DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

http://www.aub.edu.lb/ece

UNDERGRADUATE STUDENT MANUAL
(2011-2012)

July 2011
Notice

Information in this document applies to academic year 2011-2012. It is subject to change without notice. Students are responsible for checking their AUB e-mail (http://imail.aub.edu.lb) and post-office boxes for announcements and information.

The information in this manual and any updates to it can be viewed on the website of the Department of Electrical and Computer Engineering at http://www.aub.edu.lb/ece/

Course syllabi, summer training guidelines, final year project guidelines, and many other useful documents and forms are also available through the website.

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FEA Quadrant Map
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Foreword

We congratulate you on having selected the Department of Electrical and Computer Engineering (ECE) at the American University of Beirut (AUB). We welcome you to the student ranks of the department and look forward to having you join us as professional peers in the near future. In order to do this, you will of course, have to successfully complete all of the requirements for your degree as described in this manual.

Both of the undergraduate programs offered by the ECE department, Computer and Communications Engineering (CCE) and Electrical and Computer Engineering (ECE) are ABET accredited. ABET, Inc. is an organization that accredits programs in applied science, computing, engineering, and technology. It is the main body that accredits engineering programs in the US and Canada and it is increasingly accrediting programs internationally. Graduating from an ABET accredited program assures that the quality of the program meets standards for engineering education set by a well-established organization. It also means that the program is striving to keep up with developments in the field and continually working to improve the quality of education you receive. Students who graduate from ABET accredited programs have easier access to graduate programs in engineering, professional engineering registration, and membership in certain professional societies.
Purpose of this manual

This manual has been designed to aid students enrolled in the ECE department to plan their studies as they progress through the curriculum. In the manual you will find the answers to many questions that may arise about the departmental programs of study, policies, rules and regulations; in addition to many Faculty and university policies. It is a handbook of information with which all undergraduate students should be familiar. This manual will save you time, call your attention to various services available to students, make our classes run smoothly, and help to provide you with the best learning experiences possible.

We are always interested to hear your suggestions and comments about our programs and courses, and about your experiences as a student in the ECE department, or anything else you might want to mention.

With our best wishes for a productive and successful academic year in 2011-12.
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1. Department of Electrical and Computer Engineering

As early as 1913, the University recognized the need for engineering education and training in the Arab East, and courses in this field were offered in the School of Arts and Sciences. In 1951, a separate School of Engineering was established and curricula were initiated in architectural engineering, civil engineering, electrical engineering, and mechanical engineering. In 1966, the School was renamed the Faculty of Engineering and Architecture (FEA) that comprised, among others, the Department of Electrical Engineering, which was renamed later the Department of Electrical and Computer Engineering (ECE). A more detailed historical background of FEA and AUB is available in Appendix A. The department initially offered only the degree of Bachelor of Engineering in Electrical Engineering (BE in EE). In 1986, the department introduced the degree of Bachelor of Engineering in Computer and Communications Engineering (BE in CCE). In 2006, the BE in EE was renamed BE in Electrical and Computer Engineering (BE in ECE).

The mission of the Department of Electrical and Computer Engineering is to promote excellence in undergraduate and graduate education, research, and service to the profession and community at large; and to prepare students to be professionals capable of being leaders in their chosen careers, committed to life-long learning, innovation, critical thinking, integrity, and civic responsibility.

1.1 Faculty members

There are 26 full-time faculty members at the professorial rank and three full-time instructors in the ECE department (Table 1). All of the full-time professorial rank faculty members are PhD holders from top US, Canadian, and European institutions of higher learning. Full-time faculty members of the department teach most of the electrical and computer engineering courses in the undergraduate curricula. Technical courses in the upper-years are taught by faculty members with a high level of expertise in their area of specialization. Some of the EECE courses are taught by competent part-time faculty members. For the list of part-time faculty members teaching in the department during a certain term, please refer to the ECE website http://www.aub.edu.lb/ece/

The department is also served by visiting professors and local professional experts; they are mainly involved in teaching specialized graduate courses that are open as technical electives to undergraduate students.
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<table>
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</tbody>
</table>
1.2  Support Staff

A total of 6 staff members are currently available to support the ECE department (Table 2.)

Mr. Joujou the lab manager oversees the proper functioning of all laboratories for the ECE department. He also directs the preparation of labs for educational sessions as advised by faculty members.

Table 2. ECE Staff Members

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Office</th>
<th>Ext.</th>
<th>E-mail</th>
</tr>
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</tbody>
</table>

1.3  Facilities and Laboratories

Most of the existing ECE laboratories are in the CCC SRB building, and in the Raymond Ghosn Building (RGB). The CCC SRB is the temporary home for departmental labs. These labs will be moved to the Irani-Oxy Engineering Complex (IOEC) when it is completed.

1.3.1  Classrooms

The majority of the instruction takes place in the Bechtel Building, primarily in classrooms on the fourth and fifth floors of the building, and in the Engineering Lecture Hall (ELH) on the third floor. All of the classrooms are provided with equipment for computer projection. Two medium conference rooms are available for project and seminar presentations.

1.3.2  Laboratories

The ECE department maintains several specialized teaching and research laboratories. The laboratories are used for research purposes as well as to
enhance teaching through hands-on experience in the various fields of the department. In particular, lab courses, course projects, and final year projects make effective use of the facilities. Computer facilities are also available for student instruction and training.

**Antenna Measurement Laboratory**

This laboratory was established in the AY 2008-09 and is used to simulate, fabricate, and measure the properties of different types of antennas. It uses high end software to simulate the antennas and plot their characteristics. Once the researchers obtain the desired response, they will then be able to accurately prototype their design. To do so they will use a recently acquired state of the art CNC milling machine. This machine is equipped with a 35 tool changer device and a fudical camera that has the capability to produce designs with a milling accuracy of 1 µM. This accuracy has a great impact on the validity of the results. The last stage of the design process is to accurately measure the achieved response. Researchers using this lab benefit from a variety of high end measuring devices (spectrum analyzers, signal generators and network analyzers) with frequencies up to 20 GHz. Antenna Theory and Design (EECE 680), and Numerical Methods in Electromagnetics (EECE 683) use this lab. In AY 2009-10 the laboratory acquired, an Anechoic chamber to better validate the measurements.

**Biomedical Engineering Laboratory**

EEG measurements are conducted in this laboratory. The data collected is then utilized to understand the relationship between the voltage measured and the brain activity. The equipment in the laboratory is state of the art and utilizes the active probe technology. In AY 20010-11 the lab is going to acquire additional equipment to add to the existing measuring system. This additional equipment will allow researchers to measure electrical activity of muscles EMG. The laboratory is used for instruction in the biomedical engineering courses (EECE 601, EECE 602, and EECE 605).

**Circuits and Analog Electronics Lab**

In the Electronics Laboratory, first and second year students carry out experiments in circuits and electronics featuring diode and transistor circuits, amplifiers, op-amps, wave generators, and digital electronics. Projects in third year courses and during the final year are also built and tested in this lab. Equipment includes oscilloscopes, digital multimeters, function generators, power supplies, and frequency counters. Components are available to build circuits ranging from a simple diode rectifier to complete microprocessor based systems. This laboratory is used by, the introduction to engineering course (EECE 200), the Electric Circuits
Laboratory (EECE 310L), Electronics Laboratory (EECE 413L), as well as for Final Year Projects.

*Communications Laboratory*
In the Communications Laboratory, students carry out experiments in analog and digital modulation techniques. The laboratory is equipped with reconfigurable arbitrary generators and data acquisition boards that allow the generation and demodulation of any type of signal. These boards are controlled by a dedicated processor and specialized software. Communications Laboratory (EECE 442L) uses this lab.

*Control Systems Laboratory*
In this laboratory students learn the fundamentals of control theory. The lab has been recently upgraded with eight state of the art control stations. This lab is used for research in advanced control algorithms, and industrial and building automation. The laboratory is used for instruction in the Control Systems Laboratory (EECE 460L) course.

*Digital Systems Laboratory*
In the Digital Systems Laboratory, students use digital integrated circuits, microprocessors, and FPGAs to build a variety of circuits and systems. The lab experiments enhance the students' knowledge of hardware description languages, computer architecture, assembly language, as well as I/O interfacing techniques. The lab is equipped with twelve computers as well as Xilinx and Altera FPGA boards and microprocessor programmers. This laboratory is used for the Electronics Laboratory for Mechanical Engineering students (EECE 312L) Computer Organization Laboratory (EECE 321L) the introduction to engineering course EECE 200; as well as for Final Year Projects.

*Electric Machines Laboratory*
In the Electric Machines Laboratory, students study magnetic circuits and transformers, dc and ac machines, stepper motors, induction motors, and solid-state drives of small power motors. This laboratory is being upgrade with a number of new research setups with sophisticated measuring devises. This laboratory is used for instruction in the Electric Machines Laboratory (EECE 470L).
Internetworking Lab
The Internet Laboratory is equipped with state of the art hardware and software that can be used to build local-area and wide-area computer networks. The lab has six complete stations each equipped with four Dell Power Edge 650 servers, as well as four Cisco routers and four 3Com hubs. Students use this lab to develop their skills in networking, router and server configurations, and internet protocols. The lab is also used for conducting research in this field. The laboratory is used for instruction in the Internetworking Laboratory (EECE 451L).

Mobile and Distributed Computing Laboratory
This laboratory consists of ten high-end workstations along with two quad processor IBM servers. These computers are used to simulate databases and their applications. The lab is also equipped with more than 24 PDAs. They are used to conduct experiments on pervasive computing theories and distributed database architecture. The laboratory is used for teaching the following related courses: Mobile Ad Hoc and Sensor Networks (EECE 656), Distributed and Object Database Systems (EECE 630), and Pervasive Computing Systems and Applications (EECE 654).

Multi-Core Programming Laboratory
This laboratory was established with the help of a generous donation from Intel and was inaugurated during the fall semester of AY 2008-09. The laboratory can accommodate up to twenty students at a time. The laboratory is used to teach the students the techniques of writing software programs that take full advantage of multi-core processor technology. The techniques learned allow the students to run simulation software fast and efficiently. The hardware in the laboratory consists of two Intel 2U Server with Xeon Quad Core 2.33GHz, seven Intel PC with Xeon Quad core 2.66GHz, and eight Intel PC with Xeon Duo Core 2.66GHz, mini-tower. In addition to this primary role the laboratory is also used to teach data mining techniques in data bases (EECE 633: Data Mining).

Power Electronics and Drives Lab
This lab is used to teach and conduct research in low speed drives and power electronics. The laboratory is being upgraded this year along with the Machines Lab, to house a number of new research setups with sophisticated measuring devices. These setups will allow the students to conduct advanced research in power electronics and drive applications. This laboratory is used for instruction in the Power Electronics and Drives Laboratory (EECE 473L).
Power Systems Laboratory
In the Power Systems Laboratory students learn the characteristic data of transmission lines, voltage drop and power losses, the steady state operation of a generator connected to a large electric system, and the stability limits of electric power systems. The laboratory has hardware system models and features software programs to carry out steady state and fault analysis of electrical power systems based on geographic information systems (GIS). This laboratory is used for instruction in the Power Systems Laboratory (EECE 471L).

Printed Circuit Board Production Facility
This facility is equipped with all the tools necessary to produce single and double sided printed circuit boards using through-hole technology. It is primarily used for prototyping purposes. Students undergo training in this lab on all the processes and steps involved in the design and fabrication of the boards; at a later stage they can utilize this facility to produce their own designs. The laboratory houses a sophisticated CNC machine for rapid prototyping of circuit boards. The machine allows students to fabricate boards with an accuracy of 0.1µm. This capability allows researchers in the field of RF circuits and antenna design to prototype circuits with perfect quality. The machine is also capable of producing circuit boards on flexible material or on multi layer boards.

RF Systems and Wireless Communications Laboratory
The RF lab is equipped with the several network analyzers, spectrum analyzers, RF signal generators, and power meters. It is utilized by students to design, build, and test: RF filters, power amplifiers, and antennas. The laboratory uses several design and verification software tools to simulate the design before actual implementation. The laboratory is used to teach the latest technologies in wireless communication. Students design networks using industrial grade network planning tools and then use drive test equipment to validate and test cellular networks. This facility is also used for research in radio frequency circuits and systems, and in wireless communications. Instruction for two courses is offered in this laboratory: RF and Microwave Circuits for Communications (EECE 613), and Wireless Communications Laboratory (EECE 640L).

Robotics and Instrumentation Laboratory
In this laboratory, students learn the fundamentals of instrumentation and robotics. New sensors both wired and wireless have been acquired for the laboratory. In the robotics lab, five mobile robots with full wireless control have been added to the two already existing manipulators. Several courses and research projects in instrumentation and tele-robotics are taught in this
This lab is also used for research in advanced control algorithms, robotics, and instrumentation. The laboratory is used for instruction in the Instrumentation (EECE 461), and the Robotics (EECE 661) courses.

**Signal and Image Processing Laboratory**
In this laboratory, students carry out experiments in digital signal, image, and speech processing. Equipment includes DSP kits provided by Texas Instruments, audio synthesizers, computers and multimedia accessories. The laboratory was recently equipped with state of the art audio equipment that allowed the offering of an elective course in audio engineering. During AY 2009-10 new equipment was purchased to upgrade for the laboratory. This new requisition will enable the department to offer specialized laboratory courses at the graduate level as well as the standard undergraduate offerings. Courses using this laboratory include Digital Signal Processing (EECE 691), Digital Image Processing (EECE 694), Adaptive Filtering (EECE 695), as well as the Final Year Projects.

**Sun Cluster**
A new add-on to the existing computing facilities in the ECE department is the Sun computing cluster. It consists of ten Sun-Blade 150 machines and ten Sun-Blade 1500 machines. In addition to these workstations, the cluster is managed by a quad-processor Sun-Fire 440 server. The Sun computational grid is accessible from any terminal and runs a number of simulation software.

**Industrial Automation Laboratory**
This laboratory was inaugurated in AY 2009-10 and includes 5 Omron PLC stations with a 6th Station for the Instructor teaching the Lab. Each station is equipped with a state of the art PLC, touch screen and PC for programming. The laboratory also has servo drives and motors, variable speed drives, and different kind of sensors used in industrial automation. The laboratory gives students the opportunity to experiment with industrial grade programmable controllers, actuators, sensors, and HMIs.

**Industrial Networks Laboratory**
The lab is designed to introduce the students to the different industrial network protocols that are used to link distributed controllers, sensors and human machine interfaces to each other. The laboratory is equipped with network hardware and simulators for more than six different types of industrial protocols. The equipment for this laboratory has been commissioned and laboratory experiments are being developed.
Network Security
This laboratory was established in AY 2008-09 and houses an independent fully functional network that consists of 10 user nodes along with 4 servers running different applications and operating systems. The laboratory has a number of layer 2, and layer 3 switches hardware firewalls, routers, and wireless access points. This infrastructure allows students to experiment with the different layers of the physical network, learn about their vulnerabilities, and develop techniques to protect the network.

Laboratories under Development

VLSI Design and Simulation
This laboratory will be established during the academic year 2010-2011. The laboratory will be equipped with a cluster of servers as well as 10 workstations. The server cluster will be running a range of state of the art design and simulation tools. These tools include most of the packages from Cadence, Mentor Graphics, and Synopsys. The laboratory will be able to fabricate successful designs at affiliated foundries.

Cooperative Robotics
This laboratory will be established during the academic year 2010-2011. The laboratory will have a number of robots. Theses robots will include two humanoids and aerial robot and a submersible. Research on collaborative and tele-robotics will be conducted using the robots.

Computer Laboratories
Computer laboratories shared by the various departments in the FEA are available to ECE students for instruction and project execution. Several computer labs are available in the SRB and in the RGB and house more than 200 PCs, Apple computers, and Sun workstations. Scanners, plotters, and laser printers are also available. Additionally, working space and computer stations are available to ECE students in the various laboratory and department facilities, described above.

Students can connect to the AUB data network (AUBnet) using the networked computers available in laboratories, or use their personal laptops or PDAs (Personal Digital Assistant) to connect to the campus-wide wireless network, AUBwlan. More information is available on the FEA IT Unit website (http://webfea.fea.aub.edu.lb/fea/itunit/), and on the website of the Computing and Networking Services Department. (http://www.aub.edu.lb/cns/).
1.4 Program Missions, Educational Objectives and Outcomes

The department offers the degree of Bachelor of Engineering (BE) in two majors:

- Computer and Communications Engineering (CCE)
- Electrical and Computer Engineering (ECE)

1.4.1 Mission of the Undergraduate Programs

The mission of the Department of Electrical and Computer Engineering is to promote excellence in undergraduate and graduate education, research, and service to the profession and community at large; and to prepare students to be professionals capable of being leaders in their chosen careers, committed to life-long learning, innovation, critical thinking, integrity, and civic responsibility.

1.4.2 Program Educational Objectives

The objectives of the CCE/ECE program are to graduate students able to:

- Achieve their employment or post graduate educational goals.
- Advance in their careers through leadership, life-long learning, innovation, critical thinking, integrity, and civic responsibility.

1.4.3 Program Outcomes

By the time of graduation with a BE degree, CCE and ECE students possess

(a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyze and interpret data

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(d) an ability to function on multi-disciplinary teams

(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(i) a recognition of the need for, and an ability to engage in life-long learning

(j) a knowledge of contemporary issues

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

1.5 Program Requirements

Undergraduate students accepted in the CCE and ECE programs are expected to complete the degree requirements in 11 terms (eight 16-week semesters and three 8-week summer terms), spanning over four calendar years. The undergraduate curriculum is composed of 143 credit hours. Suggested course sequences to successfully complete the requirements on time are shown in Appendix B for CCE and in Appendix C for ECE. Course descriptions can be found in Appendix E.

1.5.1 CCE Program Requirements

General Education Program (30 credits)

- ENMG 400: Engineering Economy
- Arabic course
- ENGL 206: Technical English
- One other English course (excluding ENGL 204 and 208)
- Two social science courses
- Three humanities courses
- One ethics course

CCE students must select humanities and social science elective courses from the approved GE program course list on the Registrar's homepage

Mathematics (18 credits)

- MATH 201: Calculus and Analytic Geometry III
- MATH 202: Differential Equations
- MATH 211: Discrete Structures
- MATH 218: Elementary Linear Algebra with Applications or
- MATH 219: Linear Algebra I
• STAT 230: Introduction to Probability and Random Variables
  
• One of
  MATH 210: Introduction to Analysis
  MATH 224: Fourier Series and Applications
  MATH 227: Introduction to Complex Analysis
  MATH 251: Numerical Computing

**Sciences (12 credits)**

• PHYS 210: Introductory Physics II
• PHYS 210L: Introductory Physics Laboratory II
• CHEM 201: Chemical Principles *or*
  CHEM 202: Introduction to Environmental Chemistry

• CHEM 203: Introductory Chemical Techniques *or*
  CHEM 205: Introductory Chemistry Laboratory

• One additional science elective. Refer to Appendix D for the list of approved science electives.

**CCE Core Courses (54 credits)**

Refer to Appendix E for the ECE course descriptions.

• EECE 200: Introduction to Electrical and Computer Engineering
• EECE 210: Electric Circuits
• EECE 230: Introduction to Programming
• EECE 290: Analog Signal Processing
• EECE 310: Electronics
• EECE 311: Electronic Circuits
• EECE 320: Digital Systems Design
• EECE 321: Computer Organization
• EECE 330: Data Structures and Algorithms
• EECE 340: Signals and Systems
• EECE 370: Electric Machines and Power Fundamentals
• EECE 380: Engineering Electromagnetics
• EECE 411 or 412: Integrated Circuits
• EECE 421: Computer Architecture
• EECE 442: Communication Systems
• EECE 450: Computer Networks
• Two courses from EECE 430, 431, 432, 433, 434
CCE Laboratories (5 credits)

- EECE 310L: Electric Circuits Laboratory
- EECE 321L: Computer Organization Laboratory
- EECE 413L: Electronics Laboratory
- EECE 442L: Communications Laboratory
- One additional laboratory elective

Electives (18 credits)

- Six courses, at least two of which must be EECE, subject to approval of adviser. No more than two technical electives may be taken from the same department and/or program. For the list of pre-approved technical electives, refer to Appendix D.

Approved Experience

- EECE 500

Final Year Project (6 credits)

- EECE 501 and EECE 502

1.5.2 ECE Program Requirements

General Education Program (30 credits)

- ENMG 400: Engineering Economy
- Arabic course
- ENGL 206: Technical English
- One other English course (excluding ENGL 204 and 208)
- Two social science courses
- Three humanities courses
- One ethics course

ECE students must select humanities/social science elective courses from the approved GE program course list on the Registrar's homepage

Mathematics (18 credits)

- MATH 201: Calculus and Analytic Geometry III
- MATH 202: Differential Equations
- MATH 211: Discrete Structures
- MATH 218: Elementary Linear Algebra with Applications or
- MATH 219: Linear Algebra I
• STAT 230: Introduction to Probability and Random Variables

• One of
  MATH 210: Introduction to Analysis
  MATH 224: Fourier Series and Applications
  MATH 227: Introduction to Complex Analysis
  MATH 251: Numerical Computing

**Sciences (12 credits)**

• PHYS 210: Introductory Physics II
• PHYS 210L: Introductory Physics Laboratory II
• CHEM 201: Chemical Principles or CHEM 202: Introduction to Environmental Chemistry
• CHEM 203: Introductory Chemical Techniques or CHEM 205: Introductory Chemistry Laboratory

• One additional science elective. Refer to Appendix D for the list of approved science electives.

**ECE Core Courses (36 credits)**

Refer to Appendix E for the ECE course descriptions.

• EECE 200: Introduction to Electrical and Computer Engineering
• EECE 210: Electric Circuits
• EECE 230: Introduction to Programming
• EECE 290: Analog Signal Processing
• EECE 310: Electronics
• EECE 311: Electronic Circuits
• EECE 320: Digital Systems Design
• EECE 321: Computer Organization
• EECE 330: Data Structures and Algorithms
• EECE 340: Signals and Systems
• EECE 370: Electric Machines and Power Fundamentals
• EECE 380: Engineering Electromagnetics

**ECE Laboratories (2 credits)**

• EECE 310L: Electric Circuits Laboratory
• EECE 321L: Computer Organization Laboratory
ECE Restricted Electives (18 credits)

Six courses from

- EECE 411 or 412: Integrated Circuits
- EECE 421: Computer Architecture
- EECE 430, 431, 432, 433 or 434: Software 1
- EECE 430, 431, 432, 433 or 434: Software 2
- EECE 442: Communication Systems
- EECE 450: Computer Networks
- EECE 460: Control Systems
- EECE 471: Power Systems
- EECE 473 or 474: Power Electronics/Electric Drives

ECE Lab Electives (3 credits)

- Three EECE laboratory electives

Electives (18 credits)

- Six courses, at least two of which must be EECE, subject to approval of adviser. No more than two technical electives may be taken from the same department and/or program. For the list of pre-approved technical electives, refer to Appendix D.

Approved Experience

- EECE 500

Final Year Project (6 credits)

- EECE 501 and EECE 502

1.5.3 General Education Program

The undergraduate curricula includes 9 courses (27 credits) selected by each student to cover the areas of ethics, Arabic, English, humanities, and social sciences, in addition to one 3-credit course in engineering economy. The objective of these courses is to help shape and advance the knowledge of future engineers in non-technical areas.

Refer to Appendix D for the list of Pre-approved general education courses, and note the following concerning the English and Arabic requirements:

- One of the two English courses must be ENGL 206 (3 cr.).
ENGL 203 (3 cr.), if required, is considered as the other English course needed to satisfy the English requirement (ENGL 204 and ENGL 208 will not fulfill the English requirement).

Students who are exempted from Arabic must replace this requirement with a 3-credit course in humanities.

1.5.4 Summer Training

Undergraduate students in the department are required, as part of their studies, to undergo training in a professional capacity at a company in Lebanon or abroad. Such training is an integral part of the program (EECE 500: Approved Experience) and is typically done during the summer after the third year of studies. This experience consists of an eight-week internship with a professional organization that provides opportunities for training and exposure to the real engineering world. Typical venues for such experiences have to be approved by the department and include local, regional, and international companies. The FEA Career Development Center provides advice and services to assist students in securing summer internship positions. The website of the FEA Career Development Center is \texttt{http://webfea.fea.aub.edu.lb/career/}. In order to sharpen their communication and professional skills, students are required to submit at the end of their training a written report describing their experience.

Detailed guidelines for the summer training can be obtained from the ECE website \texttt{http://www.aub.edu.lb/ece/}

1.5.5 Final Year Project

As part of the final year, and in partial fulfillment of graduation requirements, undergraduate students in the ECE department need to carry out a final year project (FYP). The FYP is a substantial piece of work that will require creative activity and original thinking. A good FYP starts with the formulation of a problem, suggests alternative solutions, and then implements one of them. The project must be scheduled over a period of two semesters to potentially reach a working solution. In general, the objectives of the FYP are to:

Check objectives for FYP

- Allow students to demonstrate a wide range of the skills learned at the FEA during their course of study by asking them to deliver a product that has passed through the design, analysis, testing, and evaluation stages.
- Encourage multidisciplinary research through the integration of material learned in a number of courses.
- Allow students to develop problem solving, analysis, synthesis and evaluation skills.
- Encourage teamwork.
- Improve students’ communication skills through the production of two professional reports (one at the end of the fall and another at the end of the spring term) and a professional poster (only at the end of the spring term) and to give two presentations on their work, one at the end of the fall and another at the end of the spring term.

Detailed guidelines for the final year project can be obtained from the ECE website http://www.aub.edu.lb/ece/

1.5.6 ECE Areas

The six restricted electives in the ECE program and the other six technical electives in the CCE and ECE programs allow students to focus their courses in an area of interest. The areas and the recommended courses are shown in Flow Chart 1, which is a general guideline for students, rather than a strict rule.
Flow Chart 1. ECE Concentration Areas
1.5.7 **Undergraduate Research**

EECE 499 - Undergraduate Research is an opportunity for an undergraduate student to obtain research experience, and is recommended for those students wishing to do research or otherwise go beyond what is required in normal classes. Often these experiences lead to further research, to graduate school projects, and theses.

Students may participate, under the supervision of a faculty member, in a research project. Before registering in EECE 499, the student must submit a proposal for approval for the supervising faculty member and the ECE Undergraduate and ABET Committee, regarding the nature of the research, specific goals, and final report.

The prerequisites for EECE 499 are:

- Completion of 65 required credits in the major
- Cumulative average of 85.0 or above
- Approval of faculty member supervising the research
- Approval of the ECE Undergraduate and ABET Committee

Students taking EECE 499 are expected to:

1. Attend a weekly individual research meeting with the faculty member supervising the research.
2. Work the equivalent of twelve hours per week in a laboratory. For theoretical research, no laboratory work might be necessary; however, an equivalent amount of work is expected.
3. Present a project report to receive a numerical course grade.

The University Libraries and laboratories are available to obtain research materials. If the subject matter of the undergraduate research course is relevant to the final year project of the student, the committee evaluating the FYP will take the work done into consideration in its evaluation of the FYP of the student.

1.5.8 **Minors**

Students in ECE may take a minor in a field outside their major field of studies. Minors are offered by most departments in the Faculty of Arts and Sciences, by the Olayan School of Business, and by other schools and departments. Possible minors are in mathematics, applied energy, business, biomedical engineering, chemical engineering, engineering management, computational science, philosophy, among many others. The requirements for the minors are listed in the AUB catalogue. The ECE department offers a
minor in biomedical engineering for students majoring in CCE and ECE, as well as to other students.

**Minor in Biomedical Engineering**

The minor in biomedical engineering is open to all AUB students. Students who have completed at least 60 credits at the sophomore level and higher, and who have a cumulative average of 70 or more, may apply by completing a minor application form available from the ECE department and on the ECE website. The minor will be indicated on the transcript of the student who completes all the requirements described below, and who obtains an average in the minor courses of 70 or more. The minor requirements are divided into a set of core courses, and a set of elective courses. For engineering students, the minimum number of credits is 18, and the requirements are the following:

- EECE 401 (1 cr.)
- BIOL 201 (4 cr.)
- BIOL 202 or PHYL 246 (4 cr.)
- One core course (3 cr.) chosen from EECE 601, EECE 603, or MECH 633
- One elective course from List A below (3 cr.)
- One elective course from Lists A, B, or C below (3 cr.)

Minimum number of credits is: 18

**List A:** EECE 601, EECE 602, EECE 603 (unless the student takes EECE 694, in which case either EECE 694 or EECE 603 counts toward the minor), EECE 604, EECE 605, MECH 633, MECH 634

**List B:** MECH 606, MECH 607, MECH 624, MECH 631, MECH 640, MECH 641/EECE 661, EECE 693, EECE 694 (unless the student takes EECE 603, in which case either EECE 694 or EECE 603 counts toward the minor)

**List C:** BIOL 202, BIOL 223, BIOL 225, BIOL 244, BIOL 263, BIOL 268, PHYL 202, PHYL 246
2. Advising

When a student enrolls in the Department of Electrical and Computer Engineering, a member of the full-time faculty is appointed to serve as an advisor to the student. The name of the advisor will appear under Student Services / Registration on the AUB Student Information System (AUBSIS) after you login to http://www.aub.edu.lb/banner/.

Your academic advisor will help you in course selection and career planning matters. It is very important to keep a good rapport with your advisor, as s/he will remain with you until your graduation. Mutual respect and shared responsibility governs the personal interactions between advisors and students.

In addition to the advisor, an administrative assistant is also available in the department office to assist students with problems related to registration, evaluation, and other academic matters. She has access to the students’ academic transcript and other data relating to the students’ studies. She uses this information to record and monitor each student’s academic progress and to verify that all program requirements will be satisfied by the expected graduation date. You can contact her by email: ece-advice@aub.edu.lb or on ext: 3523.

If answers to specific questions that are not spelled out clearly in the academic manuals of the Faculty cannot be given, the student must petition the Academic and Curriculum Committee of the Faculty using the form available on the FEA website (http://aub.edu.lb/fea) under student resources.

A student services officer is also available in the FEA Dean’s Office to assist students with problems related to registration, evaluation, and other academic matters. For problems of personal nature, university counselors are available for help.

Students should consult the ECE website often http://www.aub.edu.lb/ece for useful information on advising, academic matters, rules, and online access to various documents and forms, such as the student manual, course syllabi, summer training, and final year project guidelines; and petitions and other forms. Students are required to regularly check their AUB e-mail (http://imail.aub.edu.lb) and post-office boxes for announcements and information.

Students must also read the AUB Student Handbook, available online at http://pnp.aub.edu.lb/
3. Student Evaluation

3.1 Probation

3.1.1 Placement on Academic Probation

A student is placed on academic probation if the student’s overall average is less than 68 at the end of the 2nd regular semester; if the semester average is less than 69 at the end of the 3rd or 4th regular semester; or if the semester average is less than 70 in any subsequent semester, excluding the summer term.

For evaluation purposes, the minimum number of credits at the end of the 2nd regular semester should be 24 cr. including all repeated courses and 12 cr. in each subsequent semester. Credits taken during a summer term are counted towards the semester average of the next regular semester. If the number of credits taken in any single regular semester is less than 12 cr., for approved reasons, credits taken during that semester are counted towards the semester average of the next regular semester.

Credits for incomplete courses will be included in the semester in which the incomplete courses were taken. The evaluation for that semester will be carried out as soon as the grades for the incomplete courses have been finalized.

Students placed on probation (P1) are not allowed to register more than 16 credits during a regular semester, while students on probation P2 or higher are not allowed register more than 13 credits. A student on probation will not be permitted to register for more than 7 credits during a summer term. A student who is on academic probation and has incomplete grades will not be permitted to register for more than 13 credits.

3.1.2 Removal of Probation

Probation is removed when the student attains a semester average of 69 or more in the 3rd or 4th regular semester, or a semester average of 70 or more in any subsequent regular semester. Probation must be removed within two regular semesters, excluding summer, after the student is placed on probation, or when the student completes his or her graduation requirements.
3.2 Repeating Courses

A student may repeat any course for which a grade of less than 70 was obtained. Students who want to repeat a course for which a grade of 70 or more was obtained should fill a form and get the approval of the department. A student who fails a required course with a grade less than 60 must repeat the course at the earliest opportunity. No course may be registered more than three times. When a course is repeated, the highest grade is considered in the calculation of the cumulative average. All course grades will remain a part of a student’s permanent record.

3.3 Dismissal and Readmission

A student will be dismissed from the Faculty for any of the following reasons:

- If the student’s overall average is less than 60 at the end of the 2nd regular semester.
- If the student fails to clear academic probation within two regular semesters, excluding the summer term, after being put on probation.
- If the student is placed on academic probation for a total of four regular semesters.
- If the student is deemed unworthy by the faculty to continue for professional or ethical reasons.

A student will normally be considered for readmission only if, after spending a year at another recognized institution of higher education, the student is able to present a satisfactory record and recommendation. Exceptions may be made for students who left the University for personal or health reasons. Transfer credit will be considered after departmental evaluation of a student’s course work.

3.4 Dean’s Honor List

To be placed on the Dean’s Honor List, a student must:

- be carrying at least 12 credits in the term,
- not be on probation,
- have passed all courses and attained an overall average of 85, or of 80 while ranking in the top 10 percent of the class,
- did not withdraw from any course during the semester
- not have been subjected to any disciplinary action within the University during the semester, and
be deemed worthy by the Dean to be on the Honor List.

3.5 Graduation Requirements

To be eligible for graduation with the BE degree, a student must have:

- satisfied promotion requirements throughout the program,
- passed all the required courses and approved experience,
- attained a minimum cumulative course average of 70,
- attained a cumulative average of 70 or more in major,
- met the residence requirements, and
- satisfied the faculty as to the adequacy of the student’s professional development and conduct.

To graduate with distinction a student must
- have an average of 85 or higher in all work of his/her final academic semesters, including summers: (two summer sessions are equivalent to one semester) during which 60 credits or more have been completed at AUB
- be recommended by the department for distinction

To graduate with high distinction a student must
- have an average of 90 or higher in all work of his/her final academic semesters, including summers: (two summer sessions are equivalent to one semester) during which 60 credits or more have been completed at AUB
- must be recommended by the department for high distinction

For purposes of graduation with distinction or high distinction, when a student repeats a course all grades enter into the computation of the student’s overall average.

Graduating students must fill a graduation application form at the Office of the Registrar, and must complete the clearance procedure.
4. Academic Rules and Regulations

4.1 General

The Academic Rules and Regulations of the FEA can be found in the section of the Faculty of Engineering and Architecture in the University Catalogue. It is the responsibility of every student in the Faculty to be thoroughly familiar with these rules and regulations.

4.2 Attendance

4.2.1 Classes and Laboratories

Students are expected to attend all classes, laboratories, problem sessions or required fieldwork. All missed laboratory or fieldwork must be made up. Absence of a student, whether excused or unexcused, from any class session does not excuse the student from responsibility for the work done or announcements made during the student’s absence.

Students who miss more than one-fifth of the sessions of any course in the first ten weeks of the semester (five weeks in the case of the summer term) may be required by the instructor to withdraw from the course with a grade of “W” for that course. Instructors provide their class attendance policy in the course syllabus.

4.2.2 Examinations and Quizzes

Students who miss an announced examination or quiz must present a valid excuse. Medical reports and qualified professional opinions issued by an AUB employee, AUH doctor, or by the University Health Services are accepted. The course instructor may then require the student to take a make-up examination. Should there be a question about the validity of any excuse presented by the student, the matter must be referred to the appropriate Faculty committee. Absence from a final exam may require the student to submit a petition with a valid excuse to the FEA Academic and Curriculum Committee before the student is allowed to take a make-up exam.

4.3 Course Loads

A student must carry a minimum load of 12 credits per semester to be considered full-time. A full-time student who wishes or is forced to reduce the load to less than 12 credits must first petition the FEA Academic and Curriculum Committee for permission to do so.
Students can normally register for up to 17 credits per semester and 9 credits during the summer term. “During a regular semester, a student will not be permitted to register for more than 16 credits if s/he is on academic probation (P1), and no more than 13 credits if s/he is on academic probation P2 or higher. A student on probation will not be permitted to register for more than 7 credits during a summer term. A student who is on academic probation and has incomplete grades will not be permitted to register for more than 13 credits. Normally a student with incomplete grades on good academic standing will not be permitted to register for more than 16 credits during a regular semester.”

Registration for 18 or 19 credits requires a semester or cumulative average of >= 80. The student must secure the approval of his/her academic advisor and department chair; relevant forms are available on the ECE website. Students who wish to register for more than 19 credits must petition the FEA Academic and Curriculum Committee for permission to do so. Their requests will be handled on a case-by-case basis. Petition forms are available at FEA website (http://aub.edu.lb/fea) under student resources/online forms.

4.4 Withdrawal from Courses

A student may withdraw from courses, down to a minimum of 12 credits, not later than 10 weeks (five weeks in the summer term) from the start of the semester. A student cannot withdraw, or be withdrawn, from a course after the announced deadline unless approved by the FEA Academic and Curriculum Committee.

Students cannot withdraw, or be forced to withdraw, from a course at any time if this results in the student being registered for less than 12 credits without the prior approval of the FEA Academic and Curriculum Committee. Students who withdraw or are forced to drop a course will receive a grade of “W”.

4.5 Incomplete Grades

A student who receives an incomplete grade for a course must petition the FEA Academic and Curriculum Committee within two weeks from the date of the scheduled final exam for permission to complete the course. Coursework must be completed within one month of the start of the next regular semester. In exceptional circumstances, the Committee may decide to give the student additional time to complete a course.
Incomplete course work will be reported as an “I” followed by a numerical grade reflecting the evaluation of the student available at the end of the semester. This evaluation is to be based on a grade of zero on all missed work and should be reported in units of five. If the work is not completed within the period specified, the “I” is dropped and the numerical grade becomes the final grade.

4.6 Exam Rules

Rules for quizzes and midterms are set by the course instructors. For final examinations, seating arrangements are posted at least half an hour before each examination session. Examinees are not permitted to read the examination questions before the head proctor announces the start of the examination, or to continue writing after the head proctor has announced the end of the examination. For closed-book exams, no books or papers other than the examination booklets may be used. All booklets must be handed in at the end of the examination. No communication of any kind among examinees is permitted during an examination. Cellular phones must strictly turned off during the exam. Examinees who need assistance during examination should seek the help of a proctor. Unless given permission by the head proctor, the examinees who leave the room for any reason will not be allowed to return and will receive credit only for that part of the examination that was undertaken. Students arriving late are allowed to join the exam, provided that no students have left the examination room. No additional time will granted.

4.7 Student Conduct

4.7.1 General

A student who commits cheating and misconduct will be subject to disciplinary action. Misconduct refers to any improper behavior, on the part of a student, that disturbs the normal decorum of Faculty activities or the integrity of its premises. This includes offensive behavior directed at academic personnel, non-academic personnel, or other students, and damage or defacement of university property. Serious violations shall be reported to the Dean, who may transmit the case to the Student Affairs Committee for consideration. The committee shall recommend to the Dean the appropriate disciplinary action to be taken. The student subject to disciplinary action may appeal to the committee. The penalty for misconduct shall be a Dean's Warning and may also include suspension or expulsion from the Faculty. The disciplinary action to be taken in each of
these violations is described below. The full account of every disciplinary action shall be entered in the file of the student concerned.

4.7.2 Cheating

Cases related to cheating shall be reported to the Dean by the proctor of the exam, who may transmit the case to the Student Affairs Committee for consideration. The committee shall recommend to the Dean the appropriate disciplinary action to be taken. The student subject to disciplinary action may appeal to the committee.

Cheating in Assignments
Cheating in assignments stands for misrepresentation of a student’s own work. The instructor concerned shall handle such cases. The penalty for such cases shall be a Dean's Warning and a grade of zero on the assignment.

Violations of Examinations’ Regulations
In all cases of violation, the student shall receive a grade of zero on the exam, a Dean’s Warning, and be suspended from the Faculty for up to one academic year. In case of repetition of such acts, the student shall be expelled from the Faculty.

Plagiarism
Plagiarism is the act of appropriating material from sources other than the student’s own. Plagiarism in papers, reports, or homework will therefore be penalized as in violations of examination regulations.

Falsification of Documents
For any willful and clear act of falsification of any document requested or issued by the Faculty, the student shall be suspended from the Faculty for a specified period, or expelled from the Faculty. For any willful and clear act of falsification of any document submitted for admission to the Faculty, the applicant shall be barred from admission to the Faculty at any future date or may be permitted to reapply after a specified period. In such cases the Admissions Committee shall decide upon the penalty.

Impersonation
A student of the Faculty found to have impersonated others in Faculty or university examinations, or to have been admitted to the Faculty as a result of impersonation, shall be expelled from the Faculty. An applicant to the Faculty found to have impersonated others, or to have been impersonated by others, in Faculty or university examinations shall be barred from admission to the Faculty at any future date.
4.7.3  Dean’s Warnings

A student who receives a Dean's Warning shall not be placed on the Dean's Honor List. A student who accumulates three Dean's Warnings shall be expelled from the Faculty. The student may petition the Dean to have the Dean’s Warning removed after not being subject to any other disciplinary action for at least three regular terms following the term in which the first Dean’s Warning was received.
5. Awards

5.1 Dean’s Award for Creative Achievement

The Dean's Award for Creative Achievement was initiated in the Faculty of Engineering and Architecture in December 1991. The objective of this award is to recognize and reward creativity among students of the Faculty in their approach to academic work.

5.1.1 Nature of Award

The award consists of a certificate in testimony of creative achievement as well as inscription of the recipient's name on a special board placed in the Dean's reception room or in another appropriate future location. A student who receives the award three times will be presented with a $500 prize.

5.1.2 Number of Awards

One award may be presented yearly, depending on eligibility, to a student in each of the following programs: architecture, graphic design, civil engineering, computer and communications engineering, electrical and computer engineering, construction engineering, chemical engineering and mechanical engineering.

5.1.3 Eligibility

Undergraduate students from all classes in the Faculty of Engineering and Architecture who have demonstrated creativity in their approach to academic work as applied to projects, problem solving, laboratory, shop work, etc. are eligible without restriction. If the work in question is a group activity, the award may be made to each member of the group.

5.1.4 Procedure for Nomination and Selection

Faculty members shall submit to the chairperson of the department, at the end of the spring semester, the names of candidates for the award with justification and supporting material. Selection of the candidate for each program shall be made by the department and communicated to the Dean for voting by the faculty at the end of the academic year.
5.2 Distinguished Graduate Award

5.2.1 Description

The Distinguished Graduate Award will be given to the graduating senior student who demonstrates high academic achievement, outstanding character, and contribution to the department. The award consists of an engraved plaque and a certificate signed by the Chairperson of the department and the Dean of the Faculty.

5.2.2 Number of Awards

One award may be presented yearly, depending on eligibility, to one student in the CCE program and to one student in the ECE program.

5.2.3 Nomination

The candidate should be nominated by at least three faculty members. The nomination should come in the form of a brief that addresses academic performance, character, and contribution to the department.

5.2.4 Academic Performance

The candidate for the award should have been placed on the Dean’s Honor List for Terms VII-XI and should have been nominated for graduation with distinction or high distinction.

5.2.5 Character

The nomination brief for the student should include a section addressing the student’s character and should include examples that demonstrate it. Emphasis should be given to evidence of exemplary ethical and responsible conduct inside and outside the classroom setting.

5.2.6 Contribution to the Department

The nomination brief should address and evaluate the contributions that the student made to the learning environment in the classes and to the department as a whole. This section should include supporting examples.

5.2.7 Voting

The successful candidate for the award should acquire the vote of at least two thirds of the voting faculty members of the department.
5.3 Penrose Award

This award is made on the basis of the best combination of scholarship, character, leadership, and contribution to the University as a whole. The award consists of engraving the recipient's name on a plaque which is kept on display in the Jafet Library.

5.3.1 Basis for Award

This award is made on the basis of the best combination of scholarship, character, leadership, and contribution to the university as a whole.

5.3.2 Nature of the Award

The award consists of engraving the recipient's name on a plaque that is kept on display in Jafet Library.

5.3.3 Nomination and Selection Procedures

Each member of the faculty is entitled to nominate one student. The nominee for the Penrose Award must not have received any Dean’s Warnings; attained a cumulative average of not less than 80 based on terms VI, VII, VIII, and X for engineering and graphic design students, and terms VIII, X, XI, and XIII for architecture students; and not have been placed on probation in any of the above-mentioned terms. Upon receiving the nominations made by the individual faculty members, the Student Affairs Committee will study and appraise each nominee, and will then prepare a selected list of three names, or a list of all nominated if less than three, for presentation to the faculty for final action. A Faculty meeting will be called and the list will be distributed. Final voting and selection, by the "Voting Faculty" will be made at this meeting. The name of the nominee who obtains a simple majority of the votes will be transmitted to the Board of Deans for final approval. The above actions of the Faculty will be final and will not be subject to any subsequent considerations.

5.4 Abdul Hadi Debs Award

The Abdul Hadi Debs Award will be offered to graduating students who excel in their studies. This award will be made equally to three students in the Faculty of Arts and Sciences, Faculty of Agricultural and Food Sciences, and Faculty of Engineering and Architecture according to the following restrictions:
- It is an annual award to graduating students, preferably at the graduate level.
- Students in the Faculty of Arts and Sciences, Faculty of Agricultural and Food Sciences, and Faculty of Engineering and Architecture may benefit from this award.
- Each Faculty will nominate one candidate with outstanding academic record, and who demonstrated research capabilities through a paper, project or thesis deemed by the Faculty worthy of publication.
- The recipients will receive equally a cash award depending on the amount generated by the endowment.
- The maximum amount of each award shall not exceed $1,000.

5.5 Other Awards

Other awards for best projects, papers, or posters may be presented during special academic events such as the FEA Student Conference. Academic achievement is also rewarded through the Dean’s Honor List.
6. Activities

Students in the Department of Electrical and Computer Engineering are provided with opportunities for professional as well as social development during their pursuit of higher education. These include student employment, design competitions, student conferences, seminars, field trips, participation in activities of local student chapters of professional organizations, class gatherings, and galas. Students are strongly encouraged to take part in these departmental activities, as well as participate in other Faculty and University activities.

6.1 Student Employment

Student employment provides support to the faculty members in grading homework assignments, preparing course notes, course websites, laboratory operations, clerical work, etc. at the rate 3 - 6 hours per week. Students may also work on research projects which are funded by faculty members. Interested students should inquire in the ECE department, or with faculty members concerning employment opportunities.

6.2 FEA Student Conference

A yearly student conference is organized by the FEA, where students can exhibit their projects and present technical papers, which are published in the conference proceedings. Many awards are given during the conference for best paper and presentation. Details and guidelines for the FEA Student Conference can be obtained from the FEA website http://webfea.fea.aub.edu.lb/feasc/

6.3 Seminars

The ECE department holds several seminars per semester to expose students to professional and research projects of interest to engineers. Speakers at these seminars include professional engineers, public figures, and researchers. All students are encouraged to attend these seminars.

6.4 IEEE Student Branch

The Institute of Electrical and Electronics Engineers (IEEE) is the world’s largest non-profit technical professional association. The IEEE promotes the development and application of technology in the fields of electrical and computer engineering for the advancement of its profession and the well-being of its members. The IEEE is a large producer of literature in electrical
engineering and computer technology, and is also an active contributor to the development of engineering standards through its Standards Association (IEEE-SA). The IEEE has 36 established technical societies, each of which focuses on a specific area of technology, such as the Robotics and Automation Society or the Computer Society, the largest of them all.

Members of the IEEE gain access to a vast supply of publications and online technical information. Members are also eligible for scholarships and awards granted by the IEEE. Student members improve their chances for graduate studies and employment, by establishing university and career contacts. Today, there are over 350,000 IEEE members in almost 150 countries, and the number is steadily increasing.

To reach out to its younger members, the IEEE encourages students to establish a local branch at their university. The IEEE Student Branch (IEEESB) at AUB takes on the responsibility of bringing membership benefits to students. The goal of the IEEESB is to promote knowledge, to bring the professional world closer to students, and to increase the interaction between professors and students.

IEEESB members participate in the branch activities, which include:

- Organizing technical and non-technical seminars
- Helping students find internships and work through IEEE affiliations
- Holding crash courses on practical topics
- Developing and maintaining a branch website
- Participating in the organization of a Final Year Project exhibition
- Holding an end of year ECE gala dinner

The IEEESB also collaborates with other FEA societies, such as the American Society of Mechanical Engineers (ASME) student branch, the Engineering Society, and the FEA Student Representative Committee (FEA-SRC). This creates an overall cooperative effort among students.

To learn more about the IEEE and IEEESB, please visit the IEEE website at http://www.ieee.org/ and the Student Branch website at http://webfea.fea.aub.edu.lb/ieee/
Appendix A: Background Information

American University of Beirut

The American University of Beirut (AUB) is a private, independent, non-sectarian institution of higher learning, founded in 1866. It functions under a charter from the State of New York and is governed by a private, autonomous Board of Trustees. Degrees awarded by the American University of Beirut are officially registered with the Ministry of Higher Education in Lebanon and with the Board of Education in the State of New York. AUB was granted institutional accreditation in June 2004 by the Commission on Higher Education of the Middle States Association of Colleges and Schools, 3624 Market Street, Philadelphia, PA 19104, 215-662-5606.

AUB Mission Statement

The American University of Beirut (AUB) is an institution of higher learning founded to provide excellence in education, to participate in the advancement of knowledge through research, and to serve the peoples of the Middle East and beyond. Chartered in New York State in 1863, the university bases its educational philosophy, standards, and practices on the American liberal arts model of higher education. The university believes deeply in and encourages freedom of thought and expression and seeks to foster tolerance and respect for diversity and dialogue. Graduates will be individuals committed to creative and critical thinking, life-long learning, personal integrity and civic responsibility, and leadership.

Faculty of Engineering and Architecture

As early as 1913 the University recognized the need for engineering education and training in the Middle East, and courses in this field were offered in the School of Arts and Sciences. By 1944 a sufficient number of additional courses had been added to permit the granting of the degree of Bachelor of Science in Civil Engineering. The last class in this program graduated in June 1954. In 1951 a separate School of Engineering was established and curricula were initiated in civil engineering, mechanical engineering, electrical engineering, and architectural engineering. The years from 1951 to 1954 were a transitional period of continuous development toward the new curricula, established in 1954. In 1963 a program leading to the degree of Bachelor of Architecture was introduced, replacing the bachelor of architectural engineering program, the last class of which graduated in June 1966. In that year the school was renamed the Faculty of
Engineering and Architecture. Since then curricula have been under constant review with changes introduced as necessary to keep pace with modern technology, to conform to sound developments in engineering and architecture education, and to meet the evolving needs of the region. In 1986 a new undergraduate major in computer and communications engineering was added within the Department of Electrical and Computer Engineering. In 1992 a new major in graphic design was added within the Department of Architecture and Design. In 2006 the name of the degree was changed to Bachelor of Fine Arts in Graphic Design. In 2006 the name of the Electrical Engineering degree was changed to Electrical and Computer Engineering. In 2009 two new programs offering BS degrees were added to the FEA. A Construction Engineering Program in the CEE department and a Chemical Engineering Program currently housed in the Mechanical Engineering Department.

**FEA Vision Statement**

The Faculty of Engineering and Architecture is a world-class professional school that attracts eminently qualified faculty of international caliber and outstanding students. The FEA contributes to the development of Lebanon and the region by providing undergraduate and graduate education of the highest quality, promoting strong research programs, and rendering expert services to the community.

**FEA Mission**

The Faculty of Engineering and Architecture (FEA) at the American University of Beirut is a leading professional school in the Middle East. The FEA offers educational programs of the highest standards, promotes research and creative scholarly activities of its faculty and students, and provides services to the community at large, while addressing the needs of Lebanon and the region. The FEA undergoes continuous improvement to maintain a challenging and intellectually stimulating environment, and prepares its students to be lifelong learners, innovators, and professionals capable of being leaders in their chosen careers, committed to personal integrity and civic responsibility.

**Bechtel - Engineering Building**

The Bechtel Engineering building was completed in 1952 and dedicated in April 1955 in the presence of the President of the Lebanese Republic. It houses academic offices, classrooms, laboratories, and drafting rooms of the School of Engineering. The building was donated by Mr. Stephen D. Bechtel and associates of the Bechtel Corporation of San Francisco. Mr. Stephen
Bechtel himself was one of the main donors as well as a strong supporter of the school. A number of engineering laboratory units are situated around the Bechtel building.
### Appendix B: Recommended CCE Course Sequence

<table>
<thead>
<tr>
<th>Term I (Fall)</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EECE</strong> 200</td>
<td>Introduction to Electrical and Computer Engineering</td>
</tr>
<tr>
<td><strong>EECE</strong> 210</td>
<td>Electric Circuits</td>
</tr>
<tr>
<td><strong>ENGL</strong> 201</td>
<td>English Course</td>
</tr>
<tr>
<td><strong>MATH</strong> 201</td>
<td>Calculus and Analytic Geometry III</td>
</tr>
<tr>
<td><strong>MATH/CMPS</strong> 211</td>
<td>Discrete Structures</td>
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<th>Term II (Spring)</th>
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<tbody>
<tr>
<td><strong>EECE</strong> 230</td>
<td>Introduction to Programming</td>
</tr>
<tr>
<td><strong>EECE</strong> 290</td>
<td>Analog Signal Processing</td>
</tr>
<tr>
<td><strong>MATH</strong> 202</td>
<td>Differential Equations</td>
</tr>
<tr>
<td><strong>MATH</strong> 218/219</td>
<td>Linear Algebra</td>
</tr>
<tr>
<td><strong>PHYS</strong> 210</td>
<td>Introductory Physics II</td>
</tr>
<tr>
<td><strong>PHYS</strong> 210L</td>
<td>Introductory Physics Laboratory II</td>
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<th>Term III (Summer)</th>
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<td><strong>CHEM</strong> 201/202</td>
<td>Chemistry Course</td>
</tr>
<tr>
<td><strong>CHEM</strong> 203/205</td>
<td>Chemistry Laboratory</td>
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<td>Humanities or Social Science Elective</td>
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<thead>
<tr>
<th>Term IV (Fall)</th>
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<td><strong>EECE</strong> 310</td>
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<td><strong>EECE</strong> 310L</td>
<td>Electric Circuits Laboratory</td>
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<tr>
<td><strong>EECE</strong> 320</td>
<td>Digital Systems Design</td>
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<tr>
<td><strong>EECE</strong> 330</td>
<td>Data Structures and Algorithms</td>
</tr>
<tr>
<td><strong>EECE</strong> 370</td>
<td>Electric Machines and Power Fundamentals</td>
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<tr>
<td><strong>STAT</strong> 230</td>
<td>Introduction to Probability and Random Variables</td>
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<thead>
<tr>
<th>Term V (Spring)</th>
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<td><strong>EECE</strong> 311</td>
<td>Electronic Circuits</td>
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<tr>
<td><strong>EECE</strong> 321</td>
<td>Computer Organization</td>
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<tr>
<td><strong>EECE</strong> 321L</td>
<td>Computer Organization Laboratory</td>
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<tr>
<td><strong>EECE</strong> 340</td>
<td>Signals and Systems</td>
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<tr>
<td><strong>EECE</strong> 380</td>
<td>Engineering Electromagnetics</td>
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<tr>
<td><strong>Science Elective</strong></td>
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<td><strong>Total</strong></td>
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</table>
**No more than two technical electives may be taken from the same department, program or track**
# Appendix C: Recommended ECE Course Sequence

<table>
<thead>
<tr>
<th>Term I (Fall)</th>
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<tbody>
<tr>
<td>EECE 200</td>
<td>Introduction to Electrical and Computer Engineering</td>
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<tr>
<td>EECE 210</td>
<td>Electric Circuits</td>
</tr>
<tr>
<td>ENGL</td>
<td>English Course</td>
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<td>MATH 201</td>
<td>Calculus and Analytic Geometry III</td>
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<td>PHYS 210</td>
<td>Introductory Physics II</td>
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<td>PHYS 210L</td>
<td>Introductory Physics Laboratory II</td>
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<tr>
<th>Term II (Spring)</th>
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<tbody>
<tr>
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<tr>
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<tbody>
<tr>
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<tbody>
<tr>
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**Total 71**
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<tr>
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<td>EECE  Restricted Elective</td>
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<tr>
<td>EECE  Restricted Elective</td>
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<td>MATH  Math Elective</td>
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<td>ENMG  400 Engineering Economy</td>
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<tr>
<th>Term IX (Summer)</th>
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<td>EECE  500 Approved Experience</td>
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<td>Technical Electives**</td>
<td>EECE or Other</td>
</tr>
<tr>
<td>Humanities or Social Science Elective</td>
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</tbody>
</table>

*b. stands for billing

** No more than two technical electives may be taken from the same department, program or track
Appendix D: Pre-Approved Electives

List of Pre-Approved Technical Electives

- Any EECE course with a number equal to or greater than 400
- Any ENMG course with a number equal to, or greater than 500, with the exception of ENMG 504
- ACCT 210, 215
- BIOL 201, 202, 210, 223, 224, 225, 243, 244, 247, 260, 268, 290
- BUSS 211, 235
- CHEM 200, 201, 202, 206, 208, 211, 212, 215, 217, 218, 227, 228, 229
- CIVE 460, 461, 647, 652, 656, 657, 661, 662, 663, 664, 666, 672
- DCSN 200, 205, 210
- ENTM 241/FINA 241, 220, 225, 235
- FINA 210, 215
- GEOL 201, 205, 211, 212, 213, 219, 221
- MECH 310, 314, 320, 340, 550, 631,633, 634, 642
- MKTG 210, 215, 225, 230, 238, 240
- MNGT 218, 220, 229, 230
- PHYL 246
- PHYS 212, 217, 223, 225, 226, 235, 236, 249
- Any STAT course with a number equal to, or greater than 234

List of Pre-Approved Science Electives

- BIOL 201, 202, 210
- CHEM 201, 211
- GEOL 201, 205, 211
- PHYL 246
- PHYS 212, 217, 223, 235, 236

Pre-Approved Humanities Electives

ECE students must select humanities/social science elective courses from the approved GE program course list on the Registrar's homepage.
Pre-Approved Social Sciences Electives

ECE students must select humanities/social science elective courses from the approved GE program course list on the Registrar’s homepage

Pre-Approved Ethics Electives

ECE students must select humanities/social science elective courses from the approved GE program course list on the Registrar’s homepage

Pre-Approved Arabic Electives

ECE students must select humanities/social science elective courses from the approved GE program course list on the Registrar’s homepage

Pre-Approved English Electives

- ENGL: any 200-level course (excluding ENGL 204 and 208). The English elective is taken in addition to the required ENGL 206 course.
Appendix E: ECE Course Descriptions

EECE 200  Introduction to Electrical and Computer Engineering  3 cr.
This course includes the following topics: an overview of electrical and computer engineering; engineering as a profession; introduction to the different areas of ECE such as biomedical systems, circuits, communications, computer design, control, distributed systems, electromagnetics, energy, machines, and signal processing; basic computer tools such as SPICE, MATLAB, and LabVIEW; basic laboratory instruments; laboratory experiments and a design project.

EECE 210  Electric Circuits  3 cr.
This course includes the following topics: circuit variables and elements, Kirchoff’s laws, basic analysis of resistive circuits, Thevenin’s and Norton’s equivalent circuits, circuit simplification, sinusoidal steady-state analysis, linear and ideal transformers, power relations, Fourier series and responses to periodic inputs, and circuit simulation using SPICE.

EECE 230  Introduction to Programming  3 cr.
A course on the basic principles of programming and their application to the solution of engineering problems using a high level programming language. This course introduces structured and object-oriented programming, and covers the basic data types, control structures, functions, arrays, pointers, and classes. Weekly laboratory assignments are an integral part of this course.

EECE 290  Analog Signal Processing  3 cr.
A course on circuits solution and analysis in the s and frequency domains. It includes operational amplifiers, step and steady-state response of RL, RC, and RLC circuits, Laplace transform and its use in circuit analysis; frequency-selective circuits; active filter circuits; Fourier transform, and two-port circuits; and circuit simulation using SPICE. Prerequisite: EECE 210.

EECE 310  Electronics  3 cr.
A course on semiconductors; PN junctions; diodes and diode circuits; MOS transistor and applications such as amplifier and switch; bipolar junction transistor and applications such as amplifier and switch; and circuit simulation using SPICE. Prerequisites: EECE 290, and pre- or co-requisite: EECE 200.

EECE 310L  Electric Circuits Laboratory  1 cr.
A laboratory course that covers passive electronic components; laboratory instruments; voltage-divider circuits; sources and Thevenin’s theorem; RC lead-lag networks; series resonance; the transformer; op-amp circuits; single-phase rectifier circuits; LEDs; Zener diode regulator; diode clamping and clipping; BJT and MOSFET characteristics. Pre- or co-requisite: EECE 310.
EECE 311  Electronic Circuits
A course on BJT amplifiers; MOSFET amplifiers; differential amplifiers; frequency response of amplifiers; feedback; operational amplifiers; oscillators; digital CMOS circuits; SPICE simulations. Prerequisite: EECE 310.

EECE 312  Electronics (For Mechanical Engineering Students)
This course introduces the fundamentals of electronics and electronic circuits to non-majors. Its objectives are to provide a concise treatment of the basic concepts of electronic components and to introduce the student to the basic analog and digital electronic circuits. The course covers the fundamentals of semiconductor diodes, transistors, operational amplifiers and their applications, digital circuits and systems, and basic instrumentation. Prerequisites EECE 210 and MATH 202.

EECE 312L  Circuits and Electronics Lab
A laboratory course for non-majors that covers passive electronic components, laboratory instruments, voltage-divider circuits, sources and Thevenin's Theorem, diode rectifier circuits, BJT and FET applications, op-amp circuits, filters, digital circuits, and instrumentation. Pre- or co-requisite EECE 312.

EECE 320  Digital Systems Design
This course introduces digital systems design concepts. Topics include basic combinational building blocks and design methods to construct synchronous digital systems; alternative representations for digital systems; standard logic (SSI, MSI) vs. programmable logic (PLD, FPGA); finite state machine design; digital computer building blocks as case studies; introduction to computer-aided design software in VHDL. The course also includes a substantial design project. Prerequisite: EECE 210 and EECE 230.

EECE 321  Computer Organization
This course covers the organization of modern computer systems. In addition to learning how to program computers at the assembly level, students learn how to design the main components of a von Neumann computer system, including its instruction set architecture, datapath, control unit, memory system, input/output interfaces, and system buses. To consolidate the material presented in class, students work on assembly-language programming and datapath design assignments, and a major computer interfacing project. Prerequisites: - EECE 320.

EECE 321L  Computer Organization Laboratory
A laboratory course with experiments in computer organization and interfacing techniques; digital hardware design using CAD tools and FPGAs; program-controlled and interrupt-driven I/O; memory organization; simple peripheral devices and controllers; bus interfaces; microcontroller-based designs. Pre- or co-requisite: EECE 321.
EECE 330  Data Structures and Algorithms  3 cr.
This course covers fundamental algorithms and data structures that are used in software applications today. Particular emphasis is given to algorithms for sorting, searching, and indexing. Data structures such as linked lists, binary trees, heaps, B-Trees, and graphs will also be covered along with their associated algorithms. The course also covers basic algorithmic analysis techniques and seeks to promote student programming skills. Prerequisite: EECE 230.

EECE 340  Signals and Systems  3 cr.
This course covers basic concepts and methods related to continuous and discrete-time signals and systems. The course includes: signals and systems and their properties, linear time-invariant systems, stability analysis, sampling of continuous-time signals, z-transform, discrete Fourier transform, time and frequency domain representations of discrete-time signals and systems, and introductory concepts in communications. Prerequisite: EECE 290.

EECE 370  Electric Machines and Power Fundamentals  3 cr.
This course covers three-phase circuits and power calculation, magnetic circuits, transformers: single-phase ideal and real transformers, construction, operation, autotransformers, and 3-phase transformers; fundamentals of AC and DC machines: construction and basic concepts, DC machine: types, characteristics, and performance of series motor; synchronous generators: construction, equivalent circuits, testing and performance characteristics; induction motors construction, principle of operations, tests, power efficiency and torque. Prerequisite: EECE 210.

EECE 380  Engineering Electromagnetics  3 cr.
This course covers the fundamentals of applied electromagnetics by emphasizing physical understanding and practical applications in electrical and computer engineering systems. It deals with the study of static electric fields in vacuum and dielectrics, conductors, capacitance, electrostatic energy and forces, Poisson’s equation, static magnetic fields, Biot-Savart law, Ampere’s law, vector magnetic potential, inductance, Maxwell’s equations for time varying fields, Faraday’s law, plane wave propagation, time-harmonic fields, propagation in lossless media, and wave reflection and transmission at normal incidence. The bridge between electric circuits and electromagnetics is done through the study of transmission lines and their lumped-element model, transmission line input impedance, and power flow on lossless transmission line. Prerequisites: EECE 210 and MATH 202.

EECE 401  Biomedical Engineering Seminar  1 cr.
Biweekly seminars given by members of the Faculty of Engineering and Architecture or by guest speakers. The seminars cover a range of biomedical engineering topics of theoretical and professional interest. Students are required to submit an assignment
based on each seminar, which will be graded. The seminar is required of all students taking the Biomedical Engineering Minor. Prerequisites: EECE 601, or EECE 603, or MECH 633.

**EECE 411 Analog Integrated Circuits**  
3 cr.  
A course on the design of analog integrated circuits with an emphasis on MOS circuits; op-amp design; feedback and stability; applications of analog integrated circuits such as filtering and A/D conversion; comparison with bipolar circuits; extensive use of SPICE for circuit simulation. Prerequisite: EECE 311.

**EECE 412 Digital Integrated Circuits**  
3 cr.  
This course includes the following topics: an introduction to digital electronic circuits; models, current equations and parasitic of CMOS transistors for digital design; study of CMOS inverter and logic gates, including analysis, design, simulation, layout and verification; advanced circuit styles.; sequential circuits; and the advanced topics: semiconductor memories, power grid, clocking strategies, datapath building blocks, deep-submicron design issues, and interconnect. Prerequisites: EECE 310 and EECE 320.

**EECE 413L Electronics Laboratory**  
1 cr.  
A laboratory course that covers electronic circuits used in control, communications, power, and computer interfacing. Experiments include amplifier characterization, PCB manufacturing, sensors and signal processing circuits, communication link, voltage-to-frequency conversion, and a human-computer interface. Students work in teams to complete a design project to build a product by integrating several electronic components. Prerequisites: EECE 311 and EECE 340.

**EECE 421 Computer Architecture**  
3 cr.  
A laboratory course that covers electronic circuits used in control, communications, power, and computer interfacing. Experiments include amplifier characterization, PCB manufacturing, sensors and signal processing circuits, communication link, voltage-to-frequency conversion, and a human-computer interface. Students work in teams to complete a design project to build a product by integrating several electronic components. Prerequisite: EECE 321.

**EECE 430 Software Engineering**  
3 cr.  
A course that teaches students the formal processes employed for carrying out software projects, including the design, development, testing, and deploying of practical software systems. Students are exposed to the realities involved in developing software for clients and the requirements this imposes on quality, timing, and coordination. Students will develop hands-on experience with practical tools used in real-life applications. The course requires the completion of a group-based real-life software project. Prerequisite: EECE 330.
EECE 431    Design and Analysis of Algorithms     3 cr.
This course covers techniques for the design and analysis of efficient algorithms. Topics include: sorting algorithms including merge-sort, quick-sort, and counting-sort; median and order statistics algorithms; sorting lower bound; divide-and-conquer design strategy; polynomial and matrix multiplication algorithms; balanced search trees; hash tables; augmenting data structures; number-theoretic algorithms; dynamic programming; greedy algorithms; graph algorithms including graph traversal algorithms and applications, minimum spanning tree, shortest path algorithms; introduction to NP-completeness and intractability; selected topics.  
Prerequisite: EECE 330.

EECE 432    Operating Systems     3 cr.
This course covers the principles of operating systems and systems programming. The topics discussed in class are processes, threads, concurrency and synchronization, scheduling, deadlocks, memory management, file systems, i/o devices, parallel and distributed systems, and security. The course will be accompanied with hands on assignments involving contemporary linux kernels.  
Prerequisites: EECE 321 and EECE 330. Students cannot receive credit for both EECE 432 and CMPS 272.

EECE 433    Database Systems     3 cr.
This course covers the nature and purposes of database systems and an introduction to data modeling: entity relationship model, relational model with relational algebra, relational calculus and SQL, integrity constraints, file organization and index files, and normalization.  
Prerequisite: EECE 330. Students cannot receive credit for both EECE 433 and CMPS 277.

EECE 434    Programming Language Design and Implementation     3 cr.
This course will provide an introduction to the design and implementation of various programming paradigms, namely object-oriented (Java, C++ and C#), functional (Haskell), and logic (Prolog). Compiler construction will be covered, in addition to topics such as, virtual machines, intermediate languages, and concurrency.  
Prerequisite: EECE 330. Students cannot receive credit for both EECE 434 and CMPS 258, or for both EECE 434 and CMPS 274.

EECE 442    Communication Systems     3 cr.
This course introduces the students to the transmission and reception of analog signals; performance of analog communication systems in the presence of noise; analog to digital conversion and pulse coded modulation; transmission and reception of digital signals; performance of digital communication systems in the presence of noise and inter-symbol interference.  
Prerequisites: EECE 340 and STAT 230.

EECE 442L    Communications Laboratory     1 cr.
A laboratory course with experiments covering the following topics: AM and FM
modulation/demodulation, sampling and quantization, digital modulation (PSK, FSK, MSK, GMSK), digital demodulation, and inter-symbol interference. **Prerequisite:** EECE 442.

**EECE 450  Computer Networks** 3 cr.
A course that outlines data communications; wide area networks; circuit and packet switching; routing; congestion control; local area networks; communications architecture and protocols; internetworking. **Prerequisites:** EECE 330 and STAT 230.

**EECE 451L  Internetworking Laboratory** 1 cr.
This laboratory course covers the technologies and protocols of the internet. The experiments cover the internet protocol (IP), address resolution protocol (ARP), internet control message protocol (ICMP), user datagram protocol (UDP), and transmission control protocol (TCP); the domain name system (DNS), routing protocols (RIP, OSPF, BGP), network address translation (NAT), dynamic host configuration (DHCP), network management protocols (SNMP), and IP multicast. **Prerequisite:** EECE 450.

**EECE 460  Control Systems** 3 cr.
This course seeks to impart in students a sound understanding of fundamental principles in control engineering, based on analog technologies. The course includes: mathematical modeling of linear continuous time invariant single input, single output dynamical systems; transfer functions and state space models, performance specifications, analysis and design of closed loop analog control systems. **Prerequisite:** EECE 340.

**EECE 460L  Control Systems Laboratory** 1 cr.
This course involves students in the practical implementation of the concepts acquired in EECE 460 by analyzing different types of dynamical systems, designing and understanding controllers suitable to specific models, simulating system responses, and experimentally verifying the effectiveness of various control schemes. **Pre- or co-requisite:** EECE 460.

**EECE 461  Instrumentation** 3 cr.
A design course for complete instrumentation systems, including measurements, sensors, data acquisition, and component integration. Application areas and course projects include industrial control, laboratory measurements, automation systems, and the like. This course is completed with a set of laboratory experiments. **Prerequisite:** EECE 460.

**EECE 462L  Industrial Control Laboratory** 1 cr.
A laboratory that addresses topics related to industrial automation and process control. Experiments include Programmable Logic Controllers (PLC), Supervisory
Control and Data Acquisition (SCADA), Human Machine Interface (HMI), Industrial Networks, Machine Vision and Motion Control Applications. Prerequisites: EECE 460 or MECH 431.

EECE 470L Electric Machines Laboratory 1 cr.
Transformers: open circuit, short circuit, and load test; unbalanced loading and parallel operation of transformers; speed control and load characteristics of shunt, series and compound DC machines; induction machines: blocked rotor, no-load, and loading tests; operation of single-phase induction motors; operation of a synchronous machine connected to a large external source. Prerequisite: EECE 370.

EECE 471 Fundamentals of Power Systems Analysis 3 cr.
This course covers the basic concepts of three-phase systems, generation modeling review, and generation capability curve; transformers, autotransformers, threewinding transformers, and regulating transformers. Calculation of transmission line parameters, evaluation of steady state operation of transmission lines, reactive power compensation, line capability, power flow analysis using Gauss-Seidel and Newton-Raphson methods, economic load dispatch with generation limits and line losses, symmetrical fault analysis, symmetrical components and unsymmetrical fault analysis. Prerequisite: EECE 370.

EECE 471L Power Systems Laboratory 1 cr.
This lab course includes nine experiments to study various aspects of power systems: measurement of the characteristics data of a transmission line and an assessment of its voltage drop and losses; synchronization and steady state operation of a generator connected to an infinite bus system; load characteristics of a synchronous motor and effect of field excitation on reactive power load; effect of voltage levels on power transmission and effects of various load types on power plants; load flow data preparation and system study; system analysis of symmetrical and unsymmetrical faults; Transient stability data preparation and system study. Prerequisite: EECE 471.

EECE 473 Power Electronics 3 cr.
This lab course includes an overview of power electronics devices used and their desired characteristics; diode circuits and rectifiers, effect of source inductance, three-phase rectifiers; dc-dc switched mode converters, buck, boost, and buck-boost circuits, bridge converter; pulse-width modulated inverters, voltage control, harmonics, three-phase inverters; introduction to gate and base drive circuits, snubber circuits. Prerequisites: EECE 310, and MATH 218 or 219.

EECE 473L Power Electronics and Drives Laboratory 1 cr.
This lab course includes experiments to study the following: induction motor torque-speed curve and starting characteristic, induction motor speed control through a 4-quadrant drive, single phase capacitor-start induction motor, ac to dc converter, dc
to dc converters; buck, boost, and buck-boost regulators, dc to ac inversion, ac to ac converter. **Prerequisite:** EECE 473.

**EECE 474  Electric Drives**  
A course that covers steady-state analysis of dc and poly-phase induction motors, starting, and control; AC drives: solid-state control, dc link in adjustable speed drives, voltage and frequency controls, braking and plugging; DC drives: rectifier and chopper drives, dynamic and regenerative braking, plugging; stepper motors: types, operational characteristics, control algorithms, power drive configurations; and special-purpose motors. **Prerequisite:** EECE 370.

**EECE 475  Industrial Electrification**  
A course that outlines medium and low voltage installations; lighting, practical applications of electric machines; motor control centers; emergency power supplies; and auxiliary systems. **Prerequisite:** EECE 370

**EECE 476  Power System Protection and Switchgear**  
A course that covers current and voltage transformer theories, construction, and applications, electro-mechanical relay, solid state relay, and numeric relay; analogue to digital converter (ADC), digital to analogue converter (DAC), memories, protection systems for electric machines, transformers, bus bars, overhead and underground transmission lines; over-voltage protection system; and a brief introduction to data transmission. **Prerequisite:** EECE 370.

**EECE 499  Undergraduate Research**  
This course requires participation, under supervision of a faculty member, in a research project. Before registering, the student must create a proposal regarding the nature of the research, the specific goals of the research, and the desired final report outcome; this proposal must be submitted to and approved by the supervising faculty member and the department before registering. **Prerequisites:** Completion of 65 required credits in the major, and a cumulative average of 85.0 or above.

**EECE 500  Approved Experience**  
This is an eight-week professional training course in electrical and computer engineering.

**EECE 501  Final Year Project**  
A supervised project in groups of normally 3 students aimed at providing practical experience in some aspects of computer, communications and electrical engineering. Students are expected to define the project, state its objectives, complete a literature survey, set project specifications and select a design method. They are also expected to do some preliminary modeling and analysis and to acquire the necessary material needed for the completion of the project in the spring term. A professional report and an oral presentation are also required from the students.
EECE 502 Final Year Project 3 cr.
This is a continuation of EECE 501. Students are asked to deliver a product that has passed through the design, analysis, testing and evaluation stages. The course also requires the production of a professional report that includes a description of the design process, implementation and testing, verification and validation and a critical appraisal of the project. An oral presentation and a poster are also within the project deliverables. Prerequisite: EECE 501.

EECE 503 Special Topics in ECE 3 cr.

EECE 601 Biomedical Engineering I 3 cr.
This course includes an introduction to: general instrumentation configuration, performance of instrumentation systems; types and characteristics of transducers; sources and characteristics of bioelectric signals; types and characteristics of electrodes; temperature regulation and measurement; cardiovascular system, measurements, and diagnostic equipment; blood instruments; patient care and monitoring; and electrical safety of medical equipment. Prerequisites: EECE 210 and BIOL 210, or EECE 210 and BIOL 202 for students doing a minor in Biomedical Engineering.

EECE 602 Biomedical Engineering II 3 cr.
This course covers respiratory system and measurements; nervous system and measurements; sensory and behavior measurements; biotelemetry; instrumentation for the clinical laboratory; x-rays and radioisotope instrumentation; magnetic resonance; and special surgical techniques. Prerequisite: EECE 601 or consent of the instructor.

EECE 603 Biomedical Signal and Image Processing 3 cr.
A course that introduces the fundamentals of digital signal processing as implemented in biomedical applications. It provides a concise treatment of the tools utilized to describe deterministic and random signals as the basis of analyzing biological signals: data acquisition; imaging; denoising and filtering; feature extraction; modeling. The course is tightly coupled with a practical component as it looks at and assigns several laboratory projects. Examples include the auditory system, speech generation, electrocardiogram, neuronal circuits, and medical imaging. Students should have reasonable software skills in Matlab. Prerequisites: BIOL 210 and STAT 230, or equivalent.

EECE 604 Communications Engineering for Genetics and Bioinformatics 3 cr.
This course presents current research efforts in the emerging interdisciplinary field of communications engineering for genetics and bioinformatics. It shows how concepts and techniques from the field of communications engineering can be applied to central problems from the fields of genetics and bioinformatics. As a basic analogy,
voice information is digitized, transmitted, and processed in communications, and DNA information is replicated, transmitted, and processed in genetics. The main topics covered include DNA compression, mutual information for functional genomics, channel coding for gene expression, genomic signal processing, and biological computation. **Prerequisite:** Senior or graduate standing or consent of the instructor.

**EECE 605  Neuroengineering I**  
3 cr.  
A course that focuses on the importance of biological systems from the engineering viewpoint; living cells and mechanisms; introduction to the nervous system; the resting membrane potential; generation and propagation of the action potential; motor systems; synaptic transmission; control of movement. **Prerequisite:** BIOL 210 or consent of instructor.

**EECE 611  Introduction to Analog VLSI Systems**  
3 cr.  
This course covers an introduction to digital electronic circuits; models, current equations and parasitic of CMOS transistors for digital design; study of CMOS inverter and logic gates, including analysis, design, simulation, layout and verification; advanced circuit styles; sequential circuits; advanced topics: semiconductor memories, power grid, clocking strategies, datapath building blocks, deep-submicron design issues, and interconnect. **Prerequisites:** EECE 310 and EECE 320.

**EECE 612  Digital Integrated Circuits**  
3 cr.  
A course on digital electronic circuits; models, current equations, and parasitics of CMOS transistors for digital design; study of CMOS inverter and logic gates, including analysis, design, simulation, layout, and verification; advanced circuit styles; sequential circuits; advanced topics: semiconductor memories, power grid, clocking strategies, datapath building blocks, deep-submicron design issues, interconnect. **Prerequisites:** EECE 311 and EECE 320.

**EECE 613  RF and Microwave Circuits for Communications**  
3 cr.  
The course focuses on the analysis and design of high-frequency electronic circuits, with emphasis on RF and microwave circuits and components for communication systems. The course covers the basic principles of radio-frequency (RF) and microwave circuits design, as applied to the design of microstrip and coplanar lines, impedance transformers, low-pass and band-pass filters, directional couplers, power dividers, amplifiers, mixers, and diode detectors. It provides understanding of S-parameters and signal-flow graph analysis techniques. The course enables the student to get hands-on experience in RF and microwave circuit design through the use of computer-aided design tools to simulate and analyze high frequency circuits, build them as part of a course project, and perform measurements in the lab using network and spectrum analyzers. **Prerequisites:** EECE 311, EECE 340, and EECE 380.
EECE 614  Computer-Aided Analysis and Design of VLSI Circuits  3 cr.
A course on circuit and logic simulation; timing analysis and verification; testing and fault simulation; logic and high-level synthesis; physical design automation. Prerequisite: EECE 311.

EECE 615  Computer Methods for Circuit and System Analysis  3 cr.
This course covers numerical methods and techniques for computer simulation of linear and nonlinear circuits and systems. This includes formulation methods, solution of linear equations and systems (DC analysis or static analysis), time-domain solution (transient analysis), solution of large systems, and sensitivity analysis. Application areas include simulation of electronic integrated circuits, power systems, electro-mechanical systems, mechatronics, and systems that can be modeled by sets of algebraic-differential equations. Prerequisites: EECE 210, MATH 202, and MATH 218 or 219.

EECE 616  Advanced Digital Integrated Circuits  3 cr.
A graduate level course on advanced digital integrated circuits. The following topics are covered: impact of physical technology on architecture; technology issues: CMOS scaling and issues in deep submicron regimes, process variations; device and interconnect modeling; optimization for speed; high-speed logic families; low-power design: leakage reduction techniques, voltage scaling; power distribution; clocking strategies; timing concepts; memory design: clocked storage elements, SRAM, DRAM, flash memory; and high-speed arithmetic circuits. Prerequisite: EECE 412 or 612.

EECE 621  Advanced Computer Architecture  3 cr.
This course focuses on modern advancements in parallel computer architecture, with emphasis on advanced instruction level parallelism (ILP) and multiprocessor architectures. Topics include: advanced branch prediction, data speculation, computation reuse, memory dependence prediction, trace caches, dynamic optimizations, checkpoint architectures, latency-tolerant processors, simultaneous multithreading, speculative multithreading, virtual machines, message passing multiprocessors, UMA, NUMA and COMA shared-memory multiprocessors, single-chip multiprocessors, wormhole routing techniques, cache coherence, memory consistency models, high performance synchronization methods, speculative lock elision and transactional memory. A key component of the course is a research project in which students use architecture performance simulator to investigate novel architecture techniques. Prerequisite: EECE 421.

EECE 622  VLSI for Communications and Signal Processing  3 cr.
This course introduces concepts in the design and implementation of digital signal
processing systems using integrated circuits. The main emphasis is on the architectural exploration, design and optimization of signal processing systems for communications. Algorithm, architecture, and circuit design techniques are introduced that enable joint optimization across the algorithmic, architectural, and circuit domains. A key component of the course is a project in which students investigate problems in the design and implementation of low-power and high-performance communication systems. Prerequisite: Senior or graduate standing.

EECE 623  Reconfigurable Computing  3 cr.
A course dealing with the design issues pertaining to the implementation of application specific architectures using the reconfigurable computing paradigm allowing the same circuit to be reused in order to run different applications. Emphasis is on the systematic design of reconfigurable computing platforms that exploit a high degree of parallelism. Prerequisite: EECE 321 or consent of instructor.

EECE 624  Digital Systems Testing  3 cr.
This course covers an overview of digital systems testing and testable design; test economics, fault modeling, logic and fault simulation, testability measures, test generation for combinational circuits, memory test, delay test, IDDQ test, scan design, and boundary scan. Prerequisite: EECE 320.

EECE 625  Embedded Systems Design  3 cr.
A course on embedded hardware and software design; the system design process: requirements analysis, specification, hardware/software co-design, testing; embedded computing platforms: general- and special-purpose processors, hardware accelerators, systems-on-a-chip, intellectual property (IP) core-based design, embedded networks; software design tools and technologies: CAD tools, compilers, and assemblers; hardware design tools and technologies: hardware-description languages, high-level synthesis tools, ASIC and FPGA design flows; real-time operating systems: multiple tasks and processes, context switching, task scheduling, interprocess communication mechanisms; low-power computing: circuit, architecture, and application techniques; system reliability and fault tolerance. Prerequisites: EECE 321 and EECE 321L.

EECE 630  Distributed and Object Database Systems  3 cr.
A course that covers design techniques used for distributing databases among multiple sites. The fundamental topics include fragmentation, replication, and allocation. The course also discusses the strategies used in executing distributed queries subject to given criteria and the commit protocols for managing transactions in a distributed environment. Other topics covered include parallel database implementations and the design of object database management systems. The course enables students to get hands-on experience in designing distributed database systems using a design project that requires the implementation of low-level functionality associated with the functions of distributed database system. Prerequisite:
EECE 433.

EECE 631  Advanced Topics in Algorithms  3 cr.
This is a second course on the general principles of algorithm design and analysis. The course is a continuation of EECE 431. Topics include: computability theory; complexity theory: time complexity, P versus NP, circuit complexity, and space complexity; randomized algorithms; linear programming; approximation algorithms; and selected topics. Prerequisite: EECE 431.

EECE 632  Cryptography and Computer Security  3 cr.
This course includes an overview of encryption and computer security; classical encryption techniques, block ciphers and the data encryption standard, finite fields, advanced encryption standard, confidentiality using symmetric encryption, public-key cryptography, key management, hash and MAC algorithms, digital signatures, authentication applications, email security, and Web security. Prerequisite: Junior standing

EECE 633  Data Mining  3 cr.
This course is an introduction to data mining. Data mining refers to knowledge discovery from huge amounts of data to find non-trivial conclusions. Topics will range from statistics to machine learning to database, with a focus on analysis of large data sets. The course will target at least one new data mining problem involving real data, for which the students will have to find a solution. Prerequisite: EECE 433.

EECE 636  Software Validation and Programming Practices  3 cr.
This course introduces the basics needed to understand automation techniques for the verification of computing systems. It also introduces modern programming practices such as aspect oriented programming and design patterns. Various state-of-the-art design and validation techniques will be discussed as well as their application to modern programming practices. The students will have the chance to practice and possibly advance these techniques in projects that will expose them to modern software engineering practices such as eXtreme and Agile programming. Prerequisites: EECE 330 and senior or graduate standing.

EECE 637  Advanced Programming Practice  3 cr.
This course is an advanced course on programming practices with a focus on verification. The course introduces programming tools and techniques that make individual engineers more effective and productive and help them develop quality code. Teams will work in Agile and eXtreme programming environments with a focus on design by contract. They will use formal specifications, design patterns and aspect oriented programming. Projects will use tools for code control, building, configuration, language recognition, dynamic documentation, fast prototyping,
refinement, coverage, automated and manual debugging, and dynamic and static verification. Prerequisites: EECE 330.

EECE 638 Software Testing 3 cr.
The course focuses on concepts, techniques and tools for testing software. It provides practical knowledge of a variety of ways to test software and an understanding of some of the tradeoffs between testing techniques. The topics include: software testing at the unit, module, and system levels; functional and structural testing; regression testing; mutation testing; test suite minimization and prioritization; automatic test case generation. Prerequisite: Senior or graduate standing.

EECE 639 Advanced Data Mining 3 cr.
A course that covers advanced topics in data mining and recent progress in this field. Discussions will include which techniques fit best for complex applications in data mining. Mining complex data will include general text mining, Arabic text mining, social network analysis, spatial data mining, mining of the World Wide Web, stream data, time-series data, and sequence data. We will also discuss recent application sectors and trends in data mining such as for the telecommunication, biological, and financial sectors. Prerequisites: EECE 330, and one of the following EECE 633, EECE 667, or EECE 693.

EECE 640 Wireless Communications 3 cr.
A course that covers the fundamentals of wireless communications with emphasis on wireless channel modeling; digital modulation in wireless channels; diversity techniques; channel coding and interleaving in fading channels; adaptive equalization; multiple access techniques; the cellular concept; overview of current wireless communications systems. Prerequisite: EECE 442.

EECE 640L Wireless Communications Laboratory 1 cr.
A laboratory course that covers the following topics: basics of radio network planning and optimization, radio network planning for the GSM cellular system, radio network planning for the UMTS cellular system, GSM-UMTS co-existence and co-citing, radio network planning for the WiMAX broadband system, indoor GSM drive testing measurements and analysis, outdoor GSM drive testing measurements and analysis, UMTS drive testing measurements and analysis, and measurement-based wireless channel modeling. Prerequisite: EECE 640.

EECE 641 Information Theory 3 cr.
In this course students study “data transmission” through introducing the field of information theory. The theory is introduced in a gradual fashion and students study its applications to communications theory, computer science, statistics and probability theory. Covering all the essential topics in information theory, students are introduced to the basic quantities of entropy, relative entropy, and mutual information to show
how they arise as natural answers to questions of data compression, channel capacity, rate distortion and large deviation theory. 

Prerequisite: EECE 442.

**EECE 642 Introduction to Coding Theory**

This course introduces the theory of error-correcting codes with a focus on the asymptotic, algorithmic, and algebraic aspects. Topics include: background material from combinatorics and algebra; Shannon's coding theorem; linear codes; coding bounds; classical algebraic codes: Hamming and Hadamard codes, Reed-Solomon codes and Justesen codes, and decoding algorithms; codes from graphs: low density parity check codes, expander codes, explicit constructions, and decoding algorithms; and an introduction to Turbo codes. 

Prerequisite: Senior or graduate standing.

**EECE 643 RF System Engineering for Wireless Communications**

This course introduces students to system blocks, system parameters, and architectures of RF systems for wireless communications. It focuses on the design of a radio system for transmission and reception of voice and data information: receivers and transmitters system topologies, key system blocks in a wireless system, determination of system block parameters from radio requirements and system analysis, tradeoffs between various blocks in a radio system, and frequency planning. It discusses how modulation and demodulation schemes and multiple-access techniques used in present wireless applications influence RF systems requirements. The last part of the course focuses the link budget analysis of RF radio links. 

Prerequisites: EECE 311, EECE 380, and EECE 442.

**EECE 644 Stochastic Processes, Detection, and Estimation**

This is a graduate-level introduction to the fundamentals of detection and estimation theory involving signal and system models in which there is some inherent randomness. The concepts that we develop are extraordinarily rich, interesting, and powerful, and form the basis for an enormous range of algorithms used in diverse applications. The material in this course constitutes a common foundation for work in the statistical signal processing, communication, and control areas. 

Prerequisites: STAT 230 and EECE 340.

**EECE 645 The UMTS Cellular System**

A course on the evolution of cellular technologies; UMTS standardization and services; WCDMA transmitter and receiver link level design; access and core network architectures; physical channels and signaling procedures; power control and soft/softer handover; capacity/coverage tradeoffs and cell breathing; capacity/coverage enhancement techniques; antenna diversity and MIMO techniques; multiuser detection techniques; high speed packet access (HSDPA and HSUPA); and basic principles of LTE. 

Prerequisite: EECE 640.
EECE 646  Advanced Digital and Data Communications  3 cr.
A course that addresses digital communication principles and techniques aimed at achieving improved reliability. The course examines information measures; such as entropy and mutual information for discrete and waveform channels, source coding, channel capacity and coding theorem, linear block and cyclic codes, hard and soft decision decoding, spread spectrum modulation. Prerequisite: Senior or graduate standing.

EECE 647  Queuing Theory  3 cr.
A course that covers Poisson counting and renewal processes; Markov chains and decision theory, branching processes, birth death processes, and semi-Markov processes; simple Markovian queues, networks of queues, general single and multiple-server queues, bounds and approximations. Prerequisite: Senior or graduate standing.

EECE 650  Client-Server Computing  3 cr.
A course that covers internet and intranet technologies, the client-server model of interaction, design and implementation of clients and servers, interactive and concurrent servers, distributed computing, application gateways, and includes a design project. Prerequisite: EECE 450.

EECE 651  Internet Engineering  3 cr.
A course that examines major protocols used in internet engineering: IP, ICMP, TCP, UDP; new technologies introduced on the internet, such as IP Multicast, Mobile IP, IPv6, VPNs, and quality of service; routing on the Internet; network security and firewall design; and an overview of the application protocols such as SMTP, HTTP, RTP, and SNMP. Prerequisite: EECE 450.

EECE 651L  Internetworking Laboratory  1 cr.
This laboratory course covers the technologies and protocols of the internet. The experiments cover the internet protocol (IP), address resolution protocol (ARP), internet control message protocol (ICMP), user datagram protocol (UDP) and transmission control protocol (TCP), the domain name system (DNS), routing protocols (RIP, OSPF, BGP), network address translation (NAT), dynamic host configuration (DHCP), network management protocols (SNMP), and IP multicast. Prerequisite: EECE 450.

EECE 652  Web Server Design and Programming  3 cr.
This course concentrates on major technologies used in building Web servers. Alternate versions are to be given each year: the Windows-based IIS Server and the Linux-based Apache server. For IIS, ASP.NET along with C# are used for programming Web servers. For Apache, PHP is the language of choice. The course starts with a fast track on client programming, the HTTP protocol, SQL database
servers, and XML programming. A weekly lab, two application projects, and a research project constitute the major requirements of the course. **Prerequisite:** Senior or graduate standing.

**EECE 653  Multimedia and Networking** 3 cr.
This course covers topics in multimedia such as system requirements, performance requirements, representation and compression. Multimedia networking is emphasized by discussing multicasting, streaming, multimedia networking protocols and quality of service-based traffic management protocols. Other topics covered include synchronization, VoIP, and Internet 2. Multimedia networking applications are designed and implemented as student projects. **Prerequisite:** EECE 450.

**EECE 654  Pervasive Computing Systems and Applications** 3 cr.
This course covers the technologies involved in integrating front-end mobile devices into local and global networks. An emphasis is placed on the underlying technologies and standards applied when building pervasive solutions. The course has a strong programming component in that it dedicates a significant portion of the time covering the development of mobile applications for three platforms: Windows CE for Pocket PCs, Palm OS for Palm PDAs, and Java 2 Micro Edition (J2ME) for wireless phones that run the Symbian OS. To emphasize this last component, code demonstrations will be held in class, and students will be required to complete three projects targeting the three platforms, designed to cover the different aspects of mobile applications (user interface, local database implementations, and networking). **Prerequisite:** EECE 430.

**EECE 655  Internet Security** 3 cr.
The course covers topics in internet security. The course discusses security threats, vulnerabilities of protocols and the different types of attacks. Preventive and defensive mechanisms are covered; such as: e-mail security, web security, IP security, network management security, wireless security, intrusion detection techniques, firewalls, VPNs and tracing the source of attacks. The course briefly introduces the basics of cryptography and its application to network security. Student projects will be composed of implementation, simulation and research components. **Prerequisite:** EECE 450 and EECE 632.

**EECE 655L** 1 cr.
A laboratory that addresses advanced network and computer security topics. Experiments include the execution of attacks, the setup of intrusion detection and prevention, securing computers and wired and wireless networks, and digital forensics. **Prerequisite:** EECE 655 and EECE 632 or consent of instructor.

**EECE 656  Mobile Ad hoc and Sensor Networks** 3 cr.
This course covers all aspects of ad hoc and sensor networking, from design through performance issues to application requirements. The course starts with the design
issues and challenges that are associated with implementations of ad hoc and sensor network applications. This includes dealing with mobility, disconnections, and awareness of battery power consumption. The course then provides a detailed treatment of proactive, reactive, and hybrid routing protocols, in addition to the various clustering approaches. Next, it covers the IEEE 802.11 Wireless LAN and Bluetooth standards and discusses their characteristics and operations. The course also discusses research topics that involve collaboration among mobile devices, service discovery, and data caching. Through a project, the course gives students hands-on experience in designing a mobile ad hoc network using available Pocket PCs and simulation tools. Prerequisite: EECE 450.

**EECE 657  Wireless Security** 3 cr.
A course that covers wireless network security; security challenges in wireless networks; security problems facing existing and upcoming wireless networks; security in naming, addressing, neighbor discovery, and routing; and trust and privacy. Prerequisites: EECE 450 and EECE 632.

**EECE 660  System Analysis and Design** 3 cr.
A course that outlines state-space models of discrete and continuous, linear and nonlinear systems; controllability; observability; minimality; Eigenvector and transforms analysis of linear time invariant multi-input multi-output systems; pole shifting; computer control; design of controllers and observers. Prerequisite: Senior or graduate standing.

**EECE 661  Robotics** 3 cr.
A course that examines robotic manipulators classification and work envelope; robot kinematics, dynamics and forces; joints trajectory planning for end effector desired tracking and constrained motion; control of robots using linear, non-linear, and adaptive controllers. Prerequisite: EECE 460 or MECH 433.

**EECE 662  Optimal Control** 3 cr.
A course on optimization theory and performance measures, calculus of variations, the maximum principle, dynamic programming, numerical techniques, LQR control systems. Prerequisite: Senior or graduate standing.

**EECE 663  System Identification** 3 cr.
This course introduces the fundamentals of system identification as the basic mathematical tools to fit models into empirical input-output data. While rooted in control theory, applications extend to general time-series modeling and forecasting, such as stock prices, biological data and others. Topics covered include nonparametric identification methods: time and frequency response analysis; parametric identification methods: prediction error methods, least squares, linear unbiased estimation and maximum likelihood; Convergence, consistency and asymptotic
distribution of estimates; properties and practical modeling issues: bias distribution, experiment design and model validation. Prerequisite: EECE 460.

EECE 664  Fuzzy Sets, Logic and Applications  3 cr.
A course that outlines fuzzy sets and related concepts; logical connectives; mapping of fuzzy sets; extension principle; fuzzy relations and fuzzy set ordering; fuzzy logic inference; applications: fuzzy control, signal processing, pattern recognition, decision-making, and expert systems. Prerequisite: Senior or graduate standing.

EECE 665  Adaptive Control  3 cr.
A course that includes the control of partially known systems; analysis and design of adaptive control systems; self-tuning regulators; model reference adaptive control of uncertain dynamic systems; typical applications. Prerequisite: EECE 460.

EECE 667  Pattern Recognition  3 cr.
The course provides an overview of the theory, principles and algorithms used in pattern recognition to construct high performance information processing systems that learn from experience. The course covers traditional and modern concepts for model selection and parameter estimation in recognition, decision making, multi-agent and statistical learning problems. Special emphasis will be given to regression, classification, regularization, feature selection, dimensionality reduction and density estimation in supervised, unsupervised and semi-supervised modes of learning. Students will be assigned typical pattern recognition problems to investigate as projects. Prerequisite: Senior or graduate standing.

EECE 668  Game Theory and Decision making  3 cr.
Game theory provides a set of tools, approaches, and perspectives on decision making to mimic the human elements of decision making that is best described by strategy, coercion and cooperation. This course offers an introduction to fundamentals of game theory and decision making with a special emphasis on the foundations of the mathematical background. Topics covered include: static, evolutionary, supermodular, repeated, cooperative, network, potential and congestion games as well as bargaining and uncertainty in games. Students will be assigned real-world examples of game theory and strategic decision making to investigate as projects. Prerequisite: Senior or graduate standing.

EECE 670  Power System Planning  3 cr.
The course investigates electric energy and peak demand forecasts using weather sensitive, time curve, autoregressive and causal models; generation reliability evaluation, loss of energy expectation, energy limited units, probabilistic production costing, generating capacity expansion analysis, and maintenance scheduling; operational planning, unit commitment, Hydrothermal coordination; power system security classification, contingency analysis, external equivalents, optimal power flow;
planning in a competitive electric power environment. **Prerequisite: EECE 471, or consent of instructor.**

**EECE 671  Environmental Aspects of Energy Systems  3 cr.**
A course that examines world energy resources and classifications; sources and effects of air pollution; air quality modeling, Gaussian dispersion models for pollution estimation; motor vehicle emissions and noise pollution; environmental impacts of electricity generation, pollution control systems, electromagnetic radiation, production and impacts in high-voltage applications; environmental impact assessment; basic concepts. **Prerequisite: Senior or graduate standing.**

**EECE 672  Energy Planning and Policy  3 cr.**
A course that focuses on features of modern energy planning and policy. Topics covered include the interaction among the technological, economic, environmental, and sociopolitical aspects of energy supply and use; electricity, oil, and gas industries, and their market structures; elements of energy planning on the sector and national levels; energy decision-making under conditions of uncertainty, risk management in energy planning; liberalization of energy markets; case studies. **Prerequisite: Senior or graduate standing.**

**EECE 673  Power Electronics Systems and Applications  3 cr.**
A course that reviews converter topologies for AC/DC, DC/AC, and DC/DC; power supply applications; converter applications to motor drives; utility interface of distributed energy systems; static VAR systems; flexible AC transmission; high voltage DC; power quality control; active and passive harmonics compensation. **Prerequisite: EECE 473 or EECE 471.**

**EECE 675  Renewable Energy Systems  3 cr.**
A course that covers the principles of renewable energy, solar radiation, solar water heating, building and other thermal applications, photovoltaic generation, wind power, fuel cells and the hydrogen cycle, biomass, and institutional and economic factors. **Prerequisite: Senior or graduate standing.**

**EECE 677  Electric Power System Stability and Control  3 cr.**
A course on synchronous machine modeling and simulation, response to small disturbances, and voltage instability. Topics include Park's transformation, flux linkage, voltage, and state-space equations, subtransient and transient parameters, simplified models of the synchronous machine, treatment of saturation, system reference frame, small-signal stability, power system stabilizers, and bifurcation analysis. **Prerequisite: EECE 678, or consent of instructor EECE 678**

A course on optimal dispatch of generation, symmetrical components and unbalanced faults, transient stability, control of generation, state estimation in power systems and
power system simulation. *Prerequisite: EECE 471*

**EECE 680  Antenna Theory and Design**  3 cr.
This course provides the students with an understanding of the basic principles of antenna analysis and design; an overview of the fundamental characteristics and parameters of antennas; an overview of analytical and numerical methods used to analyze and design antennas with application to some basic antenna structures such as linear antennas, loop antennas, and antenna arrays. *Prerequisite: EECE 380.*

**EECE 681  Advanced Antenna Design**  3 cr.
This course provides the students with an understanding of advanced antenna structures and presents an overview of analytical and numerical methods used to analyze and design these antenna structures. The course includes broadband antennas, frequency-independent antennas, aperture antennas, horn antennas, microstrip antennas, and reflector antennas. Students will work on a research paper on a selected antenna design topic. *Prerequisite: EECE 680.*

**EECE 682  Time-Harmonic Electromagnetic Fields**  3 cr.
A course on time-varying and time-harmonic EM fields; electrical properties of matter; wave propagation and polarization; construction of solutions; reflection and transmission; electromagnetic theorems and principles in particular equivalence; rectangular waveguides and cavities; dielectric waveguide, circular waveguides, spherical waveguide; radiation from structures; scattering by wedges, cylinders and spheres; radiation from apertures, and perturbational and variational techniques. *Prerequisite: EECE 380.*

**EECE 683  Numerical Methods in Electromagnetics**  3 cr.
This course examines the principles and applications of numerical techniques for solving practical electromagnetics problems. It covers the moment methods, finite difference methods, finite element methods, and hybrid methods. The course also investigates the application of the finite-volume control method in electromagnetics. *Prerequisite: EECE 682.*

**EECE 691  Digital Signal Processing**  3 cr.
Course topics include a review of signals, systems, and transforms; design of digital filters: FIR and IIR; sampling and reconstruction of signals; multi-rate signal processing with applications; effects of finite word length; discrete random signals and spectral estimation; and an introduction to 2D signal and image processing. *Prerequisite: Senior or graduate standing.*

**EECE 691L  Digital Signal Processing Lab**  1 cr.
This graduate lab is comprised of a set of lab experiments in MATLAB, C and Assembly covering a series of real-time signal processing topics. The developed
laboratory material is intended to complement the digital signal processing course (EECE 691). Upon completion of the lab, the student will have acquired the required knowledge and skills to develop real-time DSP systems. Prerequisites: EECE 691 Digital Signal Processing (may be waived upon approval of course instructor), and senior or graduate standing.

EECE 693   Neural Networks  3 cr.
The course provides a comprehensive foundation to artificial neural networks and machine learning with applications to pattern recognition and data mining; learning processes: supervised and unsupervised, deterministic and statistical; clustering; single layer and multilayer perceptrons; least-mean-square, back propagation, and Al-Alaoui algorithms; radial-basis function networks; committee machines; principal component analysis; self-organizing maps; and current topics of interest. Prerequisites: Senior or graduate standing.

EECE 694   Digital Image Processing  3 cr.
A course on two-dimensional signals and systems; image formation and perception; representation, coding, filtering restoration, and enhancements; feature extraction and scene analysis; introduction to computer vision. Prerequisite: Senior or graduate standing.

EECE 694L Image Processing Lab  1 cr.
The EECE 694L graduate lab comprises a set of MATLAB/C++ based lab experiments in different image processing topics covering image pre and post processing techniques, image compression, morphological transformations, image restoration and enhancement techniques, color image processing, computer vision basics, and geographical image processing. In addition, students will be exposed to software optimizations for real time image processing using SIMD instructions. Prerequisite: EECE 694, or EECE 603, or consent of instructor.

EECE 695   Adaptive Filtering  3 cr.
A course that examines the fundamentals of optimal filtering and estimation, Wiener filters, linear prediction, steepest-descent and stochastic gradient algorithms; frequency-domain adaptive filters; method of least –squares, recursive least squares, fast fixed order and order-recursive (lattice) filters; misadjustment, convergence and tracking analyses, stability issues, finite precision effects; connections with Kalman filtering; and nonlinear adaptive filters. Prerequisite: Senior or graduate standing.

EECE 696 Applied Parallel Programming

This course is an introduction to parallel programming, and GPU computing. Topics include: GPU as a part of the PC architecture; CUDA, CUDA threads, and CUDA
memory; floating point performance; OpenCL; MPI; and reductions and their implementation. The course also includes application case studies, current topics, and a course project. Senior or Graduate Standing, Prerequisites: EECE 321.
Notes
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