Electrical and Computer Engineering

Shekhar Bhansali, *Alcatel Lucent Professor and Chair*
Haneen Aburub, *Instructor*
Malek Adjouadi, *Ware Professor*
Kemal Akkaya, *Professor*
Elias Alwan, *Assistant Professor*
Jean Andrian, *Associate Professor and Associate Chairperson*
Wilmer Arellano, *Senior Instructor*
Ou Bai, *Assistant Professor*
Armando Barreto, *Professor*
Shubhendu Bhardwaj, *Assistant Professor*
Amaury Caballero, *Senior Lecturer*
Mercedes Cabrerizo, *Assistant Professor*
Gustavo Chaparro Baquero, *Instructor*
Hai Deng, *Associate Professor*
Luis Galarza, *Instructor*
Stavros Georgakopoulos, *Professor*
Mehdi Hatamian, *Distinguished University Professor*
Ahmed S. Ibrahim, *Assistant Professor*
Grover Larkins, *Professor*
Arjuna Madanayake, *Associate Professor*
Osama Mohammed, *Professor*
Mubarak Mujawar, *Instructor*
Srikanth Namuduri, *Instructor*
Nezih Pala, *Associate Professor and Graduate Program Director*
Sumit Paudyal, *Associate Professor*
Alexander Perez-Pons, *Instructor*
Gang Quan, *Professor*
Mohammad Ashiqur Rahman, *Assistant Professor*
Pulugurtha Markondeya Raj, *Associate Professor*
Gustavo Roig, *Professor*
Mario Sanchez, *Associate Director for Undergraduate Advising*
Arif Sarwat, *Associate Professor*
Atoussa Tehrani, *Instructor*
Selcuk Uluagac, *Assistant Professor*
Frank Urban, *Associate Professor*
Yuri Vlasov, *Lecturer*
John Volakis, *Dean, College of Engineering and Computing & Professor*
Herman Watson, *Lecturer and Undergraduate Program Director*
Subbarao Wunnava, *Professor Emeritus Distinguished*
Kang Yen, *Professor,Graduate Program Director, and Director of International Program Development*

Bachelor of Science in Electrical Engineering

Program Educational Objectives

The Electrical Engineering Educational Objectives are:

1. That our graduates are employed and have career advancement as electrical engineers, or in another profession using their electrical engineering skills,
2. That our graduates stay current in their field of expertise,
3. That our graduates attain supervisory/leadership positions in their respective organizations.

Program Educational Outcomes

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 solution 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
l) an ability to apply probability and statistics, including applications to electrical engineering program

Common Prerequisite Courses and Equivalencies

FIU Course(s)	Equivalent Course(s)
CHM 1045, CHM 1045L	CHMX045/X045L or CHMX045C or CHSX440/X440L
MAC 2281	MACX311 or MACX281
MAC 2282	MACX312 or MACX282
MAC 2283	MACX313 or MACX283
MAP 2302	MAPX302 or MAPX305
PHY 2048	PHYX048/X048L[2] or PHYX048C or PHYX041/PHYX048L PHYX043/PHYX048L or
PHY 2049, PHY 2049L	PHYX049/PHYX049L or PHYX049C or PHYX042/PHYX049L or PHYX044/PHYX049L

[1]or CHSX440 if 4 credit hours with included laboratory
[2]PHY2048L is not required at FIU

Courses which form part of the statewide articulation between the State University System and the Florida College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit: **http://www.flvc.org**, Search Program Listing by Alphabetic Order.

Common Prerequisites

CHM 1045	General Chemistry
CHM 1045L	General Chemistry Lab I
MAC 2281	Calculus I for Engineering
MAC 2282	Calculus II for Engineering
MAC 2283	Calculus III for Engineering
MAP 2302	Differential Equations
PHY 2048	Physics with Calculus I
PHY 2049	Physics with Calculus II

PHY 2049L	General Physics Lab II

Additional lower division courses required:

EEL 2880	Applied Software Techniques in Engineering

Degree Program Hours: 128

Students applying to Electrical Engineering should have good communication skills in English (verbal and written) and exhibit logical thinking, creativity, imagination, and persistence. They should have proven academic background in mathematics, chemistry, and physics. First time in college at FIU and eligible to enroll in Calculus I can declare Electrical Engineering as a major. All others will be admitted to Electrical Engineering after successfully registering for Calculus II. Missing courses may be taken at FIU, with advisor approval.

At the undergraduate level, the basic required program of instruction in fundamental theory and laboratory practice is balanced by a broad range of electives in such fields as bio-engineering, communication systems, control systems, energy and power. Students, with the counsel and guidance of faculty advisers, design their electives program around their own special interest and career objectives. Students are allowed to take ECE electives when they complete University core and start taking degree core. Students must choose elective classes from approved concentration list. Students may choose any class from any concentration as long as they fulfill the prerequisite(s) and corequisite(s). Students are required to choose at least two concentrations, at least nine credits from each of these two concentrations.

Any course taken without the required prerequisites and corequisites will be dropped automatically before the end of the term, resulting in a grade of “DR” or “DF”. The student will not be eligible for a refund.

Students must earn a minimum grade of “C“ and a minimum GPA of 2.0 in all EEE, EEL, and elective courses required for graduation.

Students, who have been dismissed for the first time from the University due to low grades, may appeal to the department for reinstatement. A second dismissal results in no possibility of reinstatement.

Students are required to take “SPC 2608 Public Speaking (for Engineers)”. Students who have taken Public Speaking (or equivalent) at a Community College/University and have satisfied the UCC through courses other than Public Speaking may use the course toward concentration elective credits required for the program.

Lower Division Preparation

Lower division requirements include at least 50 credit hours of pre-engineering courses (see the Undergraduate Studies portion of this catalog for specific requirements). These courses include common prerequisite courses, 2 semesters of English composition and 2 other Gordon rule writing courses. A minimum grade of “C” is required in all writing courses, all calculus courses, differential equations, both physics classes, and chemistry. In addition, both transfer students and FIU freshman must take a combination of social sciences and humanities that fulfill the FIU University Core Curriculum requirements and those topics also complement the goals and objectives of the College of Engineering and Computing (including economic, environmental, political, and/or social issues. See semester-by-semester sample program for courses that fulfill this requirement). Students who have not satisfactorily met the social science/humanities requirements will be required to take additional (advanced) humanities/social science course(s).

In addition, students may transfer a pre-approved engineering Statics course if it meets the proper prerequisites for the course (speak to an FIU engineering advisor to see if your community college offers an acceptable statics course). Students must make up any missing prerequisites before they will be allowed to begin taking certain engineering courses (see the course listing on the following page for the complete list of required courses. Required pre/corequisites are listed in the section on Course Descriptions).

University Core (Total: 50 Credits)

Any student entering Florida International University as a first-time college student (Summer 2003 or after) or transferring in without an Associates in Arts (AA) degree from a Florida public institution (Fall 2003 or after) is required to fulfill the University Core Curriculum requirements.

SLS 1501	First Year Experience	1
(Communications)		
ENC 1101	Writing and Rhetoric I	3
ENC 1102	Writing and Rhetoric II	3
(Humanities)		
Humanities Group 1		3*
Humanities Group 2		3*
(Mathematics)		
MAC 2281	Calculus I for Engineering	4
MAC 2282	Calculus II for Engineering	4
MAC 2283	Calculus III for Engineering	4
MAP 2302	Differential Equations	3
Social Science Group 1		3*
Social Science Group 2		3*
(Natural Sciences)		
Natural Science Group 1		
CHM 1045	General Chemistry I	3
	Or	
BSC 2010	General Biology	3
CHM 1045L	General Chemistry I Lab	1
	Or	
BSC 2010L	General Biology Lab	1
PHY 2048	Physics with Calculus I	4
Natural Science Group 2		
PHY 2049	Physics with Calculus II	4
PHY 2049L	General Physics Lab II	1
(Arts)		
SPC 2608	Public Speaking	3

*Please check all approved courses from Academic Advising Center: **http://undergrad.fiu.edu/advising/curriculum.html**.

Other Requirements

Students must meet the University Foreign Language Requirement, must have a minimum 2.0 GPA, must complete all required classes, and must otherwise meet all of the state and university requirements in order to graduate. Students who enter the university with fewer than 60 transferred credits must take 9 summer credits. Also see the Undergraduate Studies portion of this catalog for additional information.

Electrical Engineering students must take:

Engineering Breadth and Elective (Total: 8 Credits)

EGN 1002	Engineering Orientation	2
EIN 3235	Evaluation of Engineering Data I	3
EGN 3613	Engineering Economy	3

ECE Core (Total: 21 credits)

EEL 2880	Applied Software Techniques in Engineering	3
EEL 3110	Circuits Analysis	3
EEL 3110L	Circuits Lab	1
EEL 3120	Introduction to Linear Systems in Engineering	3
EEL 3135	Signals and Systems	3
EEL 3712	Logic Design I	3
EEL 3712L	Logic Design I Lab	1
EEL 4920	Senior Design I: Ethics, Communications and Constraints – *GL*	2**
EEL 4921C	Senior Design II: Project Implementation – *GL*	2**

**EEL 4920 and EEL 4921C are intended to be taken in last 2 semesters of undergraduate experience. Students are required to complete at least 100 credits, other ECE core courses, and Electrical Engineering Degree Core before EEL 4920 registration.

Electrical Engineering Degree Core (Total: 7 credits)

EEE 3303	Electronics I	3
EEE 3303L	Electronics I Lab	1
EEL 4410	Introduction to Fields and Waves	3

Electrical Engineering Electives (Total: 42 credits)
(Selected from Areas of Concentration offered by ECE Department)

Plan of Study

Electrical Engineering Program Freshman to Senior

First Semester: (18)

CHM 1045	General Chemistry I	3
	Or	
BSC 2010	General Biology	3
CHM 1045L	General Chemistry I Lab	1
	Or	
BSC 2010L	General Biology Lab	1
ENC 1101	Writing and Rhetoric I	3
SLS 1501	First Year Experience	1
MAC 2281	Calculus I for Engineering	4
(Social Science Group 1)		
ECO 2013	Principles of Macroeconomics	3
	or	
AMH 2020	American History Introductory Survey Since 1877 – *GRW/GL*	3
	or	
PSY 2012	Introductory Psychology	3
	or	
ANT 2000	Introduction to Anthropology – *GL*	3
	or	
POS 2041	American Government	3
	or	
SYG 2010	Social Problems – *GL*	3
(Arts)		
SPC 2608	Public Speaking	3

Second Semester: (16)

EGN 1002	Engineering Orientation	2
ENC 1102	Writing and Rhetoric II	3
PHY 2048	Physics with Calculus I	4
MAC 2282	Calculus II for Engineering	4
(Social Science Group 2)		
EGN 1033	Technology, Humans, and Society – *GL*	3

Third Semester: (15)

PHY 2049	Physics with Calculus II	4
PHY 2049L	General Physics Lab II	1
MAC 2283	Calculus III for Engineering	4
EEL 2880	Applied Software Techniques in Engineering	3
Humanities Group 1		3**

Fourth Semester: (17)

MAP 2302	Differential Equations	3
EEL 3110	Circuits Analysis	3
EEL 3110L	Circuits Lab	1
EEL 3120	Introduction to Linear Systems in Engineering	3
EIN 3235	Evaluation of Engineering Data I	3
EEL 3712	Logic Design I	3
EEL 3712L	Logic Design I Lab	1

Fifth Semester: (16)

EEL 3135	Signals and Systems	3
EEE 3303	Electronics I	3
EEE 3303L	Electronics I Lab	1
EGN 3613	Engineering Economy	3
EEL 4410	Introduction to Fields and Waves	3
Humanities Group 2		3**

Sixth Semester: (18)

ECE Electives		18

Seventh Semester: (14)

EEL 4920	Senior Design I: Ethics, Communications and Constraints – *GL*	2
ECE Electives		12

Eighth Semester: (14)

EEL 4921C	Senior Design II: Project Implementation – *GL*	2
ECE Electives		12

**At least 9 credit hours must be taken in one or more summers.

Bachelor of Science in Internet of Things

Program Educational Outcomes:

IoT students should demonstrate that they have knowledge when evaluated under the following outcomes:

a) Demonstrate practical hands-on expertise in selection, installation, customizing and maintenance of the state-of-the-art IoT devices and networks;
b) Demonstrate general understanding of at least one field where IoT plays a central role;
c) Demonstrate ability to utilize and understand contemporary IoT applications and protocols common-place to the industry;
d) Demonstrate ability to effectively communicate ideas in oral, written, and graphical form;
e) Demonstrate ability to, and experience in, collaboratively working with teams and small group settings;
f) Explain the legal and ethical implications of their work and an awareness of the impact of their

actions and decision-making on individuals, society, and the environment.

Degree Program Hours: 120

Required Courses from the FIU Core (the rest can be any from the list) Total: 50 credits

MAC 1105	College Algebra	3
CGS 2518	Data Analysis	3
COP 2250	Programming in Java	3
CHM 1045	General Chemistry I	3
PHY 2053	Physics without Calculus	4
EGN 1033	Technology, Human and Society	3
IDS 3315	Gaining Global Perspectives	3

IoT Core Courses (40 credits):

TCN 2720	Introduction to IoT	2
CTS 1120	Fundamentals of Cybersecurity	3
EGN 2271	Introduction to Circuits & Electronic Hardware	3
CDA 3104	Introduction to Computer Design	3
CNT 3142	Microcontrollers for IoT Devices	3
CNT 3162	Wireless Communications for IoT	3
EEL 2880	Applied Software Techniques in Engineering	3
EEL 4730	Programming Embedded Systems	3
EEL 4734	Embedded Operating Systems	3
TCN 4211	Telecommunications Networks	3
EEE 4717	Introduction to Security of Internet of Things	3
CGS 3767	Computer Operating Systems	3
CEN 3721	Introduction to Human Computer Interaction	3

Electives (30 credits)

Elective Courses from ECE (at least 9 credits):
Existing Courses:
1. TCN 4081 Telecommunication Network Security (3) (*Prereq: TCN 4211*)
New Courses:
2. IoT Privacy (3) (Prereq: EEL 2880)
3. Network Protocols for IoT (3) (*Prereq: TCN 4211*)
4. IoT Forensics (3) (*Prereq: Embedded Programming for IoT*)

Elective Courses from Other Departments in CEC (Up to 9 credits): As long as the prerequisites are met, up to 9 credits can be taken from other engineering departments.

Elective Courses from other Colleges (12 credits): As long as the prerequisites are met, 12 credits can be taken from other Colleges. Out of 12, up to 6 credits are acceptable/transferrable from other FL universities online programs.

First Semester: (16)

ENC 1101	Writing and Rhetoric I	3
SLS 1501	First Year Experience	1
	Humanities from Group 1	3
MAC 1105	College Algebra (Mathematics from Group 1)	3
Social Science from Group 1		3
CGS 2518	Data Analysis (Mathematics from Group 2)	3

Second Semester: (18)

ENC 1102	Writing and Rhetoric II	3
EGN 1033	Technology, Human and Society (Humanities from Group 2)	3
IDS 3315	Gaining Global Perspectives (Social Science from Group 2)	3
Social Science from Group 2		3
CHM 1045	General Chemistry I (Natural Science from Group 1)	3
Humanities from Group 2		3

Third Semester: (16)

PHY 2053	Physics without Calculus I (Natural Science from Group 1)	4
Arts from approved list		3
	Natural Science from Group 2	3
COP 2250	Programming in Java (Mathematics from Group 2)	3
Humanities from Group 2		3

Fourth Semester: (12)

EEL 2880	Applied Software Techniques in Engineering	3
EGN 2271	Introduction to Circuits & Electronic Hardware	3
CGS 3767	Computer Operating Systems	3
CEN 3721	Introduction to Human Computer Interaction	3

Fifth Semester: (15)

CDA 3104	Introduction to Computer Design	3
CNT 3142	Microcontrollers for IoT Devices	3
EEL 4730	Programming Embedded Systems	3
	Elective **	3
	Elective **	3

Sixth Semester: (12)

EEL 4734	Embedded Operating Systems	3
CNT 3122	Sensors for IoT	3
CNT 3162	Wireless Communications for IoT	3
	Elective **	3

Seventh Semester: (15)

TCN 4211	Telecommunications Networks	3
EEE 4717	Introduction to Security of Internet of Things	3
	Elective **	3
	Elective **	3
	Elective **	3

Eighth Semester: (15)

TCN 4940	Senior Project	3
	Elective **	3
	Elective **	3
	Elective **	3
	Elective **	3

** Electives can be picked from the Electives list above. Any exception to the program require departments approval.

Combined BS/MS in Electrical Engineering

This five-year program seamlessly combines a baccalaureate degree in Electrical Engineering with the Master's in Electrical Engineering. To be considered for admission to the combined bachelor's/master's degree program, students must have completed at least 75 but not more than 90 of the credits required for the bachelor's degree program at FIU, have earned at least a 3.2 GPA on both overall and upper division courses, and meet the admissions criteria for the graduate degree program to

which they are applying. Students need only apply once to the combined degree program, but the application must be submitted to Graduate Admissions before the student starts the last 30 credits of the bachelor's degree program. A student admitted to the combined degree program will be considered to have undergraduate status until the student applies for graduation from their bachelor's degree program. Upon conferral of the bachelor's degree, the student will be granted graduate status and be eligible for graduate assistantships. Students enrolled in the program may count up to 9 hours of graduate level courses (i.e., 5000 level or higher) as credits for both the undergraduate and graduate degree programs. For each of the courses counted as credits for both BS and MS degree, a minimum grade of 'B' is required. Upon completion of the combined BS/MS program, students must have accumulated a minimum of 24 hours of credits at the graduate (5000+) level. Students enrolled in the program are encouraged to seek employment with a department faculty member to work as a student assistant on a sponsored research project.

Combined BS in Electrical Engineering/MS in Biomedical Engineering

This five-year program seamlessly combines a baccalaureate degree in electrical engineering with the Master's in biomedical engineering. To be considered for admission to the combined bachelor's/master's degree program, students must have completed at least 75 but not more than 90 of the credits required for the bachelor's degree program at FIU, have earned at least a 3.2 GPA on both overall and upper division courses, and meet the admissions criteria for the graduate degree program to which they are applying. Students need only apply once to the combined degree program, but the application must be submitted to Graduate Admissions before the student starts the last 30 credits of the bachelor's degree program. A student admitted to the combined degree program will be considered to have undergraduate status until the student applies for graduation from their bachelor's degree program. Upon conferral of the bachelor's degree, the student will be granted graduate status and be eligible for graduate assistantships. Students enrolled in the program may count up to 9 hours of graduate level courses (i.e., 5000 level or higher) as credits for both the undergraduate and graduate degree programs. For each of the courses counted as credits for both BS and MS degree, a minimum grade of 'B' is required. Upon completion of the combined BS/MS program, students must have accumulated a minimum of 24 hours of credits at the graduate (5000+) level. Students enrolled in the program are encouraged to seek employment with a department faculty member to work as student assistants on sponsored research projects.

Combined BS in Electrical Engineering/ MS in Engineering Management (BSEE/MSEM)

This five-year program seamlessly combines a baccalaureate degree in Electrical Engineering with the Master's in Engineering Management. To be considered for admission to the combined bachelor's/master's degree program, students must have completed at least 75 but not more than 90 of the credits required for the bachelor's degree program at FIU, have earned at least a 3.2 GPA on both overall and upper division courses, and meet the admissions criteria for the graduate degree program to which they are applying. Students need only apply once to the combined degree program, but the application must be submitted to Graduate Admissions before the student starts the last 30 credits of the bachelor's degree program. A student admitted to the combined degree program will be considered to have undergraduate status until the student applies for graduation from their bachelor's degree program. Upon conferral of the bachelor's degree, the student will be granted graduate status and be eligible for graduate assistantships. Students enrolled in the program may count up to 9 hours of graduate level courses (i.e., 5000 level or higher) as credits for both the undergraduate and graduate degree programs. For each of the courses counted as credits for both BS and MS degree, a minimum grade of 'B' is required. Upon completion of the combined BS/MS program, students must have accumulated a minimum of 24 hours of credits at the graduate (5000+) level. Students enrolled in the program are encouraged to seek employment with a department faculty member to work as a student assistant on a sponsored research project.

Combined BS in Electrical Engineering/MS in Telecommunications and Networking

This five-year program seamlessly combines a baccalaureate degree in Electrical Engineering with the Master's in Telecommunications and Networking. To be considered for admission to the combined bachelor's/master's degree program, students must have completed at least 75 but not more than 90 of the credits required for the bachelor's degree program at FIU, have earned at least a 3.2 GPA on both overall and upper division courses, and meet the admissions criteria for the graduate degree program to which they are applying. Students need only apply once to the combined degree program, but the application must be submitted to Graduate Admissions before the student starts the last 30 credits of the bachelor's degree program.
A student admitted to the combined degree program will be considered to have undergraduate status until the student applies for graduation from their bachelor's degree program. Upon conferral of the bachelor's degree, the student will be granted graduate status and be eligible for graduate assistantships. Students enrolled in the program may count up to 9 hours of graduate level courses (i.e., 5000 level or higher) as credits for both the undergraduate and graduate degree programs. For each of the courses counted as credits for both BS and MS degree, a minimum grade of 'B' is required. Upon completion of the combined BS/MS program, students must have accumulated a minimum of 24 hours of credits at the graduate (5000+) level. Students enrolled in the program are encouraged to seek employment with a department faculty member to work as a student assistant on a sponsored research project.

Bachelor of Science in Computer Engineering

Program Educational Objectives

The Computer Engineering Educational Objectives are:

1. That our graduates are employed and have career advancement as computer engineers, or in another profession using their computer engineering skills,
2. That our graduates stay current in their field of expertise,
3. That our graduates attain supervisory/leadership positions in their respective organizations.

Program Educational Outcomes

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 solution 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
l) an ability to apply probability and statistics, including applications to computer engineering program

Common Prerequisite Courses and Equivalencies

FIU Course(s)	Equivalent Course(s)
CHM 1045, CHM 1045L	CHMX045/X045L or CHMX045C or CHSX440
MAC 2281	MACX311 or X281, or X282, X283
MAC 2282	MACX312 or X281, or X282, or X283
MAC 2283	MACX313, or X281, or X282, or X283
MAP 2302	MAPX302
PHY 2048*	PHYX048/X048L or PHYX048C
PHY 2049, PHY 2049L	PHYX049/X049L or PHYX049C

Courses which form part of the statewide articulation between the State University System and the Florida College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit: **https://flvc.org**. Search Program Listing by Alphabetic Order.

Common Prerequisites**

CHM 1045	General Chemistry I
CHM 1045L	General Chemistry Lab I
MAC 2281	Calculus I for Engineering
MAC 2282	Calculus II for Engineering
MAC 2283	Calculus III for Engineering
MAP 2302	Differential Equations
PHY 2048	Physics with Calculus I
PHY 2049	Physics with Calculus II
PHY 2049L	General Physics Lab II

Additional lower division courses required:

EEL 2880	Applied Software Techniques in Engineering
MAD 2104	Discrete Mathematics[3]
	or
COT 3100	Discrete Structures

***PHY 2048L is not a requirement for this program.*
[3]Or equivalent fulfilling Discrete Mathematics requirements

Degree Program Hours: 128

Students applying to Computer Engineering should have good communication skills in English (verbal and written) and exhibit logical thinking, creativity, imagination, and persistence. They should have proven academic background in mathematics, chemistry, and physics. First time in college at FIU and eligible to enroll in Calculus I can declare Computer Engineering as a major. All others will be admitted to Computer Engineering after successfully registering for Calculus II. Missing courses may be taken at FIU, with advisor approval.

At the undergraduate level, the basic required program of instruction in fundamental theory and laboratory practice is balanced by a broad range of electives in such fields as bio-engineering, communication systems, control systems, energy and power. Students, with the counsel and guidance of faculty advisers, design their electives program around their own special interest and career objectives. Students are allowed to take ECE electives when they complete University core and start taking degree core. Students must choose elective classes from approved concentration list. Students may choose any class from any concentration as long as they fulfill the prerequisite(s) and corequisite(s). Students are required to choose at least two concentrations, at least nine credits from each of these two concentrations.

Any course taken without the required prerequisites and corequisites will be automatically dropped before the end of the term, resulting in a grade of “DR” or “DF”. The student will not be eligible for a refund.

Students must earn a minimum grade of “C“ and a minimum GPA of 2.0 in all EEE, EEL, and elective courses required for graduation.

Students, who have been dismissed for the first time from the University due to low grades, may appeal to the department for reinstatement. A second dismissal results in no possibility of reinstatement.

Students are required to take “SPC 2608 Public Speaking (for Engineers)”. Students who have taken Public Speaking (or equivalent) at a Community College/University and have satisfied the UCC through courses other than Public Speaking may use the course toward concentration elective credits required for the program.

Sections titled "Other Requirements" and "Lower Division Preparation" in the Electrical Engineering section is also requirements for the Computer Engineering students.

University Core (Total: 50 Credits)

Any student entering Florida International University as a first-time college student (Summer 2003 or after) or transferring in without an Associates in Arts (AA) degree from a Florida public institution (Fall 2003 or after) is required to fulfill the University Core Curriculum requirements.

SLS 1501	First Year Experience	1
(Communications)		
ENC 1101	Writing and Rhetoric I	3
ENC 1102	Writing and Rhetoric II	3
(Humanities)		
Humanities Group 1		3*
Humanities Group 2		3*
(Mathematics)		
MAC 2281	Calculus I for Engineering	4
MAC 2282	Calculus II for Engineering	4
MAC 2283	Calculus III for Engineering	4
MAP 2302	Differential Equations	3
(Social Sciences)		
Social Science Group 1		3*
Social Science Group 2		3*
(Natural Sciences)		
Natural Science Group 1		
CHM 1045	General Chemistry I	3
	Or	
BSC 2010	General Biology I	3
CHM 1045L	General Chemistry I Lab	1
	Or	
BSC 2010L	General Biology I Lab	1
PHY 2048	Physics with Calculus I	4
Natural Science Group 2		
PHY 2049	Physics with Calculus II	4
PHY 2049L	General Physics Lab II	1
(Arts)		
SPC 2608	Public Speaking	3

*Please check all approved courses from Academic Advising Center: **http://undergrad.fiu.edu/advising/curriculum.html**.

Computer Engineering students must take:

Engineering Breadth and Elective (Total: 8 Credits)

EGN 1002	Engineering Orientation	2
EIN 3235	Evaluation of Engineering Data I	3
EGN 3613	Engineering Economy	3

ECE Core (Total: 21 credits)

EEL 2880	Applied Software Techniques in Engineering	3
EEL 3110	Circuits Analysis	3
EEL 3110L	Circuits Lab	1
EEL 3120	Introduction to Linear Systems in Engineering	3
EEL 3135	Signals and Systems	3
EEL 3712	Logic Design I	3
EEL 3712L	Logic Design I Lab	1
EEL 4920	Senior Design I: Ethics, Communications and Constraints – *GL*	2**
EEL 4921C	Senior Design II: Project Implementation – *GL*	2**

**EEL 4920 and EEL 4921C are intended to be taken in last 2 semesters of undergraduate experience. Students are required to complete at least 100 credits, other ECE core courses, and Electrical Engineering Degree Core before EEL 4920 registration.

Computer Engineering Degree Core (Total: 15 credits)

EEL 3160	Computer Applications in Electrical Engineering	3
EEL 4709C	Computer Design	3
EEL 4730	Programming Embedded Systems	3
EEL 4740	Embedded Computing Systems	3
MAD 2104	Discrete Mathematics	3
	or	
COT 3100	Discrete Structures	3

Computer Engineering Electives (Total: 34 credits)
(Selected from Areas of Concentration offered by ECE Department)

Plan of Study

Computer Engineering Program Freshman to Senior

First Semester: (18)

CHM 1045	General Chemistry I	3
	Or	
BSC 2010	General Biology I	3
CHM 1045L	General Chemistry Lab I	1
	Or	
BSC 2010L	General Biology I Lab	1
ENC 1101	Writing and Rhetoric I	3
SLS 1501	First Year Experience	1
MAC 2281	Calculus I for Engineering	4
(Social Science Group 1)		
ECO 2013	Principles of Macroeconomics	3
	or	
AMH 2020	American History Introductory Survey Since 1877 – *GRW/GL*	3
	or	
PSY 2012	Introductory Psychology	3
	or	
ANT 2000	Introduction to Anthropology – *GL*	3
	or	
POS 2041	American Government	3
	or	
SYG 2010	Social Problems – *GL*	3
(Arts)		
SPC 2608	Public Speaking	3

Second Semester: (16)

EGN 1002	Engineering Orientation	2
ENC 1102	Writing and Rhetoric II	3
PHY 2048	Physics with Calculus I	4
MAC 2282	Calculus II for Engineering	4
(Social Science Group 2)		
EGN 1033	Technology, Humans, and Society – *GL*	3

Third Semester: (18)

PHY 2049	Physics with Calculus II	4
PHY 2049L	General Physics Lab II	1
MAC 2283	Calculus III for Engineering	4
EEL 2880	Applied Software Techniques in Engineering	3
MAD 2104	Discrete Mathematics	3
	or	
COT 3100	Discrete Structures	3
Humanities Group 1		3**

Fourth Semester: (17)

MAP 2302	Differential Equations	3
EEL 3110	Circuits Analysis	3
EEL 3110L	Circuits Lab	1
EEL 3120	Introduction to Linear Systems in Engineering	3
EIN 3235	Evaluation of Engineering Data I	3
EEL 3712	Logic Design I	3
EEL 3712L	Logic Design I Lab	1

Fifth Semester: (18)

EEL 3135	Signals and Systems	3
EEL 3160	Computer Applications in Electrical Engineering	3
EGN 3613	Engineering Economy	3
EEL 4709C	Computer Design	3
EEL 4730	Programming Embedded Systems	3
Humanities Group 2		3**

Sixth Semester: (13)

EEL 4740	Embedded Computing Systems	3
ECE Electives		10

Seventh Semester: (14)

EEL 4920	Senior Design I: Ethics, Communications, and Constraints – *GL*	2
ECE Electives		12

Eighth Semester: (14)

EEL 4921C	Senior Design II: Project Implementation – *GL*	2
ECE Electives		12

**At least 9 credit hours must be taken in one or more summers.

Any exception to the program require departments approval.

Combined BS/MS in Computer Engineering

This five-year program seamlessly combines a baccalaureate degree in Computer Engineering with the Master's in Computer Engineering. To be considered for admission to the combined bachelor's/master's degree program, students must have completed at least 75 but not more than 90 of the credits required for the bachelor's degree program at FIU, have earned at least a 3.2 GPA on both overall and upper division courses, and meet the admissions criteria for the graduate degree program to which they are applying. Students need only apply once to the combined degree program, but the application must be submitted to Graduate Admissions before the student starts the last 30 credits of the bachelor's degree program. A student admitted to the combined degree program will be considered to have undergraduate status until the student applies for graduation from their bachelor's degree program. Upon conferral of the bachelor's degree, the student will be granted graduate status and be eligible for graduate assistantships. Students enrolled in the program may count up to 9 hours of graduate level courses (i.e., 5000 level or higher) as credits for both the undergraduate and graduate degree programs. For each of the courses counted as credits for both BS and MS degree, a minimum grade of 'B' is required. Upon completion of the combined BS/MS program, students must have accumulated a minimum of 24 hours of credits at the graduate (5000+) level. Students enrolled in the program are encouraged to seek employment with a department faculty member to work as a student assistant on a sponsored research project.

Combined BS in Computer Engineering/MS in Engineering Management (BSCpE/MSEM)

This five-year program seamlessly combines a baccalaureate degree in Computer Engineering with the Master's in Engineering Management. To be considered for admission to the combined bachelor's/master's degree program, students must have completed at least 75 but not more than 90 of the credits required for the bachelor's degree program at FIU, have earned at least a 3.2 GPA on both overall and upper division courses, and meet the admissions criteria for the graduate degree program to which they are applying. Students need only apply once to the combined degree program, but the application must be submitted to Graduate Admissions before the student starts the last 30 credits of the bachelor's degree program. A student admitted to the combined degree program will be considered to have undergraduate status until the student applies for graduation from their bachelor's degree program. Upon conferral of the bachelor's degree, the student will be granted graduate status and be eligible for graduate assistantships. Students enrolled in the program may count up to 9 hours of graduate level courses (i.e., 5000 level or higher) as credits for both the undergraduate and graduate degree programs. For each of the courses counted as credits for both BS and MS degree, a minimum grade of 'B' is required. Upon completion of the combined BS/MS program, students must have accumulated a minimum of 24 hours of credits at the graduate (5000+) level. Students enrolled in the program are encouraged to seek employment with a department faculty member to work as a student assistant on a sponsored research project.

Areas of Concentration offered by ECE Department:

(Applied to all Department degree programs)

Electrical Engineering and Computer Engineering students must choose elective classes from area of concentration from the following list and take the corresponding courses as their Electives. Students may choose any class from any concentration as long as they fulfill the prerequisite(s) and corequisite(s). Students must choose at least two concentrations, at least nine credits from at each of these two concentrations.

Bio-Engineering:

EEE 3303	Electronics I	3
EEE 3303L	Electronics I Laboratory	1
EEL 4140	Filter Design	3
BME 4503C	Medical Instrumentation: Application and Design	4
EEE 4510	Introduction to Digital Signal Processing	3
EEE 4421C	Introduction to Nanofabrication	3

Communications:

EEL 3514	Communication Systems	3
EEL 3514L	Communication Systems Lab	1
EEL 4421	Introduction to RF Circuit Design	3
EEL 4461C	Antennas	3

EEE 4510	Introduction to Digital Signal Processing	3
EEL 4515	Advanced Communication Systems	3
EEL 4595C	Introduction to Wireless Digital Communications with USRP Applications	4

Autonomous Systems and Control:

EEL 3657	Control Systems	3
EEL 3664	Introduction to Autonomous Systems	3
EEL 4611	Control Systems II	3
EEL 4611L	Systems Laboratory	1
EEL 4658	Industrial Control Systems	3
EEL 4664	Sensors, Perception, and Robotic Manipulation	3

Integrated Nano-technology:

EEE 3303	Electronics I	3
EEE 3303L	Electronics I Laboratory	1
EEE 3396	Introduction to Solid State Devices	3
EEL 4304	Electronics II	3
EEL 4304L	Electronics II Lab	1
EEE 4314	Integrated Circuits and Systems	3
EEE 4314L	Integrated Circuits Laboratory	1
EEE 4421C	Introduction to Nanofabrication	3

Power/Energy:

EEL 4213	Power Systems I	3
EEL 4213L	Energy Conversion Lab	1
EEL 4214	Power Systems II	3
EEL 4215	Power Systems III	3
EEL 4241	Power Electronics	3
EEL 5285C	Sustainable and Renewable Energy Source and Their Utilization	3

Computer Architecture and Microprocessor Design:

EEE 4343	Introduction to Digital Electronics	3
EEL 4709C	Computer Design	3
EEL 4746	Microcomputers I	3
EEL 4746L	Microcomputers I Lab	1
EEL 4747	Reduced Instruction Set Computing Processors	3
EEL 4747L	Microcomputers II (RISC) Lab	1

Data System Software (CS Oriented):

MAD 2104	Discrete Mathematics	3
COP 2210	Programming I	4
COP 3337	Computer Programming II	3
COP 3530	Data Structures	3
COP 4338	Programming III	3
COP 4610	Operating Systems Principles	3
COP 4655	Mobile Application Development	3

Embedded System Software:

EEL 3160	Computer Applications in Electrical Engineering	3
EEL 4730	Programming Embedded Systems	3
EEL 4734	Embedded Operating Systems	3
EEL 4740	Embedded Computing Systems	3
EEL 4831	Embedded GUI Programming	3

Networking and Security:

TCN 4081	Telecommunication Network Security	3
TCN 4211	Telecommunication Networks	3
TCN 4212	Telecommunication Network Analysis and Design	3
TCN 4431	Principles of Network Management and Control Standards	3
EEL 4xxx	Data Computer Communications	3
EEL 4717	Introduction to Security of Internet of Things and Cyber-Physical Systems	3

Cyber Security:

EEL 4806	Ethical Hacking and Countermeasures	3
EEL 4802	Introduction to Digital Forensics Engineering	3
EEL 4804	Introduction Malware Reverse Engineering	3

Digital Forensics:

EEL 4806	Ethical Hacking and Countermeasures	3
EEL 4802	Introduction to Digital Forensics Engineering	3
EEE 4754	Introduction to Mobile Forensics	3
EEE 4750	Introduction to Image and Video Forensics	3
EEE 4752	Introduction to Network Forensics and Incident Response	3

Internet of Things:

TCN 4211	Telecommunication Networks	3
EEE 4510	Introduction to Digital Signal Processing	3
COP 4610	Operating Systems Principles	3
COP 4655	Mobile Application Development	3
EEE 4717	Introduction to Security of Internet of Things	3
EEL 4740	Embedded Computing Systems	3
TCN 4271	Ubiquitous and Embedded Sensor Network-Centric Telecommunications	3

Entrepreneurship:

EEL 4933	Engineering Entrepreneurship	3
EEL 4151	Engineering Business Plan Development	3
EEL 4351	Economic Decision-making in Engineering	3

Artificial Intelligence and Big Data

CNT 4147	IoT & Sensor Big Data Analytics	3
CNT 4151	IoT & Sensor Data Visualization	3
CNT 4155	IoT & Sensor Programming with Python	3
CNT 3153	IoT & Analytics with Cloud Services	3
CNT 4153	IoT Applied Machine Learning	3
CNT 4149	Sensor & IoT Data Analysis with Deep Learning	3
CNT 4145	Sensor IoT Analytics	3

Pre-Medical Concentration for B.S. in Electrical and Computer Engineering

The B.S. in Electrical or Computer Engineering Pre-Med Concentration is designed for motivated students who have dual interests in engineering and medical careers.

Student are required to complete all the courses in this concentration plus the core requirements for a B.S. degree in Electrical or Computer Engineering and other ECE engineering concentration credits.

Biology

BSC 2010	General Biology I	3
BSC 2010L	General Biology I Lab	1
BSC 2011	General Biology II	3
BSC 2011L	General Biology Lab II	1

General Chemistry

CHM 1046	General Chemistry II	3
CHM 1046L	General Chemistry Lab II	1

Organic Chemistry

CHM 2210	Organic Chemistry I	4
CHM 2210L	Organic Chemistry Lab I	1

CHM 2211	Organic Chemistry II	3
CHM 2211L	Organic Chemistry Lab II	1

Pre-Medical Student Must Take

BCH 3033	General Biochemistry	3
	or	
CHM 4304	Biological Chemistry I	3

Physics Concentration for B.S. in Electrical or Computer Engineering

The B.S. in Electrical or Computer Engineering Physics Concentration is designed for motivated students who have dual interests in engineering and physics.

PHY 1033	Physics Pathways	1
PHY 3106	Modern Physics	3
PHY 3802L	Intermediate Physics Lab	3
PHY 3513	Thermodynamics	3
PHY 4221	Introduction to Classical Mechanics	4
PHY 4323	Intermediate Electromagnetism I	3
PHY 4604	Quantum Mechanics I	3
PHY 4821L	Advanced Physics Lab	3

Within Arts, Sciences and Education, any undergraduate student who elects to do so may carry two majors and work to fulfill the requirements of both concurrently. Upon successfully completion of the requirements of two majors, the student will be awarded one degree and a notation denoting both majors will be entered on the transcript.

Student are required to complete all the courses in this concentration plus the core requirements for a B.S. degree in Electrical or Computer Engineering and other ECE engineering concentration credits.

Course Descriptions

Definition of Prefixes

CDA - Computer Design/Architecture; CTS-Computer Technology and Skills; EGN - Engineering: General; EEE - Engineering: Electrical and Electronics; EEL - Engineering: Electrical; TCN – Telecommunications/Networks

Courses that meet the University's Global Learning requirement are identified as GL.

CDA 3104 Introduction to Computer Design (3). Computer architecture and design, CPU, memory systems, caches, data, input/output devices, bus architecture, and computer control. Processor types, instruction set and assembly language programming. Prerequisite: EGN 2271

CDA 4400 Computer Hardware Analysis (3). The study of hardware functions of a basic computer. Topics include logic elements, arithmetic logic units, control units, memory devices, organization, and I/O devices (for non-EE majors only). Prerequisites: CDA 4101 and MAD 2104.

CNT 3122 Sensors for Internet of Things (3). This course introduces sensors and sensor design for IoT devices. Topics include history of IoT-enabled sensors, design and fabrication of smart sensors, theory and case studies of important smart sen. Prerequisite: EGN 2271

CNT 3142 Microcontrollers for Internet of Things (3). Overview of embedded systems and microcontrollers with a comprehensive in-depth look at the MSP43Q. Students will learn about this powerful mixed-signal, low power consumption microcontroller. Prerequisite: EGN 2271.

CNT 3143 IoT Analytics with Cloud Services (3). This course will focus on IoT Hub, IoT edge and the how the sensor data is collected, stored and processed on the cloud. Prerequisite: CNT 4145

CNT 3162 Wireless Communications for IoT (3). This course will cover source coding for data compression, channel coding for error correction, digital transmission and reception, wireless channels, and the narrow-band IoT communication system.

CNT 4145 Sensor IoT Analytics (3). This course examines the ingestion, storage, analysis and reporting of massive quantities of IoT data collected from distributed devices for processing using IoT cloud and edge computing. Prerequisite: EEL 4730

CNT 4147 IoT & Sensor Big Data Analytics (3). This course examines the ingestion, storage, analysis and reporting of massive quantities of IoT/sensor data collected from distributed data sources and processing with big data technologies. Prerequisite: EEL 4730

CNT 4149 Sensor & IoT Data Analysis with Deep Learning (3). This course will focus on the application of deep learning techniques and algorithms on structured and unstructured data received from sensors and IoT devices. Prerequisites: CNT 4145, CNT 4153

CNT 4151 IoT & Sensor Data Visualization (3). This course will focus on visualization framework and libraries to get insight from sensor and IoT Data. Student will learn about various visualization techniques available on premise and cloud. Prerequisite: CNT 4145

CNT 4153 IoT Applied Machine Learning (3). This course will focus on the application of traditional machine learning algorithms and popular framework to large sensor and IoT data sets. Prerequisite: CNT 4145

CNT 4155 IoT & Sensor Programming with Python (3). This course will introduce students to the Python programming language as it applies to its interaction to sensor and IoT devices. Prerequisite: EEL 2880

CNT 4165 Network Protocols for Internet of Things (3). This course introduces the underlying network protocols for IoT communications. Protocols at the medium access and network layers are discussed. Prerequisite: TCN 4211.

CNT 4185 Internet of Things Privacy (3). Introduces the privacy issues related to IoT technologies. Focuses on privacy preserving technologies regarding IoT user data, access to such data and privacy law around such personal data. Prerequisite: EEE 4717.

CNT 4188 Internet of Things Forensics (3). This course examines the existing Digital Forensics models and methodologies for their applicability within the IoT domain. Various tools and techniques will provide access within these devices. Prerequisite: EEL 4730.

CTS 1120 Fundamentals of Cybersecurity (3). Don't get hacked, be safe, and protect your digital footprint. Actions taken can have a lasting impact in your personal, financial and professional life. Recognize and prevent threats.

EGN 1002 Engineering Orientation (2). Introduction to aspects of the engineering profession. Computer tools and basic engineering science. Team-based engineering projects.

EEE 3303 Electronics I (3). Introductory course dealing with basic electronic devices such as diodes, BJTs, FETs, Op-Amps, and their circuit applications. Prerequisites: EEL 3110 and EEL 3110L. Corequisite: EEE 3303L.

EEE 3303L Electronics I Laboratory (1). Design, build and test electronic circuits that use diodes, BJTs, FETs and Op-Amps. Prerequisite: EEL 3110L. Corequisite: EEE 3303.

EEE 3394 Electrical Engineering Science I - Electronic Materials (3). The course covers fundamental science topics in electrical engineering. This course addresses material science and quantum physics concepts, thermal and electrical conductivity, and semiconductors. Prerequisite: PHY 2048 Corequisite: MAC 2312

EEE 3396 Introduction to Solid State Devices (3). Introduction to the physics of semiconductors; charge carrier statistics and charge transport in crystalline solids. Basic operations of solid state devices including p-n junction diode, the bipolar junction transistor and field effect transistors. Prerequisites: PHY 2049, EIN 3235. Corequisite: MAP 2302, EEL 3110.

EEE 4202C Medical Instrumentation Design (4). Concepts of transducers and instrumentation systems; origins of bio-potentials; electrical safety; therapeutic and prosthetic devices. Prerequisite: EEL 3110.

EEE 4304 Electronics II (3). Second course in electronics with emphasis on equivalent circuit representation and analysis of electronic analog circuits and systems, their frequency response and behavior under feedback control. Prerequisite: EEE 3303. Corequisite: EEL 4304L.

EEE 4304L Electronics II Laboratory (1). Design and measurement experiments of advanced electronics, including applications of integrated circuits. Prerequisite: EEE 3303L. Corequisite: EEL 4304.

EEE 4314 Integrated Circuits and Systems (3). Continuation of Electronics II with major emphasis on applications of integrated circuits and design of analog, control, communication and digital electronic systems. Prerequisite: EEL 4304. Corequisite: EEE 4314L.

EEE 4314L Integrated Circuits Laboratory (1). Laboratory experiments in integrated circuits. Includes design of filters, analog systems, A/D and D/A systems. Prerequisite: EEE 4304L. Corequisite: EEE 4314.

EEE 4343 Introduction to Digital Electronics (3). This course focuses on digital electronics. BJT as a switch, CMOS and other advanced logic-gate circuits, data converters, switched capacitor filters, semiconductor memories. Prerequisites: EEL 3712 and EEL 3712L.

EEE 4421C Introduction to Nanofabrication (3). This course will give the students an introduction to micro/nanofabrication tools and techniques. It includes lab sessions where the students design, fabricate and test selected mirco-scale devices. Prerequisites: EEE 3396 or permission of the instructor.

EEE 4510 Introduction to Digital Signal Processing (3). Modeling of DSP systems, Z transform, Algorithms for convolution, correlation functions, DFT, and FFT computation. Digital filters design, and engineering applications. Prerequisites: EEL 3135 or permission of the instructor.

EEE 4550 Introduction to Radar Systems (3). Radar equation, MTI and pulse Doppler radar, tracking radar, signal detection in noise, radar clutter, propagation of radar waves, radar antenna, radar transmitters, and radar receivers. Prerequisites: EEL 3514 or permission of the instructor.

EEE 4717 Introduction to Security of Internet of Things (3). In this class, the students will learn the introductory topics related to the security of Internet of Things (IoT) by gaining hands-on training on real IoT devices. Prerequisites: Programming coursework (e.g., COP 4XXX) or embedded systems, Intro to IoT, A.S.U or permission of the instructor.

EEE 4750 Introduction to Image and Video Forensics (3). The course covers the theoretical and practical aspects and principles of forensic image and video analysis and their application to digital forensics. Prerequisite: EEL 4802

EEE 4752 Introduction to Network Forensics and Incident Response (3). The course covers the theoretical and practical aspects of the foundations of computer network security, incident response tools and techniques. Prerequisite: EEL 4802.

EEE 4754 Introduction to Mobile Forensics (3). The course covers the theoretical and practical aspects of Mobile device forensics focusing on the identification, preservation, collection, analysis, and reporting techniques and tools. Prerequisite: EEL 4802

EEE 4775 Massive Storage and I/O for Big Data Computing (3). This course provides a broad introduction to the fundamentals of massive file storage systems and I/O architecture in big data computing and its enabling systems infrastructure. Prerequisites: EEL 4709C or permission of the instructor.

EEL 2880 Applied Software Techniques in Engineering (3). Engineering problem solving process, overview of a generalized computing system, software development, real-life engineering applications, computational implications.

EEL 3003 Electrical Engineering I (3). For non-EE majors. Basic principles of DC and AC circuit analysis, electronic devices and amplifiers, digital circuits, and power systems. Prerequisites: MAC 2312, PHY 2049. Corequisite: MAP 2302.

EEL 3110 Circuit Analysis (3). Introductory circuit analysis dealing with DC, AC, and transient electrical circuit analysis and the general excitation of circuits using the Laplace transform. Prerequisites: MAC 2312 or MAC 2282, PHY 2049, (EGN 1002 or EGS 1006). Corequisites: MAP 2302, EEL 3110L, and for EE or CpE Engineering students, EEL 2880.

EEL 3110L Circuits Lab (1). This lab introduces basic test equipment; oscilloscopes, multimeters, power supplies, function generator, etc., and uses this equipment in various experiments on resistors, capacitors, and inductors. Prerequisite: PHY 2049L. Corequisite: EEL 3110.

EEL 3112 Circuits II (3). Application of operational methods to the solution of electrical circuits. Effect of poles and zeroes on the response. Transfer function of electrical networks. Laplace and Fourier transforms; network parameters. Prerequisites: MAP 2302, EEL 3110, and EEL 3135.

EEL 3120 Introduction to Linear Systems in Engineering (3). Introductory course on linear systems, deals with the use of linear algebra to analyze resistive and dynamic electric circuits. Prerequisites: MAC 2312 or MAC 2282, PHY 2049, and EGN 1002.

EEL 3135 Signals and Systems (3). Use of Fourier analysis in electrical and electronic systems. Introduction to probability theory, linear algebra and complex variables. Prerequisites: MAP 2302, EEL 3120.

EEL 3160 Computer Applications in Electrical Engineering (3). Interactive techniques of computers to simulate and design electrical engineering circuits and systems. Prerequisites: EEL 2880 or permission of the instructor.

EEL 3472 Electrical Engineering Science II (3). The course covers fundamental science topics in electrical engineering. This course addresses electromagnetic field theory, including charge distributions, electromagnetic fields, transmission lines. Prerequisites: PHY 2048, Corequisites: MAP 2302

EEL 3514 Communication Systems (3). An introductory course in the field of analog communication systems. Transmitters, receivers, and different modulation and demodulation techniques are studied. A basic treatment of noise is also included. Prerequisites: EEL 3110, EEL 3135, EIN 3235.

EEL 3514L Communication Systems Lab (1). This is a web-accessible hardware laboratory on analog and digital communication systems. Students will perform all the experiments remotely through the internet. Lab reports will be submitted for every remote lab. Prerequisite: EEL 3135.

EEL 3657 Control Systems I (3). Analysis of linear time-invariant feedback control systems. System modeling, time and frequency-domain response, stability and accuracy. Analysis by use of Root- Locus, Bode plots, Nyquist diagram. Prerequisites: EEL 3110 and EEL 3135.

EEL 3664 Introduction to Autonomous Systems (3). This course provides a comprehensive introduction to the components of autonomous systems and expose the students to the concept of autonomous systems from the perspective of autonomous mobile robotic. Prerequisite: COP 2210

EEL 3712 Logic Design I (3). Boolean Algebra. Binary number systems. Combinational logic design using SSI, MSI and LSI. Sequential logic design. Corequisites: EEL 3712L or EEL 3110.

EEL 3712L Logic Design I Lab (1). Laboratory experiments, using gates, combinational networks, SSI, MSI, LSI. Sequential logic design. Corequisites: EEL 3110L and EEL 3712.

EEL 4006 Development of Dynamic Web Sites (3). Techniques for the development of dynamic web sites, which will generate individualized web pages, according to data supplied by the user or retrieved from data stores available to the web server. Prerequisites: EEL 2880 or permission of instructor.

EEL 4015 Electrical Design in Buildings I (3). Application of electrical codes and regulations. Design of loads, circuits, surge protectors, feeders, panels, and breakers. Prerequisite: EEL 3110.

EEL 4016 Electrical Design in Buildings II (3). Electrical design of industrial buildings, size and design of distribution rooms, switchboards, transformers, bus ducts, motor control centers, starters, voltage drop calculations, and lighting distribution. Prerequisite: EEL 4015.

EEL 4062 Engineering Business Plan Development (3). This course is designed to help students develop an effective implementation plan for a new business venture. Prerequisites: EEL 4933.

EEL 4063 Introduction to Business Decisions (3). Fundamental concepts of industrial financial decisions, financial planning and analysis tools, justification for industrial capital investments, and intermediate and long-term financing options. Prerequisite: EGN 3613.

EEL 4140 Filter Design (3). Approximation techniques. Active RC second order modules. Low pass filters, band-pass filters, high pass filters, notch filters are studied in detail. Sensitivity and high order filters. Design and laboratory implementation. Prerequisites: EEE 3303 and EEE 3303L.

EEL 4151 Engineering Business Plan Development (3). This course is designed to help students develop an effective implementation plan for a new business venture. Prerequisites: EEL 4933.

EEL 4213 Power Systems I (3). Introductory course to power systems components; transformers, induction machines, synchronous machines, direct current machines, and special machines. Prerequisite: EEL 4410. Corequisite: EEL 4213L.

EEL 4213L Energy Conversion Lab (1). Operation, testing, and applications of energy conversion machines including AC and DC motors and generators. Experiments on magnetic circuits and transformers. Prerequisite: EEL 4410. Corequisite: EEL 4213.

EEL 4214 Power Systems II (3). Transmission line models, the bus admittance matrix, load flow studies and solution techniques, economic dispatch with and without losses, computer applications related to power system operations. Prerequisite: EEL 4213.

EEL 4215 Power Systems III (3). Short circuit calculations, symmetrical and unsymmetrical fault analysis, transient stability and dynamic studies as well as power system control. Computer applications. Prerequisite: EEL 4213.

EEL 4241 Power Electronics (3). Power semiconductor devices, power supplies, DC choppers, AC voltage controller, power inverter, AC and DC drives. Prerequisites: EEE 4304 and EEL 4213.

EEL 4410 Introduction to Fields and Waves (3). Electric and magnetic fields. The relation between field and circuit theory: waves and wave polarization, reflection, refraction, and diffraction. Electromagnetic effects in high-speed digital systems. Prerequisites: MAC 2313 or MAC 2283 and EEL 3110.

EEL 4413L Wave-Propagation for Wireless Communication (3). Course introduces the foundational concepts for wireless propagation used in radio communication. Topics: wave-propagation, transmission, attenuation, reflection, waveguides, microstrip lines, fibers. Prerequisite: EEL 3135

EEL 4421 Introduction to RF Circuit Design (3). Basic EM theory, transmission lines, guided EM propagation, microwave circuits, impedance matching, passive components, and filters. Full-wave simulation software will be used. Prerequisites: EEL 3135 and EEL 3110.

EEL 4461C Antennas (3). Introduction to linear antennas, linear arrays and aperture antennas. Far field pattern calculation and measurement techniques. Prerequisites: EEL 3514 or permission of the instructor.

EEL 4515 Advanced Communication Systems (3). Advanced senior level course designed for those students who desire to enhance their engineering knowledge in communication systems. State-of-the-art techniques in FM, digital communication, phase locked loops, noise treatment, threshold improvement, etc. Prerequisites: EEL 3514, EEL 4304 or permission of the instructor.

EEL 4583 Basics of RF Systems (3). The course introduces the basic concepts of radio frequency propagation and wireless receiver design. Topics include radio frequency basics, noise fundamentals, linearity, cascade designs. Prerequisite: EEL 3514 or permission of the instructor.

EEL 4595C Introduction to Wireless Digital Communications with USRP Applications (4). The course covers the fundamentals of wireless digital communications from a DSP perspective. A lab component using USRP boards complements the course through hands-on experimentation with the concepts learned in the class. Prerequisites: EEL 3514, EEE 4510.

EEL 4611 Control Systems II (3). Design by Root-Locus, Bode plot, and Guillin-Truxal approach; characteristics of some typical industrial controllers and sensors. Computer simulation and other modern topics are included. Prerequisites: EEL 3657 or permission of the instructor.

EEL 4611L Systems Laboratory (1). Laboratory experiments in various systems. Includes position and velocity control systems, zeroth order, first order, and second order systems. Communication Systems. Corequisite: EEL 3657.

EEL 4658 Industrial Control Systems (3). To learn the characteristics and the selection of hardware used in industrial control systems design. Various measurement devices, transducers, actuators used in control systems will be studied. Prerequisite: EEL 3657.

EEL 4664 Sensors, Perception, and Robotic Manipulation (3). This course will explore the state-of-the-art technology supporting autonomous robots for service domain with high robustness to environmental change and optional wear, and minimal reliance on application. Prerequisite: EEL 3657 or EEL 3664

EEL 4709C Computer Design (3). Computer architecture, arithmetic units, RAM, DRAM, ROM, disk, CPU, memory systems, data, input/output devices. Distributed and centralized control. Prerequisites: EEL 3712, EEL 3712L, and EIN 3235.

EEL 4730 Programming Embedded Systems (3). Embedded Systems implementation using programming of synchronous state machines to capture behavior of time-oriented systems for running on microcontrollers. Prerequisite: EEL 2880.

EEL 4734 Embedded Operating Systems (3). This is an intermediate course to the use of Embedded Operating Systems (OS) as developing environment. Course also includes OS concepts and unique embedded application development. Prerequisite: EEL 2880.

EEL 4740 Embedded Computing Systems (3). Principles of embedded computing systems: architecture, hardware/software components, interfacing, hardware/software co-design, and communication issues. Prerequisite: EEL 4709C.

EEL 4740L Embedded Computing Systems Laboratory (1). Hands-on experience on Hardware/Software co-design of embedded computing systems: architecture, hardware/software components, interfacing, and communication issues. Prerequisite: EEL 4709C. Corequisite: EEL 4740.

EEL 4746 Microcomputers I (3). RAM, ROM, and CPU architecture. Instruction set. Timing sequences. Sub-routines. Interrupts. Peripherals. Applications. System design. Prerequisites: EEL 4709C or permission of the instructor. Corequisite: EEL 4746L.

EEL 4746L Microcomputers I Laboratory (1). Hands-on design experience with microcomputer systems and applications including buses, interfaces, and in-circuit emulation. Prerequisite: EEL 4709C. Corequisite: EEL 4746.

EEL 4747 Reduced Instruction Set Computing Processors (3). Design of interfacing schemes of RISC processors, and state-of-the-art hardware and software features of advanced RISC processor families. Prerequisite: EEL 4709C. Corequisite: EEL 4747L.

EEL 4747L Microcomputers II (RISC) Lab (1). Hands-on design experience with microprocessor systems and applications using Electronic Design Automation tools. Prerequisite: EEL 4709C. Corequisite: EEL 4747.

EEL 4793 Special Topics in Computer Engineering (1-3). Special topics in computer engineering not covered in other courses. Prerequisite: Permission of the instructor.

EEL 4802 Introduction to Digital Forensics Engineering (3). The fundamentals of the computer and network forensics and media exploitation techniques and introduces students to computer forensic software and hardware tools. Prerequisites: EEL 4806 or permission of the instructor.

EEL 4804 Introduction Malware Reverse Engineering (3). This course familiarize the student with the practice of performing reverse engineering on suspicious files and firmware present on various devices (computer to DVD player) and understand its impact. Prerequisites: EEL 4806 or permission of the instructor.

EEL 4806 Ethical Hacking and Countermeasures (3). This course will give individuals an exposure to latest hacking tools and techniques to understand the anatomy of computer attacks and teach them the countermeasures to protect their valuable data.

EEL 4808L Ethical Hacking and Countermeasures Lab (1) This class is designed to provide a student hands-on activates on security scenario applying different hacking techniques on various information systems. Prerequisite: EEL 4806

EEL 4831 Embedded GUI Programming (3). Graphical user interface (GUI) for embedded system included elements and style, events, component and object oriented user interface models, and graphical application programming issues. Prerequisites: EEL 4730 and EEL 4740.

EEL 4905 Individual Problems in Electrical Engineering (1-3). Selected problems or projects in the student's major field of electrical engineering. It can be extended to a maximum of six hours. Student works independently with a minor advisement from designated faculty member. Prerequisites: Senior level and permission of the instructor.

EEL 4920 Senior Design I: Ethics, Communications, and Constraints – *GL* (2). Professional ethics, oral communications, project feasibility study, proposal writing, system design methodology, human factors, intellectual property, liability and schedules. Prerequisites: ECE Department Core and Program Core.

EEL 4921C Senior Design II: Project Implementation – *GL* (2). Design of a complete EE or CpE system including use of design methodology, formulation, specifications, alternative solutions, feasibility, economic, reliability, safety ethics, and social impact. Prerequisite: EEL 4920.

EEL 4930 Special Topics in Electrical Engineering (1-3). Special topics in electrical engineering not covered in other courses. Prerequisite: Permission of the instructor.

EEL 4933 Engineering Entrepreneurship (3). Lectures, case studies, and seminars. Active student participation. Course material is augmented through seminars given by engineers, business people, and specialists, based on their own experiences.

EEL 4949 Co-Op Work Experience (1-3). Practical Co-op engineering work under approved industrial supervision.

EGN 2271 Introduction to Circuits and Electronic Hardware (3). Introduction to resistive circuits, laws governing circuits, electronic switches, logic gates, electronic memories, standard input and output ports.

TCN 2720 Introduction to Internet of Things (2). Introduces the fundamental concepts of IoT and motivates the study of IoT. Focuses on the Devices, Data Collection, Networking, Cloud Computing, Risks and Opportunities in IoT context.

TCN 4081 Telecommunication Network Security (3). Introduction and overview of security issues for engineering applications. Topics include design, implementation and management of security in networks. Prerequisites: TCN 4211 or permission of the instructor.

TCN 4211 Telecommunication Networks (3). Underlying engineering principles of computer and digital networks. Topics include physical, link and network layers; telecommunication and switching technologies. Prerequisites: EEL 2880 or COP 2210 or permission of the instructor.

TCN 4212 Telecommunication Network Analysis and Design (3). The principle and practice of telecommunication and computer networks with emphasis on telecommunication network protocols, datagram services, routing and QoS. Prerequisites: TCN 4211 or permission of instructor.

TCN 4431 Principles of Network Management and Control Standards (3). Problems, principles and technologies in network management. General challenges in management of modern data and telecommunication networks. Prerequisites: TCN 4211 or permission of the instructor.

TCN 4940 Senior Project (3). Beginning of the Major Design Experiment of the Professional ethics, oral communications, project feasibility study, report writing, system design methodology, human factors, intellectual property. Prerequisite: Senior Standing