ESE Engineering

ESE 111: Making with Arduino: Hardware and Programming
Create a working electronic project using low-cost and easy-to-program Arduino development boards. Example projects may include wearable electronics, robots, and electronic displays. An introduction to the C programming language will be provided along with the basics of embedded electronics and the Internet of Things.

SBC: TECH
3 credits

ESE 118: Digital Logic Design
Develops methods of analysis and design of both combinational and sequential systems regarding digital circuits as functional blocks. Utilizes demonstrations and laboratory projects consisting of building hardware on breadboards and simulation of design using CAD tools. Topics include: number systems and codes; switching algebra and switching functions; standard combinational modules and arithmetic circuits; realization of switching functions; latches and flip-flops; standard sequential modules; memory, combinational, and sequential PLDs and their applications; design of system controllers.
Prerequisite: ESE 123
SBC: TECH
4 credits

ESE 121: Introduction to Audio Systems
Analog and digital audio systems, musical instrument amplifiers and effects, audio instrumentation, samplers, synthesizers, and audio transducers will be studied. Signal and system concepts will be demonstrated using audible examples to develop intuitive and non-mathematical insights. Audio system specifications will be explained and their effects demonstrated.
SBC: TECH
3 credits

ESE 122: Discrete Mathematics for Engineers
Introduction to topics in computational mathematics, such as number systems, Boolean algebra, mathematical induction, combinatorics and probability, recursion and graph theory. Algorithm aspects of the topics discussed will be emphasized.
Corequisite: ESE 123

3 credits

ESE 123: Introduction to Electrical and Computer Engineering
Introduces basic electrical and computer engineering concepts in a dual approach that includes: laboratories for hands-on wired and computer simulation experiments in analog and logic circuits, and lectures providing concepts and theory relevant to the laboratories. Emphasizes physical insight and applications rather than theory. This course has an associated fee. Please see www.stonybrook.edu/coursefees for more information.
Pre- or Corequisites: AMS 151 or MAT 125 or 131 or 141; PHY 125 or 131 or 141
SBC: TECH
4 credits

ESE 124: Programming Fundamentals
The course presents fundamental and more advanced C programming concepts. Lectures discuss the C language constructs and exemplify their use in relevant programming applications. The course also introduces fundamental concepts in electrical and computer engineering, such as bitwise operations, text file scanning, stack-based computation, table-based finite state machine implementation, hash tables, and linked lists. Scheduled lab activities focus on devising, implementing, debugging, and validating C programs for the concepts discussed in class. A course project focuses on developing a more extensive C program that comprehensively utilizes the programming concepts discussed during the semester.
Prerequisite: Declared Area of Interest or Major in Electrical or Computer Engineering.
4 credits

ESE 188: Understanding Machine Learning
This is a course on the basics of machine learning. Students develop an intuitive understanding of the core concepts of machine learning including supervised and unsupervised learning, classification and prediction. The course provides a number of practical examples from a wide range of disciplines including biomedicine, social sciences, and engineering. The course does not require any prerequisites in engineering or computer science.
SBC: TECH
3 credits

ESE 201: Engineering and Technology Entrepreneurship
The purpose of this course is to bridge the gap between technical competence and entrepreneurial proficiency. Students are not expected to have any formal business background, but have some background in a technical field. These fields can range from the engineering disciplines to computer science, and from biology and chemistry to medicine. Accordingly, the course will provide the necessary exposure to the fundamentals of business, while minimizing the use of business school jargon. Entrepreneurship is considered as a manageable process built around innovativeness, risk-taking and proactiveness. The course focuses on ventures where the business concept is built around either a significant technical advance in an operational process, or in the application of technology to create a new product or service.
Prerequisite: BME 100 or CME 101 or ESG 100 or ESE 123 or MEC 101 or EST 192 or EST 194 or EST 202 or LSE 320
3 credits

ESE 211: Electronics Laboratory A
Introduction to the measurement of electrical quantities; instrumentation; basic circuits, their operation and applications; electronic devices; amplifiers, oscillators, power supplies, wave-shaping circuits, and basic switching circuits.
Prerequisite: ESE 271
Corequisite: ESE 372
2 credits

ESE 224: Computer Techniques for Electronic Design II
Introduces C++ programming language for problem solving in electrical and computer engineering. Topics include C++ structures, classes, abstract data types, and code reuse. Basic object-oriented programming concepts as well as fundamental topics of discrete mathematics and algorithms are introduced.
Prerequisite: ESE 124
3 credits

ESE 231: Introduction to Semiconductor Devices
The principles of semiconductor devices. Energy bands, transport properties and generation recombination phenomena in bulk semiconductors are covered first, followed by junctions between semiconductors and metal-semiconductor. The principles of operation of diodes, transistors, light detectors, and light emitting devices based on an understanding of the character of physical phenomena in semiconductors. Provides background for subsequent courses in electronics.
Prerequisites: AMS 361 or MAT 303; PHY 127/134 or PHY 132/134 or PHY 142
3 credits

ESE 271: Electrical Circuit Analysis
Prerequisite: MAT 127 or 132 or 142 or 171 or AMS 161
Pre/co-requisite: PHY 127/134 or 132/134 or 142
3 credits

ESE 280: Embedded Microcontroller Systems Design I
Fundamental design of microcontroller-based electronic systems. Topics include system level architecture, microcontrollers, memory, configurable ports, peripheral ICs, interrupts, sensors, and actuators, serial data protocols, assembly language programming, debugging, and table driven FSMs. Hardware/software trade-offs in implementing system functions. Hardware and software design are equally emphasized. Laboratory work involves design, implementation, and verification of microcontroller systems.
This course has an associated fee. Please see www.stonybrook.edu/coursefees for more information.
Prerequisite: ESE or ECE major; ESE 118 or permission of instructor.
4 credits

ESE 290: Transitional Study
A vehicle used for transfer students to remedy discrepancies between a Stony Brook course and a course taken at another institution. For example, it allows the student to take the laboratory portion of a course for which he or she has had the theoretical portion elsewhere. Open elective credit only.
Prerequisite: Permission of department
1-3 credits

ESE 300: Technical Communication for Electrical and Computer Engineers
Topics include how technical writing differs from other forms of writing, the components of technical writing, technical style, report writing, technical definitions, proposal writing, writing by group or team, instructions and manuals, transmittal letters, memoranda, abstracts and summaries, proper methods of documentation, presentations and briefings, and analysis of published engineering writing.
Also covered are the writing of resumes and cover letters.
Prerequisite: WRT 102; ESE or ECE major, U3 standing;
Pre- or Corequisite: ESE 314 or 324 or 380 or 382
3 credits

ESE 301: Engineering Ethics and Societal Impact
The study of ethical issues facing engineers and engineering related organizations and the societal impact of technology. Decisions involving moral conduct, character, ideals and relationships of people and organizations involved in technology, the interaction of engineers, their technology, the society and the environment is examined using case studies.
Prerequisite: U3 or U4 standing; one D.E.C. E or SNW course
DEC: H
SBC: STAS
3 credits

ESE 304: Applications of Operational Amplifiers
Design of electronic instrumentation: structure of basic measurement systems, transducers, analysis and characteristics of operational amplifiers, analog signal conditioning with operational amplifiers, sampling, multiplexing, A/D and D/A conversion; digital signal conditioning, data input and display, and automated measurement systems. Application of measurement systems to pollution and to biomedical and industrial monitoring is considered.
Prerequisite: ESE 372
3 credits

ESE 305: Deterministic Signals and Systems
Pre- or Corequisite: ESE 271
3 credits

ESE 306: Random Signals and Systems
Random experiments and events; random variables, probability distribution and density functions, continuous and discrete random processes; Binomial, Bernoulli, Poisson, and Gaussian processes; system reliability; Markov chains; elements of queuing theory; detection of signals in noise; estimation of signal parameters; properties and application of auto-correlation and cross-correlation functions; power spectral density; response of linear systems to random inputs.
Pre- or Corequisite: ESE 305
4 credits

ESE 311: Analog Integrated Circuits
Engineering design concepts applied to electronic circuits. Basic network concepts, computational analysis and design techniques: models of electronic devices; biasing and compensation methods; amplifiers and filters designed by conventional and computer-aided techniques.
Prerequisite: ESE 372
3 credits

ESE 312: Lightwave Devices
Introduction to optical semiconductor devices and their applications in telecommunications, optoelectronics, and consumer electronics-areas where signal processing or the transmission of signals across free space or fiber optic cables is involved. It discusses design and operation of optical modulators, quantum well lasers, light emitting diodes, and photodetectors.
Prerequisite: ESE 231
3 credits

ESE 313: Introduction to Photovoltaics
Introduction to the basic concepts of photovoltaic solar energy conversion, including: 1. The solar resource in the context of global energy demand. 2. The operating principles and theoretical limits of photovoltaic devices; 3. Device fabrication, architecture, and primary challenges and practical limitations for the major technologies and materials used for photovoltaic devices. Students will gain knowledge of: the device physics of solar cells, the operating principles of the major commercial photovoltaic technologies, the current challenges and primary areas of research within the field of photovoltaics, and a basic understanding of the role of photovoltaics in the context of the global energy system.
Prerequisite: ESE 231 or ESG 281 or permission of instructor
3 credits

ESE 314: Electronics Laboratory B
Laboratory course on design and operation of basic building blocks of electronics. The course is coordinated with, and illustrates and expands upon, concepts presented in ESE 372. Emphasis is given to design solutions more relevant to integrated rather than to discreet element electronics. Field effect transistors are given special attention due to their importance in contemporary analog and digital IC. Frequency responses of the basic amplifiers and active filters are analyzed. Internal structure and fundamental performance limitations of digital inverter and other gates are studied. This course has an associated fee. Please see www.stonybrook.edu/coursefees for more information.

Prerequisites: ESE or ECE major; ESE 211 and 372 or permission of instructor

3 credits

ESE 315: Control System Design


Prerequisite: ESE 271

3 credits

ESE 319: Electromagnetics and Transmission Line Theory

Fundamental aspects of electromagnetics wave propagation and radiation, with application to the design of high speed digital circuits and communications systems. Topics include: solutions of Maxwell's equations for characteristic of EM wave propagation in unbounded and lossy media; radiation of EM energy; guided wave propagation with emphasis on transmission lines theory.

Prerequisite: ESE 271

3 credits

ESE 324: Electronics Laboratory C

Illustrates and expands upon advanced concepts presented in ESE 372. Experiments include analog circuits such as oscillators, voltage regulators; mixed-signal circuits such as data converters, phase-locked loops, and several experiments emphasizing the analog design issues in digital circuits. Laboratory fee required. This course has an associated fee. Please see www.stonybrook.edu/coursefees for more information.

Prerequisites: ESE or ECE major; U3 standing; ESE 211 and 372

2 credits

ESE 325: Modern Sensors

The course focuses on the underlying physics principles, design, and practical implementation of sensors and transducers including piezoelectric, acoustic, inertial, pressure, position, flow, capacitive, magnetic, optical, and bioelectric sensors. Established as well as novel sensor technologies as well as problems of interfacing various sensors with electronics are discussed.

Prerequisite: ESE 372

3 credits

ESE 330: Integrated Electronics

An overview of the design and fabrication of integrated circuits. Topics include gate-level and transistor-level design; fabrication material and processes; layout of circuits; automated design tools. This material is directly applicable to industrial IC design and provides a strong background for more advanced courses.

Prerequisite: ESE 372

3 credits

ESE 331: Modern Circuit Board Design and Prototyping

Design, fabricate, and test a prototype device using a custom made circuit board, surface mount components, and a 3D printed enclosure. Topics include printed circuit design, active and passive component selection, design for testability, solid modeling, and 3D printing.

Prerequisite: ESE 211 and ESE 380

3 credits

ESE 332: Quantum Mechanics for Engineers

Introductory undergraduate level first course in quantum mechanics geared towards engineers and applied physicists. Comprehensive introduction to quantum mechanics and its application to real-world problems.

Prerequisites: PHY 122/124 or PHY 126 and 127 and 134 or PHY 132/134 or PHY 142/143; MAT 127 or 132 or 142 or 171 or AMS 161

Advisory Corequisite: AMS 261 or MAT 203 or 205 or 307

3 credits

ESE 333: Real-Time Operating Systems

Introduces basic concepts and principles of real-time operating systems. Topics include structure, multiple processes, interprocess communication, real-time process scheduling, memory management, virtual memory, file system design, security, protection, and programming environments for real-time systems.

Prerequisites: ESE 124; CSE 214; ESE 380 or CSE 220

3 credits

ESE 337: Digital Signal Processing: Theory

Introduces digital signal processing theory sequences, discrete-time convolution, difference equations, sampling and reconstruction of signals, one- and two-sided Z-transforms, transfer functions, and frequency response. Design of FIR and IIR filters. Discrete and fast Fourier transforms and applications.

Prerequisite: ESE 305

3 credits

ESE 340: Basic Communication Theory

Basic concepts in both analog and digital data communications; signals, spectra, and linear networks; Fourier transforms, energy and power spectra, and filtering; AM, FM, and PM; time and frequency multiplexing; discussion of problems encountered in practice; noise and bandwidth considerations; pulse modulation schemes.

Prerequisites: ESE 305 and 306

3 credits

ESE 342: Digital Communications Systems


Prerequisite: ESE 340

3 credits

ESE 343: Mobile Cloud Computing

Introduction to the basic concepts of mobile cloud computing, including: 1. The mobile computing technology used in modern smart phones; 2. The cloud computing technology used in existing data centers; 3. The synergy of mobile and cloud computing and its applications; 4. Programming on smart phone utilizing data center services. Students will gain knowledge of: the fundamental principles of mobile cloud computing, the major technologies that support mobile cloud computing, the current challenges and primary areas of research within the field of mobile cloud computing, and a basic understanding.
of the role of mobile cloud computing in the context of everyday living.

Prerequisite: ESE 224, CSE 214, CSE 230 or ISE 208
3 credits

ESE 344: Software Techniques for Engineers
This course covers software techniques for solving electrical and computer engineering problems in the C++ programming language. Design, implementation, and application to engineering problems of non-linear data structures and related advanced algorithms are covered. This includes binary trees, trees, graphs, and networks. OOP features such as Polymorphism, templates, Exception handling, File I/O operations, as well as Standard Template Library are used in the programming projects.
Prerequisites: ESE 224
3 credits

ESE 345: Computer Architecture
This course focuses on the fundamental techniques of designing and evaluating modern computer architectures and tradeoffs present at the hardware/software boundary. The emphasis is on instruction set design, processor design, memory and parallel processing. Students will get an understanding of the design process in the context of a complex computer system. Students will undertake a VHDL/Verilog design project using modern CAD tools.
Prerequisites: ESE 280 and ESE 382
3 credits

ESE 346: Computer Communications
Basic theory and technology of computer communications. Introduction to performance evaluation, error codes and routing algorithms. Other topics include Ethernet, wireless networks including LTE and 5G, fiber optic networking, software defined networking, networking on chips, space networks, data centers, grids and clouds, and network security. Not for credit in addition to CSE 310 or ISE 316. This course is offered as both CSE 346 and ESE 346.
Pre- or corequisite for ESE and ECE majors: ESE 306
Pre- or corequisite for CSE majors: AMS 310 or 311
3 credits

ESE 347: Digital Signal Processing: Implementation
Fundamental techniques for implementing standard signal-processing algorithms on dedicated digital signal-processing chips.

ESE 350: Electrical Power Systems
Fundamental engineering theory for the design and operation of an electric power system. Modern aspects of generation, transmission, and distribution are considered with appropriate inspection trips to examine examples of these facilities. The relationship between the facilities and their influence on our environment is reviewed. Topics include power system fundamentals, characteristics of transmission lines, generalized circuit constants, transformers, control of power flow and of voltage, per unit system of computation, system stability, and extra-high voltage AC and DC transmission.
Prerequisite: ESE 271
3 credits

ESE 352: Electromechanical Energy Converters
Basic principles of energy conversion; DC, induction, and synchronous rotary converters; the three-phase system and symmetrical components; the relationships between voltage, current, flux, and m.m.f.; equivalent circuits and operating characteristics of rotary converters; and analysis of saturation effects.
Prerequisite: ESE 372
3 credits

ESE 355: VLSI System Design
Introduces techniques and tools for scalable VLSI design and analysis. Emphasis is on physical design and on performance analysis. Includes extensive laboratory experiments and hands-on use of CAD tools.
Prerequisite: ESE 218
4 credits

ESE 358: Computer Vision
Introduces fundamental concepts, algorithms, computational techniques, and applications in visual information processing. Covers image formation models and image filtering, binary image analysis, feature detection, contours, image segmentation, 3D image capture and analysis through stereo, motion, structured-light, and LIDAR, medical images, pattern classification, machine learning, and 3D object recognition.
Prerequisites: ESE 305; ESE 224 or CSE 230
3 credits

ESE 360: Network Security Engineering
An introduction to computer network and telecommunication network security engineering. Special emphasis on building security into hardware and software with software. Topics include encryption, public key cryptography, authentication, intrusion detection, digital rights management, firewalls, trusted computing, encrypted computing, intruders and viruses. Not for credit in addition to CSE 408.
Pre- or corequisite: ESE/CSE 346 or CSE/ISE 310
3 credits

ESE 366: Design using Programmable Mixed-Signal Systems-on-Chip
This course focuses on development of mixed-signal embedded applications that utilize systems on chip (SoC) technology. The course discusses design issues such as: implementation of functionality; realizing new interfacing capabilities; and improving performance through programming the embedded microcontroller and customizing the reconfigurable analog and digital hardware of SoC.
Prerequisites: ESE 380 and ESE 372; ESE 224 or CSE 230
4 credits

ESE 372: Electronics
The pertinent elements of solid-state physics and circuit theory are reviewed and applied to the study of electronic devices and circuits, including junction diodes, transistors, and gate and electronic switches; large- and small-signal analysis of amplifiers; amplifier frequency response; and rectifiers and wave-shaping circuits.
Prerequisite: ESE 271
Corequisite for ESE and ECE majors: ESE 211
4 credits
ESE 375: Architectures for Digital Signal Processing
This course covers various aspects of architectures in digital signal processing and multimedia data processing. The topics include iteration bound analysis, retiming the circuits, unfolding and folding the architectures, algorithmic and numerical strength reduction for low power and low complexity design, introduction to array processor architectures and CORDIC implementation.
Prerequisites: ESE 280 and ESE 305
3 credits

ESE 381: Embedded Microprocessor Systems Design II
A continuation of ESE 380. The entire system design cycle, including requirements definition and system specifications, is covered. Topics include real-time requirements, timing, interrupt driven systems, analog data conversion, multi-module and multi-language systems. The interface between high-level language and assembly language is covered. A complete system is designed and prototyped in the laboratory.
Prerequisites: ESE 271 and 380
4 credits

ESE 382: Digital Design Using VHDL and PLDs
Digital system design using the hardware description language VHDL and system implementation using complex programmable logic devices (CPLDs) and field programmable gate arrays (FPGAs). Topics include design methodology, VHDL syntax, entities, architectures, testbenches, subprograms, packages, and libraries. Architecture and characteristics of PLDs and FPGAs are studied. Laboratory work involves writing the VHDL descriptions and testbenches for designs, compiling, and functionally stimulating the designs, fitting and timing simulation of the fitted designs, and programming the designs into a CPLD or FPGA and bench testing.
Prerequisite: ESE or ECE major; ESE 218 or permission of instructor
4 credits

ESE 440: Senior Design I
The senior design sequence (ESE 440 and ESE 441) is a two-semester, team based and independent capstone project with deliverables. The primary objective of the senior design course sequence is to provide a vehicle for students to transition from an academic environment to that of a commercial/ professional engineering environment. Students learn to work in teams to complete a project from concept, practical design based on multiple constraints, to creating a deliverable product meeting the design specifications. Students present written, oral and poster presentations of the project. While most of the project work is done outside the classroom, guest speakers provide insight into other related topics from resume preparation, to program management, to team dynamics and to design methodologies used in industry. The project incorporates appropriate engineering standards and multiple realistic constraints. The final grade will be assigned at the end of the two course sequence ESE 440-441. Not counted as a technical elective. This course has an associated fee. Please see www.stonybrook.edu/coursefees for more information.
Prerequisites: ESE or ECE major, U4 standing; ESE 300; For ESE majors: two ESE electives or for ECE majors: two ECE electives.
3 credits

ESE 441: Senior Design II
The senior design sequence (ESE 440 and ESE 441) is a two-semester, team based and independent capstone project with deliverables. The primary objective of the senior design course sequence is to provide a vehicle for students to transition from an academic environment to that of a commercial/ professional engineering environment. Students learn to work in teams to complete a project from concept, practical design based on multiple constraints, to creating a deliverable product meeting the design specifications. Students present written, oral and poster presentations of the project. While most of the project work is done outside the classroom, guest speakers provide insight into other related topics from resume preparation, to program management, to team dynamics and to design methodologies used in industry. The project incorporates appropriate engineering standards and multiple realistic constraints. Not counted as a technical elective. This course has an associated fee. Please see www.stonybrook.edu/coursefees for more information.
Prerequisite: ESE 440
3 credits

This course covers fundamentals of digital image processing. Basic principles, computational algorithms, and applications are covered. Topics include image formation and sensing, sampling and quantization, image enhancement and histogram analysis, geometric transformations, filtering in the spatial and Fourier domains, edge and feature detection, color image processing, image deblurring, and medical images and computed tomography.
Prerequisites: ESE 305; ESE 224
3 credits

ESE 475: Undergraduate Teaching Practicum
Students assist the faculty in teaching by conducting recitation or laboratory sections that supplement a lecture course. The student receives regularly scheduled supervision from the faculty instructor. May be used as an open elective only and repeated once.
Prerequisites: U4 standing; a minimum g.p.a. of 3.00 in all Stony Brook courses, and a grade of B or better in the course in which the student is to assist; permission of department.
SBC: EXP+
3 credits

ESE 476: Instructional Laboratory Development Practicum
Students work closely with a faculty advisor and staff in developing new laboratory experiments for scheduled laboratory courses in electrical and computer engineering. A comprehensive technical report and the instructional materials developed must be submitted at the end of the course. May be used as a technical elective for electrical and computer engineering majors. May be repeated as an open elective.
Prerequisites: U4 standing; minimum cumulative g.p.a. of 3.0 and minimum grade of A- in the course for which the students will develop material; permission of department and instructor
SBC: EXP+
3 credits

ESE 488: Internship in Electrical/ Computer Engineering
An independent off-campus engineering project with faculty supervision. May be repeated but only three credits of internship electives may be counted toward the non-ESE technical elective requirement.
Prerequisites: ECE or ESE major; U3 or U4 standing; 3.00 g.p.a. minimum in all engineering courses; permission of department
SBC: EXP+
3 credits

ESE 494: Honors Seminar on Research
An introduction to the world wide research enterprise with special emphasis on research
in the United States. Topics include research funding, publications, patents, career options, theory versus experiment, entrepreneurship and presentation skills.

Prerequisite: Acceptance into the ECE or ESE Honors programs or permission of instructor.

1 credit

**ESE 495: Honors Research Project**

A research project, for students in the honors program, conducted under the supervision of an electrical and computer engineering faculty member.

Prerequisites: ESE 494, permission of department and acceptance into the ECE or ESE Honors programs

3 credits

**ESE 499: Research in Electrical Sciences**

An independent research project with faculty supervision. Permission to register requires a 3.00 g.p.a. in all engineering courses and the agreement of a faculty member to supervise the research. May be repeated but only three credits of research electives (AMS 487, BME 499, CSE 487, MEC 499, ESM 499, EST 499, ISE 487) may be counted toward non-ESE technical elective requirements.

Requirements: U4 standing, 3.00 g.p.a. minimum in all engineering courses, permission of department

0-3 credits