

# Department of Electrical and Computer Engineering

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Professors:	Al-Alaoui, Mohamad Adnan; Chaaban, Farid; Chedid, Riad; Diab, Hassan; EL-Hajj, Ali; Hajj, Ibrahim; Kabalan, Karim; Karaki, Sami; Kayssi, Ayman; Mrad, Fouad; Saade, Jean; Sabah, Nassir
Associate Professors:	Ali-Ahmad, Walid; Artail, Hassan
Assistant Professors:	Abou-Faycal, Ibrahim; Bazzi, Louay; Chehab, Ali; Dawy, Zaher; Elhajj, Imad; Karamah, Fadi; Mansour, Mohamed; Saghir, Mazen
Adjunct Professor:	Khoury, Shahwan
Senior Lecturers:	Abou-Chahine, Sobhi; Chahine, Hazem; Hamandi, Lama; Huijjer, Ernest; Kamali, Walid; Moghrabi, Issam; Othman, Ziad
Lecturers:	Abdallah, Rima; Droubi, Ghassan; Mehdi, Mahmoud; Mohtar, Taan; Moukallid, Ali; Tannir, Marwan
Instructors:	Barake, Taha; Gurnian, Mehran; Husseini, Ahmad; Kanafani, Zaher; Nahas, Naji; Selim, Bassel

The Department of Electrical and Computer Engineering offers two undergraduate programs leading to the degree of Bachelor of Engineering, and two minors.

## Undergraduate Programs

The Department of Electrical and Computer Engineering offers the degree of Bachelor of Engineering in two majors:

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

The mission of the undergraduate programs is to impart a basic understanding of electrical and computer engineering built on a foundation of mathematics, physical sciences, and technology; to expose students to practical and major design experiences; and to provide students with a global perspective and an awareness of their leadership role in regional development. This preparation is augmented by the liberal arts education offered to all undergraduates at the American University of Beirut.

The Electrical and Computer Engineering program provides the students with options to explore, and specialize in, one or more areas of electrical and computer engineering.

The Computer and Communications Engineering program prepares its graduates for careers and graduate studies in information and communication technologies.

The department also offers two minors:

- Minor in Information Technology
- Minor in Biomedical Engineering

# Computer and Communications Engineering Program

## Program Educational Objectives

- Graduates of the CCE program possess skills and knowledge that qualify them for professional practice in electrical and computer engineering, and for admission to reputable graduate programs.
- Graduates of the CCE program are capable of applying fundamental knowledge, appropriate mathematical principles and computing tools, critical thinking, and best practices in electrical and computer engineering analysis and design.
- Graduates of the CCE program are provided with an educational foundation that fosters creativity, team work, leadership, and communication skills, and prepares them for lifelong learning along diverse career paths.
- Graduates of the CCE program have an appreciation of technical, social, economic, environmental, ethical, and global aspects of engineering practice.

## Program Requirements

- **Mathematics:** MATH 201, MATH 202, MATH 211 or CMPS 211, MATH 218 or 219, STAT 230, and one of MATH 210, 224, 227, 251
- **Sciences:** PHYS 210, PHYS 210L, CHEM 201 or 202, CHEM 203 or 205, and one additional science elective
- **General Education:** Arabic course (according to APT), ENGL 206 and one other English course, two social sciences courses, three humanities courses, one ethics course, and ENMG 400
- **ECE Core Courses:** EECE 200, EECE 210, EECE 230, EECE 290, EECE 310, EECE 311, EECE 320, EECE 321, EECE 330, EECE 340, EECE 370, EECE 380, EECE 411 or 412, EECE 421, EECE 442, EECE 450, and two courses from EECE 430, 431, 432, 433
- **ECE Laboratories:** EECE 310L, EECE 321L, EECE 413L, EECE 442L, and one additional laboratory elective
- **Electives:** Six courses, at least two of which should be in ECE, subject to approval of adviser
- **Approved Experience:** EECE 500
- **Final Year Project:** EECE 501 and EECE 502

The program requirements can be completed according to the following proposed schedule:

<b>Term I (Fall)</b>			<b>Credits</b>
EECE	200	Introduction to Electrical and Computer Engineering	3
EECE	210	Electric Circuits	3
ENGL		English Course	3
MATH	201	Calculus and Analytic Geometry III	3
MATH/CMPS	211	Discrete Structures	3
			<b>Total 15</b>

<b>Term II (Spring)</b>			<b>Credits</b>
EECE	230	Introduction to Programming	3
EECE	290	Analog Signal Processing	3
MATH	202	Differential Equations	3
MATH	218/219	Linear Algebra	3
PHYS	210	Introductory Physics II	3
PHYS	210L	Introductory Physics Laboratory II	1
			<b>Total 16</b>

<b>Term III (Summer)</b>			<b>Credits</b>
CHEM	201/202	Chemistry Course	3
CHEM	203/205	Chemistry Laboratory	2
Humanities or Social Sciences Elective			3
			<b>Total 8</b>

<b>Term IV (Fall)</b>			<b>Credits</b>
EECE	310	Electronics	3
EECE	310L	Electric Circuits Laboratory	1
EECE	320	Digital Systems Design	3
EECE	330	Data Structures and Algorithms	3
EECE	370	Electric Machines and Power Fundamentals	3
STAT	230	Introduction to Probability and Random Variables	3
			<b>Total 16</b>

<b>Term V (Spring)</b>			<b>Credits</b>
EECE	311	Electronic Circuits	3
EECE	321	Computer Organization	3
EECE	321L	Computer Organization Laboratory	1
EECE	340	Signals and Systems	3
EECE	380	Engineering Electromagnetics	3
Science Elective			3
			<b>Total 16</b>

<b>Term VI (Summer)</b>		<b>Credits</b>
ENGL	English Course	3
ARAB	Arabic Course	3
Humanities or Social Sciences Elective		3
		<b>Total 9</b>

<b>Term VII (Fall)</b>		<b>Credits</b>
EECE	421 Computer Architecture	3
EECE	430/1/2/3 Software Elective	3
EECE	442 Communication Systems	3
MATH	Math Elective	3
ENMG	400 Engineering Economy	3
		<b>Total 15</b>

<b>Term VIII (Spring)</b>		<b>Credits</b>
EECE	411/412 Analog or Digital Integrated Circuits	3
EECE	430/1/2/3 Software Elective	3
EECE	450 Computer Networks	3
EECE	413L Electronics Laboratory	1
Ethics Elective		3
Humanities or Social Sciences Elective		3
		<b>Total 16</b>

<b>Term IX (Summer)</b>		<b>Credits</b>
EECE	500 Approved Experience	0

<b>Term X (Fall)</b>		<b>Credits</b>
EECE	501 Final Year Project	3
EECE	442L Communications Laboratory	1
EECE	EECE Elective	3
2 Electives	EECE or Other	6
Humanities or Social Sciences Elective		3
		<b>Total 16</b>

<b>Term XI (Spring)</b>		<b>Credits</b>
EECE	502 Final Year Project	3
EECE	Laboratory Elective	1
EECE	EECE Elective	3
2 Electives	EECE or Other	6
Humanities or Social Sciences Elective		3
		<b>Total 16</b>

## List of Pre-Approved Electives

- Any EECE course with a number equal to or greater than 400
- CIVE 672
- MECH 633, 634, 642
- Any ENMG course with a number equal to, or greater than 500, with the exception of ENMG 504
- CMPS 251, 257, 258, 272, 274, 277, 281, 283, 286, 287, 288, 350, 357, 366, 367, 368, 372, 373, 378, 387
- PHYS 223, 226, 235, 236, 249
- MATH 210, 213, 214, 220, 241, 242, 261, 271, 303, 304, 306, 314, 315, 341, 344
- Any STAT course with a number equal to, or greater than 234

## List of Science Electives

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

# Electrical and Computer Engineering Program

## Program Educational Objectives

- Graduates of the ECE program possess skills and knowledge that qualify them for professional practice in electrical and computer engineering, and for admission to reputable graduate programs.
- Graduates of the ECE program are capable of applying fundamental knowledge, appropriate mathematical principles and computing tools, critical thinking, and best practices in electrical and computer engineering analysis and design.
- Graduates of the ECE program are provided with an educational foundation that fosters creativity, team work, leadership, and communication skills, and prepares them for lifelong learning along diverse career paths.
- Graduates of the ECE program have an appreciation of technical, social, economic, environmental, ethical, and global aspects of engineering practice.

## Program Requirements

- **Mathematics:** MATH 201, MATH 202, MATH 211 or CMPS 211, MATH 218 or 219, STAT 230, and one of MATH 210, 224, 227, 251
- **Sciences:** PHYS 210, PHYS 210L, CHEM 201 or 202, CHEM 203 or 205, and one additional science elective

- **General Education:** Arabic course (according to APT), ENGL 206 and one other English course, two social sciences courses, three humanities courses, one ethics course, and ENMG 400
- **ECE Core Courses:** EECE 200, EECE 210, EECE 230, EECE 290, EECE 310, EECE 311, EECE 320, EECE 321, EECE 330, EECE 340, EECE 370, and EECE 380
- **ECE Laboratories:** EECE 310L, EECE 321L, and three additional laboratory electives
- **Restricted Electives:** six courses from the list below
  - **Integrated Circuits:** EECE 411 or 412
  - **Computer Architecture:** EECE 421
  - **Software 1:** EECE 430, 431, 432 or 433
  - **Software 2:** EECE 430, 431, 432 or 433
  - **Communication Systems:** EECE 442
  - **Computer Networks:** EECE 450
  - **Control Systems:** EECE 460
  - **Power Systems:** EECE 471
  - **Power Electronics:** EECE 473
- **Other Electives:** six courses, at least two of which should be in ECE, subject to approval of adviser
- **Approved Experience:** EECE 500
- **Final Year Project:** EECE 501 and EECE 502

The program requirements can be completed according to the following proposed schedule:

Term I (Fall)			Credits
EECE	200	Introduction to Electrical and Computer Engineering	3
EECE	210	Electric Circuits	3
ENGL		English Course	3
MATH	201	Calculus and Analytic Geometry III	3
PHYS	210	Introductory Physics II	3
PHYS	210L	Introductory Physics Laboratory II	1
			<b>Total 15</b>
Term II (Spring)			Credits
EECE	230	Introduction to Programming	3
EECE	290	Analog Signal Processing	3
MATH	202	Differential Equations	3
MATH	218/219	Linear Algebra	3
MATH/ CMPS	211	Discrete Structures	3
			<b>Total 15</b>
Term III (Summer)			Credits
CHEM	201/202	Chemistry Course	3
CHEM	203/205	Chemistry Laboratory	2
		Humanities or Social Sciences Elective	3
			<b>Total 8</b>

<b>Term IV (Fall)</b>			<b>Credits</b>
EECE	310	Electronics	3
EECE	310L	Electric Circuits Laboratory	1
EECE	320	Digital Systems Design	3
EECE	330	Data Structures and Algorithms	3
EECE	370	Electric Machines and Power Fundamentals	3
STAT	230	Introduction to Probability and Random Variables	3
			<b>Total 16</b>

<b>Term V (Spring)</b>			<b>Credits</b>
EECE	311	Electronic Circuits	3
EECE	321	Computer Organization	3
EECE	321L	Computer Organization Laboratory	1
EECE	340	Signals and Systems	3
EECE	380	Engineering Electromagnetics	3
Science Elective			3
			<b>Total 16</b>

<b>Term VI (Summer)</b>			<b>Credits</b>
ENGL		English Course	3
ARAB		Arabic Course	3
Humanities or Social Sciences Elective			3
			<b>Total 9</b>

<b>Term VII (Fall)</b>			<b>Credits</b>
EECE		Restricted Elective	3
EECE		Restricted Elective	3
EECE		Restricted Elective	3
MATH		Math Elective	3
ENMG	400	Engineering Economy	3
			<b>Total 15</b>

<b>Term VIII (Spring)</b>			<b>Credits</b>
EECE		Restricted Elective	3
EECE		Restricted Elective	3
EECE		Restricted Elective	3
EECE		Laboratory Elective	1
Ethics Elective			3
Humanities or Social Sciences Elective			3
			<b>Total 16</b>

Term IX (Summer)			Credits
EECE	500	Approved Experience	0
Term X (Fall)			Credits
EECE	501	Final Year Project	3
EECE		EECE Elective	3
EECE		Laboratory Elective	1
2 Electives		EECE or Other	6
Humanities or Social Sciences Elective			3
			<b>Total 16</b>
Term XI (Spring)			Credits
EECE	502	Final Year Project	3
EECE		EECE Elective	3
EECE		Laboratory Elective	1
2 Electives		EECE or Other	6
Humanities or Social Sciences Elective			3
			<b>Total 16</b>

## List of Pre-Approved Electives

- Any EECE course with a number equal to, or greater than 400
- CIVE 672
- MECH 633, 634, 642
- Any ENMG course with a number equal to, or greater than 500, with the exception of ENMG 504
- CMPS 251, 257, 258, 272, 274, 277, 281, 283, 286, 287, 288, 350, 357, 366, 367, 368, 372, 373, 378, 387
- PHYS 223, 226, 235, 236, 249
- MATH 210, 213, 214, 220, 241, 242, 261, 271, 303, 304, 306, 314, 315, 341, 344
- Any STAT course with a number equal to or greater than 234

## List of Science Electives

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

# Minor in Information Technology

The minor in Information Technology is open to all AUB students, except students majoring in Computer and Communications Engineering, Electrical and Computer Engineering, or Computer Science. Students may apply by completing a minor application form available in the ECE Department. The minor will be indicated on the transcript of the student who completes all the requirements, and who obtains an average in the minor courses of 70 or more.

The IT minor program consists of six courses: three core courses and three electives.

## Core Courses

ITEC 240, ITEC 241, ITEC 242

## Elective Courses

EECE 230, EECE 321, EECE 330, EECE 430, EECE 431, EECE 432, EECE 433, EECE 450

# 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 in the ECE Department. 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 requirements are as follows:

- 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: 18

### For Biology students, the requirements are as follows:

- EECE 401 [1 cr.]
- BIOL 201 [4 cr.]
- BIOL 202 [4 cr.]
- (EECE 210 [3 cr.] (or equivalent) and EECE 601 [3 cr.])  
or (CIVE 210 [3 cr.] (or equivalent) and MECH 634 [3 cr.])
- One elective course from Lists A or B below [3 cr.]

Minimum number of credits: 18

### For other students, the requirements are as follows:

- EECE 401 [1 cr.]
- BIOL 201 [4 cr.]
- BIOL 202 or PHYL 246 [4 cr.]
- (EECE 210 [3 cr.] (or equivalent) and EECE 601 [3 cr.])  
or (CIVE 210 [3 cr.] (or equivalent) and MECH 634 [3 cr.])
- One elective course from Lists A, B, or C below [3 cr.]

Minimum number of credits: 18

## Elective Courses

**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

## Course Descriptions

**EECE 200 Introduction to Electrical and Computer Engineering 3 cr.**

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 design project.

**EECE 210 Electric Circuits 3 cr.**

A course on fundamentals of electric circuits; basic elements and laws; techniques of circuit analysis: node voltage, mesh current, Thevenin, Norton, and source transformation; inductors, capacitors, mutual inductance, and transformers; transient response of RC, RL, and RLC circuits; steady state AC circuits; power calculations; 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 Laplace transform and its use in circuit analysis; s-domain representation; network functions; frequency-selective circuits; Bode plots; two-port networks; ideal op-amp; active filters; Fourier series; 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. *Prerequisite: EECE 290.*

**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 corequisite: EECE 310.*

**EECE 311                    Electronic Circuits                    3 cr.**  
A course on MOSFET and BJT amplifiers; low-frequency and high-frequency response of transistor amplifiers; digital CMOS and bipolar logic circuits; transient response and power dissipation; signal generators and waveform-shaping circuits; and, SPICE simulations. *Prerequisite: EECE 310.*

**EECE 312                    Electronics                    3 cr.**  
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                    1 cr.**  
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                    3 cr.**  
A course that covers number systems and codes, switching algebra; combinational circuit analysis, synthesis, and practice; minimization methods; sequential logic design principles; latches and flip-flops, clocked synchronous state machines, designing state machines using state tables and state diagrams; and introduction to the VHDL hardware description language. *Prerequisite: EECE 210.*

**EECE 321                  Computer Organization                    3 cr.**  
A course on the organization of modern computer systems; basic hardware and software components of von Neumann computers; machine instruction sets and assembly language programming; fixed- and floating-point computer arithmetic; processor datapath and control unit design; instruction pipelining; the memory system; input/output interfacing techniques; system buses. *Prerequisites: EECE 230 and EECE 320.*

**EECE 321L                 Computer Organization Laboratory                    1 cr.**  
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 corequisite: EECE 321.*

**EECE 330                  Data Structures and Algorithms                    3 cr.**  
This course covers fundamental algorithms and data structures that are used in software applications. Particular emphasis is given to algorithms for sorting, searching, and indexing. Data structures such as linked lists, binary trees, heaps, B-Trees, and graphs are 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.**  
A course on signals and systems; linear time-invariant systems; review of Fourier series representation of periodic signals; Fourier transform and its applications; discrete-time Fourier transform; time and frequency characterization of signals and systems; sampling; introduction to communication and control systems; review of the Laplace transform and the z-transform. *Prerequisite: EECE 290.*

- EECE 370            Electric Machines and Power Fundamentals            3 cr.**  
A course on three-phase circuits and power calculation; magnetic circuits; transformers: single-phase ideal and real transformers, construction, operational characteristics, autotransformers, 3-phase transformers; DC and AC machines: construction and basic concepts; synchronous generators: construction, equivalent circuit, testing and performance characteristics. *Prerequisite: EECE 210.*
- EECE 380            Engineering Electromagnetics            3 cr.**  
This course applies the electromagnetic model consisting of Maxwell's equations to the study of static electric fields in vacuum and dielectrics, conductors, capacitance, the study of magnetic fields in magnetic and non-magnetic media, and inductance. The concepts of electrostatic and magnetic potentials, energy and forces are introduced. The second part of the course emphasizes the study of time-varying fields, plane wave propagation in unbounded media, propagation in lossless media, and wave reflection and transmission at normal incidence. The basic bridge between electric circuits and electromagnetics is done through the study of transmission lines. *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.
- 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.**  
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 413L          Electronics Laboratory            1 cr.**  
A laboratory course that focuses on circuit layout and fabrication; amplifier characterization; low-frequency and high-frequency response; active filters; wave generators; communication circuits; low current motor drives. *Prerequisite: EECE 311.*
- EECE 421            Computer Architecture            3 cr.**  
A course on the principles, techniques, and trade-offs used in designing modern processor architectures. Topics include: benchmarking and performance evaluation, long-latency instruction pipelining, hardware and software techniques for exploiting instruction-level parallelism (out-of-order, speculative, and predicated instruction execution; multithreading; loop unrolling, software pipelining, and trace scheduling), high performance memory systems, and multiprocessor systems and programming. *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 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; distributed algorithms; introduction to NP-completeness and intractability. *Prerequisite: EECE 330.*

**EECE 432 Operating Systems 3 cr.**

A course that covers operating systems principles; processes and threads; concurrency and synchronization; CPU scheduling; virtual memory management; communication in distributed systems, secondary-storage management; file systems; security. *Prerequisites: EECE 321 and EECE 330. Students can not receive credit for both EECE 432 and CMPS 272.*

**EECE 433 Database Systems 3 cr.**

A course that 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 can not receive credit for both EECE 433 and CMPS 277.*

**EECE 442 Communication Systems 3 cr.**

A course that introduces 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; equalization. *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.**

A laboratory course that covers the technologies and protocols of the Internet. The experiments cover the Internet Protocol, Address Resolution Protocol, Internet Control Message Protocol, Transmission Control Protocol, the Domain Name System, routing protocols (RIP, OSPF, BGP), network address translation, dynamic host configuration, network management protocols, and IP multicast. *Prerequisite: EECE 450.*





- EECE 602                      Biomedical Engineering II                      3 cr.**  
A course on the respiratory system; non-invasive diagnostic instrumentation; nervous system; bio-telemetry; clinical laboratory; x-ray and radioisotopes; magnetic resonance; electro-surgery; computers in medicine. *Prerequisite: EECE 601.*
- 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.*
- 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.**  
A course that focuses on basic analog IC building blocks; current mirrors, voltage, current references, and amplifiers; digital to analog converters, analog to digital converters, continuous-time filters, and switch capacitor filters; modulators and multiplexers, oscillators, and phase-locked loops. *Prerequisite: EECE 311.*
- 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.**  
**and Systems**  
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 620                      Computer Graphics                      3 cr.**  
A course on interactive graphics; graphics hardware; graphical input devices; windowing; clipping; viewports; zooming, geometrical transformations (2D and 3D); data structures; advanced raster display architectures; raster algorithms; special graphics techniques; applications. *Prerequisite: Senior or graduate standing.*
- EECE 621                      Advanced Computer Architecture                      3 cr.**  
A course that focuses on the allocation of hardware and software resources in solving large-scale computing problems, with emphasis on the relationships between hardware organization, system programming, and language support in the evolution of advanced computer architectures. *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.**  
A course on digital systems testing and testable design: test economics, fault modeling, logic and fault simulation, testability measures, test generation for combinational and sequential circuits, memory test, delay test, scan design, built-in self test, 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 626                      Computer System Analysis                      3 cr.**  
A course on the development of analytical models of computer systems and application of such models to performance evaluation. Topics covered include scheduling policies, paging algorithms, multi-programmed resource management, and queuing theory. *Prerequisite: EECE 421.*

**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.**  
A course that covers general principles of algorithm design and analysis; linear programming; randomized algorithms; advanced graph algorithms; NP completeness; introduction to complexity theory; approximation algorithms; number theoretic algorithms; selected topics. *Prerequisite: EECE 431.*

**EECE 632                      Cryptography and Computer Security                      3 cr.**  
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, intruders, and malicious software. *Prerequisite: Senior or graduate standing.*

**EECE 634                      Optimizing Compilers                      3 cr.**  
Theoretical and practical aspects of building modern optimizing compilers. Topics: intermediate representations, basic blocks and flow graphs, data flow analysis, partial evaluation and redundancy elimination, loop optimizations, register allocation, instruction scheduling, and interprocedural analysis. Students will implement significant optimizations within the framework of a modern research compiler. *Prerequisites: EECE 330 and EECE 421, or consent of the instructor.*

**EECE 635                      Advanced Software Engineering                      3 cr.**

This course provides the students with an understanding of current topics in software engineering with an emphasis on software architectural design, software development, and autonomic computing. *Prerequisite: EECE 430.*

**EECE 640                      Wireless Communications                      3 cr.**

A course on wireless channel models; performance of digital modulation schemes in wireless channels; diversity techniques; channel coding and interleaving in fading channels; adaptive equalization in wireless channels; multiple access techniques; fundamentals of cellular communications; current wireless communication 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, computer-based wireless channel modeling, indoor GSM measurements and analysis, outdoor GSM measurements and analysis, and measurement-based wireless channel modeling. *Prerequisite: EECE 640.*

**EECE 641                      Information Theory                      3 cr.**

This course introduces the field of information theory and its application to communications theory, computer science, statistics, and probability theory. Covering all the essential topics in information theory, the course introduces the basic quantities of entropy, relative entropy, and mutual information, and show how they arise as natural answers to questions of data compression, channel capacity, rate distortion, and hypothesis testing. *Prerequisite: Senior or graduate standing.*

**EECE 642                      Introduction to Coding Theory                      3 cr.**

This course introduces the theory of error-correcting codes. The course focuses on results of asymptotic or algorithmic significance. Topics include: construction and existence results for error-correcting codes; limitations on the combinatorial performance of error-correcting codes; low density parity check codes; algebraic geometric codes; turbo codes; and decoding algorithms. *Prerequisite: Senior or graduate standing.*

**EECE 643                      RF and Microwave Communication Systems                      3 cr.**

A course that introduces students to hardware components, system parameters, and architectures of RF and microwave wireless systems. It focuses on the design of a radio system for transmission and reception of information: types of receivers and transmitters, matching techniques, antenna types in wireless systems, RF and microwave radio components, receiver and transmitter RF system parameters, and radio links; basic modulation and demodulation schemes and multiple-access techniques used in present RF systems and includes an overview of different RF and microwave point-to-point, mobile, and satellite communications systems. *Prerequisites: EECE 311 and EECE 340.*

**EECE 644                      Stochastic Processes, Detection, and Estimation                      3 cr.**

A course on types of random processes, series representation, and filtering; hypothesis testing and parameter estimation from a probabilistic point of view; extension to detection and estimation of known signals in white and non-white noise; prediction and filtering problems. *Prerequisites: STAT 230 and EECE 340.*

- EECE 645                    The UMTS Cellular System                    3 cr.**  
A course on GSM, EDGE, and GPRS; UMTS standardization; multimedia and data services; UMTS transmitter design; UMTS receiver design; power control and soft handover; radio network planning; multiantenna techniques; multiuser detection; packet and Internet access over wireless; and an overview of CDMA2000. *Prerequisite: EECE 442.*
- EECE 646                    Advanced Digital and Data Communications                    3 cr.**  
A course that examines measures of information; source coding, channel coding, channel capacity, soft and hard decision decoding, digital signaling over a channel with intersymbol interference, and other topics. *Prerequisite: EECE 442.*
- 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 Internet2. 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. A strong emphasis is placed on the programmability and networking of mobile phones, PDAs, and Pocket PCs. Hands-on experience involves programming in Java2 ME, C/C++ for Palm OS, and .NET Compact Framework for Windows CE. The course provides a general coverage of underlying technologies and standards, including XML, WAP, UMTS, GPRS, Bluetooth, and Jini. *Prerequisite: Senior or graduate standing.*
- 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.*
- 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 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 robot manipulators: kinematics, control, programming, task planning, and effect of load; design of robot controllers: path tracking, force feedback control, real-time computation issues; and includes a set of laboratory experiments and a design project. *Prerequisite: EECE 460.*
- 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.**  
An introduction to time series; auto regressive moving average models and their characteristics; modeling; forecasting; stochastic trends and seasonality; multiple series and optimal control. Applications. *Prerequisite: Senior or graduate standing.*

- 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 670                      Power System Planning                      3 cr.**  
A course that investigates energy and peak load forecasts, weather-sensitive forecasts, generation reliability, load duration curves, loss-of-load expectation, capacity reserve evaluation, generation and transmission expansion, power flow analysis, reliability of bulk supply, and cost-benefit analysis. *Prerequisite: EECE 471.*
- 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 wind, solar, hydro, biomass, and geothermal resources; resource assessment, electric drive options, control problems, environmental aspects of electricity generation, and stand-alone and utility applications; institutional and policy issues, and integrated energy systems. *Prerequisite: Senior or graduate standing.*
- EECE 676                      Computer Analysis of Power Systems                      3 cr.**  
A course on large scale power systems, power system matrices, and programming considerations; advanced power flow studies, voltage, and reactive flow control; fault analysis, transient analysis, and power system stability. *Prerequisite: EECE 471.*

**EECE 677                      Electric Power System Operation and Control                      3 cr.**

A course on short-term load forecasting, generation unit commitment, economic load dispatch, loss formula coefficients, nonlinear programming, optimal power flow, security assessment, security dispatch, spinning reserve evaluation, automatic generation control, reactive power and voltage control, and state estimation. *Prerequisite: Senior or graduate standing.*

**EECE 680                      Antenna Theory and Design                      3 cr.**

A course on radiation systems, wire antennas, aperture antennas, arrays, input impedance, microstrip antennas, dielectric antennas, antennas in material layers. *Prerequisite: Senior or graduate standing.*

**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. This 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. Perturbational and variational techniques. *Prerequisites: EECE 380.*

**EECE 683                      Method of Moments in Electromagnetics                      3 cr.**

Introduction to the method of moments. Applications of the method to perfectly conducting bodies, material bodies, apertures, thin wires, and microstrip transmission lines. Development of computer codes solving typical problems in electromagnetics using the method of moments. Introduction to other numerical methods such as variational methods and finite element method. *Prerequisite: EECE 682.*

**EECE 691                      Digital Signal Processing                      3 cr.**

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. Introduction to 2D signal and image processing. *Prerequisite: Senior or graduate standing.*

**EECE 693                      Neural Networks                      3 cr.**

A course on perceptron, madaline, back propagation, and adaptive neural networks; transformation by layered networks, statistical neurodynamics, associative memory, and neural learning; applications to functional approximations, signal filtering, and pattern classification. *Prerequisite: 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 695          Adaptive Filtering****3 cr.**

A course that examines the fundamentals of adaptive filter analysis and design, with emphasis on applications in linear and decision-feedback equalization, beam forming, channel estimation and tracking, noise and echo cancellation, source separation, and blind equalization; stochastic gradient algorithms (LMS-type) and recursive least-squares algorithms (RLS-type). *Prerequisite: Senior or graduate standing.*

## IT Course Descriptions

**ITEC 240          Computers and Communication Systems****3 cr.**

This course gives an encompassing introduction to computer and communication system hardware. Computer hardware topics include microprocessors, memory, disk storage, and input/output devices. Network topics on the other hand include protocols and hardware, in addition to the Internet and the World Wide Web.

**ITEC 241          Software Systems****3 cr.**

This course covers major aspects of software systems and programming languages with hands on experience that focuses on developing skills for building applications and web pages. The course teaches students how to program in XHTML, JavaScript, Visual Basic, SQL, and Active Server Pages (ASP). Students are also introduced to IT security. Lab assignments are given to enhance learned concepts.

**ITEC 242          Management Information Systems****3 cr.**

This course introduces students to the strategic role of information and communication technologies. These include building and using information systems as well as their integration in all aspects of management. The course covers IT need assessment, technology evaluation and selection, and project planning and implementation. Additional topics include advances in IT and issues related to administration, security, risks, and control.