

MAJOR IN COMPUTER ENGINEERING, EMBEDDED AND IOT SYSTEMS CONCENTRATION

Approaching innovation from a holistic perspective is key to advancing our hyper-connected world. The interdisciplinary embedded and IoT computing concentration takes a bird's eye view of computer engineering to help students understand how electronic devices, software, and networks function together to enable end-to-end solutions. Take a smart home, for example. Rather than designing one aspect of the solution, such as the temperature sensors on a thermostat, this concentration will help students design and optimize software and hardware technologies across the entire spectrum to enable an integrated, smart system. Centering on the science and design of both hardware and software for computing systems across applications ranging from medical imaging tools to wearable electronic devices, students will work on complex engineering problems such as improving energy-efficiency in mobile

devices, integrating artificial intelligence into computing platforms, and developing solutions for reliability and security in safety critical applications. Coursework focuses on applications of key computer engineering principles in the areas of computer architecture, embedded systems, internet-of-things (IoT), machine learning, computer security, software algorithms, and more.

Requirements Effective Fall 2022

In order to maintain professional standards required of practicing engineers, the Department of Electrical and Computer Engineering requires a cumulative grade point average of at least 2.000 in Electrical Engineering courses as a graduation requirement. It is the responsibility of any student who fails to maintain a 2.000 average to work with their advisor to correct grade point deficiencies. ECE courses required for the major at the 100, 200, and 300 level must be passed with a minimum grade of C (2.000); grades below a C will require the student to retake the course. ECE courses designated as an elective are exempt from the C or higher minimum grade requirement.

Freshman

		AUCC	Credits
CO 150	College Composition (GT-CO2)	1A	3
CS 163 or 164	CS1—No Prior Programming Experience CS1—Computational Thinking with Java		4
CS 165	CS2—Data Structures		4
ECE 102	Digital Circuit Logic		4
ECE 251	Introduction to Microcontrollers and IoT		4
MATH 160	Calculus for Physical Scientists I (GT-MA1)	1B	4
MATH 161	Calculus for Physical Scientists II (GT-MA1)	1B	4
Diversity, Equity, and Inclusion (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-equity-inclusion)		1C	3
Career Development Seminar ¹			
Total Credits			30

Sophomore

CS 220	Discrete Structures and their Applications		4
ECE 103	DC Circuit Analysis		3
ECE 202	Circuit Theory Applications		4
ECE 232	Introduction to Project Practices		1
ECE 303/STAT 303	Introduction to Communications Principles		3
MATH 261	Calculus for Physical Scientists III		4
MATH 340	Intro to Ordinary Differential Equations		4
PH 141	Physics for Scientists and Engineers I (GT-SC1)	3A	5
Select at least one course totaling a minimum of 3 credits from the following:			3
AA 100	Introduction to Astronomy (GT-SC2)	3A	
AA 101	Astronomy Laboratory (GT-SC1)	3A	
ANTH 120	Human Origins and Variation (GT-SC2)	3A	
ANTH 121	Human Origins and Variation Laboratory (GT-SC1)	3A	
BZ 110	Principles of Animal Biology (GT-SC2)	3A	
BZ 111	Animal Biology Laboratory (GT-SC1)	3A	
BZ 120	Principles of Plant Biology (GT-SC1)	3A	

2 Major in Computer Engineering, Embedded and IoT Systems Concentration

CHEM 103	Chemistry in Context (GT-SC2)	3A	
CHEM 104	Chemistry in Context Laboratory (GT-SC1)	3A	
CHEM 107	Fundamentals of Chemistry (GT-SC2)	3A	
CHEM 108	Fundamentals of Chemistry Laboratory (GT-SC1)	3A	
CHEM 111	General Chemistry I (GT-SC2)	3A	
CHEM 112	General Chemistry Lab I (GT-SC1)	3A	
CHEM 120	Foundations of Modern Chemistry (GT-SC2)	3A	
CHEM 121	Foundations of Modern Chemistry Laboratory (GT-SC1)	3A	
GEOL 120	Exploring Earth - Physical Geology (GT-SC2)	3A	
GEOL 121	Introductory Geology Laboratory (GT-SC1)	3A	
GEOL 122	The Blue Planet - Geology of Our Environment (GT-SC2)	3A	
GEOL 124	Geology of Natural Resources (GT-SC2)	3A	
GEOL 150	Physical Geology for Scientists and Engineers	3A	
HONR 292A	Honors Seminar: Knowing in the Sciences	3A	
LIFE 102	Attributes of Living Systems (GT-SC1)	3A	
LIFE 103	Biology of Organisms-Animals and Plants (GT-SC1)	3A	
LIFE 201A	Introductory Genetics: Applied/Population/Conservation/Ecological (GT-SC2)	3A	
LIFE 201B	Introductory Genetics: Molecular/Immunological/Developmental (GT-SC2)	3A	
LIFE 220/LAND 220	Fundamentals of Ecology (GT-SC2)	3A	
MIP 101	Introduction to Human Disease (GT-SC2)	3A	
NR 150	Oceanography (GT-SC2)	3A	
PH 110	Physics of Everyday Phenomena (GT-SC2)	3A	
PH 111	Physics of Everyday Phenomena Laboratory (GT-SC1)	3A	
PH 122	General Physics II (GT-SC1)	3A	
PH 142	Physics for Scientists and Engineers II (GT-SC1)	3A	
Career Development Seminar ¹			
Total Credits			31
Junior			
CS 253	Software Development with C++		4
CS 356	Systems Security		3
ECE 311	Linear System Analysis I		3
ECE 450	Digital System Design Laboratory		1
ECE 451	Digital System Design		3
ECE 452	Computer Organization and Architecture		3
ECON 202	Principles of Microeconomics (GT-SS1)	3C	3
Select a minimum of three credits from the following:			3
DSCI 369	Linear Algebra for Data Science		
MATH 369	Linear Algebra I		
Select one course from the following:			3
CO 301B	Writing in the Disciplines: Sciences (GT-CO3)	2	
JTC 300	Strategic Writing and Communication (GT-CO3)	2	
Historical Perspectives (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives)			3D
Computer Engineering Electives (see list below) and Technical Electives (see list below)			3
Career Development Seminar ¹			
Total Credits			32
Senior			
CS 320	Algorithms--Theory and Practice		3
ECE 401	Senior Design Project I	4A,4B	3

ECE 402	Senior Design Project II	4C	3
Select one course from the following:			4
ECE 456	Computer Networks		
ECE 528/CS 528	Embedded Systems and Machine Learning		
Computer Engineering Electives and Technical Electives (see list below)			14
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)			6
Career Development Seminar ¹			
Total Credits			33
Program Total Credits:			126

Computer Engineering Electives 0-3 credits

Code	Title	Credits
ECE 101	Foundations in ECE	
ECE 395A	Independent Study ²	
ECE 395B	Independent Study: Open Option Project ²	
ECE 395C	Independent Study : Vertically Integrated Project ²	

Technical Electives 13-17 credits

Code	Title	Credits
CS 314	Software Engineering	3
CS 345	Machine Learning Foundations and Practice	3
CS 370	Operating Systems	3
CS 4XX	Any CS at course at the 400-level, excluding CS457 and CS470	4
CS 545	Machine Learning	4
CS 553	Algorithmic Language Compilers	4
CS 559	Quantitative Security	4
CS 575	Parallel Processing	4
ECE 340	Electromagnetics for Computer Engineering	3
ECE 455	Introduction to Robot Programming/ Simulation	3
ECE 456	Computer Networks ³	4
Select any course from the following: ²		1-3
ECE 495A	Independent Study	
ECE 495B	Independent Study: Open Option Project	
ECE 495C	Independent Study: Vertically Integrated Projects	
ECE 528/CS 528	Embedded Systems and Machine Learning ³	4
ECE 544	Silicon Photonics for Computing Systems	3
ECE 554	Computer Architecture	3
ECE 558	Manycore System Design Using Machine Learning	3
ECE 561/CS 561	Hardware/Software Design of Embedded Systems	4

ECE 571	VLSI System Design	3
ECE 575	Experiments in VLSI System Design I	1
MATH 451	Introduction to Numerical Analysis II	3
MATH 450	Introduction to Numerical Analysis I	3
STAT 421	Introduction to Stochastic Processes	3

¹ Students are required to complete three Career Development Seminars: 1) Resume Writing; 2) Behavior Based Interviewing; and 3) Using LinkedIn™. Completion of the required workshops may be spread over the student's four-year program.

² A total 6 credits of Independent Study may apply toward total degree requirements. This includes credit awarded for ECE 395A, ECE 395B, ECE 395C and ECE 495A, ECE 495B, ECE 495C combined.

³ Course may count as a Technical Elective ONLY when not taken as part of the major requirements. The course cannot count as credit toward both major and technical elective requirements.

Major Completion Map

Distinctive Requirements for Degree Program:

TO PREPARE FOR FIRST SEMESTER: The curriculum for this major assumes students enter college prepared to take calculus.

The ECE curriculum has been modified as part of the Revolutionizing Engineering Departments initiative (RED). Three threads run through the new curriculum: Foundations, Creativity and Professional Formation of Engineers. This new curriculum incorporates skills that engineers need beyond technical expertise, in areas like communication, ethics, social impact and interaction in large, diverse groups. The ECE department requires that students also complete the following three Career Development Seminars: 1) Resume Writing; 2) Behavior Based Interviewing; and 3) Using LinkedIn™.

In order to maintain professional standards required of practicing engineers, the Department of Electrical and Computer Engineering requires a cumulative grade point average of at least 2.000 in Electrical Engineering courses as a graduation requirement. It is the responsibility of any student who fails to maintain a 2.000 average to work with their advisor to correct grade point deficiencies. ECE courses required for the major at the 100, 200, and 300 level must be passed with a minimum grade of C (2.000); grades below a C will require the student to retake the course. ECE courses designated as an elective are exempt from the C or higher minimum grade requirement.

Freshman

Semester 1		Critical	Recommended	AUCC	Credits
CO 150	College Composition (GT-CO2)		X	1A	3
CS 163 or 164	CS1--No Prior Programming Experience CS1--Computational Thinking with Java	X			4
ECE 102	Digital Circuit Logic	X			4
MATH 160	Calculus for Physical Scientists I (GT-MA1)	X		1B	4
Career Development Seminar(s)			X		
Total Credits					15

Semester 2		Critical	Recommended	AUCC	Credits
CS 165	CS2--Data Structures	X			4
ECE 251	Introduction to Microcontrollers and IoT	X			4
MATH 161	Calculus for Physical Scientists II (GT-MA1)	X		1B	4
Diversity, Equity, and Inclusion (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-equity-inclusion)		X		1C	3
Career Development Seminar(s)			X		
Total Credits					15

Sophomore

Semester 3		Critical	Recommended	AUCC	Credits
CS 220	Discrete Structures and their Applications	X			4
ECE 103	DC Circuit Analysis	X			3
MATH 261	Calculus for Physical Scientists III	X			4
PH 141	Physics for Scientists and Engineers I (GT-SC1)	X		3A	5
Career Development Seminar(s)			X		
Total Credits					16

Semester 4		Critical	Recommended	AUCC	Credits
ECE 202	Circuit Theory Applications	X			4
ECE 232	Introduction to Project Practices	X			1
ECE 303/ STAT 303	Introduction to Communications Principles	X			3
MATH 340	Intro to Ordinary Differential Equations	X			4
Department Approved Science (See List on Requirements Tab)			X	3A	3
Career Development Seminar(s)			X		
Total Credits					15

Junior

Semester 5		Critical	Recommended	AUCC	Credits
CS 253	Software Development with C++	X			4
ECE 311	Linear System Analysis I	X			3
ECE 450	Digital System Design Laboratory	X			1
ECE 451	Digital System Design	X			3
Select one course from the following:					3
CO 301B	Writing in the Disciplines: Sciences (GT-CO3)		X	2	
JTC 300	Strategic Writing and Communication (GT-CO3)		X	2	
Computer Engineering Electives (see list below) and Technical Electives (see list below)		X			3
Career Development Seminar(s)			X		
Total Credits					17

Semester 6		Critical	Recommended	AUCC	Credits
CS 356	Systems Security	X			3
ECE 452	Computer Organization and Architecture	X			3
ECON 202	Principles of Microeconomics (GT-SS1)		X	3C	3

Select a minimum of three credits from the following: 3

DSCI 369	Linear Algebra for Data Science	X		
MATH 369	Linear Algebra I	X		

Historical Perspectives (<http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives>) X 3D 3

Career Development Seminar(s) X

Total Credits 15

Senior

Semester 7 **Critical** **Recommended** **AUCC** **Credits**

ECE 401 Senior Design Project I X 4A,4B 3

Choose one of the following: 4

ECE 528/ Embedded Systems and Machine Learning
CS 528

Technical Electives (See List on Requirements Tab) X

Technical Electives (See List on Requirements Tab) X 6

Arts and Humanities (<http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities>) X 3B 3

Career Development Seminar(s) X

Total Credits 16

Semester 8 **Critical** **Recommended** **AUCC** **Credits**

CS 320 Algorithms--Theory and Practice X 3

ECE 402 Senior Design Project II X 4C 3

Choose one of the following: X 4

ECE 456 Computer Networks

Technical Electives (See List on Requirements Tab)

Technical Electives (See List on Requirements Tab) X 4

Arts and Humanities (<http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities>) X 3B 3

The benchmark courses for the 8th semester are the remaining courses in the entire program of study. X

Total Credits 17

Program Total Credits: 126