinney in Electrical and Computer Engineering for further information.

### 4.3. Study Abroad

There is no such thing as a “local” company or issue anymore. You need the skills that international experience will provide to work effectively in industry, academia, or the public sector. I.T. students should consider gaining international experience through study abroad.

Regular financial aid and scholarships can be applied to study abroad. And, there are many additional scholarships available. Program fees vary widely, with some costing less than a semester on campus.

If you plan to take **courses in your major**, several universities have been identified where EE courses could be pursued for a semester or an academic year. Most students take courses abroad during either their sophomore or junior years, though there is not one formula for everyone.

You may wish to explore topics outside of the EE major, such as international business, a foreign language, international technology management, or take courses toward a minor or second major outside of I.T.

For example, you can take a summer, semester, or academic year program in Finland, in English, focusing on International Technology Management.

EE students can study abroad and cover major and **liberal education** requirements. You may be able to complete an **internship** or take **major courses**, take a couple of your **technical electives**, or do **research**. Many programs offer a flexible curriculum. Advance planning will ensure that courses taken during study abroad will fit smoothly into your degree program.

The following universities abroad offer course work in engineering in English unless otherwise noted:

Australia, University of Melbourne  
Australia, University of Sydney  
Canada, University of Calgary  
China, Hong Kong U of Sci and Tech  
England, Cambridge University  
England, Oxford University  
England, University College-London  
England, University of Leeds  
France, INSA-Lyon (French required)  
Ireland, Trinity College - Dublin  
Korea, Pohang University of Science & Technology (POSTECH)  
Norway, Norwegian U of Sci and Tech – Trondheim  
Norway, University of Oslo  
Scotland, University of Edinburgh  
Scotland, University of Strathclyde

Sweden, Chalmers University of Tech, Gothenberg  
These are just a few of the options available to you. There are many additional international colleges and universities who offer Study Abroad programs, but not taught in English. For a complete listing of study abroad opportunities, you can speak to Adam Pagel in the I.T. Student Services Office, attend a Global Campus First Step Meeting, talk with a Global Campus advisor, look at the U of M Study Abroad Catalog, and visit the Global Campus web site.

## 5.0. NON-EE PROGRAMS

### 5.1. EARNING A CLA MAJOR OR MINOR

An EE student may pursue a minor, major, or entire second degree through CLA. A CLA minor or major is noted on the student's official transcript upon graduation. A second degree is also listed on the transcript and the student is awarded an individual diploma. See an adviser in the IT Student Services Office, 130 Lind Hall, for procedures and forms.

**There is no minor in Electrical Engineering.**

A Computer Science minor is also available through CLA. Contact the Computer Engineering & Science Department for information in 4-192 EE/CS Building.

### 5.2. EARNING AN IT SECOND MAJOR

A student may earn a degree in a second IT program by completing the course requirements for both EE and the second program. The student's transcript will show degrees earned for both majors, and the degrees can be earned at the same time or sequentially. A separate "Application for Degree" must be filed for each. A student interested in a second IT major should submit a petition in the IT Student Services Office, 130 Lind Hall.

### 5.3. COMBINED IT / CARLSON SCHOOL of MANAGEMENT DEGREE

Please contact the Carlson School of Management for information about "The Management Minor for IT Students", 612-624-3313, 2-190 Hanson Hall. The web site for further information is at <http://www.csom.umn.edu/> followed by 'Undergraduate', 'Admissions' and 'Management Minor'. For EE students obtaining a Management Minor some of the 3xxx level management and marketing courses are accepted in the 12-credit non-major technical elective category in the EE program.

### 5.4. PROFESSIONAL ENGINEERING LICENSE

Engineers who perform engineering that may affect the public health and safety are required to be licensed by the state in which they work. An engineer who is licensed is a 'Professional Engineer' (P.E.). This licensing is particularly important for those engineers who may serve as consultants, technical witnesses in courts, etc. on matters affecting the public health and safety.

Registration standards are set and governed by a state board established for that purpose. In Minnesota it is the State Board of Architecture, Engineering Land Surveying, Landscape Architecture, Geoscience, & Interior Design, The Golden Rule Building, Ste. 160 • 85 East Seventh Place, St. Paul 55101-2113, (651) 296-2388 • Fax: (651) 297-5310, <http://www.aelslagid.state.mn.us/>. Information about registration and the advantages can be obtained from the National Society of Professional Engineers (NSPE) ([www.nspe.org](http://www.nspe.org)).

## 6.0. CURRICULUM AND COURSE RESTRICTIONS

### 6.1. DIRECTED STUDY

Under certain conditions a student may register for a directed-study project (EE 4970). For information about the necessary procedures request information in the ECE Department Office (EE/CS 4-174).

**No more than 3 directed study (4970) credits are allowed as Senior Technical Electives.**

### 6.2. GENERAL COLLEGE COURSE POLICY

Students who have taken General College classes should check the complete transfer guide in the IT Student Services Office, 130 Lind Hall.

Generally:

1. Courses with a liberal arts focus transfer to IT.
2. Courses with a technical focus (math, chemistry, physics, and computer science) **do not** transfer to IT.

### 6.3. RESIDENCY REQUIREMENT POLICY

**A student earning a bachelor's degree must complete 30 semester credits after admission to I.T. in his or her declared major department.**

**Transfer credits cannot be used to fulfill credits for the Electrical Engineering Senior Technical Program except for non-EE technical electives.**

### 6.4. COURSES NOT ACCEPTED FOR THE BEE DEGREE POLICY

1. Technical courses in which a grade below C- has been earned do not apply to the Program.
2. Credit may be applied only once for courses treating equivalent subject matter.
3. Technical courses from a technology or technician program do not transfer.
4. Physical education courses (beyond 3 credits) may not be applied.
5. **Generally, work experience does not satisfy any academic requirements.** The only exceptions to this would be for those students that are part of the ECE Coop Program, or students who are allowed to test out of a course by the course instructor.

See also Section 6.2. for General College Course Policy.

### 6.5. TRANSFER CREDIT POLICY

A student who enters with transfer credit from another accredited institution may need to complete additional coursework in order to satisfy minimum credit requirements in mathematics, basic sciences, and/or engineering subjects.

## 6.6. CHANGING DEGREE REQUIREMENTS POLICY

Any changes to the degree requirements need prior written approval by the Director of Undergraduate Studies. Requests for such variances must be submitted by petition. Petitions are filed in the IT Student Services Office, 130 Lind Hall.

Possible approval of such variance requests is enhanced if supported by written statements, e.g., a statement from a member of the Undergraduate Advising Committee supporting the change.

## 6.7. GRADING POLICIES

### 6.7.1. The "D" grade

1. All courses required of the major, except liberal education courses, must be passed with a grade of C- or better.
2. Concerning technical courses transferred from other colleges, no credit is given for a course with a grade below C-.

### 6.7.2. S-N Grading - ECE Policy

1. All EE courses will be offered for either A-F or S-N grading with the exception of EE 1001, EE 3041, 3990, 4043W and 4044 which will be offered S-N only.
2. **For EE majors** the following restrictions will apply to their selection of grading systems, in addition to those restrictions adopted college-wide for all I.T. students.
  - (1) **All EE courses must be taken A-F with the following exceptions: EE 1001, EE 3041, EE 3990, EE 4043W and EE 4044.**
  - (2) **All required technical courses must be taken A-F** except those offered S-N only.

### 6.7.3. The "I" grade

The I grade is used "in accordance with provisions announced in class at the beginning of the semester, when in the instructor's opinion there is a reasonable expectation that the student can complete successfully the missing work of the course. *The I grade is assigned only when a student has completed all but a **small** portion of the work of a course and has made prior arrangements with the instructor to make up the work.*

*The I.T. Bulletin states "The instructor assigns an I when, due to extraordinary circumstances, the student was prevented from completing coursework on time. An I requires a written agreement between the instructor and the student specifying the time and manner in which the student will complete the course requirements during the student's next term of enrollment.*

*For undergraduates and non-degree students, work to make up an I must be submitted within 72 hours of the last final examination of the student's next term of enrollment; if not submitted by that time, in the sixth week of the next term the I will automatically change to an F (if A-F registration) or N (if S-N registration)."*

**If a student wishes to request an "I" in a course, a written statement co-signed by both faculty instructor and student must be presented to the ECE Undergraduate Advising Office prior to submission of the "I" grade, specifying all details on how & when the "I" will be removed.**



## 8.0. EE DEGREE CURRICULUM REQUIREMENTS

The EE program leads to a Bachelor of Electrical Engineering (B.E.E.) degree without a designated emphasis on the diploma. **The curriculum requires a minimum of 128 semester credits.** (126 for students entering prior to Fall 2006.)

### 8.1. Liberal Education (including Writing Practice) Approximately 23 cr required

The liberal education requirements are detailed on the web page  
[http://www1.umn.edu/tc/students/registrar/liberal\\_ed\\_req.html](http://www1.umn.edu/tc/students/registrar/liberal_ed_req.html)

Students are required to take four 'writing intensive' WI courses two, of which, must be upper division courses, and one of the latter must be in the major. The course number for these courses has a suffix of W. EE courses satisfying this requirement are EE 1701W, EE 4043W, EE 4951W, EE 4982V, EE 4389W and EE 5657W.

### 8.2. Mathematics (16 cr required)

Math 1371-1372 (8 cr) IT Calculus I-II  
Math 2373 (4 cr) IT Linear Algebra & Differential Equations  
Math 2374 (4 cr) IT Multivariable Calculus & Vector Analysis

or

Math 1571-1572H Honors Calculus I-II  
Math 2573H Honors Calculus III  
Math 2574H or 3574H Honors Mathematics IV

### 8.3. Chemistry & Physics (16 cr required)

Phys 1301W (4 cr) Introductory Physics I  
Phys 1301W (4 cr) Introductory Physics II  
Chem 1021 (4 cr) Chemical Principles I

**and** either

Chem 1022 (4 cr) Chemical Principles II

or

Phys 2303 (4 cr) Physics of Matter (formerly Physics III)

or

Phys 2403H (4 cr) Honors Physics III

or

Phys 2311 (4 cr) Modern Physics

### 8.4. Computer Science (4 cr required)

EE 1301 (4 cr) Intro to Computing Systems  
(or CSci 1113 (4 cr) Intro to C for Sc & Eng  
for students entering prior to Fall 2006)

## Electrical Engineering Core Courses (35 cr required)

### 8.5.1 Lower Division (15 cr required)

EE 2301/301 (4 cr) Into Digital System Design/Discussion  
EE 2361/361 (4 cr) Intro to Microcontrollers/ Discussion  
EE 2001 (3 cr) Intro Electronic & Electrical Circuits

EE 2002 (1 cr)  
EE 2011 (3 cr)

Intro Circuits & Electronics Lab  
Linear Systems & Circuits

### 8.5.2 Upper Division (20 cr required)

EE 3115 (4 cr) Analog & Digital Electronics  
EE 3161 (3 cr) Semiconductor Devices  
EE 3015 (3 cr) Signals & Systems  
EE 3025 (3 cr) Statistical Methods  
EE 3101-3102 (4 cr) Circuits & Electronics Lab I-II  
EE 3601 (3 cr) Transmission Lines

## 8.6. EE Technical Program (34 cr required) (32 for students entering prior to Fall 2006)

**8.6.1 EE Senior Technical Electives (22 cr minimum required)** (20 for students entering prior to Fall 2006)

### 1) One of the following projects courses:

EE 4951W (4 cr) Senior Design Project (1 Lab) **OR**  
EE 4981H-4982V (4 cr) Senior Honors Project (2 Labs)

**2) 4xxx-5xxx EE Courses that, in combination with above, total at least 22** (20 for students entering prior to Fall 2006) **semester credits, and obtain three EE 4xxx-5xxx level courses containing a laboratory.** EE 4041, 4043W and 4044 do not count as part of the 22 credits listed above (Section 8.6.1.), but will count as part of the 12 credits below (Section 8.6.2.)

**3) Students entering Fall 2007 or later must select the courses in 2) above according to a breadth requirement; see Section 8.6.3 below.**

### 8.6.2. Additional Electives (0-12 cr)

If needed, select from the approved list of courses below so that, in combination with 8.6.1 above, the total number of credits is at least 34. When courses are listed in pairs, both must be taken to receive credit as technical electives. Similarly, many CSci 4XXX and 5XXX courses require CSci 1902 as a prerequisite; if both courses are completed, the 4 credits for 1902 will also count as elective credits. Availability of courses may depend upon prerequisites; some that require prerequisites are marked below.

AEM 2021 (4 cr) Statics & Dynamics  
AEM 2011 & 2012 (6 cr) Statics; Dynamics [must complete both to obtain credit]  
AEM 2011 & 3031 (6 cr) Statics; Deformable Body Mechanics  
AEM 4601 (3 cr) Instrumentation Laboratory

BBE 3013 (3 cr) Engr. Principles of Molecular & Cellular Processes

BioC 3021 (3 cr) Biochemistry

BLaw 3058 (4 cr)\*\* The Law of Contracts & Agency  
 BLaw 5078 (2 cr)\*\* Partnerships and Corporations  
 BLaw 5088 (2 cr)\*\* Law of Personal Property, Real Property, & Commercial Paper  
 \*\*Students not in Carlson School of Mgmt (CSOM) can only register after Registration Queue Period, & then only by obtaining permission from Undergraduate Office of CSOM.

BMEN 5401 (3 cr) Adv Functional Biomedical Imaging  
 CE 3502 (4 cr) Fluid Mechanics (prereq: AEM 2012 or AEM 3031)  
 CE 4101W (3 cr) Project Management  
 Chem 2301 (3 cr) Organic Chemistry I  
 Chem 2302 (3 cr) Organic Chemistry II  
 Chem 2311 (4 cr) Organic Chem Lab  
 Chem 3501 (3 cr) Intro to Thermodynamics, Kinetics, Statistical Mechanics  
 Chem 3502 (3 cr) Intro to Quantum Mechanics and Spectroscopy

CSci 4XXX Any 4000-level Comp Science Course (except 4921)  
 CSci 5XXX Any 5000-level Comp Science Course

EE 3041 & 4043W (6 cr) Industrial Assignment I & II - Co-op Students only  
 EE 4044 (2 cr) Industrial Assignment III - Co-op Students only

IE 5441 (4 cr) Engineering Cost Accounting, Analysis, & Control  
 IE 5511 (4 cr) Human Factors & Work Analysis  
 IE 5512 (4 cr) Applied Ergonomics (requires IE 5511)  
 IE 5513 (4 cr) Engineering Safety  
 IE 5522 (4 cr) Quality Engineering & Reliability  
 IE 5531 (4 cr) Engineering Optimization  
 IE 5541 (4 cr) Project Management  
 IE 5551 (4 cr) Production Planning & Inventory Control  
 IE 5552 (4 cr) Design & Analysis of Manufacturing Systems  
 IE 5553 (4 cr) Simulation of Manufacturing Systems

MatS 3011 (3 cr) Intro to Materials Science and Engineering  
 MatS 3012 (3 cr) Metals and Alloys  
 MatS 3851W (2 cr) Materials Properties Lab (prereq MatS 3011)  
 MatS 4013 (3 cr) Elect. & Mag Properties of Materials

Math 3283W Sets, Series and Sequences  
 Math 4XXX Any 4000-level Mathematics Course  
 Math 5XXX Any 5000-level Mathematics Course

ME 3324 (4 cr) Intro to Thermal Science

Phsl 3061 (4 cr) Principles of Physiology

Phys 2601 (4 cr) Quantum Physics  
 Phys 2605 (3 cr) Quantum Physics Laboratory

Phys 4101 (4 cr) Quantum Mechanics  
 Phys 4201 (3 cr) Statistical and Thermal Physics

Stat 5041 (3 cr) Bayesian Decision Making (prereq: STAT 4101 or 5021 or 5101)

Stat 5101 (4 cr) Theory of Statistics I  
 Stat 5102 (4 cr) Theory of Statistics II

Students obtaining a Management Minor may use the following courses as technical electives:

Acct 3001 (3 cr) Intro Managerial Accounting  
 Fina 3001 (3 cr) Finance Fundamentals  
 Mgmt 3001 (3 cr) Principles of Management  
 Mktg 3001 (3 cr) Principles of Marketing

### 8.6.3. Breadth and Depth Requirement for Students entering Fall 2007 or later.

Students entering Fall 2007 or later must select the 22 credits of EE technical electives so that at least one course is chosen from at least four of the following specialty areas and at least two courses must be chosen from one of the specialty areas. This requirement is in addition to those listed in Sections 8.6.1 and 8.6.2 above. The specialty areas are

#### Communications, Signal Processing and Biomedical

EE 4541 (3 cr)	Digital Signal Processing
EE 4501/5 (3/4 cr)	Communications Systems/lab
EE 5381 (3 cr)	Telecommunication Networks*
EE 5501 (3 cr)	Digital Communication*
EE 5505 (3 cr)	Wireless Communication*
EE 5531 (3 cr)	Probability and Stochastic Processes*
EE 5542 (3 cr)	Adaptive Digital Signal Processing*
EE 5545 (3 cr)	Digital Signal Processing Design*
EE 5549 (3 cr)	DSP Structures for VLSI*
EE 5551 (3 cr)	Multiscale and Multirate Signal Processing*
EE 5561 (3 cr)	Image Processing and Applications*
EE 5581 (3 cr)	Information Theory and Coding*
EE 5583 (3 cr)	Error Control Coding*
EE 5585 (3 cr)	Data Compression*
EE 5811 (3 cr)	Biomedical Instrumentation* [unavailable 2008-09]
EE 5821 (3 cr)	Biological System Modeling and Analysis* [unavailable 2008-09]
EE 5863 (3 cr)	Computer System Performance Analysis*

#### Controls

EE 4231/5 (3/4 cr)	Linear Control Systems: Designed by Input/Output Methods/lab
EE 4233/7 (3/4 cr)	State Space Control System Design/lab
EE 5231 (3 cr)	Linear Systems and Optimal Control*
EE 5235 (3 cr)	Robust Control System Design*
EE 5239 (3 cr)	Introduction to Nonlinear Optimization*

#### Digital Systems and Computer Architecture

EE 4341 (4 cr)	Microprocessor and Microcontroller System Design
EE 4609 (3 cr)	Digital Signal Integrity
EE 4301 (4 cr)	Digital Design with Programmable Logic
EE 4363 (4 cr)	Computer Architecture and Machine Organization
EE 4389W (3 cr)	Empirical Inference and Soft Computing
EE 5364 (3 cr)	Advanced Computer Architecture*
EE 5371 (3 cr)	Computer Systems Performance Measurement and Evaluation*
EE 5393 (3 cr)	Circuits, Computation and Biology

EE 5393

#### VLSI and CAD

EE 43xx (4 cr)	Practical Programming and Scripting for Real Engineers/Designers
EE 5301 (3 cr)	VLSI Design Automation I*
EE 5302 (3 cr)	VLSI Design Automation II*

EE 5323 (3 cr)	VLSI Design I*
EE 5324 (3 cr)	VLSI Design II*
EE 5327 (3 cr)	VLSI Design Laboratory*
EE 5329 (3 cr)	VLSI Digital Signal Processing Systems*
EE 5333 (3 cr)	Analog Integrated Circuit Design*

#### Electronics, Microelectronics and Semiconductor Devices

EE 4111 (4 cr)	Advanced Analog Electronics Design
EE 5121 (3 cr)	Transistor Device Modeling for Circuit Simulation*
EE 5141 (4 cr)	Introduction to Microsystem Technology*
EE 5163 (3 cr)	Semiconductor Properties and Devices I*
EE 5164 (3 cr)	Semiconductor Properties and Devices II*
EE 5171/3 (4/5 cr)	Microelectronic Fabrication/lab*
EE 5181 (3 cr)	Introduction to Nanotechnology*
EE 5657W (4 cr)	Physical Principles of Thin Film Technology*

#### Power and energy

EE 4701/3 (3/4 cr)	Electric Drives/lab
EE 4721/2 (3/4 cr)	Introduction to Power System Analysis/lab
EE 4724 (3 cr)	Power System Planning and Operation
EE 4741/3 (3/4 cr)	Power Electronics/lab
EE 5705 (3 cr)	Advanced Electric Drives*
EE 5721 (3 cr)	Power Generation Operation and Control*
EE 5725 (3 cr)	Power Systems Engineering*
EE 5741 (3 cr)	Advanced Power Electronics*

#### Magnetics, Optics and RF

EE 4607 (3 cr)	Wireless Hardware System Design
EE 5601/13 (3/5 cr)	Intro to RF/Microwave Engineering/lab*
EE 5602 (3 cr)	RF/Microwave Circuit Design*
EE 5611 (3 cr)	Plasma Aided Manufacturing*
EE 5616 (3 cr)	Antenna Theory and Design*
EE 5621/2 (3/4 cr)	Physical Optics/lab*
EE 5624 (3 cr)	Optical Electronics*
EE 5627/8 (3/4 cr)	Optical Fiber Communication/lab*
EE 5629 (3 cr)	Optical System Design*
EE 5653 (3 cr)	Physical Principles of Magnetic Materials*
EE 5655 (3 cr)	Magnetic Recording*

\*5XXX level courses are graduate level courses; they can be taken by an undergraduate student if the student has a gpa of at least 3.2 or if the student obtains the permission of the course instructor and the ECE Scholastic Standards Committee.

### 8.7. EE Senior Technical Program

The courses offered in satisfaction of the EE Senior Technical Program (except non-EE courses in Section 8.6.2) must be completed at the University of Minnesota while officially enrolled in I.T. as an EE major.

## 8.8. Further Notes

Every student should be aware that degree requirements must be referred to the date of graduation rather than to the date of entry into the program. When a student's program is prolonged well beyond the nominal 4-year duration, degree requirements and even course content can change considerably, and the student must be prepared to take additional coursework as necessary to satisfy the new requirements.

## 9.0. SEMESTER SCHEDULES

### 9.1. EE Degree Program

#### EE SEMESTER SCHEDULE 1

First Year	Title	Credits Fall	Credits Spring
EngC 1011	Univ. Writing & Critical Reading	4	--
Math 1371	IT Calculus I	4	--
Math 1372	IT Calculus II	--	4
Phys 1301	Intro Physics I	4	--
Phys 1302	Intro Physics II	--	4
Chem 1021	Chemical Principles I	--	4
EE 1301	Intro to Comp. Sys.	4	--
EE 1001 (Optional)	Intro to Electrical Engr.	--	(1)
Biol	Biology w/ lab (CLE Elective)	--	4
		16	16 (17)

**Total Credits (32)**

Second Year	Title	Credits Fall	Credits Spring
Math 2373	IT Lin Alg & Diff. Eq	4	--
Math 2374	IT Multivariable Calculus & Vector Analysis	--	4
Phys 2303 or 2403H or Chem 1022	Physics of Matter or Honors or Chemical Principles II	4	--
EE 2301 / 301	Intro. Digital System Design/Discussion	4 (lab)	--
EE 2361 / 361	Intro to Microcontrollers/ Discussion	--	4 (lab)
EE 2001	Intro. Electronic & Electrical Circuits	3	--
EE 2002	Intro. Circuits & Electronics Lab	1	--
EE 2011	Linear Systems & Circuits	--	3
Lib. Ed.	Liberal Education Electives	--	6-8
		16	17-19

**Total Credits (33-35)**

Third Year	Title	Credits Fall	Credits Spring
EE 3115	Analog & Digital Electronics	4	--
EE 3161	Semiconductor Devices	--	3
EE 3015	Signals & Systems	3	--
EE 3025	Statistical Methods	--	3
EE 3101	Circuits & Electronics Lab. I	2	--
EE 3102	Circuits & Electronics Lab. II		2
EE 3601	Transmission Lines	--	3
*Technical Elective	Technical Elective	4	--
Lib. Ed	Liberal Education	3-4	3-4
		1-17	14-15

**Total Credits (30-32)**

Fourth Year	Title	Credits Fall	Credits Spring
EE 4951W	Senior Design Project	--	4
*Technical Elective	Technical Elective	16	10
Lib. Ed.	Liberal Education Electives	--	3-4
		16	17-18

**Total Credits (31-34)**

**Total Credits: 128**

**\*See Section 8.6. in the EE Curriculum Guide**

## EE SEMESTER SCHEDULE 2

First Year	Title	Credits Fall	Credits Spring
EngC 1011	Univ. Writing & Critical Reading	4	--
Math 1371	IT Calculus I	4	--
Math 1372	IT Calculus II	--	4
Phys 1301	Intro Physics I	4	--
Phys 1302	Intro Physics II	--	4
EE 1301	Intro to Comp. Sys.	--	4
EE 1001 (Optional)	Intro to Electrical Engr.	--	(1)
Lib Ed	Liberal Education Elective	4	4
		16	16 (17)

**Total Credits (32)**

Second Year	Title	Credits Fall	Credits Spring
Math 2373	IT Lin Alg & Diff. Eq	4	--
Math 2374	IT Multivariable Calculus & Vector Analysis	--	4
Chem 1021	Chemical Principles I	4	--
Phys 2303 or 2403H or Chem 1022	Physics of Matter or Honors or Chemical Principles II	--	4
EE 2301/301	Intro. Digital System Design	4 (lab)	--
EE 2361/361	Intro to Microcontrollers	--	4 (lab)
EE 2001	Intro. Electronic & Electrical Circuits	3	--
EE 2002	Intro. Circuits & Electronics Lab	1	--
EE 2011	Linear Systems & Circuits	--	3
		16	15

**Total Credits (31)**

Third Year	Title	Credits Fall	Credits Spring
EE 3115	Analog & Digital Electronics	4	--
EE 3161	Semiconductor Devices	--	3
EE 3015	Signals & Systems	3	--
EE 3025	Statistical Methods	--	3
EE 3101	Circuits & Electronics Lab. I	2	--
EE 3102	Circuits & Electronics Lab. II	--	2
EE 3601	Transmission Lines	--	3
*Technical Elective	Technical Elective	4	--
Lib. Ed	Liberal Education	3-4	4
		16-17	15

**Total Credits (31-32)**

Fourth Year	Title	Credits Fall	Credits Spring
EE 4951W	Senior Design Project	--	4
*Technical Elective	Technical Elective	16	10
Lib. Ed.	Liberal Education Electives	--	4
Totals		16	18

**Total Credits (34)**

**Total Credits: 128**

**\*See Section 8.6.**

## 9.2. EE Engineering Co-op Program Schedule

A student enters the co-op program after the second year; consequently, the first two years are the same as for a non-co-op student. The third and fourth years vary depending on whether the work assignment is Fall, Spring or Summer. Example schedules for a Fall and a Spring assignment are shown below. Note that these example schedules do not include a third co-op assignment nor do they include Summer courses; if Summer courses are taken, the program can be shortened by at least a semester.

### Fall Co-op Work Assignment

Third Year	Title	Credits Fall	Credits Spring
EE 3115	Analog & Digital Electronics	--	4
EE 3015	Signals & Systems	--	3
EE 3101	Circuits & Electronics Lab. I	--	2
*EE 3041	Industrial Assignment I	2	--
*Technical Elective	Technical Elective	--	4
Lib. Ed	Liberal Education	--	3-4
		2	16-17

**Total Credits (18-19)**

Fourth Year	Title	Credits Fall	Credits Spring
EE 3161	Semiconductor Devices	--	3
EE 3025	Statistical Methods	--	3
EE 3102	Circuits & Electronics Lab. II	--	2
EE 3601	Transmission Lines	--	3
*EE 4043W	Industrial Assignment II	4	--
Lib. Ed	Liberal Education	--	4
		4	15

**Total Credits (19)**

Fifth Year	Title	Credits Fall	Credits Spring
EE 4951W	Senior Design Project	--	4
*Technical Elective	Technical Elective	16	4
Lib. Ed.	Liberal Education Electives	--	4
Totals		16	12

**Total Credits (28)**

**Total Credits: 128**

### Spring Co-op Work Assignment

Third Year	Title	Credits Fall	Credits Spring
EE 3115	Analog & Digital Electronics	4	--
EE 3015	Signals & Systems	3	--
EE 3101	Circuits & Electronics Lab. I	2	--
*EE 3041	Industrial Assignment I	--	2
*Technical Elective	Technical Elective	4	--
Lib. Ed	Liberal Education	3-4	--
		16-17	2

**Total Credits (18-19)**

Fourth Year	Title	Credits Fall	Credits Spring
EE 3161	Semiconductor Devices	3	--
EE 3025	Statistical Methods	3	--
EE 3102	Circuits & Electronics Lab. II	2	--
EE 3601	Transmission Lines	3	--
*EE 4043W	Industrial Assignment II	--	4
Lib. Ed	Liberal Education	4	--
		15	4

**Total Credits (19)**

Fifth Year	Title	Credits Fall	Credits Spring
EE 4951W	Senior Design Project	--	4
*Technical Elective	Technical Elective	16	4
Lib. Ed.	Liberal Education Electives	--	4
Totals		16	12

**Total Credits (28)**

**Total Credits: 128**

\* If both 3041 and 4043W are completed, then they count as 6 credits within the technical elective requirements in the non-major category. If a third assignment is included, 4044 will add another 2 credits to the non-major technical elective category.

## 10.0. NEW OR CHANGED EE COURSES

EE 4951W is changed from 2 credits to 4 credits starting Spring 2007. EE 4389W Introduction to Empirical Inference and Soft Computing was added Spring 2007. EE 5607 Wireless Hardware System Design was converted to EE 4607 starting Spring 2009. EE 5181 Introduction to Nanotechnology was added for Fall 2007.

## 11.0. APPLICATION FOR DEGREE

### 11.1. General

A student's eligibility for graduation will be evaluated from the student's APAS report (APAR Academic Progress Audit Report).

The APAR is available at [www.onestop.umn.edu/registrar/transcripts/index.html](http://www.onestop.umn.edu/registrar/transcripts/index.html).

Students should obtain a copy of their APAS on a regular basis (at least twice a year) and monitor their progress against the program they are completing. The APAR divides the requirements for graduation into the various categories of required and elective courses. The particular categories and requirements depend upon the student's program of study. Within Electrical Engineering, a student may be in the Coop Program or I.T. Honors or both. If your APAR does not correspond to your desired program of study, contact the ECE Advising Office to request a clarification of your status.

Students who have transferred courses to the University of Minnesota, which satisfy requirements, need to check their APAR to verify that these courses have been assigned to the proper category of program requirements. If a transfer course is not listed in the proper category, then that course is not satisfying required credits in that category. If your transfer credits do not appear to be listed as satisfying a requirement as you expected, contact the ECE Advising Office to request a review of your APAR.

For the B.E.E. degree to be granted officially, all following requirements must be satisfied:

1. Curriculum requirements
  - a. Specific course requirements of the Lower and Upper Division.
  - b. Total credit requirement (with applicable courses and credits).
2. Grade average requirements
  - a. G.P.A. minimum of 2.0 for all applicable University of Minnesota courses.
  - b. G.P.A. minimum of 2.0 for all EE courses.
  - b. All required courses must be passed with a minimum grade of C-. Otherwise, the course must be repeated. Check with the ECE Advising Office on correct procedure for repeating a course.

## 11.2. Application for Degree

When a student registers for his or her last semester of courses, he or she must file The Application for Degree (Form OTR179). You must download this form off the web (<http://www.onestop.umn.edu/onestop/graduating.html>). This form must be submitted on time to avoid a semester's delay in the official granting of the degree. The deadlines for submission of the Application for Degree for 2007-08 are given in the table below:

<u>SEMESTER</u>	<u>DEADLINE</u>
Summer Session 2008	06/10/2008
Fall 2008	09/16/2008
Spring 2009	02/03/2009
May Term 2009	03/26x/2009
Summer Session 2009	06/09/2009

I.T. has only one graduation ceremony per year, held at the end of Spring Semester.

## 11.3. Graduation Clearance

After registration is completed for the FINAL semester of course work and an Application for Degree is filed, the Registrar's Office will send a notice listing any course or credit deficiencies that may exist. Of course, these deficiencies must be removed before a student can be graduated. If any of these listed deficiencies appear to be in error, contact the ECE Advising Office. In addition, all courses marked as IP ("In-Progress") must be successfully completed before the student is eligible for graduation. **(NOTE: If a student's APAS shows a course as "In-Progress" that satisfies some of the credit requirements for an APAS category and that course is not successfully completed, then graduation will not be permitted even though enough additional courses were completed to satisfy that category.** If this situation occurs, the student must request the ECE Advising Office to remove the course from the APAS requirement category. **It will not happen automatically.**)

## 11.4. Curriculum Requirements

1. For specific course requirements and approved substitutions, see current EE Curriculum Guide, Section 8.
2. Inapplicable Courses  
Some courses offered at the University of Minnesota or transferred from another college or university may not apply to the BEE degree even as electives. Such courses may be useful and interesting - even necessary, but are considered supplemental to and not part of the engineering degree program. See Section 6.4. for courses not accepted for the BEE degree. See Section 6.2. for policy regarding General College courses.