Electrical Engineering (BS): Biomedical Instrumentation Concentration

The EE core courses provide a foundation for all EE students in electric circuits, digital logic, computer systems, programming, signals, linear systems, microelectronics, electromagnetics, teaming and communication, and the social and ethical dimensions of the practice of electrical and computer engineering.

EE offers a robust set of concentrations to guide students in their studies. All concentrations within EE share the core courses required by the major. Concentrations are offered in the following areas: Analog Circuits, Artificial Intelligence and Machine Learning, Biomedical Instrumentation, Communications and Signal Processing, Controls and Robotics, Digital Circuits, Electronic Devices, Music Technology, Optics and Photonics, Power Systems, and Radio Frequency Circuits.

Each EE concentration contains 24 hours of work. Students will take 12 hours from a prescribed list of courses that provide the necessary depth and background to pursue a career in the area. An additional 12 hours from a broader list of “open” electives are also required as part of the concentration, and these are meant to reinforce and add breadth to that area. There are many connections between areas and too many to explicitly list, and therefore, the open category gives students the freedom to choose courses that either broaden or deepen their expertise as they determine appropriate in consultation with their advisor. Furthermore, the open elective list intentionally allows students to take courses outside of ECE, such as other engineering, math, or science courses.

In their final year, all Electrical Engineering majors participate in a two-semester senior design course sequence. Students work in teams to solve an engineering problem identified by faculty or industrial sponsors. Over the course of two semesters, students gain experience designing, documenting, and communicating about their project to various audiences.

This curriculum leads to a Bachelor of Science in Electrical Engineering and is nationally accredited by ABET, http://www.abet.org.

The Biomedical Instrumentation concentration prepares students for the design of computer and electrical systems for use in biomedical applications. The required courses focus on wearable biosensors and microsystems and embedded systems architecture. Electives in this concentration emphasize deeper knowledge in electronics, custom hardware design, nanomanufacturing techniques and applications, neural interface engineering, and medical instrumentation.

Plan Requirements

Code	Title	Hours
Major Field of Study Requirements		
Math		
MA 141	Calculus I [1,2]	4
MA 241	Calculus II [1,2]	4
MA 242	Calculus III	4
ST 371	Introduction to Probability and Distribution Theory	3
Science		
CH 101 & CH 102	Chemistry - A Molecular Science and General Chemistry Laboratory [1,2]	4
PY 205 & PY 206	Physics for Engineers and Scientists I and Physics for Engineers and Scientists I Laboratory [1,2]	4
PY 208 & PY 209	Physics for Engineers and Scientists II and Physics for Engineers and Scientists II Laboratory	4
Electrical Engineering Core		
ECE 109	Introduction to Computer Systems [3]	3
ECE 200	Introduction to Signals, Circuits and Systems [3]	4
ECE 209	Computer Systems Programming [3]	3
ECE 211	Electric Circuits [3]	4
ECE 212	Fundamentals of Logic Design [3]	3
ECE 220	Analytical Foundations of Electrical and Computer Engineering [3]	3
ECE 301	Linear Systems	3
ECE 302	Microelectronics	4
ECE 303	Electromagnetic Fields	3
ECE 380	Engineering Profession for Electrical Engineers	1
or ECE 381	Engineering Profession for Computer Engineers	
or ECE 383	Introduction to Entrepreneurship and New Product Development	
ECE 484	Electrical and Computer Engineering Senior Design I	3
or ECE 482	Engineering Entrepreneurship Senior Design I	
ECE 485	Electrical and Computer Engineering Senior Design II	3
or ECE 483	Engineering Entrepreneurship Senior Design II	
Biomedical Instrumentation Concentration		
ECE 418	Wearable Biosensors and Microsystems [4]	3
or ECE 518	Wearable Biosensors and Microsystems	
ECE 460	Course ECE 460 Not Found [4]	3
or ECE 560	Course ECE 560 Not Found	
Biomedical Instrumentation Required Electives (p. 2)		6
Open Electives (p. 2) [5]		12
Other Major		
COM 110	Public Speaking	3
ENG 331	Communication for Engineering and Technology	3
College Requirements		
E 101	Introduction to Engineering & Problem Solving [3]	1
E 102	Engineering in the 21st Century [3]	2
E 115	Introduction to Computing Environments [3]	1
Other		
EC 205	Fundamentals of Economics	3
or EC 201	Principles of Microeconomics	
or ARE 201	Introduction to Agricultural & Resource Economics	
or ARE 201A	Introduction to Agricultural & Resource Economics	
Total Hours		**101**

Code	Title	Hours
GEP Courses		
ENG 101	Academic Writing and Research[3]	4
GEP Humanities (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/)		6
GEP Social Sciences (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-social-sciences/)		3
GEP Health and Exercise Studies (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/)		2
GEP Elective (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)		3
GEP Interdisciplinary Perspectives (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-interdisciplinary-perspectives/)		3
GEP Global Knowledge (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-global-knowledge/) (verify requirement)		
GEP Foundations of American Democracy (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-fad/) (verify requirement)		
World Language Proficiency (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/world-language-proficiency/) (verify requirement)		
Total Hours		**21**

Biomedical Instrumentation Required Electives

Code	Title	Hours
ECE 403	Electronics Engineering	3
ECE 425	Neural Networks and Deep Learning[4]	3
or ECE 525	Neural Networks and Deep Learning	
ECE 442	Introduction to Integrated Circuit Technology and Fabrication	3
ECE 464	ASIC and FPGA Design with Verilog[4]	3
or ECE 564	ASIC and FPGA Design with Verilog	
ECE 468	Conventional and Emerging Nanomanufacturing Techniques and Their Applications in Nanosystems[4]	3
or ECE 568	Conventional and Emerging Nanomanufacturing Techniques and Their Applications in Nanosystems	
ECE 505	Neural Interface Engineering[4]	3
ECE 522	Medical Instrumentation[4]	3

Open Electives

Open Electives

Choose from the ECE Elective List or the other Open Electives listed below.

ECE Elective

Code	Title	Hours
ECE 402	Communications Engineering	3
ECE 403	Electronics Engineering	3
ECE 404	Introduction to Solid-State Devices	3
ECE 406/506	Architecture Of Parallel Computers	3
ECE 407	Introduction to Computer Networking	3
ECE 410/510	Introduction to Signal Processing	3
ECE 411	Introduction to Machine Learning	3
ECE 418/518	Wearable Biosensors and Microsystems	3
ECE 420	Wireless Communication Systems	3
ECE 422	Transmission Lines and Antennas for Wireless	3
ECE 423	Introduction to Photonics and Optical Communications	3
ECE 424/524	Radio System Design	3
ECE 426	Analog Electronics Laboratory	3
ECE 434	Fundamentals of Power Electronics	3
ECE 436	Digital Control Systems	3
ECE 442	Introduction to Integrated Circuit Technology and Fabrication	3
ECE 451	Power System Analysis	3
ECE 452/552	Renewable Electric Energy Systems	3
ECE 453	Electric Motor Drives	3
ECE 455	Industrial Robot Systems	3
ECE 456/556	Mechatronics	3
ECE 460/560	Course ECE 460 Not Found	3
ECE 461/561	Embedded System Analysis and Optimization	3
ECE 463/563	Microprocessor Architecture	3
ECE 464/564	ASIC and FPGA Design with Verilog	3
ECE 465/565	Operating Systems Design	3
ECE 466/566	Compiler Optimization and Scheduling	3
ECE 468/568	Conventional and Emerging Nanomanufacturing Techniques and Their Applications in Nanosystems	3
ECE 470	Internetworking	3
ECE 488/588	Systems Biology Modeling of Plant Regulation	3
ECE 489/589	Solid State Solar and Thermal Energy Harvesting	3
ECE 492	Special Topics in Electrical and Computer Engineering	1-4
ECE 505	Neural Interface Engineering	3
ECE 511	Analog Electronics	3
ECE 512	Data Science from a Signal Processing Perspective	3
ECE 514	Random Processes	3
ECE 515	Digital Communications	3
ECE 516	System Control Engineering	3
ECE 517	Object-Oriented Design and Development	3
ECE 522	Medical Instrumentation	3
ECE 523	Photonics and Optical Communications	3
ECE 530	Physics of Semiconductors	3
ECE 531	Course ECE 531 Not Found	3
ECE 532	Course ECE 532 Not Found	3
ECE 533	Power Electronics Design & Packaging	3
ECE 534	Power Electronics	3
ECE 535	Design of Electromechanical Systems	3
ECE 536	Digital Control System Projects	3
ECE 538	Integrated Circuits Technology and Fabrication	3
ECE 540	Electromagnetic Fields	3
ECE 541	Antennas and Arrays	3

ECE 542	Neural Networks and Deep Learning	3
ECE 544	Design Of Electronic Packaging and Interconnects	3
ECE 546	VLSI Systems Design	3
ECE 547	Cloud Computing Technology	3
ECE 549	RF Design for Wireless	3
ECE 550	Power System Operation and Control	3
ECE 551	Smart Electric Power Distribution Systems	3
ECE 553	Semiconductor Power Devices	3
ECE 554	Electric Motor Drives	3
ECE 555	Autonomous Robot Systems	3
ECE 557	Principles Of MOS Transistors	3
ECE 558	Digital Imaging Systems	3
ECE 570	Computer Networks	3
ECE 573	Internet Protocols	3
ECE 574	Computer and Network Security	3
ECE 575	Introduction to Wireless Networking	3
ECE 576	Networking Services: QoS, Signaling, Processes	3
ECE 577	Switched Network Management	3
ECE 578	LTE and 5G Communications	3
ECE 579	Introduction to Computer Performance Modeling	3
ECE 581	Electric Power System Protection	3
ECE 582	Course ECE 582 Not Found	3
ECE 583	Electric Power Engineering Practicum I	3
ECE 584	Electric Power Engineering Practicum II	3
ECE 585	The Business of the Electric Utility Industry	3
ECE 586	Communication and SCADA Systems for Smart Grid	3
ECE 587	Power System Transients Analysis	3
ECE 591	Special Topics In Electrical Engineering	1-6
ECE 592	Special Topics In Electrical Engineering	1-6

Code	Title	Hours
ECE 303	Electromagnetic Fields	3
E 304	Introduction to Nano Science and Technology	3
ECE 305	Principles of Electromechanical Energy Conversion	3
ECE 306	Introduction to Embedded Systems	3
ECE 308	Elements of Control Systems	3
ECE 309	Data Structures and Object-Oriented Programming for Electrical and Computer Engineers	3
ECE 310	Design of Complex Digital Systems	3
ECE 384	Practical Engineering Prototyping	3
ECE 425	Neural Networks and Deep Learning	3
or ECE 525	Neural Networks and Deep Learning	
ECE 469	Quantum Programming	3
CE 214	Engineering Mechanics-Statics	3
or MAE 206	Engineering Statics	
MSE 200	Mechanical Properties of Structural Materials	3
or MSE 201	Structure and Properties of Engineering Materials	
ISE 311	Engineering Economic Analysis	3
MAE 208	Engineering Dynamics	3
MAE 201	Thermal-Fluid Sciences	3
MAE 302/ BME 525	Engineering Thermodynamics II	3
DSA 200 or higher level courses, up to 3 credit hours		3
College of Science courses 400-level or higher with permission of advisor		
College of Engineering Courses 400-level or higher with permission of advisor		

[1] Course required for Change of Degree Audit (CODA).
[2] A grade of C or higher is required.
[3] A grade of C- or higher is required.
[4] A grade of C- or higher is required.
[5] Suggested open electives include: Electronics: 403, 442, 468/568, 505, 522. Power systems: ECE 434, 452, 453; Communications and Signal Processing: ECE 410/510; Machine Learning and AI: ECE 411, 425/525; Embedded Systems: ECE 306, 460, 560. With permission of the other departments, we also recommend: MAE 420/MAE 520, BIT 476 Applied Bioinformatics, BME 463.

First Year		
Fall Semester		**Hours**
CH 101	Chemistry - A Molecular Science [1,2]	3
CH 102	General Chemistry Laboratory [1,2]	1
E 101	Introduction to Engineering & Problem Solving [3]	1
E 115	Introduction to Computing Environments [3]	1
ENG 101	Academic Writing and Research [3]	4
MA 141	Calculus I [1,2]	4
GEP Health and Exercise Studies (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/)		1
	Hours	**15**
Spring Semester		
ECE 109	Introduction to Computer Systems [3]	3
MA 241	Calculus II [1,2]	4
PY 205	Physics for Engineers and Scientists I [1,2]	3
PY 206	Physics for Engineers and Scientists I Laboratory [1,2]	1
E 102	Engineering in the 21st Century [3]	2
EC 205 or EC 201 or ARE 201 or ARE 201A	Fundamentals of Economics or Principles of Microeconomics or Introduction to Agricultural & Resource Economics or Introduction to Agricultural & Resource Economics	3
	Hours	**16**
Second Year		
Fall Semester		
ECE 200	Introduction to Signals, Circuits and Systems [3]	4
ECE 209	Computer Systems Programming [3]	3
MA 242	Calculus III	4
PY 208	Physics for Engineers and Scientists II	3
PY 209	Physics for Engineers and Scientists II Laboratory	1
	Hours	**15**

Spring Semester		
COM 110	Public Speaking	3
ECE 211	Electric Circuits [3]	4
ECE 212	Fundamentals of Logic Design [3]	3
ECE 220	Analytical Foundations of Electrical and Computer Engineering [3]	3
GEP Requirement (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)		3
	Hours	**16**
Third Year		
Fall Semester		
ECE 301	Linear Systems	3
ECE 302	Microelectronics	4
ST 371	Introduction to Probability and Distribution Theory	3
Open Electives (p. 2) [5]		3
GEP Health and Exercise Studies (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/)		1
	Hours	**14**
Spring Semester		
ECE 303	Electromagnetic Fields	3
Select one of the following:		1
ECE 380	Engineering Profession for Electrical Engineers	
ECE 381	Engineering Profession for Computer Engineers	
ECE 383	Introduction to Entrepreneurship and New Product Development	
Open Electives (p. 2) [5]		6
ENG 331	Communication for Engineering and Technology	3
GEP Requirement (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)		3
	Hours	**16**
Fourth Year		
Fall Semester		
ECE 484	Electrical and Computer Engineering Senior Design I	3
ECE 418 or ECE 518	Wearable Biosensors and Microsystems [4] or Wearable Biosensors and Microsystems	3
ECE 460 or ECE 560	Course ECE 460 Not Found [4] or Course ECE 560 Not Found	3
Open Electives (p. 2) [5]		3
GEP Requirement (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)		3
	Hours	**15**
Spring Semester		
ECE 485	Electrical and Computer Engineering Senior Design II	3
Biomedical Instrumentation Required Elective (p. 2)		3
Open Electives (p. 2) [5]		3
GEP Requirement (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)		3
GEP Requirement (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)		3
	Hours	**15**
	Total Hours	**122**

[1] Courses required for Change of Degree Audit (CODA).

[2] A grade of C or higher is required.

[3] A grade of C- or higher is required. E 115 requires satisfactory completion (S).

[4] A minimum GPA of 3.5 is required to enroll in graduate-level courses.

[5] Suggested open electives include: Electronics: 403, 442, 468/568, 505, 522. Power systems: ECE 434, 452, 453; Communications and Signal Processing: ECE 410/510; Machine Learning and AI: ECE 411, 425/525; Embedded Systems: ECE 306, 460, 560. With permission of the other departments, we also recommend: MAE 420/MAE 520, BIT 476 Applied Bioinformatics, BME 463.

Career Opportunities

Career Titles

- Computer Network Architects
- Control and Valve Installers and Repairers, Except Mechanical Door
- Electrical Drafter
- Electrical Engineer
- Electrical EngineeringTechnician
- Electro-Mechanical Technicians
- Electronic Drafter
- Electronics Engineer
- Electronics Technician
- Engineering Professor
- Instrument Technician
- Mechanical Drafter
- Mechatronics Engineers
- Photonics Engineers
- Radio Frequency Identification Device Specialists
- Sales Engineers
- Solar Energy Systems Engineers

Learn More About Careers

NCcareers.org (https://nccareers.org/)
Explore North Carolina’s central online resource for students, parents, educators, job seekers and career counselors looking for high quality job and career information.

Occupational Outlook Handbook (https://www.bls.gov/ooh/)
Browse the Occupational Outlook Handbook published by the Bureau of Labor Statistics to view state and area employment and wage statistics. You can also identify and compare similar occupations based on your interests.

Career One Stop Videos (https://www.careeronestop.org/)
View videos that provide career details and information on wages, employment trends, skills needed, and more for any occupation. Sponsored by the U.S. Department of Labor.

Focus 2 Career Assessment (https://careers.dasa.ncsu.edu/explore-careers/career-assessments/) (NC State student email address required)

This career, major and education planning system is available to current NC State students to learn about how your values, interests, competencies, and personality fit into the NC State majors and your future career. An NC State email address is required to create an account. Make an appointment with your career counselor (https://careers.dasa.ncsu.edu/about/hours-appointments/) to discuss the results.

Focus 2 Apply Assessment (https://www.focus2career.com/Portal/Register.cfm?SID=1929) (Available to prospective students)
A career assessment tool designed to support prospective students in exploring and choosing the right major and career path based on your unique personality, interests, skills and values. Get started with Focus 2 Apply and see how it can guide your journey at NC State.

Institute of Electrical and Electronic Engineers (http://www.ieee.org/)
National Society of Professional Engineers (https://www.nspe.org/)