

DEPARTMENT OF ELECTRICAL ENGINEERING

**EE STUDENT
HANDBOOK**

**SWENSON COLLEGE OF SCIENCE & ENGINEERING
UNIVERSITY OF MINNESOTA DULUTH**

FALL 2018

Telephone: 218-726-6147

Fax: 218-726-7267

Email: umdee@d.umn.edu

www.d.umn.edu/ee/

Individuals who have any disability, either permanent or temporary, which might affect their ability to perform in class are encouraged to inform the instructor at the start of the semester. Adaptation of methods, materials, or testing may be made as required to provide for equitable participation.

The University of Minnesota is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, religion, color, sex, national origin, handicap, age, veteran status or sexual orientation.

UNIVERSITY OF MINNESOTA

Duluth Campus

Department of Electrical Engineering

271 Marshall W. Alworth Hall
1023 University Drive
Duluth, MN 55812-3009

Swenson College of Science and Engineering

Office: 218-726-6147
Fax: 218-726-7267
<http://www.d.umn.edu/ee>
Email: umdee@d.umn.edu

Fall 2018

Dear EE student:

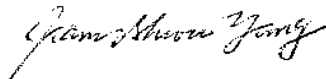
On behalf of the faculty and staff, I would like to welcome you to the Department of Electrical Engineering!

I am very proud of our EE program, our faculty and staff, and our facilities. The courses we are offering are rigorous and taught by well-trained, dedicated faculty. We have excellent laboratories with state-of-the-art equipment. Our faculty have rich academic, industrial, and professional engineering practice experience. Therefore, I strongly encourage you to visit them not only to seek assistance on specific course topics but to discuss academic and career planning as well. The student branch of the Institute for Electrical and Electronics Engineers (IEEE) also provides you with opportunities to learn about engineering outside the classroom through a variety of organized activities. I encourage you to actively participate in this professional society and departmental activities to benefit your career development.

EE faculty and staff are here to assist you as you work towards your Bachelor or Master of Science degree in Electrical Engineering. This handbook has been assembled to provide you with important information, so please read it carefully. You can also check our updated EE Web page at <http://www.d.umn.edu/ee/>. Feel free to visit me or to contact me via telephone or email.

Again, I welcome you to the EE Department and offer the best wishes for a successful academic career.

Sincerely,



Jiann-Shiou Yang
Professor and Department Head
Phone: (218) 726-6290
Email: jyang@d.umn.edu

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PART I: EE DEPARTMENT INFORMATION

EE FACULTY AND STAFF

NAME	POSITION	MWAH ROOM #	OFFICE TELEPHONE
Bai, Dr. Jing jingbai@d.umn.edu	Professor (on sabbatical leave 2018-19)	255	8606
Baz Khallouf, Mr. Ibrahim bazkh001@d.umn.edu	Instructor	157	7382
Burns, Dr. Stanley sburns@d.umn.edu	Professor	274	7506
Carroll, Dr. Christopher ccarroll@d.umn.edu	Associate Professor	252	7530
Chen, Mr. Xiaogang Chen1557@d.umn.edu	Laboratory Services Coordinator	189E	6153
Fang, Dr. Peng p.fang@queensu.ca	Assistant Professor	257	8410
Ferguson, Mr. Thomas tferguso@d.umn.edu	Adjunct Instructor	155	7798
Hallberg, Mr. David hall0937@d.umn.edu	Instructor	157	7382
Hasan, Dr. Mohammed mhasan@d.umn.edu	Associate Professor	254	6150
Hayee, Dr. Imran ihayee@d.umn.edu	Professor	278	6743

<p><u>IEEE Officers</u></p> <p>Janice Gualpa gual006@d.umn.edu</p> <p>Rebecca Bourget bourg048@d.umn.edu</p> <p>Garrett St. Germain stger053@d.umn.edu</p> <p>David Okeson okeso011@d.umn.edu</p> <p>MaryPat Thune thune014@d.umn.edu</p> <p>Mandy Chapman chapm315@d.umn.edu</p>	<p>President</p> <p>Vice President</p> <p>Secretary</p> <p>Treasurer</p> <p>Public Relations</p> <p>Social Media Chair</p>	<p>102</p>	<p>6196</p>
<p>Kochmann, Mr. Todd kochm006@d.umn.edu</p>	<p>Finance Professional II (EE & Physics)</p>	<p>147</p>	<p>7123</p>
<p>Kozlovski, Mr. Donald dkozlovski@allete.com</p>	<p>Chair, EE Industrial Advisory Board, 30 W Superior St, Duluth 88502</p>	<p>----</p>	<p>(218) 723-7575</p>
<p>Kwon, Dr. Taek tkwon@d.umn.edu</p>	<p>Professor</p>	<p>253</p>	<p>8211</p>
<p>Naidu, Dr. Desineni Subbaram dsnaidu@d.umn.edu</p>	<p>Professor, Jack Rowe Chair Director of Graduate Studies</p>	<p>273</p>	<p>6531</p>
<p>Norr, Mr. Scott snorr@d.umn.edu</p>	<p>Instructor</p>	<p>154</p>	<p>8947</p>
<p>Peterson, Shey speters1@d.umn.edu</p>	<p>Executive Secretary</p>	<p>271</p>	<p>6830</p>
<p>Tang, Dr. Hua htang@d.umn.edu</p>	<p>Associate Professor</p>	<p>276</p>	<p>7095</p>
<p>Yang, Dr. Jiann-Shiou jyang@d.umn.edu</p>	<p>Professor and Department Head</p>	<p>272</p>	<p>6290</p>
<p>Zimmerman, Dr. Lee lzimmerm@d.umn.edu</p>	<p>Adjunct Assistant Professor</p>	<p>153</p>	<p>6385</p>

ELECTRICAL ENGINEERING FACULTY PROFILES

The electrical engineering curriculum is presented by faculty members who bring a wide range of research, industrial and consulting experience to their teaching assignments. Each is well aware of the national goals that must be met in order to produce graduates who are prepared to compete in an international technical market place. Faculty work together to evolve a curriculum that is challenging to the student, a curriculum that reflects the scope of the faculty expertise and training. A brief summary of the research areas in which faculty members are involved follows.

Dr. Jing Bai, Professor: Dr. Bai joined the EE Department in Fall 2007. She received her Bachelor of Engineering degree from Tsinghua University, China, and M.S. and Ph.D. degrees in Electrical and Computer Engineering from Georgia Institute of Technology. Her research interests include optoelectronic devices, semiconductor nanostructures, nonlinear optics, quantum optics and micro-electro-mechanical system (MEMS).

Mr. Ibrahim Baz Khallouf: Mr. Khallouf received his BSEE in 2011 from Aleppo University in Syria. He joined the EE Department as a graduate student, and graduated with his MSEE in 2017. He became a faculty member in the EE Department in Spring 2018. His research interests include optimal control, nonlinear control systems, robotics, biomedical engineering, artificial intelligence, industrial electronic systems, electronic circuit design and renewable energy.

Dr. Stanley G. Burns, Professor: Dr. Burns joined EE as Department Head in 1998. He received his B.S., M.S., and Ph.D. degrees in Electrical Engineering from the University of Wisconsin-Madison. Dr. Burns' research interests include microelectronics, semiconductor device processing, and high frequency analog circuit design. He is a senior member of the IEEE, and a member of ASEE and ECS. Dr. Burns is a registered Professional Engineer in Minnesota and Iowa.

Dr. Christopher Carroll, Associate Professor: Dr. Carroll has been at UMD since the fall of 1988. He received his Bachelor of Engineering Science degree from Georgia Institute of Technology and received the Master of Science in Electrical Engineering and a Ph.D. in Computer Science from California Institute of Technology. Dr. Carroll's research interests include special purpose digital systems, VLSI design, and microprocessor/microcontroller applications.

Dr. Peng Fang, Assistant Professor: Dr. Fang joined the EE Department in Fall 2018. He received his B. Eng. degree in Information and Computer Science from Chong Qing University of Post and Telecommunication, China, in 2006, the MSEE degree from Hong Kong University of Science and Technology, Hong Kong, China, in 2007, and his Ph.D. in Electrical Engineering from Queens's University, Ontario, Canada in 2016. Dr. Fang's research interests are in the area of power electronics technology for EV charger, distributed renewable energy integration, solar energy harvesting technology, and power converter design.

Mr. Thomas Ferguson, Instructor: Mr. Ferguson joined the EE Department as 3M McKnight Visiting Professor from Fall 2007 to Spring 2009. He is now an Instructor. He was Vice President of Power Delivery and Transmission with Minnesota Power for many years. Mr. Ferguson received his B.S.E.E. and M.S.E.E. degrees from the University of Minnesota, Twin Cities. He is a registered Professional Engineer in the State of Minnesota and had served as the Chair of the Department's Industrial Advisory Board for many years. His research and teaching interests include renewable energy, power delivery and transmission, and telecommunication.

Mr. David Hallberg, Instructor: Mr. Hallberg received both his BS in EE and Master of Engineering degrees at University of Minnesota Duluth. He has been working on the UMD campus as a developer in the Medical School since graduated in 2010 and started teaching after receiving his Masters in 2017. His interests include VR/AR, solar/green power, and micro grids.

Dr. Mohammed Hasan, Associate Professor: Dr. Hasan began with the EE Department in September 1997. He received his B.S. degree in Mathematics from the University of Baghdad, Iraq, and the M.S. degree in Electrical Engineering from Colorado State University. Dr. Hasan has a Ph.D. in Applied Mathematics and a Ph.D. in Electrical Engineering both from Colorado State University. His research interests include modeling and estimation of random processes and their applications to signal processing and biomedical research, adaptive filtering and sinusoidal estimation.

Dr. Imran Hayee, Professor: Dr. Hayee joined the EE Department in Fall 2004. He received a B.Sc.E.E. at UET Pakistan, and his M.S.E.E. and Ph.D. degrees at the University of Southern California in Los Angeles. Dr. Hayee's research interests are in the field of state-of-the-art optical fiber communication products, cabled and wireless communication regimes.

Dr. Taek Mu Kwon, Professor: Dr. Kwon has been in the department since Fall 1988. He received his B.S. degree in Electrical Engineering from Sung-Jun University, Seoul, Korea, and his M.S. and Ph.D. degrees from the Florida Institute of Technology, Melbourne. Dr. Kwon's research interests include neural networks, neural nets and fuzzy controllers, genetic algorithms, digital signal processing, computer networks, and intelligent transportation systems..

Dr. Desineni Subbaram Naidu, Professor, Minnesota Power Jack Rowe Chair, and Director of Graduate Studies: Dr. Naidu joined the EE Department as Minnesota Power Jack Rowe Endowed Chair in August 2014. He received his M.S. and Ph.D. degrees from the Indian Institute of Technology (IIT), Kharagpur, India. Before joining UMD, Dr. Naidu was Professor with the EE Department at Idaho State University, Pocatello. His area of teaching and research include electrical engineering, industrial control systems and cyber security, biomedical engineering and time scales in engineering and life sciences. Dr. Naidu is an IEEE Fellow.

Mr. Scott Norr, Instructor: Mr. Norr has 13 years of industry experience in the areas of power systems and electrical consulting. He is especially interested in dynamic stability of power systems, voltage collapse phenomena and power quality. Mr. Norr received his B.S.E.E. from North Dakota State University in 1986 and his M.S.E.E degree from University of Minnesota Duluth in 2017. He is a registered Professional Engineer in the State of Minnesota.

Dr. Hua Tang, Associate Professor joined the department in Fall 2005. He received his B.E. in Electrical Engineering from North China Electric Power University (Beijing), Beijing, P.R. China, and M.S. and Ph.D. in Electrical Engineering from State University of New York at Stony Brook, Stony Brook, NY in 2002 and 2005 respectively. Dr. Tang's research interests include high-performance analog, digital and mixed-signal VLSI circuit design and computer aided design. He is a member of IEEE.

Dr. Jiann-Shiou Yang, Professor and Department Head: Dr. Yang began teaching at UMD in the fall of 1988. He received his B.S. and M.S. degrees in Control Engineering from National Chiao-Tung University, Taiwan and his M.S. and Ph.D. degrees in Electrical Engineering from the University of Maryland at College Park. Dr. Yang's research interests include robust control, system theory, computer-aided control system design, optimization, intelligent transportation systems, biped locomotion, and control applications. He is a senior member of the IEEE.

Dr. Lee Zimmerman, Adjunct Assistant Professor: Dr. Zimmerman joined the Department in the Fall of 2012. He received the B.S.E.E. degree from the University of Utah and his Ph.D. in Electrical Engineering from the University of Minnesota, Twin Cities. He was Assistant Professor with Tulane University, New Orleans, from 1991 to 1998 and adjunct Assistant Professor with the EE Department at UMD from 1999 to 2008. Dr. Zimmerman's research interest is computer vision, neurobiology and experimental psychology.

ELECTRICAL ENGINEERING STAFF PROFILES

Xiaogang Chen, Laboratory Services Coordinator: As lab services coordinator, Xiaogang provides equipment, maintenance, and support for the EE laboratories. He received his B.S.M.E. degree from Dalian Jiaotong University in China and his M.S.E.E. from the University of Minnesota Duluth and. See Xiaogang if you need materials, supplies, or equipment for use in laboratory instruction.

Shey Peterson, Executive Secretary: As department secretary, Shey provides administrative support for the EE office. See Shey for information on grant expenses, payroll, applying to the upper division of EE, advisement, etc.

Todd Kochmann, Accountant: As accountant for EE and Physics, Todd prepares purchase orders, requisitions and processes invoices. In addition, he also prepares employee reimbursement, travel expenses and purchasing card reports.

IEEE STUDENT BRANCH

The UMD branch chapter of the IEEE Computer Society is a student organization for EE students, as well as other students majoring in technical/engineering fields. The UMD IEEE Computer Society is affiliated with the Institute of Electrical and Electronics Engineers (IEEE), an international professional organization.

New members are always welcome. To join, application forms are available (during the academic year only) in the IEEE office (102 MWAH), or in the EE Department office (271 MWAH). There is an annual membership fee. IEEE membership includes subscriptions to two national IEEE publications. Members are eligible for scholarships and can participate in national and regional professional conferences. The EE student group sponsors student-faculty feedback forums, arranges tours to industries, publishes an annual "Resume Book" in collaboration with the department, and plans recreational activities.

Meetings are held starting late September, with regular meetings to follow. Check your email for meeting announcements. Faculty advisor is Imran Hayee.

E-mail contacts for the IEEE Student Branch are: ieee_officers@d.umn.edu

Janice Gualpa, President, guall006@d.umn.edu
Rebecca Bourget, Vice President, bourg048@d.umn.edu
Garrett St. Germain, Secretary, stger053@d.umn.edu
David Okeson, Treasurer, okeso011@d.umn.edu
MaryPat Thune, Public Relations, thune014@d.umn.edu
Mandy Chapman, Social Media Chair, chapm315@d.umn.edu

GENERAL INFORMATION ABOUT THE DEPARTMENT OF ELECTRICAL ENGINEERING

EE DEPARTMENT OFFICE HOURS - The EE department office (271 MWAH) is open from 8:00 a.m. to 4:30 p.m. Monday-Friday. This is subject to change during semester breaks and summer, and adjusted hours are usually posted. Your cooperation in visiting the department office during scheduled office hours will be appreciated.

GRADUATE SCHOOL AND CAREER INFORMATION is available on the bulletin board outside 291 MWAH. Please do not remove these materials from the area. (FYI: Employment, internship, and undergraduate opportunities are also sent via UMD email to EE majors.)

EMAIL is routinely used to inform students of course changes, seminar announcements, employment, internships, undergraduate opportunities and other pertinent information. Please be sure to check your email on a regular basis. When sending email to the department office, you will receive the quickest response if you address it to umdee@d.umn.edu. You should use only your UMD email address for resumes and communicating with potential employers.

EE BULLETIN BOARDS

Department Bulletin Board (across from the EE Office) is for EE announcements only. Please check with Shey if you wish to post something on the department bulletin board. Important information about course changes is posted on this board, as well as information on new courses, seminar announcements, information on UROP, etc.

Employment Board is located next to the display case (just outside the department office). Information on internships and employment for graduates is posted here. This information is also sent via email. Please check with Shey to post information on the employment board.

Miscellaneous Board is next to the 295 MWAH; University and miscellaneous announcements are placed here. Please check with Shey to post information on the miscellaneous board.

PHOTOCOPYING is available in the Library or Kirby Student Center. The photocopier in the EE Office is not available for student use, nor are EE staff allowed to make copies for students.

EE WORKROOM - Due to security concerns, undergraduate students are not allowed in the EE workroom.

102 MWAH STUDENT ACTIVITY AND LEARNING CENTER See page 12

EE TEACHING LABS - Labs in 41, 60, 141, 291, 291A, 293, 295, 391, 393 MWAH have swipe card access which is available through the department office (MWAH 271). Upon obtaining code(s)/key card, you will be responsible for the following:

1. You must not give this code/key card to any other student, not even another EE student.
2. You are responsible for locking the lab and closing the windows when you leave.
3. Equipment, program manuals and other supplies are not to be removed from any lab. Anyone found removing such items will have their lab privileges revoked.
4. You must not work alone after business hours in any of the departmental laboratories.
5. Please keep the labs clean; dispose of food wrappers, recycle scrap paper and pop cans, etc.

SENIOR DESIGN PROJECT GUIDELINES - Pick up a copy of the EE Senior Design Project Guidelines in the EE Department office or you can download the online version from the EE website.

SENIOR DESIGN PROJECT/INDEPENDENT STUDY PERMISSION NUMBERS - You need to have written permission from the faculty member with whom you are going to do your senior project or independent study. To receive your permission number, pick up the appropriate request form in the EE Office.

Complete the form, **including the title of your project and the names of your team members** and bring to the faculty member with whom you wish to do your project to obtain their signature. Bring to the EE Office for override number. You may fill out one form for all your team members; if you list their names and email addresses, the department will email the permission number to each.

FORMS AND INFORMATION AVAILABLE IN EE

Application to Upper Division	EE Electives
APAS, Transcripts	Lab Access Forms
Student Handbook, Resume Book, Senior Design Book	
EE Senior Design Project Permission Number Request	

ITEMS AVAILABLE IN SCSE STUDENT AFFAIRS, 140 ENGINEERING BUILDING (EB). (Note: Some of these forms are available on the web. Go to: <http://www.d.umn.edu/onestop/> and click "Forms".)

SCSE Amendment Forms	Registration Materials/Class Schedules
Change of College Request Form	Petition forms
Change of Advisor/Major	Transcripts

ADVISEMENT AND REGISTRATION

1. **ALL EE MAJORS MUST SEE THEIR ADVISORS BEFORE THEY CAN REGISTER.** (Exception: Seniors who are graduating at the end of the semester.)
2. Do not expect to see your advisor without an appointment. Sign up ahead of time, preferably a day in advance so that your advisor has time to retrieve your file.
3. Check your registration queue time, and sign up for advisement in plenty of time to allow you to register as scheduled.
4. Check your advisor's calendar early (posted near or on their office door), and sign up for an advisement time.
5. After meeting with your advisor, he/she will release your Advisement Hold.
6. Remember, lack of planning on your part does not constitute an emergency for your advisor or the department. Please do your part to make advisement a worthwhile experience for you.
7. Students are also encouraged to visit with their advisor to discuss career planning and the practice of engineering. It is important to observe that your academic advisor is often a good choice as a reference for job applications.

GRADES

A "D" is the minimum grade required in an EE course. Although it is not required, students receiving a D in an EE course are encouraged to retake the course.

REPEATING A COURSE - The student should pick up a "Course Repeat" card at the Solon Campus Center Information Desk. Complete the card and bring to the instructor for approval. Return to the Information Desk.

DIRECTIONS FOR APPLYING TO ELECTRICAL ENGINEERING UPPER DIVISION PROGRAM

Students should complete these courses before applying to the junior/senior EE program. A minimum GPA of 2.0 is required for admission.

EE Lower Division Courses (10)

EE 1001 - Introduction to EE (2)
EE 1315 - Digital Logic (4)
EE 2006 - Electrical Circuit Analysis (4)

Required Courses from other programs*

Chem 1153 (4) & Chem 1154 (1) - General Chemistry I (5)
WRIT 1120 - College Writing (3)
CS 1511 - Computer Science I (5)
Math 1296 - Calculus I (5)
Math 1297 - Calculus II (5)
Math 3280 - Differential Equations (4)
Phys 2013 (4) & Phys 2014 (1) - General Physics I (5)
Phys 2015 (4) & Phys 2016 (1) - General Physics I (5)

**Six out of the eight non-EE courses required*

Students who have completed the above courses should apply online to the EE upper division program. Students who are not accepted will receive a letter (or e-mail) from the department indicating what they need to do in order to be accepted into the program. Required GPA is 2.0. (You must maintain at least a 2.0 GPA in order to stay in the program and to graduate). For additional information, visit the EE Department Office, 271 MWAH.

Steps to Complete Prior to Graduation:

- _____ Review Senior Checklist by checking the web site: <http://www.d.umn.edu/onestop/>
- _____ Review Credit Check Balance Sheet by checking the web site: <http://www.d.umd/onestop/>
- _____ Review Application for Degree by checking the web site: <http://www.d.umn.edu/onestop/>
- _____ Register with Career and Internship Services, 22 Solon Campus Center
- _____ Arrange exit interview with the Department Head. You will receive a letter from Department Head before the end of the semester in which you graduate. The exit interview is an EE graduation requirement.

EE LABORATORY SAFETY RULES

1. No horseplay or running is allowed in the labs.
2. No bare feet or open sandals are permitted.
3. Before energizing any equipment, check whether anyone is in a position to be injured by your actions.
4. When working on equipment where more than 120 volts exist between circuit points and/or ground, get your lab instructor's approval before energizing the circuit.
5. Read the appropriate equipment instruction manual sections or consult with your instructor before applying power or connecting unfamiliar equipment or instruments into any circuits.
6. Position all equipment on benches in a safe and stable manner.
7. Do not make circuit connections by hand while circuits are energized. This is especially dangerous with high voltage and current circuits.
8. Do not work alone in the lab if equipment is energized; at least one other person is to be present. You must not work alone after normal business hours.
9. The use of 110 volts, 60 Hz plug-in cords with open wire or alligator clip ends is hazardous; use them only with the permission and direction of your instructor.
10. For safety reasons, metal cases of instruments and appliances are usually grounded through the third wire ground. Do not consider any departure from the use of the third wire ground. e.g., "cheater plugs", without the instruction and supervision of your instructor. Failure to know whether or not an instrument case is grounded can lead to hazardous circuit conditions.
11. Tag instruments with badly frayed or broken power leads and deliver them to the shop (189E) for repair. Notify your instructor. Also notify your instructor if equipment is not working correctly.
12. Do not bring food or beverages near the work areas in the labs.
13. Do not attempt chemical or electro-chemical experiments or activities, e.g., printed circuit board etching, without proper supervision, or in areas other than those designated for that purpose.
14. When using equipment with high voltage, e.g., color television circuits, take precautions to guard against radiation, primarily x-rays.
15. Remove metal rings and metal watch bands when working around energized, especially high voltage and current, circuits.
16. Treat high voltages with care to avoid endangering your life or the lives of your lab partners.

Rules for Use of EE Laboratories

1. Labs are maintained for use not only by you but also by others. Do not treat equipment as your personal property. It is a resource made available for specific purposes. Whether for class work or for research, be sure that your use of equipment does not diminish its value to others.
2. Some labs are equipped with combination locks to allow authorized people to use those facilities at their convenience. If you are such an authorized person in one or more of these labs, treat that access as a privilege, not a right. Do not disclose the combination to unauthorized persons. Only authorized lab users should enter such rooms. Labs are crowded enough ... don't bring your friends. Labs are places to work and learn, not to socialize.
3. The equipment on lab benches is organized into lab "stations," where each station is properly configured to support the class(es) using that room. Do not reconfigure the lab stations by moving instruments from one station to another, or by taking an instrument from a lab station for use elsewhere. Doing so makes life difficult for the next user of that lab station. If additional equipment is needed for a particular experiment, see your lab TA or research advisor and s/he will either find it for you or show you how to work around its absence.

Some spare instruments are stored in cabinets in the above lab rooms for temporary use within that lab when additional equipment is required. For long-term needs, such as senior project use, please check out instruments from the EE Lab Coordinator. Such instruments will be your responsibility until you personally check them back in to the Lab Coordinator.

4. Be observant and security-minded. You could buy a nice house with the equipment in many of our labs. If you see someone engaged in questionable activities please call 911 from the public telephone in the ground-floor hall of MWAH and report it. False alarms are better than suffering a loss that might seriously impair your educational opportunities.

Student Activity and Learning Center (MWAH 102)

Access

MWAH 102 is intended for EE students and faculty as a venue for studying/research, meetings, and events. Access cards are available through the department office in 271 MWAH. Since these cards are available, the door should not be propped open except during events. Visitors should be accompanied at all times. Please do not abuse the room or its resources.

Food/Drink

Food and drink are allowed in MWAH 102. This is a privilege that can be taken away, so guidelines must be followed. Students bring their own lunches, and the IEEE provides light refreshments for purchase by students. A refrigerator and microwave are provided for safe storage and preparation of food. The food purchasing is handled on the honor system, so payments must be made in full and on time to prevent the IEEE from losing money in this service. When finished, food scraps and food containers must be removed or disposed of properly. Drinks and foods such as candy, chips, or other packaged snack foods may be disposed of in a bag-lined garbage can. Other foods (i.e. greasy foods) cannot be thrown away with regular garbage. An example would be pizza boxes (even empty). If this food is served at an event, one of the following means of disposal will be used: 1) Make arrangements with Facilities Management for pickup immediately following said event; 2) Bring garbage to a food dumpster (get access from Facilities Mgmt); 3) Take garbage out of the building and away after said event. The university's policy can be found following this link: <http://www.d.umn.edu/ehso/events/serving.html>

Computers/Equipment

MWAH 102 serves as a departmental personal computer lab, used in several EE courses. The PC's in this room are maintained to support educational activities in course work and beyond. Feel free to use the equipment as needed. However, the equipment is meant for serious work, and such work takes priority over game playing or just "surfing" the Internet. Please be considerate of others and realize that these machines are not your personal workstations. Do not leave your stuff cluttered with programs or data that are of no use to others, and if you are using the computers for frivolous games or other such activities, yield to students who need the computers for course work.

The IEEE will also post procedures for security and file storage.

Be sensitive to the feelings of your colleagues. Inappropriate screen savers or related materials on the computers is strictly prohibited.

MWAH 102 is also a student presentation area, both for developing presentations and for making the presentations to small audiences. All students participate in oral presentations that are part of the senior project or design workshop experience.

In summary, MWAH 102 serves the EE department in many ways. It is a room focused on student activities, whether for presentations, computer use, meetings, or general student gatherings. This is a room designed for you. Please take the responsibility of keeping it neat and orderly so that its use in the above functions is not impeded.

PART II: EE CURRICULUM INFORMATION

FALL 2018

AND

SPRING 2019

<http://www.d.umn.edu/courseinfo/>

EE PROGRAM DESCRIPTION

The electrical engineering B.S.E.E. program combines traditional electrical engineering topics with current computer design and analysis topics. The program is concerned with the theory, design, and application of electrical phenomena and digital computers, including electronic circuits, signal analysis, system design, and computer architecture. The department displays strengths in such diverse areas as electronics, signal processing, electromagnetics, digital computer systems, communications, and controls. Individual faculty members specialize in areas such as VLSI design, microprocessor systems, image processing, automatic control, solid state devices, optoelectronics, nanostructures, medical instrumentation and neural networks. The program balances theoretical and practical experience in electrical engineering through analysis, synthesis, and experimentation, using facilities that include major instructional laboratories and research laboratories.

EE MISSION STATEMENT

The Mission of the Department of Electrical Engineering is to provide high quality education for students through a program that offers challenging hands-on laboratory and design components in conjunction with a thorough foundation in theory, and to equip students with the skills to be life-long major contributors to their profession and society.

EE PROGRAM OBJECTIVES AND OUTCOMES

Using the EE Mission Statement for guidance, the EE Program Educational Objectives are given below (The resultant Outcomes are listed in Table 1).

EE Program Educational Objectives

Consistent with the mission of the University, the Duluth campus, and the College, the Electrical Engineering program educational objectives are to produce graduates who will

1. Develop a productive career.
2. Advance knowledge in their field through technical innovations and scholarly research.
3. Integrate the imparted ethical foundation, creative purpose, and technical knowledge into responsible citizenship.
4. Contribute to the well-being of their community.
5. Pursue life-long learning.

EE MAJOR: GENERAL INFORMATION

Freshman-Level Admission: Students who enter the Electrical Engineering program as freshmen must follow the lower division program listed under Required Courses below.

Junior-Level Admission: Students should complete the lower division EE program before applying to the upper division (junior and senior years) program. A minimum GPA of 2.0 is required for admission to the upper division program. See department for further details.

Honors Requirements: To receive department honors upon graduation, students must finish the program with an overall GPA of at least 3.50, satisfactorily complete a research project under the guidance of a faculty member, and convey the results in an oral and written presentation to the department.

Advising: EE majors are required to meet with their advisor each semester to discuss their academic plans for the upcoming semester and to obtain a registration hold release. Students are encouraged to meet as often as needed to discuss curriculum choices, professional interests, and any other topics that will be of assistance as they pursue their electrical engineering education. Students who have questions about any part of the EE program should see their advisor.

EE MAJOR - DEGREE REQUIREMENTS (127)

Requirements for the B.S.E.E. in electrical engineering (127 credits) include:

- UMD liberal education requirements - courses listed within the major or minor indicated by * may be used to fulfill this requirement
- Advanced writing requirement: WRIT 3130 Advanced writing: engineering (3 credits)
- Twenty one EE technical elective credits to achieve breadth and depth in the major
- Enough required math, science, engineering science, engineering design, and writing credits to meet or exceed accreditation requirements

Required Courses for the EE Major:

Lower Division (22)

EE 1001 – Intro. to Electrical Engineering (2)
EE 1315 - Digital Logic (4)
EE 2006 - Electrical Circuit Analysis (4)
EE 2111 - Linear Systems and Signal Analysis (4)
EE 2212 - Electronics I (4)
EE 2325 - Microprocessor Systems (4)

Upper Division (36)

EE 3151 - Control Systems (4)
EE 3235 - Electronics II (4)
EE 3445 - Electromagnetic Fields (3)
EE Technical Electives (21)
EE 4899 - Senior Design Project I (1)
and EE 4999 - Senior Design Project II (3)
Or EE 4951- Design Workshop (4)

Required Courses from Other Programs:

Lower Division (40)

WRIT 1120 - College Writing (3)*
Chem 1153 (lect; 4) & Chem 1154 (lab; 1) -
General Chemistry I (5)*

CS 1511 - Computer Science 1 (5)*
Math 1296 - Calculus I (5)*
Math 1297 - Calculus II (5)
Math 3280 - Differential Equations (4)
Phys 2013 (lect; 4) & Phys 2014 (lab; 1) -
General Physics I (5)*
Phys 2015 (lect; 4) & Phys 2016 (lab; 1) -
General Physics II (5)
Econ 1022 - Principles of Economics: Macro (3)*
Or
Econ 1023 - Principles of Economics: Micro (3)*

Upper Division (29)

Engineering “Breadth” elective (3)[‡]
WRIT 3130 - Adv Writing: Engineering (3)
Math 3298 - Calculus III (4)
Phil 3242 – Values and Technology (3)*
Or Phil 3325 Environmental Ethics (3)*
Or CS 3111 Computer Ethics (3)*
Stat 3611 - Intro to Probability and Statistics (4)
Lib. Ed. Elective (12)

Liberal education electives (18) must include the following:

- Econ 1022 or Econ 1023
- Writ 1120 and Writ 3130
- Phil 3242 or Phil 3325 or CS 3111
- At least one course from LE - OCL
- At least one course from each of the following categories: LE - SS, LE - H, LE - FA
- At least one course emphasizing GP (Global Perspectives)
- At least one course emphasizing CD (Cultural Diversity in the US)
- At least one course emphasizing S (Sustainability)

Liberal Education (LE) Requirement Abbreviations: Writing & Information Literacy - WL; Oral Communication & Language - OCL; Logic & Quantitative Reasoning - LQR; Natural Sciences - NS; Natural Sciences with lab - NS W/LAB; Social Sciences - SS; Humanities - H; Fine Arts - FA; Global Perspectives - GP; Cultural Diversity in the US - CD; Sustainability - S.

* Courses that may be used to fulfill UMD liberal education program requirements

‡ Engineering-outside-EE requirement is met by taking one of the following courses:

CE 2017, ChE 2001, ChE 2111, IE 3115, ME 2105

Final Project: Electrical Engineering students must complete a capstone design project integrating the knowledge from their academic career. This team project must involve the design of hardware or software to meet specifications agreed upon by the student and the faculty project advisor. Oral and written reports are required.

Electrical Engineering (127 cr)

1. Non-Engineering Courses (66 cr)

A. Required (48)

Chem 1153 – General Chemistry I (4)
Chem 1154 – General Chemistry Lab I (1)
CS 1511 – Computer Science I (5)
Math 1296 – Calculus I (5)
Math 1297 – Calculus II (5)
Math 3280 – Differential Equations (4)
Math 3298 – Calculus III (4)
Phys 2013 – General Physics I (4)
Phys 2014 – General Physics Lab I (1)
Phys 2015 – General Physics II (4)
Phys 2016 – General Physics Lab II (1)
Stat 3611 – Probability and Statistics (4)
Writ 1120 – College Writing (3)
Writ 3130 – Advanced Writing (3)

B. Lib Ed Electives (18)

Must meet global perspective, cultural diversity in the US, and sustainability requirements.

- * 6 credits of Humanities (including Phil 3242 or Phil 3325 or CS 3111)
- * 6 credits of Social Science (including either Econ 1022 or Econ 1023)
- * 3 credits of Fine Arts
- * 3 credits of oral communication

2. Engineering Courses (61 cr)

A. EE Required (37)

EE 1001 – Intro to Electrical Engineering (2)
EE 1315 – Digital Logic (4)
EE 2006 – Electric Circuit Analysis (4)
EE 2111 – Linear Systems and Signal Analysis (4)
EE 2212 – Electronics I (4)
EE 2325 – Microprocessor Systems (4)
EE 3151 – Control Systems (4)
EE 3235 – Electronics II (4)
EE 3445 – Electromagnetics (3)
EE 4899 – Senior Design Project I (1) **
EE 4999 – Senior Design Project II (3) **

**EE 4951 (4) can replace (EE 4899 + EE 4999)

† For undergraduate students only

B. EE Electives (21)

Minimum one course from four out of five areas of specialization. The rest of credits can be filled from any five areas.

Communications and Signal Processing

EE 4781 – Telecommunications (3)
EE 5477 – Antennas and Transmission Lines (3)
EE 5479 – Antennas and Transmission Lines Laboratory (1)
EE 5741 – Digital Signal Processing (3)
EE 5745 – Medical Imaging (3)
EE 5765 – Modern Communication (4)

Controls and Robotics

EE 5151 – Digital Control System Design (3)
EE 5161 – Linear State-Space Control Systems (3)
EE 5351 – Robotics and Mobile Robot Control (3)
EE 5742 – Pattern Recognition/Machine Learning (3)
EE 5801 – Intro to Neural Networks (3)
EE 5831 – Fuzzy Set Theory and Applications (3)

Power and Energy

EE 4501 – Power Systems (4)
EE 5501 – Energy Conversion Systems (3)
EE 5522 – Power Electronics (3)
EE 5533 – Grid – Resiliency, Efficiency & Technology (3)

Microelectronics and VLSI

EE 4611 – Intro. to Solid State Semiconductors (3)
EE 5211 – Advanced Analog Integrated Circuits (3)
EE 5311 – Design of VLSI Circuits (4)
EE 5611 – Microelectronics Technology (3)
EE 5813 – Tools and Methods of Design Auto. (3)

Digital Systems

EE 4305 – Computer Architecture (4)
EE 4321 – Computer Networks (3)
EE 4341 – Digital Systems (4)†
EE 5315 – Multiprocessor Based System Design (3)

Group depends on Topic

EE 5995 – Special Topics (1-3)

C. Non-EE Engineering Electives (3)

Minimum 3 credits from:

CE 2017 – Engineering Mechanics (5)
CHE 2001 – Intro to Environmental Eng (3)
CHE 2111 – Material and Energy Balances (3)
IE 3115 – Operations Research (4)
ME 2105 – Intro. to Material Science for Engineers (3)

DEGREE REQUIREMENTS FOR THE CpE MINOR (36)

Computer Engineering (CpE) Minor

Lower Division (32)

Math 1296 – Calculus I (5)*
Math 1297 – Calculus II (5)
CS 1511 – Computer Science I (5)
CS 1521 – Computer Science II (5)
CS 2511 – Software Analysis and Design (4)
EE 1315 – Digital Logic (4)
EE 2325 – Microprocessor Systems (4)** Or
CS 2521 – Computer Organization and Architecture (4)

Upper Division (4)

EE 4305 – Computer Architecture (4) or CS 5621 Computer Architecture (4)

* Courses that may be used to fulfill UMD liberal education program requirements

** For computer science majors: CS 2521 - Computer Organization and Architecture (4) may be substituted for EE 2325 Microprocessor Systems (4)

DEGREE REQUIREMENTS FOR THE EE MINOR (41-42)

Electrical Engineering (EE) Minor

Lower Division (38)

Math 1296 – Calculus I (5)*
Math 1297 – Calculus II (5)
Math 3280 – Differential Equations (4)
Phys 2013 – General Physics I (4)
Phys 2015 – General Physics II (4)
EE 1315 – Digital Logic (4)
EE 2006 – Electrical Circuit Analysis (4)
EE 2111 – Linear Systems and Signal Analysis (4)
EE 2212 – Electronics I (4)

Upper Division (3-4)

Choose one course from the following list:

EE 3151 – Control Systems (4)
EE 3235 – Electronics II (4)
EE 3445 – Electromagnetic Fields (3)
EE 4501 – Power Systems (4)
EE 4611 – Introduction to Solid-State Semiconductors (3)

REQUIREMENTS FOR THE B.S.E.E.

- (1) Completion of at least of 127 degree credits.
- (2) Completion of at least 30 degree credits at UMD.
- (3) Completion of at least 20 of the last 30 credits earned before graduation at UMD.
- (4) Completion of the electrical engineering major. A minimum GPA of 2.0 in all work attempted at UMD, successful completion (with grades of A through D, or S) of all lower division courses listed on page 14, and a minimum GPA of 2.0 overall (including transfer credits) are required for admission to the EE upper division program.
- (5) Completion of UMD and ABET liberal education requirements. Liberal education elective choices must include the following:
 - Econ 1022 or Econ 1023
 - Writ 1120 and Writ 3130
 - Phil 3242 or Phil 3325 or CS 3111
 - At least one course from LE - OCL
 - At least one course from each of the following categories: LE - SS, LE - H, LE - FA
 - At least one course emphasizing LE - GP
 - At least one course emphasizing LE - CD
 - At least one course emphasizing LE – S
- (6) A minimum GPA of 2.00 in all courses taken in the major including required supporting courses is required for graduation. This average applies to all courses in the major taken at UMD and calculated separately and also to all courses in the major when transfer credits are included.
- (7) Acceptance to the upper division of EE by filing the EE Upper Division Application Form with the department. Students who fail to file this form after completing all lower division credits may not be permitted to register.
- (8) Completion of the Electrical Engineering “Exit Survey”, and a one-to-one exit interview with the EE Department Head.
- (9) Compliance with the general regulations governing the granting of degrees.

ELECTRICAL ENGINEERING

Typical Program of Undergraduate Study

Fall Semester

First Year

MATH 1296-CALCULUS I	5
EE 1001-INTRO TO EE	2
WRIT 1120 COLLEGE WRITING	3
CS 1511-COMPUTER SCIENCE I	5
	15

Spring Semester

MATH 1297-CALCULUS II	5
EE 1315-DIGITAL LOGIC	4
PHYS 2013/2014-GENERAL PHYSICS I	5
ECON 1023 -PRIN. OF ECON: MICRO	3
	17

Second Year

MATH 3280-DIFF EQUATIONS LIN ALGEBRA	4
EE 2006-ELEC CIRCUIT ANALYSIS	4
EE 2325-MICROPROCESSOR SYS	4
PHYS 2015/2016-GENERAL PHYSICS II	5
	17

MATH 3298-CALCULUS III	4
CHEM 1153/1154 GENERAL CHEMISTRY I	5
EE 2111-LIN SYSTEMS & SIGNALS	4
EE 2212-ELECTRONICS I	4
	17

Third Year

EE 3151-CONTROL SYSTEMS	4
EE 3235-ELECTRONICS II	4
EE 3445-ELECTROMAGNETICS	3
STAT 3611-INTRO TO STATISTICS	4
LIB ED ELECTIVE ¹	3
	18

EE TECHNICAL ELECTIVE	3
EE TECHNICAL ELECTIVE	3
EE TECHNICAL ELECTIVE	3
LIB ED ELECTIVE ¹	3
WRIT 3130 ADV WRITING – ENGR	3
	15

Fourth Year

EE 4899-SENIOR DESIGN PROJECT I ²	1
EE TECHNICAL ELECTIVE	3
PHIL 3242 or PHIL 3325 or CS 3111	3
ENGINEERING “BREADTH” ELECTIVE ³	3
LIB ED ELECTIVE ¹	3
	13

EE 4999-SENIOR DESIGN PROJECT II ²	3
EE TECHNICAL ELECTIVE	3
EE TECHNICAL ELECTIVE	3
EE TECHNICAL ELECTIVE	3
LIB ED ELECTIVE ¹	3
	15

1. Lib Ed electives (plus [Phil 3242 or Phil 3325 or CS 3111], [Econ 1022 or Econ 1023], Writ 1120 and Writ 3130) must include the following:

- At least one course from LE - OCL
- At least one course from each of the following categories: LE - SS, LE - H, LE - FA
- At least one course emphasizing LE - GP
- At least one course emphasizing LE - CD
- At least one course emphasizing LE – S

2. EE 4951-Design Workshop may be taken in place of EE 4899 and EE 4999

3. Engineering “Breadth” elective must include one course from the following list: CE 2017, ChE 2001, ChE 2111, IE 3115, ME 2105

NOTE Liberal Education (LE) Requirement Abbreviations: Writing & Information Literacy - WL; Oral Communication & Language - OCL; Logic & Quantitative Reasoning - LQR; Natural Sciences - NS; Natural Sciences with lab - NS W/LAB; Social Sciences - SS; Humanities - H; Fine Arts - FA; Global Perspectives - GP; Cultural Diversity in the US - CD; Sustainability - S.

EE COURSE PREREQUISITES

KEY TO SYMBOLS:

§ = Credit will not be granted if credit has been received for the course listed after this symbol

¶ = Concurrent registration is allowed in the course listed after this symbol

= Consent of the instructor is required for registration

€ = Consent of the department is required for registration

EE 1001. INTRODUCTION TO ELECTRICAL ENGINEERING.

(2 cr; prereq CE, ChE, CS, EE, IE, ME majors only; A-F only)

EE 1315. DIGITAL LOGIC.

(4 cr; prereq CE, ChE, CS, EE, IE, ME majors only; A-F only)

EE 1501. FRESHMAN SEMINAR HONORS: RENEWABLE ENERGY.

(3 cr; A-F only)

EE 2006. ELECTRICAL CIRCUIT ANALYSIS.

(4 cr; prereq ¶Math 3280, ¶Phys 2015/2016; A-F only)

EE 2111. LINEAR SYSTEMS AND SIGNAL ANALYSIS.

(4 cr; prereq 2006; A-F only)

EE 2212. ELECTRONICS I.

(4 cr; prereq 2006; A-F only)

EE 2325. MICROPROCESSOR SYSTEMS.

(4 cr; prereq 1315; A-F only)

EE 3151. CONTROL SYSTEMS.

(4 cr; prereq 2111; A-F only)

EE 3235. ELECTRONICS II.

(4 cr; prereq 2212; A-F only)

EE 3445. ELECTROMAGNETIC FIELDS.

(3 cr; prereq Math 3280, Math 3298, Phys 2015/2016; A-F only)

EE 4305. COMPUTER ARCHITECTURE.

(4 cr; prereq EE 2325; A-F only)

EE 4321. COMPUTER NETWORKS.

(3 cr; prereq 4341, Stat 3611; A-F only)

EE 4341. DIGITAL SYSTEMS.

(4 cr; prereq 2325; A-F only)

EE 4501. POWER SYSTEMS.

(4 cr; prereq 2006; no Grad School credit; A-F only)

EE 4611. INTRODUCTION TO SOLID STATE SEMICONDUCTORS.

(3 cr; prereq Phys 2015/2016; A-F only)

EE 4781. TELECOMMUNICATIONS.

(3 cr; prereq 3445; no Grad School credit; A-F only)

EE 4896. CO-OP IN ELECTRICAL ENGINEERING

(1 cr; BSEE or MSEE standing in Electrical Engineering, or department consent; S-N only)

EE 4899. SENIOR DESIGN PROJECT I.
(1 cr; ¶WRIT 3130, §4951; BSEE candidate, #; no Grad School credit; A-F only)

EE 4951. DESIGN WORKSHOP.
(4 cr; ¶WRIT 3130, §4899, §4999; BSEE candidate, #; no Grad School credit; A-F only)

EE 4991. INDEPENDENT STUDY.
(1-3 cr; prereq #; does not qualify as EE technical elective; A-F only)

EE 4999. SENIOR DESIGN PROJECT II.
(3 cr; prereq 4899; §4951; BSEE candidate, #; no Grad School credit; A-F only)

EE 5151. DIGITAL CONTROL SYSTEM DESIGN.
(3 cr; prereq 3151, §4151; A-F only)

EE 5161. LINEAR STATE-SPACE CONTROL SYSTEMS.
(3 cr; prereq 3151, §4151; A-F only)

EE 5211. ADVANCED ANALOG INTEGRATED CIRCUIT DESIGN.
(3 cr; prereq 3235; A-F only)

EE 5311. DESIGN OF VERY LARGE-SCALE INTEGRATED CIRCUITS.
(4 cr; prereq 3235, 3341 or #; A-F only)

EE 5315. MULTIPROCESSOR BASED SYSTEM DESIGN.
(3 cr; prereq 4305; § 4315; A-F only)

EE 5351. INTRODUCTION TO ROBOTICS AND MOBILE ROBOT CONTROL ARCHITECTURE
(3cr; prereq 3151; A-F only)

EE 5477. ANTENNAS AND TRANSMISSION LINES.
(3 cr; co-prereq 3445, §4477; A-F only)

EE 5479. ANTENNAS AND TRANSMISSION LINES LABORATORY.
(1 cr; prereq 5477, §5477; A-F only)

EE 5501. ENERGY CONVERSION SYSTEMS.
(3 cr; prereq Chem 1153/1153; A-F only)

EE 5522. POWER ELECTRONICS.
(3 cr; prereq 3235; A-F only)

EE 5533. GRID – RESILIENCY, EFFICIENCY AND TECHNOLOGY.
(3cr; EE 2006 or Permission from instructor; A-F only)

EE 5611. MICROELECTRONICS TECHNOLOGY.
(3 cr; prereq 3235; A-F only)

EE 5741. DIGITAL SIGNAL PROCESSING.
(3 r; prereq 2111 §4741; A-F only)

EE 5742. PATTERN RECOGNITION AND MACHINE LEARNING.
(4 cr; prereq 2111; A-F only)

EE 5745. MEDICAL IMAGING.
(3 cr; prereq 2111; A-F only)

EE 5765. MODERN COMMUNICATION.
(4 cr; prereq 2111, 3235; A-F only)

EE 5801. INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS.

(3 cr; prereq CS 1521, Math 3280, Stat 3611, or #, §4801; A-F only)

EE 5813. TOOLS AND METHODS OF DESIGN AUTOMATION.

(3 cr; prereq 4341, §4813; A-F only)

EE 5831. FUZZY SET THEORY AND ITS APPLICATIONS.

(3 cr; prereq CS 1521, Math 3280, §4831; A-F only)

EE 5995. SPECIAL TOPICS (Various titles to be assigned).

(1 to 3 cr; [max 3 cr]; prereq #; A-F only)

Open to Graduate Students Only

EE 8001. GRADUATE PROFESSIONAL COMMUNICATION SEMINAR.

(1 cr)

EE 8151. OPTIMAL CONTROL SYSTEMS.

(3 cr; prereq EE 3151, A-F)

EE 8315. EMBEDDED SYSTEMS AND MICROCOMPUTER INTERFACES DESIGN.

(4 cr; prereq 2325, 4341, CS 1511, CS 2521, A-F)

EE 8611. SEMICONDUCTOR DEVICE DESIGN, FABRICATION, AND ANALYSIS.

(3 cr; prereq EE 4611 or Physics 4021 and Math 3280, A-F)

EE 8741. DIGITAL IMAGE PROCESSING.

(4 cr; prereq EE 4741, A-F)

EE 8742. FUNDAMENTALS OF SIGNAL DETECTION AND ESTIMATION.

(3 cr; prereq EE 2111, STAT 3611, A-F)

EE 8765. DIGITAL COMMUNICATIONS.

(3 cr; prereq 4765, A-F)

EE 8831. SOFT COMPUTING.

(3 cr; prereq: the student is expected to have knowledge of linear algebra and computer programming; A-F only)

EE ELECTIVES

- EE 4305. COMPUTER ARCHITECTURE (4)
- EE 4321. COMPUTER NETWORKS (3)
- EE 4341. DIGITAL SYSTEMS (4)
- EE 4501. POWER SYSTEMS (4)
- EE 4611. INTRODUCTION TO SOLID STATE SEMICONDUCTORS (3)
- EE 4781. TELECOMMUNICATIONS (3)
- EE 4991. INDEPENDENT STUDY (3)
- EE 5151. DIGITAL CONTROL SYSTEM DESIGN (3)
- EE 5161. LINEAR STATE-SPACE CONTROL SYSTEMS (3)
- EE 5211. ADVANCED ANALOG INTEGRATED CIRCUIT DESIGN (3)
- EE 5311. DESIGN OF VERY LARGE SCALE INTEGRATED CIRCUITS (4)
- EE 5315. MULTIPROCESSOR BASED SYSTEM DESIGN (3)
- EE 5351. INTRO TO ROBOTICS AND MOBILE ROBOT CONTROL ARCHITECTURES (3)
- EE 5477. ANTENNAS AND TRANSMISSION LINES (3)
- EE 5479. ANTENNAS AND TRANSMISSION LINES LABORATORY (1)
- EE 5501. ENERGY CONVERSION SYSTEMS (3)
- EE 5522. POWER ELECTRONICS (3)
- EE 5533. GRID – RESILIENCY, EFFICIENCY AND TECHNOLOGY (3)
- EE 5611 MICROELECTRONICS TECHNOLOGY (3)
- EE 5741. DIGITAL SIGNAL PROCESSING (3)
- EE 5742. PATTERN RECOGNITION AND MACHINE LEARNING (4)
- EE 5745. MEDICAL IMAGING (3)
- EE 5765. MODERN COMMUNICATION (4)
- EE 5801. INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS (3)
- EE 5813. TOOLS AND METHODS OF DESIGN AUTOMATION (3)
- EE 5831. FUZZY SET THEORY AND ITS APPLICATIONS (3)
- EE 5995. SELECTED ADVANCED TOPICS OR SEMINAR (3)

ELECTRICAL ENGINEERING UNDERGRADUATE COURSES

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= Consent of the instructor is required for registration
∈ = Consent of the department is required for registration

EE 1001. INTRODUCTION TO ELECTRICAL ENGINEERING.

(2 cr; prereq Pre-engr, ChE, CS, EE, IE majors only; A-F only)

Definition and description of electrical and computer engineering. Digital and analog systems. Electrical and computer engineering lab equipment and software. Selected specialties. (2 hrs lect)

EE 1315. DIGITAL LOGIC.

(4 cr; prereq Pre-engr, ChE, CS, EE, IE majors only; A-F only)

Binary number system and digital coding techniques. Boolean algebra, combinational logic circuits, and minimization techniques. Synchronous sequential circuits and state reduction techniques. Medium Scale Integration (MSI) combinational components. (3 hrs lect, 3 hrs lab)

EE 1501. FRESHMAN SEMINAR HONORS: RENEWABLE ENERGY.

(3 cr; A-F only)

Introduces energy resource and consumption patterns and current issues on global and local levels. Consider how social, political, financial and technological aspects of renewable energy related to climate change and resource constraints. Exploration of energy's impact on all aspects of human life through discussion, selected readings and guest lectures.

EE 2006. ELECTRICAL CIRCUIT ANALYSIS.

(4 cr; prereq ¶Math 3280, ¶Phys 2012; A-F only)

Basic circuit analysis: resistive circuits, voltage and current sources - independent and dependent. Nodal and mesh analysis. Network theorems. Energy storage elements. RC, RL, and RLC transient and steady state analysis, phasors. SPICE analysis. (3 hrs lect, 3 hrs lab)

EE 2111. LINEAR SYSTEMS AND SIGNAL ANALYSIS.

(4 cr; prereq 2006; A-F only)

Signal and system modeling concepts, system analysis in time domain, Fourier series and Fourier transform. Discrete time domain signals and systems, Z transform, applications. (3 hrs lect, 3 hrs lab)

EE 2212. ELECTRONICS I.

(4 cr; prereq 2006; A-F only)

Diodes, BJTs, FETs, ideal operational amplifiers, DC analysis, small signal models and analysis; single-stage circuits design; power amplifiers. (3 hrs lect, 3 hrs lab)

EE 2325. MICROPROCESSOR SYSTEMS.

(4 cr; prereq 1315; A-F only)

Microcomputer components. Instruction set, machine and assembly language programming. Addressing modes. Signed/unsigned arithmetic. Stack uses. Assembly-level translation of high level language constructions. Input/Output interfacing. Interrupt programming. Microcomputer system hardware. (3 hrs lect, 3 hrs lab)

EE 3151. CONTROL SYSTEMS.

(4 cr; prereq 2111; A-F only)

System mathematical modeling: differential equations, Laplace transform, block diagrams, signal flow graphs. System performance characteristics: time response, sensitivity, steady-state error. Stability analysis: Routh-Hurwitz, root locus and Nyquist. State variables. Compensation design, software tools. (3 hrs lect, 3 hrs lab)

EE 3235. ELECTRONICS II.

(4 cr; prereq 2212; A-F only)

Multistage circuits, frequency analysis, non-ideal operational amplifiers, feedback and stability, oscillators, filters. (3 hrs lect, 3 hrs lab)

EE 3445. ELECTROMAGNETIC FIELDS.

(3 cr; prereq Math 3280, Math 3298, Phys 2012; A-F only)

Fundamentals of electromagnetic analysis. Electrostatic and Magnetostatic fields. Introductory numerical analysis of electromagnetic fields. Time-varying fields and potentials. Maxwell's equations and their applications. (3 hrs lect)

EE 4305. COMPUTER ARCHITECTURE.

(4 cr; prereq 2325; A-F only)

Advanced assembly language programming techniques. Memory design principles. Virtual memory. Cache memory. Processor design. Pipelined and Reduced Instruction Set Computers (RISC). Advanced microprocessor features. (3 hrs lect, 3 hrs lab)

EE 4321. COMPUTER NETWORKS.

(3 cr; prereq 3341, Stat 3611; A-F only)

Network classification and services. Protocol and communication architectures. Hardware components: multiplexers, concentrators, bridges, routers, access servers. (3 hrs lect)

EE 4341. DIGITAL SYSTEMS.

(4 cr; prereq 2325; A-F only)

Digital logic family characteristics. Medium Scale Integration (MSI) components and applications. Programmable Logic Devices (PLDs). Alternative clocking techniques. Computer arithmetic circuits and memory design. Fundamental mode asynchronous finite-state machine design. (3 hrs lect, 3 hrs lab)

EE 4501. POWER SYSTEMS.

(4 cr; prereq 2006; no Grad School credit; A-F only)

Fundamentals of rotating machines: DC, synchronous, and induction machines. Transformers. Power system representation. Transmission lines. Power system analysis: stability and dynamic performance. Balanced and unbalanced faults. Power system protection. (3 hrs lect, 3 hrs lab)

EE 4611. INTRODUCTION TO SOLID STATE SEMICONDUCTORS.

(3 cr; prereq Phys 2012; A-F only)

Fundamentals of solid-state semiconductors and devices. Quantum mechanical concepts and atomic states, solid state structure, band structure, semiconductor statistics, and transport. (3 hrs lect)

EE 4781. TELECOMMUNICATIONS.

(3 cr; prereq 3445; no Grad School credit; A-F only)

Topics in switching theory, transmission, networking, traffic engineering, and associated engineering problems and solutions. (3 hrs lect)

EE 4896. CO-OP IN ELECTRICAL ENGINEERING

(1 cr; BSEE or MSEE standing in Electrical Engineering, or department consent; S-N only)

Career-related work experience with employer closely associated with student's academic area. Students must have department approval for the course prior to starting the Co-Op or the internship. Midterm status report and final written report with employer survey must be submitted to the EE department. This course cannot be counted towards EE degree requirements or EE technical electives.

EE 4899. SENIOR DESIGN PROJECT I.

(1 cr; prereq §4951; 3341, BSEE candidate, #; no Grad School credit; A-F only)

Selection and completion of team project approved and supervised by faculty. (See also EE 4999.)

EE 4951. SENIOR DESIGN WORKSHOP.

(4 cr; ¶ WRIT 3130; §4899, §4999; Comp 3130, BSEE candidate, #; no Grad School credit; A-F only)

Study of a selected topic; its application to a design project, completed in a small group. Focuses on a different method each semester offered. Completion satisfies the requirement for a senior design project.

EE 4991. INDEPENDENT STUDY.

(1-3 cr; prereq #; does not qualify as EE technical elective; A-F only)

Special projects not available in regular curriculum. Independent investigation, research studies, or survey of selected projects or problems.

EE 4999. SENIOR DESIGN PROJECT II.

(3 cr; ¶ WRIT 3130; §4951; 4899, BSEE candidate, #; no Grad School credit; A-F only)

Students present senior design project results in formal written and oral reports after making refinements. Complete documentation of results in professional manner required. Results must be presented in an oral report with other senior project team members. EE 4899 and EE 4999 must be completed within one year for credit.

EE 5151. DIGITAL CONTROL SYSTEM DESIGN.

(3.0 cr; prereq 3151, 3341, § 4151; A-F only)

Digital control system characteristics: transient and steady-state responses, frequency response, stability. Digital control system design using transform techniques. Controllability and observability. Design of digital control systems using state-space methods: pole placement and observer design, multivariable optimal control. Implementation issues in digital control.

EE 5161. LINEAR STATE-SPACE CONTROL SYSTEMS.

(3.0 cr; prereq 3151; A-F only)

State space representations of control systems and analysis and design. Stability, controllability, observability, realizations, state estimator or observer design and state feedback design.

EE 5211. ADVANCED ANALOG INTEGRATED CIRCUIT DESIGN.

(3 cr; prereq 3235; A-F only)

This course aims to provide EE students with fundamental analysis and design skills for transistor-level analog integrated circuits, such as operational amplifiers, transconductance amplifiers, bandgap references, amplifier-based filters, analog-to-digital converters, digital-to-analog converters and phase-locked loop. The course is project-oriented with a focus on transistor-level design of analog circuits from transistor sizing to layout in an integrated circuit environment such as Cadence tool sets. The expected outcomes are that students are able to design an analog system of medium complexity at transistor-level.

EE 5311. DESIGN OF VERY LARGE-SCALE INTEGRATED CIRCUITS.

(4 cr; prereq 3235, 3341 or #; A-F only)

Philosophy of and techniques for designing VLSI circuits in CMOS technology. Full- and semi-custom design techniques. Digital, analog, and hybrid CMOS circuits and systems. Substantial design project required. (3 hrs lect)

EE 5315. MULTIPROCESSOR-BASED SYSTEM DESIGN.

(3.0 cr; prereq 4305, § 4315 ; A-F only)

Parallelism, interconnection networks, shared memory architecture, principles of scalable performance, vector computers, multiprocessors, multicomputers, dataflow architectures, and supercomputers.

EE 5351. INTRODUCTION TO ROBOTICS AND MOBILE ROBOT CONTROL ARCHITECTURES.

(3 cr; prereq 3151; no Grad School credit; A-F only)

Basic concepts and tools for the analysis, design, and control of robotic mechanisms. Topics include basic robot architecture and applications to dynamical systems, mobile mechanisms, kinematics, inverse kinematics, trajectory and motion planning, mobile robots, collision avoidance, and control architectures.

EE 5477. ANTENNAS AND TRANSMISSION LINES.

(3 cr; prereq 3445; A-F only)

Concepts and theory of antennas and transmission lines; emphasis on design and applications. Topics: nonlinear source and loads, cross talk, interconnecting circuits, line characteristics, radiation, measurements. EM propagation, scattering and antenna design techniques. Numerical analysis of wire, aperture, reflector antennas, diffraction theory.

EE 5479. ANTENNAS AND TRANSMISSION LINES LABORATORY.

(1 cr; prereq 5477 or concurrent registration in 5477; A-F only)

This laboratory course provides hands-on experience with designing, constructing, and measuring the performance of radiofrequency (RF) antennas and transmission lines. Concepts include velocity factor, propagation factors, characteristic impedance, tuning stubs and matching sections, resonance, parasitic elements, gain, directivity, return loss, and RF safety. This course supports the theory presented in EE5477 (Antennas and Transmission Lines), and is optional for those enrolled in, or having completed, 5477.

EE 5501. ENERGY CONVERSION SYSTEMS.

(3 cr; prereq Chem 1153/1154; A-F only)

Theory, design and operation of conventional and alternative electrical energy conversion systems. Carbon dioxide cycle, Earth/Sun radiation balance, and environmental impacts. Power delivery systems and integration of conversion systems with the grid. Development of generation portfolios. Impact of energy policies and current energy issues. Case studies.

EE 5522. POWER ELECTRONICS.

(3 cr; prereq 3235; A-F only)

Power semiconductor devices; traditional power converters; ac-dc converters: half-wave and full-wave rectifiers; dc-dc converters: traditional and transformer derived choppers; dc-ac converters: single-phase and three-phase inverters; ac-ac converters; pulse-width modulation; applications

EE 5533 GRID – RESILIENCY, EFFICIENCY AND TECHNOLOGY.

(3 cr; 2006 or permission of instructor; A-F only)

Concepts and architecture of grid, smart grid and microgrid; resiliency under physical and cyber attacks; grid efficiency via sensors, networks and control; technology including standards and protocols for cybersecurity and protection of the grid; case studies and testbeds.

EE 5611. MICROELECTRONICS TECHNOLOGY.

(3 cr; prereq 3235; A-F only)

Various fabrication processes in silicon-based microelectronic circuits and devices: lithography, oxidation, diffusion, thin film deposition, etching and integration of various technologies; material defects analysis and device characterization skills; design of fabrication process with SUPREME IV simulator; fabrication technologies involved in other devices: optical devices, MEMS and semiconductor nanostructures.

EE 5741. DIGITAL SIGNAL PROCESSING.

(3.0 cr; prereq 2111, § 4741 ; A-F only)

The fundamentals of two-dimensional signal processing techniques, discrete image analysis, and image quality measures.

EE 5742. PATTERN RECOGNITION AND MACHINE LEARNING.

(4 cr; prereq 2111; A-F only)

Various methods of pattern recognition, non-parametric techniques, linear discriminant functions, support vector machines, statistical classification, minmax procedures, maximum likelihood decisions, case studies.

EE 5745. MEDICAL IMAGING.

(3 cr; prereq 2111; A-F only)

Introduction to the methods and devices for medical imaging, including x-ray imaging, x-ray computed tomography (CT), nuclear medicine (single photon planar imaging, single photon emission computed tomography (SPECT), and positron emission tomography (PET), magnetic resonance imaging (MRI), and ultrasound imaging. The physics and design of systems, typical applications, medical image processing, and tomographic reconstruction.

EE 5765. MODERN COMMUNICATION.

(4 cr; prereq 2111, 3235; A-F only)

Design and analysis of modern communication systems; evaluation of analog and digital modulation techniques. (3 hrs lect, 3 hrs lab)

EE 5801. INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS.

(3.0 cr; prereq CS 1521, Math 3280, Stat 3611 or #,§ 4801 ; A-F only)

General techniques and theory of neural networks, their applications and limitations. The course particularly addresses the design issues and learning algorithms for diverse areas of applications.

EE 5813. TOOLS AND METHODS OF DESIGN AUTOMATION.

(3.0 cr; prereq 3341, § 4813; A-F only)

Methods and techniques for designing electronic systems based on top-down strategy. Emphasis on high-level synthesis techniques and tools. Automated design of large, electronic systems. Design project using electronic design automation tools available in the EE department.

EE 5831. FUZZY SET THEORY AND ITS APPLICATION.

(3.0 cr; prereq CS 1521, Math 3280, §4831 ; A-F only)

Fuzzy sets and operations on fuzzy sets. Fuzzy relations and the extension principle. Linguistic variable and fuzzy IF-THEN rules. Fuzzy arithmetic. Fuzzy logic and approximate reasoning. Design of Fuzzy Systems from I/O data. Fuzzy logic--based control. Pattern Classifications.

EE 5995. SPECIAL TOPICS: (Various titles to be assigned).

(1.0-3.0 cr; 3.0 max cr; prereq #; A-F only)

Current problems and research. Discussions, selected reading, and/or invited speakers.

EE Major 2018-2019

Semester #

2 Econ³ 1022/23

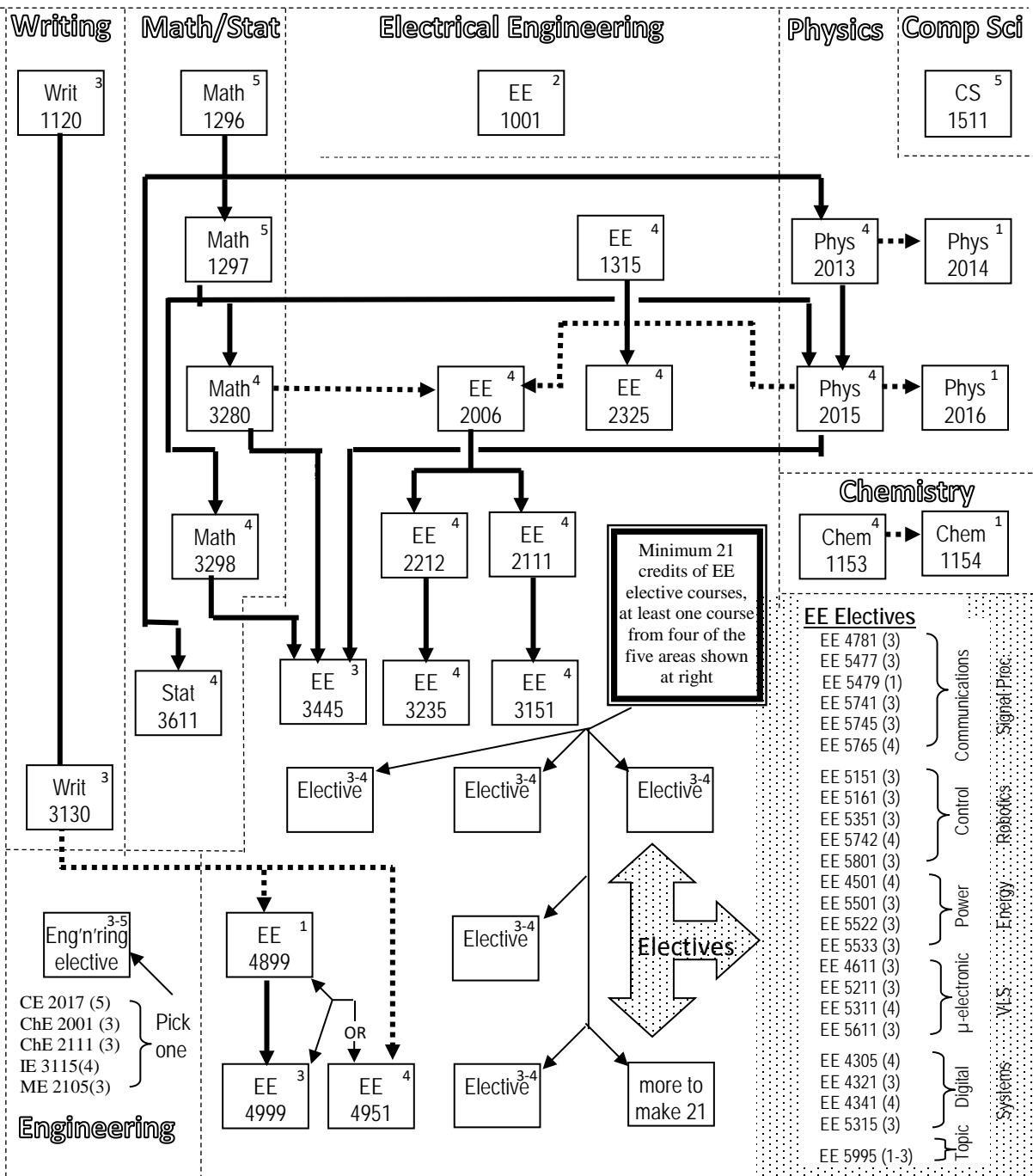
3 Liberal Education (new program Fall 2012)

5 Humanities³

6 Oral Comm.³

7 Ethics³ (Phil 3242 or Phil 3325 or CS 3111) Fine Arts³

8 Social Science³



Lib. Ed. requirements must include courses covering the following Key Topic issues...

- Global Perspectives (3 cr)
- Cultural Diversity in US (3 cr)
- Environmental Sustainability (3 cr)

Bold arrows indicate prerequisite structure

Dotted arrows indicate concurrent

Min 127 cr

EE Minor (41-42 cr)

Math 1296,1297,3280
Phys 2013,2015,
EE 1315,2006,2111,2212
and one of the following:
EE 3151,3235,3445,4501,4611

CpE Minor(36 cr)

Math 1296,1297
CS 1511,1521 2511
EE 1315,2325,4305
(CS subs CS 2521 for 2325)

Energy Minor(40 cr)

Math 1296,1297,3280;Phys 2013,2014,2015,2016; EE 2006, ChE 2111,2121.6 cr. from the following.. CE 5515, ChE 4603, 4612, ME 4050,4375 or EE 4501,5501

CpE minor achieved by choosing EE 4305, and adding two extra courses, CS 1521 and 2511

Energy minor achieved by choosing EE 4501 and 5501, ChE 2111 and adding one extra course, ChE 2121 or ME 2212

Math minor achieved by adding one extra Math/Stat course numbered 3000 or above, except 3411 and 3326

CS minor achieved by choosing EE 4341 and 4305, and adding two extra courses, CS 1521 and 2511

Other minors can be achieved but require several extra courses
Other minors can be achieved but require several extra courses

FALL SEMESTER 2018 EE COURSE OFFERINGS

COURSE	TIME	DAYS	ROOM	CREDIT	INSTRUCTOR	ENROLLMENT CAP
EE 1001 INTRO TO EE	09:00-09:50	TTh	CHEM 150	2	S. BURNS	70
EE 1315 DIGITAL LOGIC	10:00-10:50	MWF	MWAH 191	4	L. ZIMMERMAN	40
2-Lab	09:00-11:50	Th	MWAH 295		B. KUNDU	20
3-Lab	01:00-03:50	Th	MWAH 295		B. KUNDU	20
EE 2006 ELEC CIRCUIT ANALYSIS	11:00-11:50	MWF	MWAH 191	4	D. HALLBERG	48
2-Lab	09:00-11:50	T	MWAH 391		W. JIA	16
3-Lab	01:00-03:50	T	MWAH 391		W. JIA	16
4-Lab	04:00-06:50	T	MWAH 391		M. K. P. KHAN	16
EE 2006 ELEC CIRCUIT ANALYSIS	11:00-12:15	TTh	MWAH 191	4	I. BAZ KHALLOUF	48
6-Lab	04:00-06:50	M	MWAH 391		S. PAUL	16
7-Lab	04:00-06:50	W	MWAH 391		W. JIA	16
8-Lab	04:00-06:50	Th	MWAH 391		M. K. P. KHAN	16
EE 2006 ELEC CIRCUIT ANALYSIS	12:00-12:50	MWF	MWAH 177	4	L. ZIMMERMAN	
10-Lab	09:00-11:50	T	MWAH 393		B. KUNDU	16
11-Lab	01:00-03:50	T	MWAH 393		S. BHATTACHARJEE	16
EE 2111 LINEAR SYS & SIGNALS	10:00-10:50	MWF	MWAH 175	4	I. HAYEE	30
2-Lab	09:00-11:50	Th	MWAH 393		S. CHOWDHURY	15
3-Lab	01:00-03:50	Th	MWAH 393		S. CHOWDHURY	15
EE 2212 ELECTRONICS I	11:00-11:50	MWF	CHEM 251	4	S. BURNS	40
2-Lab	01:00-03:50	Th	MWAH 391		S. BURNS	20
3-Lab	10:00-12:50	Th	MWAH 391		S. BURNS	20
EE 2325 MICROPROCESSOR SYS.	08:00-08:50	MWF	MWAH 191	4	C. CARROLL	40
2-Lab	ARR.	T	MWAH 295		C. CARROLL	40
EE 3151 CONTROL SYSTEMS	03:00-03:50	MWF	EB 280	4	J. YANG	40
2-Lab	09:00-11:50	T	MWAH 141		S. PAUL	20
3-Lab	01:00-03:50	T	MWAH 141		S. PAUL	20
EE 3235 ELECTRONICS II	01:00-01:50	MWF	MWAH 175	4	H. TANG	24
2-Lab	09:00-11:50	Th	MWAH 293		S. BHATTACHARJEE	12
3-Lab	01:00-03:50	Th	MWAH 293		S. BHATTACHARJEE	12
EE 3445 ELECTROMAGNETIC FIELDS	09:00-09:50	MWF	MWAH 175	3	M. HASAN	30
EE 4305 COMPUTER ARCHITECTURE	02:00-02:50	MWF	MWAH 175	4	T. KWON	30
2-Lab	01:00-03:50	Th	MWAH 41		T. KWON	15
EE 4501 POWER SYSTEMS	12:00-12:50	MWF	CHEM 251	4	S. NORR	32
2-Lab/4-Lab	09:00-11:50	T/Th	MWAH 291		T. HOSSAIN	8/8
3-Lab/5-Lab	01:00-03:50	T/Th	MWAH 291		T. HOSSAIN/S. BHATTI	8/8
EE 4896 CO-OP IN EE	ARR.	ARR.	ARR.	1	ARR.	
EE 4951 DESIGN WORKSHOP	08:00-08:50	T	MWAH 279	4	S. NORR	12
EE 5311 VLSI	12:00-01:15	TTh	MWAH 291A	4	H. TANG	15
EE 5351 ROBOTICS & MOBILE ROBOTS	08:00-08:50	MWF	MWAH 175	3	L. ZIMMERMAN	15
EE 5501 ENERGY CONVERSION SYS	05:00-06:15	TTh	MWAH 175	3	S. NORR	15
EE 5533 GRID	03:30-04:45	TTh	MWAH 175	3	S. NAIDU	20
EE 5745 MEDICAL IMAGING	01:00-01:50	MWF	HH 306	4	M. HASAN	20
EE 5765 MODERN COMMUNICATION	05:30-06:45	MW	MWAH 175	4	I. HAYEE	20
2- Lab	ARR.	ARR.	MWAH 60		S. BHATTI	10
3- Lab	ARR.	ARR.	MWAH 60		S. BHATTI	10

SPRING SEMESTER 2019 EE COURSE OFFERINGS

COURSE	TIME	DAYS	ROOM	CREDIT	INSTRUCTOR	ENROLLMENT CAP
EE 1315-1 DIGITAL LOGIC	10:00-10:50	MWF	MWAH 191	4	L. ZIMMERMAN	40
2-Lab	09:00-11:50	T	MWAH 295		L. ZIMMERMAN	20
3-Lab	01:00-03:50	T	MWAH 295		L. ZIMMERMAN	20
EE 2006 ELEC CIRCUIT ANALYSIS	11:00-12:15	TTh	MWAH 191	4	I. BAZ KHALLOUF	
2-Lab	04:00-06:50	M	MWAH 391		I. BAZ KHALLOUF	16
3-Lab	04:00-06:50	W	MWAH 391		I. BAZ KHALLOUF	16
4-Lab	04:00-06:50	Th	MWAH 391		I. BAZ KHALLOUF	16
EE 2006 ELEC CIRCUIT ANALYSIS	12:00-12:50	MWF	MWAH 191	4	D. HALLBERG	48
6-Lab	09:00-11:50	T	MWAH 391		D. HALLBERG	16
7-Lab	01:00-03:50	T	MWAH 391		D. HALLBERG	16
8-Lab	04:00-06:50	T	MWAH 391		D. HALLBERG	16
EE 2006 ELEC CIRCUIT ANALYSIS	04:00-04:50	MWF	MWAH 191	4	M. HASAN	32
10-Lab	09:00-11:50	T	MWAH 393		M. HASAN	16
11-Lab	01:00-03:50	T	MWAH 393		M. HASAN	16
EE 2111 LINEAR SYS & SIGNALS	10:00-10:50	MWF	MWAH 175	4	I. HAYEE	30
2-Lab	09:00-11:50	Th	MWAH 393		I. HAYEE	15
3-Lab	01:00-03:50	Th	MWAH 393		I. HAYEE	15
EE 2212 ELECTRONICS I	11:00-11:50	MWF	CHEM 251	4	S. BURNS	40
2-Lab	09:00-11:50	Th	MWAH 391		S. BURNS	20
3-Lab	01:00-03:50	Th	MWAH 391		S. BURNS	20
EE 2325 MICROPROCESSOR SYS	12:00-12:50	MWF	MWAH 175	4	I. BAZ KHALLOUF	30
2-Lab	ARR.	ARR.	MWAH 295		I. BAZ KHALLOUF	30
EE 3151 CONTROL SYSTEMS	04:00-05:15	MWF	CHEM 155	4	J. YANG	30
2-Lab	09:00-11:50	T	MWAH 141		J. YANG	30
3-Lab	01:00-03:50	T	MWAH 141		J. YANG	30
EE 3235 ELECTRONICS II	11:00-11:50	MWF	HH 216	4	H. TANG	16
2-Lab	09:00-11:50	Th	MWAH 293		H. TANG	8
3-Lab	01:00-03:50	Th	MWAH 293		H. TANG	8
EE 3445 ELECTROMAGNETIC FIELDS	09:00-09:50	MWF	MWAH 191	3	L. ZIMMERMAN	30
EE 4305 COMPUTER ARCHITECTURE	01:00-01:50	MWF	MWAH 175	4	T. KWON	30
2-Lab	ARR.	Th	MWAH 41		T. KWON	30
EE 4321 COMPUTER NETWORKS	11:00-11:50	MWF	CHEM 155	4	T. KWON	30
EE 4501 POWER SYSTEMS	05:30-06:45	MW	MWAH 175	4	P. FENG	32
2-Lab/4-Lab	09:00-11:50	T	MWAH 291		P. FENG	8/8
3-Lab/5-Lab	01:00-03:50	T	MWAH 291		P. FENG	8/8
EE 4611 SEMICONDUCTORS	02:00-02:50	MWF	ABAH 245	3	S. BURNS	30
EE 4951 DESIGN WORKSHOP	08:00-08:50	T	MWAH 175		S. NORR	12
EE 5161 STATE-SPACE CONTROL SYS	03:30-04:45	TTh	CHEM 200	3	D. NAIDU	15
EE 5351 ROBOTICS & MOBILE ROBOTS	03:00-03:50	MWF	HH 306	3	L. ZIMMERMAN	15
EE 5477 ANTENNAS & TRANS LINES	04:00-05:15	MW	HH 306	3	T. FERGUSON	10
EE 5479 ANTENNAS LAB	11:00-12:50	Th	MWAH 291	1	T. FERGUSON	10
EE 5522 POWER ELECTRONICS	12:15-12:50	MWF	VK 115	3	P. FENG	15
EE 5765 MODERN COMMUNICATION	05:30-06:45	MW	MWAH 191	4	I. HAYEE	30
2-Lab/3-Lab	ARR.	ARR.	MWAH 60		I. HAYEE	30
EE 5995 SPECIAL TOPICS – ELEC. DRIVES	TBD	ARR	ARR	3	S. NORR	30

Undergraduate Minor in Energy Engineering

Administered by: The Department of Electrical Engineering

Description

The objective of this undergraduate Energy Engineering minor is to provide students with basic knowledge and skills needed to understand and address energy and environmental concerns, and to make effective decisions about the production and utilization of energy in engineering applications. It provides high quality education in energy that will prepare students for employment opportunities, graduate studies and research. This interdisciplinary minor administered by the Department of Electrical Engineering is designed for students seeking education for careers in the field of energy or as preparation for graduate work in a wide range of academic disciplines. It is intended for students with majors in engineering. Coursework provides broad-based science and engineering knowledge suited to energy management.

Degree Requirements

A minimum of 16 credit hours of course work must be completed to meet the requirements for the minor in Energy Engineering. This includes three core courses (10 credits) and at least two elective courses (6 credits minimum).

Core courses (10 cr.)

EE 2006 – **Electrical Circuit Analysis**

(4.0 cr; Prereq-Phys 2011, Math 3280; A-F or Aud, fall, spring, every year)

Basic circuit analysis: resistive circuits, voltage and current sources - independent and dependent. Nodal and mesh analysis. Network theorems. Energy storage elements. RC, RL, and RLC transient and steady state analysis, phasors. SPICE analysis.

ChE 2111– **Material and Energy Balances**

(3.0 cr; Prereq-Chem 1151 or 1161, Math 1296 or 1596 minimum grade of C; fall, spring, every year)

Elementary principles of chemical processes, emphasizing material and energy balances.

ChE 2121– **Chemical Engineering Thermodynamics**

(3.0 cr; Prereq-2111, (prereq or coreq Math 3280); A-F or Aud, spring, every year)

Application of thermodynamic principles to chemical engineering, emphasizing pressure-volume-temperature relationships, thermodynamic laws, thermochemistry, chemical equilibrium, and phase relationships.

OR

ME 2211 – **Thermodynamics**

(3.0 cr; Prereq-Phys 2013; credit will not be granted if already received for ME 3211; A-F or Aud, fall, spring, every year)

Thermodynamics, thermodynamic properties of liquids and gases, 1st and 2nd laws of thermodynamics, irreversibility and entropy. Carnot systems, work producing systems, combustion engine cycles, work absorbing systems, refrigeration cycles, psychrometrics.

Elective courses (6 cr. minimum)

CE 5515 – Sustainable Design and Construction

(3.0 cr; Prereq-BSCE or BSCHE or BSECE or BSIE or BSME or Grad student; A-F or Aud, fall, spring, offered periodically)

Introduction to sustainable design and construction including LEED, materials, construction/transportation/production, life-cycle/service, rating systems, codes, regulations, economical issues and social issues.

ChE 4603 – Biorenewable Resources

(3.0 cr; Prereq-2111 or #; no grad credit; A-F or Aud, spring, even years)

Comprehensive investigation of the engineering systems involved in the sustainable production of fuels, chemicals, and materials from bioresources.

ChE 4612 – Hazardous Waste Processing Engineering

(3.0 cr; Prereq-ChE 2111; A-F or Aud, once a year)

Identification of hazardous substances and their effects. Federal and state regulations. Design of waste treatment processes. Management of hazardous wastes. Modification of processes to avoid hazardous waste formation.

ME 4050 – Introduction to Nuclear Engineering

(3.0 cr; Prereq – Chem 1151, Chem 1154, Phys 2012, Math 3280)

Introduction to the fundamentals of nuclear engineering including atomic and nuclear physics, fission, fusion, isotopes, radioactivity, nuclear reactions, radiation detection, criticality, and reactor kinetics. Overview of types of reactors and some operational considerations.

ME 4375 - Pipeline Engineering

(3.0 cr; Prereq-ME 3111 or ChE 3111 or CE 3221; A-F or Aud, spring, offered periodically)

Overview of basic elements of pipeline transportation. Multi-disciplined introduction to concepts and methods of pipeline engineering. Topics include mechanical, electrical and geotechnical design, hydraulics, route selection, materials selection, construction, operation and maintenance.

EE 4501– Power Systems

(4.0 cr; Prereq-2006; no Grad School cr; A-F or Aud, spring, every year)

Fundamentals of rotating machines: DC, synchronous, and induction machines. Transformers. Power system representation. Transmission lines. Power system analysis: stability and dynamic performance. Balanced and unbalanced faults. Power system protection.

EE 5501– Energy Conversion Systems

(3.0 cr; Prereq – Chem 1153 and Chem 1154; A-F or Aud, fall, every year)

Theory, design and operation of conventional and alternative electrical energy conversion systems. Carbon dioxide cycle, Earth/Sun radiation balance, and environmental impacts. Power delivery systems and integration of conversion systems with the grid. Development of generation portfolios. Impact of energy policies and current energy issues. Case studies.

OR

ME 5325 – Sustainable Energy Systems

(3.0 cr; Prereq-3211, BSChE or BSECE or BSIE or BSME candidate, or %; A-F only, spring, even years)

A comparison of different energy systems will be made in terms of economic, environmental and political implications. Specific energy alternatives will include coal, oil, geothermal, bioenergy, solar, wind, fission, fusion, hydrogen, fuel cell.

MASTER OF SCIENCE IN ELECTRICAL ENGINEERING

The University of Minnesota Duluth (UMD), Department of Electrical Engineering (EE) welcomes applications from students interested in pursuing a graduate degree at the master's level. The EE Department has active research programs in several major research areas that include control systems, communications, signal processing, VLSI and nanoscale optoelectronics and photovoltaics, biomedical engineering digital systems, and intelligent transportation systems.

The MSEE degree combines scholarship and research in a program oriented towards students and engineering practitioners in the private and public sectors who are interested in advanced coursework and applied research. The program requires 31 credits of graduate coursework and research with focus on the departmental faculty's research areas of control systems, communications, signal processing, VLSI, nanoscale optoelectronics and photovoltaics, biomedical engineering, and intelligent transportation systems.

In our department, faculty and students have a close working relationship. We strive for research that balances laboratory and theoretical studies. Although most of the candidates will have completed a bachelor's degree in electrical engineering, computer engineering, or related fields, students in other engineering fields, physics or mathematical sciences are encouraged to apply.

Requirements

The Master of Science in Electrical Engineering (MSEE) degree requires 31 semester credits. The program offers two degree plans, plan A and plan B. Plan A is research oriented and it requires students to complete a research thesis (10 credits) and additional coursework. Plan B is coursework oriented with a project (1~3 credits) as the research component. For both thesis research and project research, a student is expected to identify a research adviser during the first two semesters in the program. All students are required to take EE8001 (1 credit) course. Plan A: Thesis Option Students must complete a minimum of 31 semester credits including 10 thesis credits and 21 coursework credits. Plan A students must register for 10 thesis (EE 8777) credits, and write and defend a thesis on original research. Students may take up to 6 credits from graduate programs in related fields outside of EE. All courses must be 4xxx or above; a maximum of 6 credits in courses at 4xxx level is allowed, a minimum of 3 credits in courses at 8xxx is required (excluding EE8001 and EE8777). Plan B: Project Option Students must complete a minimum of 31 semester credits including project credits. Plan B students must register for at least 1 project credit (EE 8222), and write and defend a project report. Students may take up to 6 credits from graduate programs in related fields outside of EE. All courses must be 4xxx or above; a maximum of 6 credits in courses at 4xxx level is allowed, a minimum of 3 credits in courses at 8xxx (excluding 8001 and EE8222)

Goals

The goal of the MSEE program at UMD is to provide EE graduate students and practicing engineers the opportunity to expand their knowledge in the field of electrical engineering. The department is committed to offering research and knowledge development recognizing the importance of collaboration between students and faculty to solve complex engineering problems.

Admission Requirements

Students wishing to major in Electrical Engineering at the master's level should have completed an undergraduate degree in Electrical, Computer, Electrical and Computer Engineering, or a related discipline, and must meet the general admission requirements of the Graduate School of the University of Minnesota Duluth, namely: a preferred performance level of 3.0/4.0 GPA from an accredited U.S. institution or foreign equivalent, and two letters of recommendation concerning the student's readiness for graduate education, and academic abilities.

For applicants whose native language is not English, the preferred performance level on the TOEFL is a score of at least 213 on the computer-based test. GRE score is recommended but not required by EE.

Industrial experience and professional licensure will be considered for admittance to the MSEE program. Previous graduate-level coursework completed after receiving baccalaureate degree may qualify for transfer credit upon recommendation and approval by the MSEE Program's Director of Graduate Studies at umdee@d.umn.edu or (218) 726-6147, or visit the website at www.d.umn.edu/ee/

MSEE Program Director of Graduate Studies for 2018-2019

Dr. Desineni Subbaram Naidu
Electrical Engineering Department
University of Minnesota Duluth
255 MWAH, 1023 University Drive
Duluth, MN 55812
Phone: (218) 726-8606
Email: dsnaidu@d.umn.edu

Application Deadlines

Applicants are encouraged to apply for admission well in advance of the term in which they wish to enter the Graduate School, but no more than one year in advance of the proposed entry date. The Graduate School application, completed with all required materials, must be submitted by the following deadlines:

- Fall Semester – April 15th
- Spring Semester – November 1st

Online Application System

All applications for admission for Fall 2009 and beyond will be submitted online rather than in paper form. Please check the web page www.d.umn.edu/grad for details.

Request Application Materials, Forms, and Resources from:

Graduate School
University of Minnesota Duluth
420 Darland Administration Building
Duluth, MN 55812
Phone: (218) 726-7523
Email: grad@d.umn.edu
www.d.umn.edu/grad

**MASTER OF SCIENCE IN ELECTRICAL ENGINEERING
(M.S.E.E.) COURSES**

EE 8001. GRADUATE PROFESSIONAL COMMUNICATION SEMINAR.
(1.0 cr)

EE 8151. OPTIMAL CONTROL SYSTEMS.
(3.0 cr; prereq 3151)

EE 8315. EMBEDDED SYSTEMS AND MICROCOMPUTER INTERFACES DESIGN.
(4 cr; prereq 2325, 4341, CS 1511, CS 2521)

EE 8611. SEMICONDUCTOR DEVICE DESIGN, FABRICATION, AND ANALYSIS.
(3 cr; prereq 4611 or Physics 4021 and Math 3280, A-F)

EE 8741. DIGITAL IMAGE PROCESSING.
(4 cr; prereq 4741, A-F)

EE 8742. FUNDAMENTALS OF SIGNAL DETECTION AND ESTIMATION.
(3 cr; prereq 2111, STAT 3611, A-F)

EE 8765. DIGITAL COMMUNICATIONS.
(3 cr; prereq 4765, A-F)

EE 8831. SOFT COMPUTING.
(3 cr; prereq: the student is expected to have knowledge of linear algebra and computer programming; A-F only)

PART III
MISCELLANEOUS

ACADEMIC CALENDAR

FALL SEMESTER, 2018 (70 instructional days)

Date	Day	Milestone
August 20	Monday	Academic appointments begin
August 21-25	Tuesday-Saturday	Welcome Week (required for all new freshmen)
August 27	Monday	Fall semester classes begin
September 5	Monday	Holiday - campus closed
October 25, 26	Thursday-Friday	Fall Break
November 22	Thursday	Holiday - campus closed
November 23	Friday	Floating holiday* - campus closed
December 7	Friday	Last day of fall semester classes
December 10-14	Monday-Friday	Final exams
December 24	Monday	Floating holiday* - campus closed
December 25	Tuesday	Holiday - campus closed
December 26	Wednesday	Floating holiday* - campus closed
December 31	Monday	Floating holiday* - campus closed
January 1	Tuesday	Holiday - campus closed

SPRING SEMESTER, 2019 (72 instructional days)

January 16	Wednesday	Spring semester classes begin
January 21	Monday	Holiday - campus closed
March 8	Friday	Last day of classes before break
March 11-15	Monday-Friday	Spring break
March 18	Monday	Classes resume
May 3	Friday	Last day of spring semester classes
May 6-10	Monday-Friday	Final exams
May 11	Saturday	Commencement
May 19	Sunday	Academic appointments end

MAY SESSION, 2019 (18 instructional days)

Date	Day	Milestone
May 13	Monday	May session classes begin
May 27	Monday	Holiday - campus closed
June 7	Friday	Final exams; end of May session

SUMMER SESSION, 2019 (37 instructional days)

Date	Day	Milestone
June 10	Monday	Summer term classes begin
July 4	Thursday	Holiday - campus closed
July 5	Friday	Floating holiday* - campus closed
August 2	Friday	Final exams; end of summer term

* Floating holidays are set in consultation with civil service employees (bargaining unit and non-bargaining unit) and are subject to change.

UNIVERSITY OF MINNESOTA

GRADUATION PLANNER

<https://onestop2.umn.edu/gradplanner/home.jsp>

Graduation Planner is an interactive planning tool for University of Minnesota students on all campuses. Use Graduation Planner to:

- Explore the requirements for majors and minors
- Discover what courses you need to take, and when you should take them
- Make a plan that will help you stay on track for graduation

Your adviser will be able to review and comment on the plans you create. Be sure to work with your adviser as you plan for your degree. Some majors or programs have application procedures or special requirements, and your adviser is the best source for this information.

Academic Progress Audit System (APAS) Information

The APAS provides reports about undergraduate degree requirements and how your credits transfer to UMD. Generate an APAS report to see what courses are needed and how completed courses fulfill degree those requirements. Generate a “What-if” report for the University of Minnesota Duluth and explore other undergraduate majors and run your Transfer Course Evaluation report.

View APAS report at <https://onestop2.umn.edu/darwin/login.jsp>

Each APAS report indicates how your academic coursework or test credits apply to the Liberal Education and degree requirements for a specific major.

APPENDIX

TABLE 1: STUDENT OUTCOMES

ABET STUDENT OUTCOMES ARE TO:	OUTCOMES STUDENTS SHALL DEMONSTRATE:
(a) Teach students the core disciplines of mathematics, science, and engineering	An ability to apply knowledge of mathematics, science, and engineering
(b) Educate students on how to design and conduct experiments, as well as to analyze and interpret data	An ability to design and conduct experiments, as well as to analyze and interpret data
(c) Provide opportunities and guidance so that students can design a system, component, or process to meet desired needs	An ability to design a system, component, or process to meet desired needs
(d) Provide opportunities and guidance for students to function on multi-disciplinary teams	An ability to function on multi-disciplinary teams
(e) Train students to identify, formulate, and solve engineering problems	An ability to identify, formulate, and solve engineering problems
(f) Expose students to an understanding of their professional and ethical responsibility	An understanding of professional and ethical responsibility
(g) Instruct students on the techniques to communicate effectively in writing and orally	An ability to communicate effectively in writing and orally
(h) Expose students to the broad education necessary to understand the impact of engineering solutions in a global and societal context	The broad education necessary to understand the impact of engineering solutions in a global and societal context
(i) Instill in students a recognition of the need for, and an ability to engage in life-long learning	A recognition of the need for, and an ability to engage in life-long learning
(j) Expose students to the knowledge of contemporary issues	A knowledge of contemporary issues
(k) Train students to use the techniques, skills, and modern engineering tools necessary for engineering practice	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(l) Provide students with a knowledge of computer software and hardware which supports students obtaining a Computer Engineering or Computer Science Minor with an appropriate selection of EE/CS courses	A fundamental knowledge of computer software and hardware
(m) Provide students with in-depth knowledge of mathematics which supports students obtaining a Math Minor with an appropriate selection of an advanced math course	A knowledge of mathematics as demonstrated by students obtaining a Math Minor with an appropriate selection of an advanced math course
(n) Tutor and guide students to work in the hands-on laboratories associated with most of the required courses.	An ability to work in a hands-on laboratory in most of the required courses

Note that Student Outcomes for the EE Program are based on the eleven ABET Outcomes (a) through (k) plus three additional outcomes (l, m, n) adopted by the EE faculty. The EE program provides several opportunities for our students to specialize by offering minors. It is important that we also assess these additional student outcomes (l) and (m) even though they do not apply to all of the EE students.

TABLE 2: STUDENT OUTCOMES – REQUIRED COURSES

STUDENT OUTCOMES	A	B	C	D	E	F	G	H	I	J	K	L	M	N
<u>EE Introduction</u> EE 1001 Introduction to Electrical Engineering	X			X		X		X		X				
<u>EE Digital (with labs)</u> EE 1315 Digital Logic EE 2325 Microprocessor Systems	X ↓	X ↓	X ↓		X ↓						X ↓	X ↓		X ↓
<u>EE Systems (with labs)</u> EE 2006 Electrical Circuit Analysis EE 2111 Linear Systems and Signal Analysis EE 3151 Control Systems	X X X	X X X	X X X		X X X						X X X			X X X
<u>EE Electronics (with labs)</u> EE 2212 Electronics I EE 3235 Electronics II	X X	X X	X X		X X		X X				X X			X X
<u>EE Engineering Physics</u> EE 3445 Electromagnetic Fields	X		X		X						X			
<u>EE Capstone Design (with labs)</u> EE 4899 Senior Project I EE 4951 Design Workshop EE 4999 Senior Project II	X ↓	X ↓	X ↓	X ↓	X ↓	X ↓	X ↓	X ↓	X ↓	X ↓	X ↓			X ↓
<u>Basic Sciences (with labs)</u> Phys 2013/2014 General Physics I Phys 2015/2016 General Physics II Chem 1153/1154 General Chemistry I	X ↓	X ↓												X ↓
<u>Computer Science</u> CS 1511 Computer Science I	X	X	X									X		X
<u>Mathematics/Statistics</u> Math 1296 Calculus I Math 1297 Calculus II Math 3280 Differential Equations with Linear Algebra Math 3298 Calculus III Stat 3611 Introduction to Probability and Statistics	X ↓												X ↓	
<u>Composition</u> WRIT 1120 College Writing WRIT 3130 Advanced Writing- Engineering							X X							

**TABLE 3: STUDENT OUTCOMES – ELECTIVE COURSES AND
OPTIONAL STUDENT ACTIVITIES**

STUDENT OUTCOMES	A	B	C	D	E	F	G	H	I	J	K	L	M	N
<u>Liberal Education Electives¹</u>														
Econ 1022 Principles of Economics: Macro Or Econ 1023 Principles of Economics: Micro						X		X	X	X				
Phil 3242 Values and Technology ² Category LE - Oral Communication and Languages Category LE - Social Sciences Category LE - Humanities Category LE - Fine Arts						↓		↓	↓	↓				
<u>Engineering Breadth Elective³</u>														
CE 2017 Engineering Mechanics	X	X	X											
ChE 2001 Introduction to Environmental Engineering	↓	↓	↓											
ChE 2111 Material and Energy Balance														
IE 3115 Operation Research														
ME 2105 Introduction to Material Science														
<u>EE Technical Electives^{4,5}</u>														
EE 4305 Computer Architecture	X		X		X						X			
EE 4321 Computer Networks	↓		↓		↓						↓			
EE 4341 Digital Systems														
EE 4501 Power Systems		X												X
EE 4611 Solid State Semiconductors														
EE 4781 Telecommunications														
EE 5161 Linear State-Space Control Systems														
EE 5211 Advanced Analog IC Circuit Design														
EE 5311 Design of Very Large Scale Integrated Circuits														
EE 5315 Multiprocessor-Based System Design														
EE 5351 Robotics and Mobile Robot Control Architectures		X												
EE 5477 Antennas and Transmission Lines		X												X
EE 5479 Antennas and Transmission Lines Laboratory				X					X		X			
EE 5501 Energy Conversion Systems														
EE 5522 Power Electronics														
EE 5533 Grid – Resiliency, Efficiency and Technology														
EE 5611 Microelectronics Technology														
EE 5742 Pattern Recognition and Machine Learning														
EE 5745 Medical Imaging														

EE 5765 Modern Communications EE 5813 Tools and Methods of Design Automation EE 5995 Special Topics ⁶ ... for Applied Math Minor ⁷	X ↓		X ↓		X ↓						X ↓		X ↓	
EE 5151 Digital Control System Design EE 5741 Digital Signal Processing EE 5801 Introduction to Artificial Neural Networks EE 5831 Fuzzy Set Theory and its Applications						X			X	X				
Professional Society IEEE														
EE 4896 Co-Op in EE (Internships)	X	X	X	X	X	X	X	X	X	X	X			
UROP and Undergraduate Research	X	X	X	X	X	X	X	X	X	X	X			

1. Liberal education electives chosen to meet UMD campus requirements.
2. Effective Fall 2014, EE students can take one of the following three courses to fulfill this requirement: Phil 3242 Values and Technology, Phil 3325 Environmental Ethics, CS 3111 Computer Ethics
3. Engineering breadth elective (3 credits): choose one of the specified five courses.
4. EE technical electives (21 credits): Electives may not include EE 4899, 4951, or 4999.
5. 5XXX courses are open to both undergraduate and graduate students.
6. Course outcomes vary with the topics offered.
7. Effective Spring 2008, the “Applied Mathematics” Minor no longer exists. EE students need to take one additional 3xxx level (or above) mathematics course to earn a “Mathematics” Minor, with the exception of MATH 3411 and 3326.