Electrical and Computer Engineering

Jean Andrian, Associate Professor, and Interim Chair
Malek Adjouadi, Ware Professor
Kemal Akkaya, Professor
Elias Alwan, Assistant Professor
Wilmer Arellano, Teaching Professor
Ou Bai, Associate Professor and Graduate Program Director of the Ph.D. Program
Armando Barreto, Professor
Shekhar Bhansali, Lucent Technologies CALA Distinguished University Professor
Shubhendu Bhardwaj, Assistant Professor
Amaury Caballero, Teaching Professor
Mercedes Cabrero, Associate Professor
Gustavo Chaparro-Baquero, Assistant Teaching Professor
Hai Deng, Associate Professor and Graduate Program Director of the Master’s Programs
Yu Du, Assistant Teaching Professor
Bilal El-Zahab, Research Associate Professor
Luis Galarza, Assistant Teaching Professor, and Interim Associate Chairperson
Stavros Georgakopoulos, Professor
Mehdi Hatamian, Distinguished University Professor
Deidra Hodges, Associate Professor
Ahmed S. Ibrahim, Assistant Professor
Shaful Islam, Assistant Teaching Professor
Vivek Kamat, Assistant Teaching Professor
Grover Larkins, Professor
Arjuna Madanayake, Associate Professor
Osama Mohammed, Professor, and Associate Dean of Research
Mubarak Mujawar, Assistant Teaching Professor
Nezih Pala, Associate Professor
Imtiaz Parvez, Assistant Teaching Professor
Sumit Paudyal, Assistant Professor
Alexander Perez-Pons, Associate Professor
Vladimir Pozdin, Assistant Professor
Gang Quan, Professor
Mohammad Ashiqur Rahman, Assistant Professor
Md Tauhidur Rahman, Assistant Professor
Pulugurtha Markondeya Raj, Associate Professor
Nonnarit O-Larnnithipong, Assistant Teaching Professor
Gustavo Roig, Professor
Mario Sanchez, Associate Director for Undergraduate Advising
Arif Sarwat, Professor
Mst Shamim Ara Shawkat – Assistant Professor
Atoussa Tehrani, Assistant Teaching Professor
Asahi Tomitaka, Assistant Teaching Professor
Selcuk Ulugac, Associate Professor
Frank Urban, Associate Professor
Yuri Vlasov, Associate Teaching Professor
John Volakis, Dean, College of Engineering and Computing & Professor
Herman Watson, Assistant Teaching Professor, and Undergraduate Program Director
Subbarao Wunnava, Professor Emeritus Distinguished Professor, and Director of the International Development Program

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

<table>
<thead>
<tr>
<th>FIU Course(s)</th>
<th>Equivalent Course(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHM 1045, CHM 1045L</td>
<td>CHMX045/X045L or CHMX045C or CHSX440/X440L</td>
</tr>
<tr>
<td>MAC 2281</td>
<td>MACX311 or MACX281</td>
</tr>
<tr>
<td>MAC 2282</td>
<td>MACX312 or MACX282</td>
</tr>
<tr>
<td>MAC 2283</td>
<td>MACX313 or MACX283</td>
</tr>
<tr>
<td>MAP 2302</td>
<td>MAPX302 or MAPX305</td>
</tr>
<tr>
<td>PHY 2048</td>
<td>PHYX048/X048L or PHYX048C or PHYX041/PHYX048L</td>
</tr>
<tr>
<td>PHY 2049, PHY 2049L</td>
<td>PHYX049/PHYX049L or PHYX049C or PHYX042/PHYX049L or PHYX044/PHYX049L</td>
</tr>
</tbody>
</table>

¹or CHSX440 if 4 credit hours with included laboratory
²PHY2048L 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.
Please visit [https://cpm.fiu.org](https://cpm.fiu.org) for a current list of state-approved common prerequisites.

**Degree Program Hours: 128**

### 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 C Programming for Embedded Systems

### Academic Progression Standards

Students who are unsuccessful in passing common prerequisites after two attempts will be advised to change their major into an area where they can be successful. Drops after the add/drop period, which result in a DR grade, are considered an attempt in the course and count as an unsuccessful enrollment.

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 a 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 bioengineering, communication systems, control systems, energy, and power. Students, with the counsel and guidance of faculty advisers, design their electives program around their own special interests and career objectives. Students are allowed to take ECE electives when they complete the University core and start taking degree core. Students must choose elective classes from an 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 are 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.

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLS 1501</td>
<td>First Year Experience (Communications)</td>
<td>1</td>
</tr>
<tr>
<td>ENC 1101</td>
<td>Writing and Rhetoric I</td>
<td>3</td>
</tr>
<tr>
<td>ENC 1102</td>
<td>Writing and Rhetoric II</td>
<td>3</td>
</tr>
<tr>
<td>Humanities Group 1</td>
<td></td>
<td>3*</td>
</tr>
<tr>
<td>Humanities Group 2</td>
<td></td>
<td>3*</td>
</tr>
<tr>
<td>Mac 2281</td>
<td>Calculus I for Engineering</td>
<td>4</td>
</tr>
<tr>
<td>Mac 2282</td>
<td>Calculus II for Engineering</td>
<td>4</td>
</tr>
<tr>
<td>Mac 2283</td>
<td>Calculus III for Engineering</td>
<td>4</td>
</tr>
<tr>
<td>MAP 2302</td>
<td>Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>Social Science Group 1</td>
<td></td>
<td>3*</td>
</tr>
<tr>
<td>Social Science Group 2</td>
<td></td>
<td>3*</td>
</tr>
<tr>
<td>Natural Science Group 1</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CHM 1045</td>
<td>General Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td>Or</td>
<td>BSC 2010 General Biology</td>
<td>3</td>
</tr>
<tr>
<td>CHM 1045L</td>
<td>General Chemistry I Lab</td>
<td>1</td>
</tr>
<tr>
<td>Or</td>
<td>BSC 2010L General Biology Lab</td>
<td>1</td>
</tr>
<tr>
<td>PHY 2048</td>
<td>Physics with Calculus I</td>
<td>4</td>
</tr>
</tbody>
</table>
Natural Science Group 2
PHY 2049    Physics with Calculus II          4
PHY 2049L   General Physics Lab II          1
(Art)
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 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
ESI 3215    Evaluation of Engineering Data I 3
EGN 3613    Engineering Economy            3

ECE Core (Total: 21 credits)
EEL 2880    C Programming for Embedded Systems 3
EEL 3110C   Circuit Analysis and Lab        4
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 the last 2 semesters of the 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 3303C   Electronics I & Lab             4
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

Second Semester: (16)
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
(Art)
SPC 2608    Public Speaking                 3

Third Semester: (15)
EEL 3712    Logic Design I                  3
EEL 3712L   Logic Design I Lab              1
MAC 2283    Calculus III for Engineering     4
EEL 2880    C Programming for Embedded Systems 3
Humans Group 1 3**

Fourth Semester: (17)
MAP 2302    Differential Equations          3
EEL 3110C   Circuit Analysis and Lab        4
EEL 3120    Introduction to Linear Systems in Engineering 3
ESI 3215    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 3303C   Electronics I & Lab             4
EGN 3613    Engineering Economy            3
EEL 4410    Introduction to Fields and Waves 3
Humans 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 a general understanding of at least one field where IoT plays a central role;
c) Demonstrate the ability to utilize and understand contemporary IoT applications and protocols common-place to the industry;
d) Demonstrate the 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.

Common Prerequisite Courses and Equivalencies

**FIU Course(s)** | **Equivalent Course(s)**
--- | ---
MAC 1105 | MACX105
MAC 1114 | MACX114 or MACX147
PHY 2053, PHY 2048L | PHYX053/PHYX048L
 | PHYX053/PHYX053L
 | PHYX004/X004L
 | PHYX053C
PHY 2054, PHY 2049L | PHYX054/PHYX049L
 | PHYX054/PHYX054L
 | PHYX005/X005L
 | PHYX054C

**Academic Progression Standards**

Students who are unsuccessful in passing common prerequisites after two attempts will be advised to change their major into an area where they can be successful. Drops after the add/drop period, which result in a DR grade, are considered an attempt in the course and count as an unsuccessful enrollment.

**Degree Program Hours:** 120

**Required Courses from the FIU Core (the rest can be any from the list)**

<table>
<thead>
<tr>
<th>Total: 50 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAC 1105</td>
</tr>
<tr>
<td>CGS 2518</td>
</tr>
<tr>
<td>COP 2250</td>
</tr>
<tr>
<td>CHM 1045</td>
</tr>
<tr>
<td>PHY 2053</td>
</tr>
<tr>
<td>EGS 1041</td>
</tr>
<tr>
<td>IDS 3315</td>
</tr>
</tbody>
</table>

**IoT Core Courses (40 credits):**

<table>
<thead>
<tr>
<th>TCP 2720</th>
<th>Introduction to IoT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTS 1120</td>
<td>Fundamentals of Cybersecurity</td>
</tr>
<tr>
<td>EGN 2271</td>
<td>Introduction to Circuits &amp; Electronic Hardware</td>
</tr>
<tr>
<td>CDA 3104</td>
<td>Introduction to Computer Design</td>
</tr>
<tr>
<td>CNT 3142</td>
<td>Microcontrollers for IoT Devices</td>
</tr>
<tr>
<td>CNT 3162</td>
<td>Wireless Communications for IoT</td>
</tr>
<tr>
<td>EEL 2880</td>
<td>C Programming for Embedded Systems</td>
</tr>
<tr>
<td>EEL 4730</td>
<td>Programming Embedded Systems</td>
</tr>
<tr>
<td>EEL 4734</td>
<td>Embedded Operating Systems</td>
</tr>
<tr>
<td>TCN 4211</td>
<td>Telecommunications Networks</td>
</tr>
<tr>
<td>EEE 4717</td>
<td>Introduction to IoT Security</td>
</tr>
<tr>
<td>CGS 3767</td>
<td>Computer Operating Systems</td>
</tr>
<tr>
<td>CEN 3721</td>
<td>Introduction to Human-Computer Interaction</td>
</tr>
</tbody>
</table>

**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 |
| MAC 1105 | College Algebra | 3 |
| Social Science from Group 1 | | 3 |
| CGS 2518 | Data Analysis | 3 |

**Second Semester:** (18)

| ENC 1102 | Writing and Rhetoric II | 3 |
| EGS 1041 | Technology, Human and Society – GL | 3 |
| IDS 3315 | Gaining Global Perspectives | 3 |
| Social Science from Group 2 | | 3 |
| CHM 1045 | General Chemistry I | 3 |
| Humanities from Group 2 | | 3 |

**Third Semester:** (16)

| PHY 2053 | Physics without Calculus | 4 |
| Arts from approved list | | 3 |
| COP 2250 | Programming in Java | 3 |
| Humanities from Group 2 | | 3 |

**Fourth Semester:** (12)

| EEL 2880 | C Programming for Embedded Systems | 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 |
Combined BS/MS in Electrical Engineering Degree Pathway

This five-year pathway 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 pathway, students must have completed at least 75 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; the application is submitted to Graduate Admissions prior to the student starting the last 30 credits of the bachelor's degree program. A student admitted to the combined degree pathway 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 pathway 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 pathway, students must have accumulated a minimum of 24 hours of credits at the graduate (5000+) level. Students enrolled in the pathway 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 Engineering Management (BSEE/MSEM) Degree Pathway

Students, who are pursuing a Bachelor of Science degree in Electrical Engineering and have completed at least 75 credits with a minimum of a 3.2 overall GPA on both overall and upper division courses may, upon recommendation from three ECE faculty members, apply to enroll in the combined BSEE/MSEM pathway. Students need only apply once to the combined degree pathway; the application is submitted to Graduate Admissions typically before the student starts the last 30 credits of the bachelor's degree program. In addition to the admission requirements of the MSEM program, students must meet all the admission requirements of the University Graduate School.

Students enrolled in the combined degree pathway could count up to two Electrical Engineering graduate courses for both the BSEE electives and the MSEM electives, for a total of 6 credit hours. A minimum grade of "B" is required for graduate courses counted as credits for both BSEE and MSEM degrees. Only 5000-level or higher courses may be applied toward both degrees. Only graduate courses with formal lecture can be counted for both degrees.

The combined BSEE/MSEM pathway has been designed to be a continuous enrollment program. Students will receive their BSEE degree upon completion of all the requirements of the BSEE program. A student admitted to the combined degree pathway will be considered to have undergraduate status until the student applies for graduation from his/her 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 may elect to permanently leave the combined pathway and earn only the BSEE degree. Students who elect to leave the combined pathway and earn only the BS degree will have the same access requirements to regular graduate programs as any other student but will not be
able to use the 6 credit hours in both the BSEE and MSEM degrees.

Students interested in the combined pathway should consult with their undergraduate advisor on their eligibility to the pathway. The student should also meet the MSEM Program Director to learn about the graduate program and available tracks/courses before completing the application form and submitting it to their undergraduate advisor. Final decision for admission to the MSEM program will be made by the University Graduate School upon recommendation by the Engineering Management program director. Applicants will be notified by the Engineering Management Program and the University Graduate School of the decision on their applications.

Combined BS in Electrical Engineering/MS in Telecommunications and Networking Pathway

Students who pursue a BS degree and are in their junior year, with at least a 3.3 GPA on both overall and upper division courses may apply to enroll in the combined BS/MS pathway. To be considered for admission to the combined bachelor's/master's degree pathway, students must have completed at least 75 credits in the bachelor's degree program at FIU and meet the admissions criteria for the graduate degree program to which they are applying. Students need only apply once to the combined degree pathway; the application is submitted to Graduate Admissions typically before the student starts the last 30 credits of the bachelor's degree program. A student admitted to the combined degree pathway 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. Only 5000-level or higher courses, and no more than the number of credits specified by the program catalog, may be applied toward both degrees. In addition to the admission requirements of the combined BS/MS pathway, students must meet all the of the University’s graduate admissions requirements.

Students enrolled in the pathway may count up to six credit hours of Telecommunications and Networking graduate courses as credits for both the BS and MS degrees. The combined BS/MS pathway has been designed to be a continuous enrollment pathway. During this combined BS/MS pathway, upon completion of all the requirements of the undergraduate program, students will receive their BS degrees. Students in this pathway have one year to complete the master's degree after receipt of the bachelor's degree. Students who fail to meet this one year post B.S. requirement or who elect to leave the combined pathway at any time and earn only the BS degree will have the same access requirements to regular graduate programs as any other student, but will not be able to use the six credits in both the bachelor's and master's degrees.

For each of the graduate courses counted as credits for both BS and MS degree, a minimum grade of "B" is required. Students enrolled in the pathway may count up to six credit hours of Telecommunications and Networking graduate courses toward the elective BSEE requirements as well as toward the MS in Telecommunications and Networking degree. Only graduate courses with formal lectures can be counted for both degrees. The students are responsible for confirming the eligibility of each course with the undergraduate advisor.

Students interested in the pathway should consult with the undergraduate advisor on their eligibility to the pathway. The students should also meet the graduate advisor to learn about the graduate program and available courses before completing the application form and submitting it to the undergraduate advisor. Applicants will be notified by the department and the University Graduate School of the decision on their applications.

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

<table>
<thead>
<tr>
<th>FIU Course(s)</th>
<th>Equivalent Course(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHM 1045, CHM 1045L</td>
<td>CHMX045/X045L or CHMX045C or CHSX440</td>
</tr>
<tr>
<td>MAC 2281</td>
<td>MACX311 or X281, or X282, X283</td>
</tr>
<tr>
<td>MAC 2282</td>
<td>MACX312 or X281, or X282, or X283</td>
</tr>
<tr>
<td>MAC 2283</td>
<td>MACX313, or X281, or X282, or X283</td>
</tr>
<tr>
<td>MAP 2302</td>
<td>MAPX302</td>
</tr>
<tr>
<td>PHYX048/X048L</td>
<td></td>
</tr>
</tbody>
</table>
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.

Please visit https://cpm.flvc.org for a current list of state-approved common prerequisites.

Degree Program Hours: 128

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  C Programming for Embedded Systems
MAD 2104  Discrete Mathematics¹
or
COT 3100  Discrete Structures

**PHY 2048L is not a requirement for this program.
¹Or equivalent fulfilling Discrete Mathematics requirements

Academic Progression Standards

Students who are unsuccessful in passing common prerequisites after two attempts will be advised to change their major into an area where they can be successful. Drops after the add/drop period, which result in a DR grade, are considered an attempt in the course and count as an unsuccessful enrollment.

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 bioengineering, communication systems, control systems, energy and power. Students, with the counsel and guidance of faculty advisers, design their electives program around their own special interests and career objectives. Students are allowed to take ECE electives when they complete the University core and start taking degree core. Students must choose elective classes from an 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)” and “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
CHM 1045L General Chemistry I Lab 1

Or

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

Or

PHYS 2048  Physics with Calculus I 4
Natural Science Group 2
PHYS 2049  Physics with Calculus II 4
PHYS 2049L General Physics Lab II 1
(Other)
SPC 2608  Public Speaking 3

*Please check all approved courses from Academic Advising Center:

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 4920 and EEL 4921C are intended to be taken in the last 2 semesters of the 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)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEL 3370</td>
<td>Computer Applications in Electrical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4709C</td>
<td>Computer Design</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4730</td>
<td>Programming Embedded Systems</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4740</td>
<td>Embedded Computing Systems</td>
<td>3</td>
</tr>
<tr>
<td>MAD 2104</td>
<td>Discrete Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>or</td>
<td>Discrete Structures</td>
<td>3</td>
</tr>
<tr>
<td>COT 3100</td>
<td>Discrete Structures</td>
<td>3</td>
</tr>
</tbody>
</table>

### Computer Engineering Electives (Total: 34 credits)

(Selected from Areas of Concentration offered by ECE Department)

### Plan of Study

#### Computer Engineering Program Freshman to Senior

<table>
<thead>
<tr>
<th>Semester</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Semester: (18)</strong></td>
<td><strong>Second Semester: (16)</strong></td>
</tr>
<tr>
<td>CHM 1045</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>BSC 2010</td>
<td>General Biology I</td>
</tr>
<tr>
<td>CHM 1045L</td>
<td>General Chemistry Lab I</td>
</tr>
<tr>
<td>BSC 2010L</td>
<td>General Biology Lab I</td>
</tr>
<tr>
<td>ENC 1101</td>
<td>Writing and Rhetoric I</td>
</tr>
<tr>
<td>SLS 1501</td>
<td>First Year Experience</td>
</tr>
<tr>
<td>MAC 2281</td>
<td>Calculus I for Engineering</td>
</tr>
<tr>
<td>(Social Science Group 1)</td>
<td>(Arts)</td>
</tr>
<tr>
<td>ECO 2013</td>
<td>Principles of Macroeconomics</td>
</tr>
<tr>
<td>AMH 2020</td>
<td>American History Introductory Survey Since 1877 – GRW/GL</td>
</tr>
<tr>
<td>PSY 2012</td>
<td>Introductory Psychology</td>
</tr>
<tr>
<td>ANT 2000</td>
<td>Introduction to Anthropology – GL</td>
</tr>
<tr>
<td>POS 2041</td>
<td>American Government</td>
</tr>
<tr>
<td>SYG 2010</td>
<td>Social Problems – GL</td>
</tr>
<tr>
<td>SPC 2608</td>
<td>Public Speaking</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGN 1002</td>
<td>Engineering Orientation</td>
<td>2</td>
</tr>
<tr>
<td>ENC 1102</td>
<td>Writing and Rhetoric II</td>
<td>3</td>
</tr>
<tr>
<td>PHY 2048</td>
<td>Physics with Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>MAC 2282</td>
<td>Calculus II for Engineering</td>
<td>4</td>
</tr>
<tr>
<td>(Social Science Group 2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGS 1041</td>
<td>Technology, Humans, and Society – GL</td>
<td>3</td>
</tr>
</tbody>
</table>

#### Third Semester: (18)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 2049</td>
<td>Physics with Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>PHY 2049L</td>
<td>General Physics Lab II</td>
<td>1</td>
</tr>
<tr>
<td>MAC 2283</td>
<td>Calculus III for Engineering</td>
<td>4</td>
</tr>
<tr>
<td>EEL 2880</td>
<td>C Programming for Embedded Systems</td>
<td>3</td>
</tr>
<tr>
<td>MAD 2104</td>
<td>Discrete Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>or</td>
<td>Discrete Structures</td>
<td>3</td>
</tr>
<tr>
<td>COT 3100</td>
<td>Humanities Group 1</td>
<td>3**</td>
</tr>
</tbody>
</table>

#### Fourth Semester: (17)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAP 2302</td>
<td>Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>EEL 3110C</td>
<td>Circuit Analysis and Lab</td>
<td>4</td>
</tr>
<tr>
<td>EEL 3120</td>
<td>Introduction to Linear Systems in Engineering</td>
<td>3</td>
</tr>
<tr>
<td>EIN 3235</td>
<td>Evaluation of Engineering Data I</td>
<td>3</td>
</tr>
<tr>
<td>EEL 3712</td>
<td>Logic Design I</td>
<td>3</td>
</tr>
<tr>
<td>EEL 3712L</td>
<td>Logic Design I Lab</td>
<td>1</td>
</tr>
</tbody>
</table>

#### Fifth Semester: (18)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEL 3135</td>
<td>Signals and Systems</td>
<td>3</td>
</tr>
<tr>
<td>EEL 3370</td>
<td>C++ Programming for Embedded Systems</td>
<td>3</td>
</tr>
<tr>
<td>EGN 3613</td>
<td>Engineering Economy</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4709C</td>
<td>Computer Design</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4730</td>
<td>Programming Embedded Systems</td>
<td>3</td>
</tr>
<tr>
<td>Humanities Group 2</td>
<td>3**</td>
<td></td>
</tr>
</tbody>
</table>

#### Sixth Semester: (13)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEL 4740</td>
<td>Embedded Computing Systems</td>
<td>3</td>
</tr>
<tr>
<td>ECE Electives</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

#### Seventh Semester: (14)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEL 4920</td>
<td>Senior Design I: Ethics, Communications, and Constraints – GL</td>
<td>2</td>
</tr>
<tr>
<td>ECE Electives</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

#### Eighth Semester: (14)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEL 4921C</td>
<td>Senior Design II: Project Implementation – GL</td>
<td>2</td>
</tr>
<tr>
<td>ECE Electives</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

**At least 9 credit hours must be taken in one or more summers. Any exception to the program requires the department's approval.**

### Combined BS/MS in Computer Engineering Degree Pathway

This five-year pathway 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 pathway, students must have completed at least 75 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 pathway; the application is submitted to Graduate Admissions typically before the student starts the last 30 credits of the bachelor's degree program. A student admitted to the combined degree pathway 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 pathway 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 pathway, students must have accumulated a minimum of 24 hours of credits at the graduate (5000+) level. Students enrolled in the pathway 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) Degree Pathway**

Students, who are pursuing a Bachelor of Science degree in Computer Engineering and have completed at least 75 credits with a minimum of a 3.2 overall GPA on both lower and upper division courses may, upon recommendation from three ECE faculty members, apply to enroll in the combined BSCpE/MSEM pathway. Students need only apply once to the combined degree pathway; the application is submitted to Graduate Admissions typically before the student starts the last 30 credits of the bachelor's degree program. In addition to the admission requirements of the MSEM program, students must meet all the admission requirements of the University Graduate School.

Students enrolled in the combined degree pathway could count up to two Electrical Engineering graduate courses for both the BSCpE electives and the MSEM electives, for a total saving of 6 credit hours. A minimum grade of "B" is required graduate courses counted as credits for both BSCpE and MSEM degrees. Only 5000-level or higher courses may be applied toward both degrees. Only graduate courses with formal lecture can be counted for both degrees.

The combined BSCpE/MSEM pathway has been designed to be a continuous pathway enrollment. Students will receive their BSCpE degree upon completion of all the requirements of the BSCpE program. A student admitted to the combined degree pathway will be considered to have undergraduate status until the student applies for graduation from his/her bachelor's degree program. Upon conferral of the bachelor's degree, the student will be granted graduate status and be eligible for graduate assistanships.

Students may elect to permanently leave the combined pathway and earn only the BSCpE degree. Students who elect to leave the combined pathway and earn only the BS degree will have the same access requirements to regular graduate programs as any other student but will not be able to use the 6 credit hours in both the BSCpE and MSEM degrees.

Students interested in the combined pathway should consult with their undergraduate advisor on their eligibility to the pathway. The student should also meet the MSEM Program Director to learn about the graduate program and available tracks/courses before completing the application form and submitting it to their undergraduate advisor. Final decision for admission to the MSEM program will be made by the University Graduate School upon recommendation by the Engineering Management program director. Applicants will be notified by the Engineering Management Program and the University Graduate School of the decision on their applications.

**Areas of Concentration offered by the ECE Department:**

(Applied to all Department degree programs)

Electrical Engineering and Computer Engineering students must choose elective classes from an 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 each of these two concentrations.

**Bioengineering:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEE 3303C</td>
<td>Electronics I &amp; Lab</td>
<td>4</td>
</tr>
<tr>
<td>EEL 4140</td>
<td>Filter Design</td>
<td>3</td>
</tr>
<tr>
<td>BME 4503C</td>
<td>Medical Instrumentation: Application and Design</td>
<td>4</td>
</tr>
<tr>
<td>EEE 4510</td>
<td>Introduction to Digital Signal Processing</td>
<td>3</td>
</tr>
<tr>
<td>EEE 4421C</td>
<td>Introduction to Nanofabrication</td>
<td>3</td>
</tr>
</tbody>
</table>

**Communications:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEL 3514</td>
<td>Communication Systems</td>
<td>3</td>
</tr>
<tr>
<td>EEL 3514L</td>
<td>Communication Systems Lab</td>
<td>1</td>
</tr>
<tr>
<td>EEL 4421</td>
<td>Introduction to RF Circuit Design</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4461C</td>
<td>Antennas</td>
<td>3</td>
</tr>
<tr>
<td>EEE 4510</td>
<td>Introduction to Digital Signal Processing</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4515</td>
<td>Advanced Communication Systems</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4595C</td>
<td>Introduction to Wireless Digital Communications with USRP</td>
<td>4</td>
</tr>
</tbody>
</table>

**Autonomous Systems, Control and Robotics:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEL 3657</td>
<td>Control Systems I</td>
<td>3</td>
</tr>
<tr>
<td>EEL 3664</td>
<td>Introduction to Autonomous Systems</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4611</td>
<td>Control Systems II</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4611L</td>
<td>Systems Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>EEL 4658</td>
<td>Industrial Control Systems</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4664</td>
<td>Sensors, Perception, and Robotic Manipulation</td>
<td>3</td>
</tr>
</tbody>
</table>

**Integrated Nano-technology:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEE 3303C</td>
<td>Electronics I &amp; Lab</td>
<td>4</td>
</tr>
<tr>
<td>EEE 3396</td>
<td>Introduction to Solid State Devices</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4304C</td>
<td>Electronics II and Lab</td>
<td>4</td>
</tr>
<tr>
<td>EEE 4314</td>
<td>Integrated Circuits and Systems</td>
<td>3</td>
</tr>
<tr>
<td>EEE 4314L</td>
<td>Integrated Circuits Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>EEE 4421C</td>
<td>Introduction to Nanofabrication</td>
<td>3</td>
</tr>
</tbody>
</table>

**Power/Energy:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEL 4213</td>
<td>Power Systems I</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4213L</td>
<td>Energy Conversion Lab</td>
<td>1</td>
</tr>
<tr>
<td>EEL 4214</td>
<td>Power Systems II</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4215</td>
<td>Power Systems III</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4241</td>
<td>Power Electronics</td>
<td>3</td>
</tr>
<tr>
<td>EEL 5285C</td>
<td>Sustainable and Renewable Energy Source and Their Utilization</td>
<td>3</td>
</tr>
</tbody>
</table>

**Computer Architecture and Microprocessor Design:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEE 4343</td>
<td>Introduction to Digital Electronics</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4709C</td>
<td>Computer Design</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4746</td>
<td>Microcomputers I</td>
<td>3</td>
</tr>
<tr>
<td>EEL 4746L</td>
<td>Microcomputers I Lab</td>
<td>1</td>
</tr>
</tbody>
</table>
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 Systems Programming 3
COP 4610 Operating Systems Principles 3
COP 4655 Mobile Application Development 3

Embedded System Software:
EEL 3370 C++ Programming for Embedded Systems 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 4xx Data Computer Communications 3
EEL 4717 Introduction to Security of Internet of Things and Cyber-Physical Systems 3

Cybersecurity:
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
EEL 4510 Introduction to Digital Signal Processing 3
COP 4610 Operating Systems Principles 3
COP 4655 Mobile Application Development 3
EEL 4717 Introduction to IoT Security 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 4171 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

Cyber Defense:
TCN 4211 Telecommunication Networks 3
TCN 4081 Telecommunication Network Security 3
EEL 4802 Introduction to Digital Forensics 3
EEL 4804 Introduction to Malware Reverse Engineering 3
EEL 4806 Ethical Hacking and Countermeasures 3
EEL 4730 Programming Embedded Systems 3
EEL 4734 Embedded Operating Systems 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 I 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 successful 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.

Students 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 3007 Introduction to Networking and Cybersecurity for Engineers (3).**
Introduction to fundamentals of computer networks and cybersecurity for Engineering students. Main principles of networking protocols and cybersecurity aspects. Design issues, network appliances, security techniques. Prerequisite: EEL 2880

**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 sensors. 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. Prerequisites: EEL2880 or COP 2210 or COP 2250 or equivalent or instructor permission.

**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. Prerequisites: EEL2880 or COP 2210 or COP 2250 or equivalent or instructor permission

**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: EEL2880 or COP 2210 or COP 2250 or equivalent or instructor permission.

**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. Prerequisites: EEL2880 or COP 2210 or COP 2250 or equivalent or instructor permission.

**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. Prerequisites: EEL2880 or COP 2210 or COP 2250 or equivalent or instructor permission.

**CNT 4155 IoT & Sensor Programming with Python (3).**
This course will introduce students to the Python programming language as it applies to its interaction with sensor and IoT devices. Prerequisites: EEL2880 or COP 2210 or COP 2250 or equivalent or instructor permission.

**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 3303C Electronics I & Lab (4).**
Introductory course dealing with basic electronic devices such as diodes, BJTs, FETs, Op-Amps, and their circuit applications. Hands on Lab with weekly activities are included. Prerequisite: EEL 3110C
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 3110C.

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

EEE 4262 IoT Design of Embedded Sensing, Network, and Signal Processing (3). This course will provide hands-on experience on the software design and implementation of a typical IoT system/device on a customer-made IoT education platform of CyberSens-EDU. Prerequisites: COP 2210 or permission from instructor (Basic programming experience is required)

EEE 4304C Electronics II & Lab (4). 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. Hands on Lab with weekly activities are included. Prerequisite: EEE 3303C

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: EEE 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.. 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 micro-scale devices. Prerequisites: EEE 3396 or permission of the instructor.

EEE 4423 Introduction to Quantum Computers (3). This course provides the foundations of quantum computers and quantum information systems with an emphasis on physical implementations. Prerequisites: EEL 3120, EEL 3135.

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 IoT Security (3). In this class, the students will learn the introductory topics related to the security of IoT by gaining hands-on experience on real IoT devices. This class involves significant programming. Prerequisites: EEL 2880 or COP 2210 or COP 2250 or equivalent

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: Senior Standing.

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 4761 Embedded Systems Design and Implementation for IoT Applications (3). This course will provide hands-on experience on the hardware design and implementation of a typical IoT system/device using Eagle/Autodesk PCB design software. Prerequisites: EEL 3110C or permission from instructor (No hardware design experience is required)

EEE 4762 Platform Design and Implementation for IoT Applications (3). This course will provide hands-on experience on the hardware design and implementation of a typical IoT system/device using Eagle/Autodesk PCB design software. Prerequisite: EEL 3110C or permission from instructor (No hardware design experience is required)

EEE 4763 Embedded Programming for IoT Sensing, Network, Control, and Applications (3). This course will provide hands-on experience on the software design and implementation of a typical IoT system/device on a customer-made IoT education platform of CyberSens-EDU. Prerequisite: COP 2210 or Permission from Instructor (Basic programming experience is required)

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 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 3110C Circuit Analysis and Lab (4). Introductory circuit analysis dealing with DC, AC, and transient electrical circuit analysis and the general excitation of circuits using the Laplace transform. Hands on Lab with weekly activities are included. Prerequisites: MAC 2312 or MAC 2282, PHY 2049, (EGN 1002 or EGS 1006). Corequisites: MAP 2302, and for EE or CpE Engineering students, EEL 2880.


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. Prerequisite: EEL 3120 or BME 2740 for BME students Corequisite: MAP2302

EEL 3200 Electrical Energy Systems (3). Introductory course on topics related to electrical energy systems. Energy requirements, resources, and sustainability. Conversion of non-renewable and renewable energy sources to electric energy. Principles of electric power delivery. Principles of electric energy processing and conversion. Prerequisite: EEL 3110C

EEL 3370 C++ Programming for Embedded Systems (3). Object-oriented programming in C++ with emphasis on evaluation of alternative program design strategies. Class design, recursion, linked and dynamically allocated structures. This class will also include data structure concepts and applications. 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. Basic treatment of noise is also included. Prerequisites: EEL 3110C, 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 3664 Introduction to Autonomous Systems (3). This course provides a comprehensive introduction to the components of autonomous systems and exposes the students to the concept of autonomous systems from the perspective of autonomous mobile robotic. Prerequisite: EEL 2880.s

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 3110C.

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

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 3303C

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 4304C 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 3110C.

EEL 4413 Wave-Propagation for Wireless Communication (3). Basics of wireless propagation of radio wave for communication, imaging, and circuit design. Introduce Maxwell’s equation and types of waves, link budget, antennas, transmission lines, and waveguides. Prerequisite: MAP 2302

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 3110C.

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 radiofrequency 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 the 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 a 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 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 2880 or equivalent or CNT 4403 or permission of the instructor.

EEL 4804 Introduction Malware Reverse Engineering (3). This course familiarizes 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 2880 or equivalent or CNT 4403 or permission of the instructor.

EEL 4806 Ethical Hacking and Countermeasures (3). This course will give individuals 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 the embedded system including 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 minor advisement from the 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 the 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 (3). 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 the 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