

The George Washington University
School of Engineering and Applied Science
Department of Electrical and Computer Engineering
Course Learning Objectives

At the end of the course the student will be able to:

ApSc 114 – Engineering Analysis II

1. *Represent complex functions (conformal transformations) on corresponding complex planes and utilize the special properties of bilinear transformations, the elementary (exponential) functions and their (multivalued) inverses*
2. *Differentiate and integrate complex functions, and evaluate integrals via deformation of contours and the residue theorem*
3. *Represent functions via Taylor or Laurent series expansions*
4. *Represent (real periodic) functions via complex Fourier series and (real) functions via their Fourier transforms*
5. *Use the Laplace transformation to solve linear differential equations with constant coefficients with given driving functions and initial conditions*

ECE 1 – Introduction to Electrical, Computer, and Biomedical Engineering

1. *Understand basic programming using Interactive C*
2. *Understand operation of basic robotic components such as motors, micro-processors, digital sensors, gears, etc.*
3. *Using Interactive C computer program to control motors and navigate a robot through a maze*

ECE 2 – Introduction to Electrical, Computer, and Biomedical Engineering

1. *Understand and characterize analog sensors such as photo sensor, IR sensor and ultrasonic sensor*
2. *Understand robotics and use of sensors in robotic navigation*
3. *Understand basics of Matlab such as: Vectors, matrices, matrix operations, M-files, plotting functions*

ECE 11 – Circuit Theory

1. *Understand basic circuit analysis and design*
2. *Use CAD tools such as P-Spice in circuit analysis and design*
3. *Design and build simple circuits to understand the theory*

ECE 12 – Circuits, Signals, and Systems

1. *Understand the theory of signals and linear systems at an introductory level*
2. *Use Laplace, Fourier and Z transforms in solving engineering problems*
3. *Apply computer tools to analyze signals and systems*

ECE 20 – Engineering Electronics

1. *Understand the basic device physics and large/small-signal operation of diodes, BJT's and FET's*
2. *Use CAD tools, such as Spice, in electronic circuit analysis and design*
3. *Analyze, design, build and test voltage regulators, linear amplifiers and basic logic gates*

ECE 30 – Introduction to Electromagnetics

1. *Understand transmission lines and how their behavior differs from lumped circuits*
2. *Understand Maxwell's equations: their physical origin and their relationship to transmissions*

3. Use commercial software such as Agilent Advanced Design System to simulate transmission line circuits and to apply this software to the design problems

ECE 31 – Fields and Waves I

1. Utilize vector analysis and complex phasor notation to describe fundamental relations governing electric and magnetic fields in three dimensions in their differential and integral forms
2. Evaluate the electrostatic field, force and potential due to electric charges and charge distributions
3. Understand the dipole (Coulomb) model of dielectric materials
4. Calculate capacitance, resistance, inductance and stored energies in simple geometries
5. Evaluate properties of sinusoidally time varying voltages and currents on uniform transmission lines

ECE 32 – Fields and Waves II

1. Evaluate magnetostatic fields and force due to filamentary and general electric current distributions
2. Understand the current (Ampere) model of magnetic materials
3. Understand transformers, generators and motors in relation to Faraday's law of induction
4. Understand the properties of plane electromagnetic waves, polarization
5. Understand elementary properties of radiating systems

ECE 114 – Analog Signals and Systems

1. Apply Linear Graph Theory to the analysis of Linear Lumped Network through the derived Loop and Node equations
2. Apply Electrical Power Networks Design through the corresponding Linear Graph Matrix
3. Apply Analysis and design of Electrical Network by given a Network Function
4. Apply Analog Filter Design - Low Pass, High Pass and Band Pass

ECE 117 – Introduction to Digital Signal Processing

1. Use computer tools such as MATLAB
2. Understand spectrum, sampling and discrete-time signals and systems
3. Understand basic objectives in design of digital filters

ECE 121 – Analog Electronics Design

1. Analyze, design and test of basic analog circuits, such as, differential and multistage amplifiers, operational amplifiers, power amplifiers, and active filters
2. Analyze, design and build analog circuits for basic RF applications, such as, wide-band amplifiers and transmitter-receivers
3. Understand and employ the following concepts in analog electronic circuit design: frequency response, feedback, and two-port network parameter

ECE 122 – Digital Electronics and Design

1. Understand the operation of the following digital logic families: CMOS, BiCMOS, TTL and ECL
2. Design and simulate synchronous and asynchronous digital circuits employing CMOS and TTL logic
3. Design, layout and test large scale integrated circuits employing CAD software (Tanner Tools)

ECE 126 – VLSI Design and Simulation

1. Understand CMOS VLSI design techniques
2. Use CADENCE CAD tools to design and simulate VLSI chips
3. Design medium size VLSI chips for implementation on the MOSIS chip and have the chips fabricated by MOSIS

ECE 127 – VLSI Fabrication Techniques

1. Understand basic processing steps of modern IC
2. Understand deep submicron techniques of fabrication
3. Understand limitations and problems of current technology

ECE 128 – Testing of VLSI Circuits

1. *Understand basic principles of testing electronic systems*
2. *Test his/her previously designed chip in the laboratory*
3. *Understand basics of IC design automation and ASIC design*

ECE 134 – Optical Systems

1. *Understand the basic principles how fiber optical parts and systems work*
2. *Design and specify optical communication systems*
3. *Choose and evaluate system components, such as fibers, light sources, detectors, couplers, etc.*

ECE 140 – Design of Switching Systems I

1. *Understand basic logic design and principles of combinational and sequential circuits design*
2. *Use VHDL techniques to design and simulate logic circuits*
3. *Design and build simple digital circuits in the laboratory using basic logic gates and CAD software*

ECE 141 – Microprocessors: Software, Hardware, and Interfacing

1. *Understand the basic architecture of a current 16-bit microprocessor with hands on experience*
2. *Use assembly language for programming of the target microprocessor*
3. *Understand the correspondence between instruction execution and the timing signals on the microprocessor external buses and pins*
4. *Understand the interrupt structures and microprocessor interfacing to memory and simple I/O subsystems*

ECE 143 – Communications Engineering I

1. *Understand the basic concept and principles of modern communication systems*
2. *Understand the mathematical tools for signal and system representation and analysis*
3. *Use mathematical tools to model and analyze properties of transmitters, channels and receivers*
4. *Design communication system blocks that satisfy specified requirements*

ECE 144 – Introduction to Computer Networks

1. *Understand the basic concepts and principles of modern communication networks*
2. *Model and analyze communication networks using mathematical tools*
3. *Design communication networks with specified requirements*

ECE 146 – Communications Laboratory

1. *Understand how practical electrical communication systems work*
2. *Design, analyze, build and test circuits used in communication systems*

ECE 147 – Data Communications Laboratory

1. *Understand how communication networks work*
2. *Design and analyze network protocols using network simulation software*

ECE 148 – Simulation of Communication Systems**ECE 150 – Introduction to Telemedicine****ECE 151 – Signal and Image Analysis***ECE 153 – Biomedical Engineering Seminar I*

1. *Demonstrate understanding of the breadth of the application areas of Biomedical Engineering*

2. *Determine the area of the Biomedical Engineering field that best suits his or her individual interests and career goals*
3. *Work in small groups to achieve defined project objectives*

ECE 154 – Biomedical Engineering Seminar II

1. *Locate, read, and critique journal articles in specific areas of Biomedical Engineering*
2. *Give effective oral presentations of research findings in various Biomedical Engineering topics*
3. *Demonstrate understanding of potential career opportunities available in their area of interest within Biomedical Engineering*

ECE 155 – Biomedical Engineering Seminar III

1. *Decompose engineering systems into functional block diagrams*
2. *Select, investigate, and propose a potential project for the capstone design project course sequence*
3. *Understand the key aspects of biomedical signals as they are related to physiological measurement systems*

ECE 156 – Electrical, Computer, and Biomedical Engineering Capstone Project Lab I

1. *Understand the constraints placed on the selection and definition of engineering projects (e.g., limited time, money, staff expertise, resources, etc.), and incorporate these constraints into the selection of your own project*
2. *Understand basic issues, concepts and procedures in engineering practice including basic graphical representations of design such as the various types of electrical schematic diagrams, mechanical drawings, context diagrams, requirements and specifications, cost estimation, cost and time tracking, etc. Introduce Microsoft Project and AutoCAD*
3. *Select a senior project that meets the above constraints; conceive of a preliminary design for that project; perform suitable proof-of-principle demonstrations*
4. *Prepare the Preliminary Design Review, the traditional first formal step in a new engineering project*

ECE 157 – Electrical, Computer, and Biomedical Engineering Capstone Project Lab II

1. *Understand more advanced concepts and procedures in engineering design including the large variety of graphical and other representations needed to fully convey a design, design vs. implementation, logical vs. physical decomposition, functional vs physical decomposition, etc.*
2. *Convey the importance of performing (a) order-of-magnitude calculations of expected noise and signal levels; (b) appropriate design verification procedures (e.g., simulations such as Spice); and (c) appropriate test procedures for the system as a whole, as well as testing individual modules*
3. *Prepare and deliver the traditional documentation and oral presentations for the middle of an engineering project (e.g., Critical & Final Design Reviews)*
4. *Complete the design of your senior project*

ECE 158– Electrical, Computer, and Biomedical Engineering Capstone Project Lab III

1. *Submit a viable implementation plan which includes items such as a Bill of Materials, PCB layout files and AutoCAD or other mechanical drawings...*
2. *Design and execute test procedures appropriate to your particular project*
3. *Integrate the various major systems comprising their project, e.g., electrical, mechanical, optical, chemical, etc.*
4. *Prepare and deliver the traditional documentation and oral presentations for the post-design phase of an engineering project (e.g., BFD (and BOM), Progress Reports, Engineering Change Notices, and Final Product Review) utilizing the tools and procedures described above as applied to their own project*

ECE 159 – Biomedical Properties Laboratory

1. *Understand fundamental physical processes in the body at the cellular level, including diffusion, transport, and optical properties*

2. *Demonstrate, through physical experiment and simulation, understanding of the interplay among the fundamental processes*
3. *Understand the implications of the microscopic behavior for the integrity of the organism as a whole*

ECE 160 – Modern Measurements & Sensors

1. *Select the proper method, principle of measurement, and the sensor/actuator in order to detect, modify, record, transmit, control, and analyze electronic signals, of physical, chemical, mechanical, biological origin*
2. *Specify and build the system for this purpose, including the input signal conditioning, sensor, interface electronics, data transmission devices*
3. *Make decisions based on cost and performance analysis*

ECE 161 – Introduction to Embedded Systems

1. *Understand functional and architectural characteristics of a microcontroller, memory devices, and key peripheral devices*
2. *Understand polling, interrupts and interfacing techniques*
3. *Interface a microcontroller to digital and analog devices such as timers, keyboards, LCD monitors, step motors, A/D and D/A converters*
4. *Program a microcontroller using assembler, C and mixed (C and assembler) language*
5. *Implement real-time controllers for a real-time application using interrupts and timer subsystem*

ECE 162 – Design of Logic Systems II

1. *Understand in detail complex logic design*
2. *Understand FPGA and its use in modern design*
3. *Use CAD to design FPGA circuits and realize the design in the laboratory*

ECE 166 – Electrical Power Laboratory

1. *Test dc machines and three phase simple ac machines*
2. *Estimate power, current & voltage limitations of machines*
3. *Test modern power electronic control circuits for machine control*

ECE 168 – Microwave and Optics Laboratory

ECE 172 – Control Systems Design

1. *Analyze the dynamical behavior of SISO linear systems*
2. *Understand the purpose of feedback in system behavior*
3. *Design pole-placement feedback control systems using the root-locus technique*
4. *Design control feedback compensators using the Nyquist frequency technique*

ECE 176 – Control System Laboratory

1. *Use the principles taught in companion course ECE 172 to design control systems for actual (hardware) processes*
2. *Program the digital computer for real-time data acquisition, conversion, and control of laboratory processes*
3. *Use Matlab to simulate open and closed-loop linear and non-linear processes*

ECE 177 – Electrical Energy Conversion

1. *Understand magnetic circuits*
2. *Use electromagnetic and circuit techniques to develop simple models*
3. *Understand performance characteristics of machines and transformers*
4. *Apply various machines to practical environments*
5. *Apply power electronic circuits for speed and torque control*

ECE 178 – Electrical Power Systems

1. *Analyze three phase ac circuits, both balanced & unbalanced, in an electrical power environment*
2. *Estimate power, current & voltage limitations of transmission lines and synchronous generators*
3. *Understand modern computer methods to the solution of electrical power system problems*

ECE 181 Computer Organization

1. *Understand the organization of a simple computer system including memory and ALU*
2. *Understand the instruction set architecture options*
3. *Understand the role of assembly language as an interface between hardware and high-level programs, using a RISC processor assembly language such as MIPS*
4. *Understand processor microarchitecture concepts including processor datapath and basic control concepts*
5. *Understand the architectures and tradeoffs behind hardware arithmetic units including adders and multipliers*

ECE 182 – Computer Systems Architecture

1. *Understand the role of performance metrics and benchmarking in designing computer systems*
2. *Understand instruction pipelining and instruction level parallelism and how it can be exploited*
3. *Understand the design of the memory subsystem and interleaving*
4. *Understand the memory hierarchy, and virtual memory management*
5. *Understand I/O subsystems interfacing and arbitration*

ECE 184 – Introduction to Medical Engineering

1. *Understand and use biomedical terminology as it describes the body's structure and systems*
2. *Understand the logical and physiological interrelationships among the body's systems that work to maintain homeostasis*
3. *Understand and describe the sources of physiological signals, and the corresponding functional aspects and limitations of basic medical instrumentation*

ECE 186 – Medical Engineering Laboratory

1. *Understand the principles of medical instrument design and application, from the points of view of both electronics and physiology, and with regard to their safety considerations*
2. *Demonstrate the ability to use instruments and computers in measuring, recording, and analyzing physiological measurements*
3. *Demonstrate the ability to write clearly and vigorously while making clear the reproducibility of the work*

ECE 187 Introduction to Medical Imaging Methods

1. *Understand the fundamental physics that underlie conventional medical imaging technologies*
2. *Understand the advantages and disadvantages of the most widely used medical imaging modalities*
3. *Understand basic image characteristics such as resolution, contrast, etc.*
4. *Understand how linear systems methods, such as the Fourier transform, are applied to medical image formation*

ECE 188 – Introduction to Parallel and Distributed Computers

1. *Understand the architectural differences among parallel computer systems*
2. *Understand parallel computations and parallel algorithms*
3. *Understand interprocessor communication techniques*
4. *Understand issues of concurrency control and synchronizations in parallel and distributed systems*
5. *Understand the current trends in parallel and distributed computer systems including massively parallel systems, clusters and grids*

ECE 192 – Robotic Systems

- 1. To provide an introduction of robotics fundamentals**

ECE 196 – Robotics Laboratory

- 1. To provide laboratory education in robotics taught in ECE 192, and hands-on experience**