ELECTRICAL ENGINEERING

HANDBOOK

UNIVERSITY OF NEVADA, LAS VEGAS

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

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This handbook describes the undergraduate Electrical Engineering major at the University of Nevada, Las Vegas. The handbook includes the following sections.

1. OVERVIEW OF THE ELECTRICAL ENGINEERING MAJOR

Electrical engineering is the application of scientific and mathematical principles to the design, manufacture, and control of structures, machines, processes, and systems. In the past, the work of electrical engineers has had a direct and vital impact on people's lives. Electrical engineers have been responsible for the creation of electric power, modern electronics, computers, electronic communication systems, modern flight controllers, automated manufacturing, and medical diagnostic tools. An electrical engineering education continues to provide opportunities for solving problems of great social significance and for increasing people's quality of life.

The electrical engineering program, accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org), spans the disciplines of electronics, computers, circuits, electromagnetic fields, photonics, power systems, controls, communications, signal processing, and solid state materials and devices. The degree requires a minimum of 121 credit hours which include at least 27 credit hours from UNLV's General Education Core. Graduates of the program will receive a Bachelor of Science in Engineering with a major in Electrical Engineering.

The Department also offers a major in Computer Engineering. For further information about that major, a separate handbook is available on the Electrical and Computer Engineering Department website.

2. MISSION, PROGRAM OBJECTIVES, AND OUTCOMES

2.1 THE MISSION OF THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

The mission of the Department of Electrical and Computer Engineering is to serve society as a center of higher learning by providing an electrical and computer engineering education to society's future leaders, innovators, and engineers.

Goals

1. Provide undergraduate, graduate, and professional education.
2. Create knowledge through research.
3. Disseminate knowledge through publication.
4. Provide private and public service, in as much as said service educates, creates and disseminates knowledge, or functions as a repository of knowledge.

2.2 ELECTRICAL ENGINEERING PROGRAM EDUCATIONAL OBJECTIVES

The Program Educational Objective of the Electrical Engineering program is to create, apply, and disseminate knowledge immediately or within a few years after graduation the graduate

1. Can successfully practice and mature intellectually in the field of Electrical Engineering or a related field.
2. Can be admitted to and successfully progress through a post graduate program in Electrical Engineering or related program.

2.3 ELECTRICAL ENGINEERING STUDENT OUTCOMES

To achieve these objectives and goals, each graduate of the Electrical Engineering major will attain the following outcomes before graduation:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

3. ELECTRICAL ENGINEERING MAJOR ENTRANCE REQUIREMENTS

To enter the Electrical Engineering (EE) major, a student must be admitted to the College of Engineering. Students who have been admitted to the College of Engineering and are interested in being admitted to the EE major will be placed in the Electrical Engineering pre-major (EEPRE). A student in the EEPRE is eligible to submit an application to the Engineering Advising Center for advanced standing in the EE major after completing 18-credit Electrical Engineering pre-major (EEPRE) curriculum listed below. Students who have not completed the EEPRE curriculum and do not have advanced standing in the EE major cannot enroll in upper division Electrical Engineering courses *except* for those listed below in the EEPRE Extended Curriculum.

ELECTRICAL ENGINEERING PRE-MAJOR (EEPRE) CURRICULUM

Sciences (4 credits)

- PHYS 195 Physics for Scientists and Engineers A
- PHYS 195L Physics for Scientists and Engineers Lab A

Mathematics (8 Credits)

- Math 181 Calculus I
- Math 182 Calculus II

Electrical and Computer Engineering (4 credits)

- CpE 100 Digital Logic Design I
- CPE 100L Digital Logic Design I Laboratory

Computer Science (3 credits)

- CS 135 Computer Science I

ELECTRICAL ENGINEERING PRE-MAJOR (EEPRE) EXTENDED CURRICULUM

Sciences (4 credits)

- PHYS 196 Physics for Scientists and Engineers B
- PHYS 196L Physics for Scientists and Engineers Lab B

Mathematics (10 Credits)

- MATH 283 Calculus III
- MATH 431 Mathematics for Engineers and Scientists I
- (MATH 432 Mathematics for Engineers and Scientists II or
- CPE 260 Theory of Systems)

Electrical and Computer Engineering (11 credits)

- CPE 200 Digital Logic Design II
- CPE 200L Digital Logic Design II Laboratory
- EE 220 Circuits I
- EE 220D Circuits I Discussion
- EE 221 Circuits II
- EE 221L Circuits II Laboratory

4. ELECTRICAL ENGINEERING CURRICULUM

The undergraduate Electrical Engineering major requires the completion of courses in the following areas, which are described in the remainder of this section.

• General Education Core:	27-30	credits
• Math, Computer Science, and Natural Science:	29	credits
• Fundamental Courses:	34	credits
• Core Courses:	12	credits
• Labs:	3	credits
• Professional Electives:	12	credits
• Math/Science Elective:	4	credits
TOTAL:	**121-124**	**credits**

4.1 REQUIRED UNLV GENERAL EDUCATION CORE COURSES (27-30 CREDITS)

English Composition (6 credits)

- ENG 101 Composition & Rhetoric I
- ENG 102 Composition & Rhetoric II

Seminars (2-3 credits)

- EGG 101 Introductory Engineering Experience (1 Credit)
- EGG 202 Second Year Hands-on Design Experiences in Engineering and Computer Science (1 Credit)

Constitutions (4-6 credits)

- Choose one from this list (Recommended):
  - Satisfies both US and Nevada Constitution requirements:
    - ECON 200, HIST 100, HON 111, HON 112, or PSC 101
- Or choose one from each of the following two lists:
  - Satisfies US Constitution requirement
    - GWK 350, HIST 101, HIST 401, HIST 412, PSC 304, PSC 330, PSC 409C, or URST 241
  - Satisfies Nevada Constitution requirement
    - HIST 102, HIST 217, HIST 402, HIST 417A, PSC 100, and PSC 401D.

Social Science (6 credits)

- CEE 307 Engineering Economics
- See the Faculty Senate General Education webpage for courses that satisfy this requirement. (Not ECON)

Humanities (6 credits)

- PHIL 242 Ethics For Engineers and Scientists (counted towards Ethics)
- Humanities course (any Humanities course, except PHIL 242. See the Faculty Senate General Education Core Requirements website for courses that satisfy this requirement.)

Fine Arts (3 credits)

- See the Faculty Senate General Education website for courses that satisfy this requirement.

Mathematics - Credits: (Fulfilled by Major Requirements)

- MATH 181 - Calculus I

Multicultural and International Requirements (overlap)

- Multicultural requirement (3 credits)
- International requirement (3 credits)

The multicultural and international requirements can simultaneously fulfill other general education core requirements; however, a single course cannot meet the multicultural and international requirements simultaneously. To determine courses satisfying these requirements, consult the Faculty Senate General Education Committee.

4.2 REQUIRED MATHEMATICS, COMPUTER SCIENCE, AND NATURAL SCIENCE COURSES (29 CREDITS)

CS 135	Computer Science I
MATH 181	Calculus I (also counted as UNLV General Education Core Requirements)
MATH 182	Calculus II
MATH 283	Calculus III
MATH 431	Mathematics for Engineers and Scientists I
(MATH 432	Mathematics for Engineers and Scientists II
or MATH 459	Elementary Complex Analysis
or CPE 260	Theory of Systems)
PHYS 195	Physics for Scientists and Engineers A
PHYS 195L	Physics for Scientists and Engineers Lab A
PHYS 196	Physics for Scientists and Engineers B
PHYS 196L	Physics for Scientists and Engineers Lab B

4.3 REQUIRED ELECTRICAL ENGINEERING FUNDAMENTAL COURSES (34 CREDITS)

Each student must complete the following courses:

CPE 100	Digital Logic Design I
CPE 100L	Digital Logic Design I Laboratory
CPE 200/D	Digital Logic Design II + Discussion (must be taken or re-taken together)
CPE 200L	Digital Logic Design II Laboratory
EE 220/D	Circuits I + Discussion (must be taken or re-taken together)
EE 221	Circuits II
EE 221L	Circuits II Laboratory
EE 320	Electronics I
EE 320L	Electronics I Laboratory
EE 330/D	Engineering Electromagnetics + Discussion (must be taken or re-taken together)
EE 360	Signals and Systems + Discussion
EE 361	Engineering Probability and Stochastic Processes
EE 370	Control Systems (or ME 421 - Automatic Controls)
EE 497	Senior Design Project I
EE 498	Senior Design Project II

4.4 REQUIRED ELECTRICAL ENGINEERING CORE COURSES (12 CREDITS)

Each student must complete at least one course in four out of the nine core areas below:

Communications
- EE 460 Analog and Digital Communications

Computers
- CPE 300 Digital System Architecture and Design
- CPE 301 Embedded Systems Design
- CPE 302 Synthesis and Verification using Programmable Devices

Controls
- EE 472 Digital Control Systems

Digital Signal Processing
- EE 480 Digital Signal Processing

Electromagnetism
- EE 430 Transmission Lines
- EE 431 Engineering Optics
- EE 432 Antenna Engineering
- EE 436 Active and Passive Microwave Engineering

Electronics
- EE 420 Electronics II
- EE 421 Digital Electronics

Photonics and Quantum Engineering
- EE 310 Principles of Solid State and Optoelectronic Systems
- EE 452 Optical Electronics

Power
- EE 340 Power System Engineering

Solid State
- EE 450 Solid State Devices

4.5 REQUIRED ELECTRICAL ENGINEERING LABORATORY COURSES (3 CREDITS)

Each student must complete at least three laboratory courses from any 300- or 400-level CPE or EE laboratory course (such as CPE 300L, CPE 310L, EE 340L, EE 420L, etc.):

CPE 3xxL	Any 300-level CpE laboratory course
CPE 4xxL	Any 400-level CpE laboratory course
EE 3xxL	Any 300-level EE laboratory course
EE 4xxL	Any 400-level EE laboratory course

4.6 REQUIRED ELECTRICAL ENGINEERING PROFESSIONAL ELECTIVE COURSES (12 CREDITS)

Each student must complete 12 credits of approved professional electives listed in Table 1. Professional electives do not include courses listed as requirements in other areas of the EE major. Students are encouraged to select sequences within a particular core field. Students who want to apply a professional elective that is not listed in Table 1, including ECG 600 and ECG 700 level graduate courses, toward their EE major must obtain approval from the Department Chair, Advising Center, and Associate Dean using the Course Consent Form.

Table 1: Professional Electives for Electrical Engineering

CPE 3xx	Any 300-level CpE course	EE 493	Independent Study (max 3 credits)
CPE 4xx	Any 400-level CpE course	MGT 497	Business Plan Creation
EE 3xx	Any 300-level EE course	EGG 460	Technology Commercialization
EE 4xx	Any 400-level EE course		

4.7 REQUIRED MATH / SCIENCE ELECTIVE COURSES (4 CREDITS)

All majors must also take 4 credits of elective math (MATH or STAT) or science (BIOL, CHEM, or PHYS) courses from the list below.

Table 2: Math/Science Electives for Electrical Engineering

CHEM 121A	General Chemistry I	MATH 468	Applied Finite Element Analysis
CHEM 121L	General Chemistry Laboratory I	PHYS 250	Special Relativity
CHEM 122A	General Chemistry II	PHYS 411	Modern Physics I
CHEM 122L	General Chemistry II Laboratory	PHYS 461	Light and Physical Optics
MATH 251	Discrete Math I	PHYS 462	Modern Optics
MATH 271	Elementary Probability	PHYS 483	Special Topics in Physics
MATH 330	Linear Algebra	STAT 467	Intro. to Mathematical Statistics
MATH 365	Computational Linear Algebra	STAT 493	Applied Regression Analysis
MATH 451	Foundations of Mathematics I	STAT 495	Nonparametric Statistics

4.8 GRADE REQUIREMENTS

All EE, CPE, EGG, ENG, ME, CS, BIOL, CHEM, MATH, PHYS, and STAT courses must be completed with a grade of C or higher.

4.9 MISCELLANEOUS REQUIREMENTS

Each student must also meet all College of Engineering requirements including those relating to college suspension and readmission. The Department can refuse to accept any course taken more than eight years prior to graduation.

5. COURSE PLANS AND GRADUATION APPLICATIONS

Every student must consult an advisor in the Engineering Advising Center every semester before registering and make or update a Degree Worksheet. One year before graduation the student should submit a Graduation application. The example schedules and degree worksheet located at the end of this handbook are provided to help guide students while planning their class schedules.

Electrical engineering students should expect to study about 2 to 3 hours per week outside class for each credit. For example, a student taking 16 credit hours should expect to spend 32 to 48 hours each week studying outside of class. Combined with time in class, this works out to a total of 48 to 64 hours spent on academic work. Students who are working while attending school should adjust their academic load accordingly. The following serves as an overall guideline.

Academic Load		**Expected Study Time**	**Maximum Non-Academic Workload**
Fall or Spring	**Summer**		
16 credits	6 credits	32 to 48 hours / week	0 to 8 hours / week
12 credits	3 credits	24 to 32 hours / week	8 to 16 hours / week
8 credits		16 to 24 hours / week	16 to 22 hours / week
3 credits		6 to 9 hours / week	32 to 40 hours / week

6. FACULTY

The faculty of the Department of Electrical and Computer Engineering are:

Yahia Baghzouz	Ebrahim Saberinia
Biswajit Das	Henry Selvaraj
Dema Govalla (visiting)	Roman Shugayev
Sarah Harris, **Undergraduate Coordinator**	Sahjendra Singh
Yingtao Jiang	Peter Stubberud
Pushkin Kachroo	Ke-Xun (Kevin) Sun
Shahram Latifi	Rama Venkat
Brendan Morris	Mei Yang, **Chair**
Venkatesan Muthukumar, **Graduate Coordinator**	Shengjie (Patrick) Zhai
Emma Regentova	
Jacob Baker (Emeritus)	Eugene McGaugh, Jr. (Emeritus)
William L. Brogan (Emeritus)	Robert Schill, Jr. (Emeritus)
Ramon Martinez (Emeritus)	

7. COURSE DESCRIPTIONS IN ELECTRICAL ENGINEERING

ELECTRICAL ENGINEERING

EGG 101 - Introduction to Engineering Experience

Seminar: Introduction to UNLV learning outcomes and the programs that reside within the College of Engineering. Topics include professional ethics, technical communication, the design process, and technology's impact on a global society. **1-2 credits**
Prerequisites: For undergraduate degree-seeking students only.
Notes: Combination of EGG 101 and EGG 202 satisfies First Year Seminar requirement.

EGG 202 - Second Year Hands-on Design Experiences in Engineering and Computer Science

A holistic experience for second-year engineering and computer science students. Lab work, improve study skills, strengthen/solidify their sense of community, career paths exploration, update of their academic plan. **1 credit**
Prerequisites: Sophomore standing and EGG 101.
Notes: Combination of EGG 101 and EGG 202 satisfies First Year Seminar requirement.

EE 220 Circuits I

Introduction to linear circuit analysis. Kirchhoff's laws, operational amplifiers, node and loop analysis. Thevenin, Norton, and other network theorems, first order RL and RC circuits, second order RLC circuits. **3 credits**
Prerequisite: MATH 182; **Corequisite**: EE 220D

EE 220D Circuits I Discussion

Introduction to PSpice simulation tool for electrical circuits, problem solving using SPICE. **0 credits**
Corequisite: EE 220

EE 221 Circuits II

Sinusoidal steady state analysis using phasors, sinusoidal steady state power, three-phase circuits, the Laplace transform and its application to circuit analysis, transfer functions, frequency response, magnetically coupled circuits and transformers, two-port networks. **3 credits**
Prerequisites: EE 220 and (CS 117 or CS 135)

EE 221L Circuits II Laboratory

Basic measurements and instrumentation. Principles of experimentation. **1 credit**
Corequisite: EE 221

EE 292 Fundamentals of Electrical and Computer Engineering

Introduction to electric circuit analysis, electronic devices and circuits, transducers, electric machines, and power transmission. For non-electrical engineering majors only. **3 credits**
Prerequisites: MATH 182 and (PHYS 195 or (PHYS 151A and PHYS 151L))

EE 310 - Principles of Solid State and Optoelectronic Systems

Modern experiments, concepts, and theory important for study in photonics, optoelectronics, solid state devices, and nanotechnology. Topics: electrons and photons, counting and interference experiments, optical resonator, Schrodinger equation, quantum dots, atoms, molecules, solids, Fermi-Dirac distribution, Bose-Einstein distribution, energy bands, photonic crystals. **3 credits**
Prerequisites: PHYS 196

EE 320 Engineering Electronics I
Circuit design and analysis using diodes and transistors. Introduction to semiconductor physics. Circuit simulation with SPICE. **3 credits**
Prerequisites: EE 221, PHYS 196, PHYS 196L, and (MATH 431 or CPE 260)

EE 320L Engineering Electronics I Laboratory
Laboratory-based analysis and design of electrical and electronic systems. **1 credit**
Prerequisite: EE 221L; **Corequisite:** EE 320

EE 330 Engineering Electromagnetics
Static electric and magnetic fields. Dielectric and ferromagnetic materials. Laplace's equation. Time varying electric and magnetic fields. Maxwell's equations. Plane waves in various mediums. Normal incidence. Engineering applications. **3 credits**
Prerequisites: EE 221, (PHYS 181 or PHYS 196), and MATH 431; **Corequisite:** MATH 432 or MATH 459 or CPE 260

EE 330D Engineering Electromagnetics Discussion
This discussion class reinforces electromagnetic theory and problem solving by applying the laws of nature in a vector calculus manner. **0 credits**
Corequisite: EE 330

EE 340 Power System Engineering
Electric energy sources (including renewable) and energy conversion principles, modeling and analysis of synchronous generators, transmission lines, transformers, AC machines, introduction to power system analysis including economic dispatch, power flow, fault calculations. **3 credits**
Prerequisite: EE 221

EE 340L Power System Engineering Laboratories
Measurement of power quantities, derivation of equivalent circuit parameters and characteristics of electric generators, transformers, transmission lines, AC motors, use of software packages for fault calculation, economic dispatch, and load flow analysis. **1 credit**
Corequisite: EE 340

EE 360 Signals and Systems
Deterministic signals and linear systems. Time domain description and analysis of analog and discrete linear systems. Analysis of linear systems using the Laplace transform and the *z*-transform. Block diagram and flow graph representation of signals and linear systems. Introduction to state space representation and analysis. **3 credits**
Prerequisites: (EE 221 or EE 292) and MATH 431; **Corequisites:** EE 360D and (MATH 432 or MATH 459 or CPE 260)

EE 360D Signals and Systems Discussion
Programming methods in signals and systems. Topics include generating signals, implementing systems including direct form and state space implementations, determining zero input and zero state responses of linear systems, plotting linear system frequency responses and generating pole zero plots from system functions. **0 credits**
Corequisite: EE 360

EE 361 Engineering Probability and Stochastic Processes
Stochastic and deterministic signals and linear systems. Analog and discrete Fourier series, analog and discrete Fourier transforms, basic probability theory, stochastic processes, stochastic signals, and linear systems. **3 credits**
Prerequisites: EE 360 and (MATH 432 or MATH 459 or CPE 260)

EE 370 Control Systems I
Introduction to control systems. Feedback control characteristics, performance, stability. Analysis, synthesis and design of feedback control systems. **3 credits**
Prerequisites: EE 360 and (MATH 432 or MATH 459 or CPE 260)

EE 370L Control Systems I Laboratory
Laboratory projects and exercises in feedback control. **1 credit**
Corequisite: EE 370

EE 411 Introduction to Quantum Space Science
Review of mechanics, quantum mechanics, electromagnetics, and optics. Survey of space environment, spacetime, special relativity, general relativity, gravitational wave. Space experimental verifications. Applications to GPS navigation. Entangled photons and space distribution for secure communication. Space quantum links. Projects on science instruments. **3 credits**
Prerequisites: Electrical Engineering or Computer Engineering majors must have completed EE 310 or EE 320 or EE 330. Other majors must have completed PHYS 181 or PHYS 196.

EE 411L Introduction to Quantum Space Science Laboratory
Project based laboratory course for quantum space science instrumentation. Laboratory safety and basic operations. Hands on design and experiments in electronics, photonics, programming. Quantum science space flight hardware and software. **1 credit**
Prerequisites: Electrical Engineering or Computer Engineering majors must have completed EE 310 or EE 320 or EE 330. Other majors must have completed PHYS 181 or PHYS 196.

EE 414 Quantum Communication
Review of quantum mechanics and wave optics. Quantum harmonic oscillators. Field quantization. Single mode, two mode, and multi-mode quantum optics. Quantum information. Semiclassical and quantum photo-detection. Fiber optics and free space communication channels. Quantum key distribution. **3 credits**
Prerequisites: Electrical Engineering or Computer Engineering majors must have completed EE 310 or EE 320 or EE 330. Other majors must have completed PHYS 181 or PHYS 196.

EE 415 Spacecraft and Payload Engineering
Mixed classroom and hands-on sessions on spacecraft and payload engineering. Space system design overview. Multi degrees of freedom ground test platform. Optical and vision sensors. Avionics. Computer control for rendezvous and proximity (RPO) operation. Mechanisms for space construction. Simultaneous Location and Mapping (SLAM). Flexible constellation flight. Quantum payloads in space. **3 credits**
Prerequisites: Electrical Engineering or Computer Engineering majors must have completed EE 310 or EE 320 or EE 330. Other majors must have completed PHYS 181 or PHYS 196.

EE 415L Spacecraft and Payload Engineering Laboratory
Project based laboratory course for quantum space science instrumentation. Laboratory safety and basic operations. Hands on design and experiments in electronics, photonics, programming. Quantum science space flight hardware and software. **1 credit**
Prerequisites: Electrical Engineering or Computer Engineering majors must have completed EE 310 or EE 320 or EE 330. Other majors must have completed PHYS 181 or PHYS 196.

EE 416 Space Sensors and Instruments
Astrophysical and space science concepts. Space environments. Spacecraft orbits. Spacecraft sensors for electromagnetic waves, photons, and particle radiation. Radiometry. Interferometry. Telescope design. Arrayed sensors. Remote sensing. CubeSats. Constellation flight. Case study of spacecraft, payload, and mission design. May involve hands-on projects. **3 credits**
Prerequisites: Electrical Engineering or Computer Engineering majors must have completed EE 310 or EE 320 or EE 330. Other majors must have completed PHYS 181 or PHYS 196.

EE 420 Engineering Electronics II
An introduction to the design, layout, and simulation of analog integrated circuits including current mirrors, voltage and current references, amplifiers, and op-amps. **3 credits**
Prerequisites: EE 320 and (Math 431 or CPE 260)

EE 420L Electronics II Laboratory
Applications and study of modern electronic analog and digital circuits. Advanced instrumentation. **1 credit**
Prerequisite: EE 320L; **Corequisite:** EE 420

EE 421 Digital Electronics
An introduction to the design, layout, and simulation of digital integrated circuits. MOSFET operation and parasitics. Digital design fundamentals including the design of digital logic blocks. **3 credits**
Prerequisite: EE 320

EE 421L Digital Electronics Laboratory
Digital circuit analysis. Discrete and integrated circuit technology, logic families, A/D-D/A circuits, comparators, Schmitt triggers. **1 credit**
Prerequisite: EE 320L; **Corequisite:** EE 421

EE 424 Biomedical Instrumentation
Principles of modern electronic design including microcomputer applications, transducer technology, digital design, interface design, biomedical information systems. **3 credits**
Prerequisite: EE 320 and Advanced Standing

EE 430 Transmission Lines
Telegraphist's equation; transient response, steady state response; reflection diagrams; Smith chart; matching techniques and designs; narrow and broadband impedance; scattering matrix; introduction to stripline and microstrip devices. **3 credits**
Prerequisite: EE 330

EE 431 Engineering Optics
Engineering applications of optics. Includes aperture and grating antennas, holography, optical image processing, optical waveguides, and tomography. **3 credits**
Prerequisites: EE 330 and (MATH 432 or MATH 459 or CPE 260)

EE 432 Antenna Engineering
Fundamentals of antennas and antenna design; linear wire, loop and antenna arrays. Antenna measurements. **3 credits**
Prerequisites: EE 330 and (MATH 432 or MATH 459 or CPE 260)

EE 436 Active and Passive Microwave Engineering
Waveguides, dispersion diagrams, microwave network analysis, broadband impedance matching, open and closed resonators, power dividers, directional couplers, filters, circulators, phase shifters, introduction to solid state amplifier or oscillator design. **3 credits**
Prerequisites: EE 330 and (MATH 432 or MATH 459 or CPE 260)

EE 438 Radar in Industry
Fundamentals of radar including industry applications such as mapping, imaging and electronic warfare.
Prerequisites: EE 320 or equivalent or consent of instructor.

EE 442 Power Electronics
Characteristics of static switches, AC-to-DC diode and thyristor rectifier circuits, DC-to-DC converters, DC-to-AC inverters, resonant converters, switch-mode DC power supplies, AC motor drives, residential and industrial applications, electric utility applications. **3 credits**
Prerequisites: EE 320 and EE 340

EE 446 Photovoltaic Devices and Systems
Solar resource characteristics, solar cell physics and technologies, cell electrical characteristics, PV module design, DC-AC inverters, battery energy storage and charge controllers, design of stand-alone and grid-connected PV Systems, economic considerations. **3 credits**
Prerequisites: MATH 182 or consent of instructor.

EE 447 Battery Energy Storage Systems
Explores the technical aspects of various battery technologies including their chemistry, performance, and degradation. Covers system-level considerations including battery pack design, management, and safety. Addresses applications in the electric grid (integration of renewable resources, energy arbitrage and ancillary services) and in transportation systems. **3 credits**
Prerequisite: EE 221 or EE 292

EE 450 Solid State Devices
Semiconductor physics, pn diode, bipolar junction transistor, metal semiconductor FET devices, metal oxide semiconductor FET devices. **3 credits**
Prerequisites: EE 320 and MATH 431

EE 450L Solid State Characterization Laboratory
Capacitance and voltage, Hall mobility and carrier concentration, oxidation and etching silicon dioxide processing of silicon. **1 credit**
Prerequisite: EE 450

EE 451 Electronic and Magnetic Materials and Devices
Semiconductors, dielectrics, ferroelectrics, antiferromagnetics, ferromagnetics, ferrimagnetics, crystal structure, structure-property relations, device applications. **3 credits**
Prerequisite: EE 330

EE 452 Optical Electronics
Electromagnetic theory of light, polarization, external modulation of light, Gaussian beams, cavity resonators, fiber optics, lasers, CW and pulsed operations, photodetectors, optical sensing, laser beam steering and scan, LIDAR, and display devices. **3 credits**
Prerequisite: EE 330

EE 453 Introduction to Nanotechnology
Overview of Nanotechnology, Physics of the Solid State and quantum mechanics, Properties of Individual Nanostructures, magnetic nanoparticles, Quantum Wells, Wires, and Dots, Fabrication and synthesis of nanoparticles, Self-assembly and catalysis, nanoscale electronic and optoelectronic devices, nanobiotechnology. **3 credits**
Prerequisite: EE 320

EE 454 Sensors and Sensor Systems
Sensors play a key role in Electrical Engineering applications including consumer electronics, autonomous vehicles, industrial manufacturing and many other areas. This course provides an overview of various types of sensors including their operational principles, underlying issues that govern sensor performance and the implementation of sensor based electronic systems. **3 credits**
Prerequisite: EE 320 or instructor consent

EE 456 Integrated Circuit Fabrication Processes
Integrated Circuits (IC) form the backbone of modern technology. This course provides an overview of device and circuit design and the processing steps for semiconductor device fabrication. Topics covered include the basic process steps of crystal growth, oxidation, photolithography, diffusion, ion implantation, and metallization used to build integrated circuits. **3 credits**
Prerequisite: EE 320 or instructor consent

EE 460 Introduction to Communication Systems
An introduction to analog and digital communication systems. Communication channels, modulation and demodulation, DSB, AM, SSB, FM and PM modulation schemes. Analog to digital conversation, sampling theorem, quantization noise and PCM systems. Line coding and digital carrier modulation schemes including ASK, PSK, FSK and QAM. **3 credits**
Prerequisite: EE 361

EE 460L Communication Systems Laboratory
Laboratory experiments related to the communication system theory taught in EE 460. The lab includes experiments related to spectrum analysis, AM and FM modulations and demodulations, analog to digital conversion, PCM coding, and baseband and carrier digital modulations. **1 credit**
Corequisite: EE 460

EE 462 Digital Communication Systems
Fundamentals of digital communication systems including Line Coding, ASK, PSK, FSK and QAM modulations, receiver design and performance evaluation, band-limited channels. **3 credits**
Prerequisite: EE 460

EE 466 Wireless and Mobile Communication Systems
The study of wireless systems including cellular telephone systems, wireless local area networks and other wireless data services. Topics include digital modulation techniques, frequency reuse, diversity techniques, multiple access schemes and channel modeling including path loss, shadowing, fading and multipath interference. **3 credits**
Prerequisite: EE 460

EE 472 Digital Control Systems
Introduction to discrete time of control. State space representation of linear systems; stability; the concepts of controllability and observability. Sample data control system design techniques, including pole placement, observer design. **3 credits**
Prerequisite: EE 370 or ME 421

EE 475 Autonomous Systems and Control

Autonomous multivariable systems, state space analysis, controllability, observability and stability, design of control systems, aircraft longitudinal and lateral dynamics, modal approximations, lateral and longitudinal autopilots, VTOL UAVs dynamics and control. **3 credits**
Prerequisite: EE 370

EE 480 Digital Signal Processing
Review of discrete linear system theory including the *z*-transform, the Fourier transform, discrete and fast Fourier transform. Sampling, reconstruction and multirate systems, IIR and FIR digital filter design including digital filter structures and finite word length effects. **3 credits**
Prerequisite: EE 361

EE 480L Digital Signal Processing Laboratory
Laboratory projects and exercises in digital signal processing including the design and implementation of FIR, IIR, and multirate systems. **1 credit**
Corequisite: EE 480

EE 482 Digital Signal Processing Applications
Application of signals and system theory. Topics may include audio and speech signal processing, image processing, multi-spectral imaging, biomedical signals, and active sensing technologies such as Radar and Lidar. **3 credits**
Prerequisite: EE 360

EE 493 Independent Study
Independent study of a selected engineering topic. May be repeated up to a maximum of three credits. Please verify that all credits will apply towards your degree. **1-3 credits**
Prerequisite: Senior standing in Electrical Engineering or Computer Engineering and departmental consent.

EE 495 Special Topics
Covers experimental and other topics which may be of current interest. Topics and credits to be announced. May be repeated once under a different topic. May have a laboratory. May be repeated to a maximum of six credits. **1-4 credits**
Prerequisite: Upper division standing in Engineering

EE 497 Senior Design Project I
Capstone synthesis course to teach students the design process from problem definition, team building, to project planning, paper design, written and oral communications. **1 credit**
Prerequisites: EE 320 and EE 320L. Senior standing and advanced standing and department consent

EE 498 Senior Design Project II
Capstone synthesis course to teach students hardware and software implementation of their projects proposed and paper-designed in EE 497, testing and recommendations, project presentation. **2 credits**
Prerequisite: EE 497 and final semester senior

COMPUTER ENGINEERING

CPE 100 Digital Logic Design I
Number systems, including unsigned binary and two's complement numbers. Logic gates. Boolean algebra. Combinational circuits. Introduction to sequential circuits. **3 credits**
Prerequisites: MATH 127 or MATH 128 or MATH 181

CPE 100L Digital Logic Design I Laboratory
Number Systems. Logic gates. Simplification of Boolean functions. Design and testing of combinational and sequential circuits. **1 credit**
Corequisite: CPE 100

CPE 200 Digital Logic Design II
Sequential circuits, finite state machines (FSMs), and integer arithmetic circuits. Timing analysis. Programmable logic devices (PLDs). Hardware Description Language (HDL). Assembly language. **3 credits**
Prerequisite: CPE 100; **Corequisite:** CPE 200L

CPE 200D Digital Logic Design II Discussion
HDL tools and assembly language. **0 credits**
Corequisite: CPE 200

CPE 200L Digital Logic Design II Laboratory
Design of sequential circuits, finite state machines (FSMs), and arithmetic circuits. Timing analysis. Use of programmable logic devices (PLDs) and hardware description languages (HDLs). Assembly language. **1 credit**
Prerequisite: CPE 100; **Corequisite:** CPE 200

CPE 260 Theory of Systems
Real and complex signals and linear time invariant (LTI) systems. Signal analysis using linear combinations of signals from linear signal spaces. Analysis of LTI systems described by linear constant coefficient differential equation using zero input and zero state responses, homogeneous and particular responses, and the Laplace transform. **3 credits**
Prerequisite: MATH 182

CPE 300 Digital Systems Architecture and Design
Design of dedicated digital systems and general microprocessors using HDL and CAD tools. RISC-V instruction set and assembly language. Performance analysis. Memory systems. **3 credits**
Prerequisite: CPE 200 and CPE 200L

CPE 300L Digital Systems Architecture and Design Lab
Design of dedicated digital systems and general-purpose RISC microprocessors using HDL tools and design platforms. Instruction sets and assembly language. Datapath and control unit design. Performance analysis. Memory systems. **1 credit**
Prerequisites: CPE 200 and CPE 200L**; Corequisite:** CPE 300

CPE 301 Embedded Systems Design
Microcontrollers and their application to a broad range of engineering problems. Microcontroller architecture, instruction set, and interfaces with sensors, actuators, motors, peripheral devices and communication modules. Assembly and C programming for microcontrollers. Use of simulation and emulation tools. **3 credits**
Prerequisite: CPE 200 or CS 218

CPE 310L Embedded Systems Design Laboratory for EE
Hands-on study of microcontroller applications for a broad range of engineering problems. Use of simulation and emulation tools. Assembly and C microcontroller programming. Hardware interface design and programming. **1 credit**
Prerequisites: CPE 200L and (EE 221L or EE 292)

CPE 302 Synthesis and Verification Using Programmable Devices
Advanced methodologies in the design of digital systems. Hardware Description Languages (HDLs). Simulation, synthesis, verification of digital system designs using FPGAs. FPGA placement, routing, and timing analysis tools. **3 credits**
Prerequisites: CPE 200 or CS 302

CPE 400 Computer Communications Networks
Computer network architecture; OSI model; network protocols; local area networks; communication technologies; Network performance analysis, with emphasis on hardware design issues. This course is crosslisted with ECG 600. Credit at the 600-level requires additional work. **3 credits**
Prerequisites: CPE 300, CS 370, and (MATH 431 or CPE 260).

CPE 403 Advanced Embedded Systems
Hardware and software for embedded systems using 32-bit microcontrollers. High-level language programming, simulation and debugging. RTOS for embedded systems. Project-based course. **3 credits**
Prerequisite: CPE 301

CPE 404 Modern Processor Architecture
Instruction-, data-, and thread-level parallelism. Scalar and superscalar pipelines. Instruction and data flow techniques. Memory hierarchy. Input/Output subsystem. Advanced architectures. **3 credits**
Prerequisite: CPE 300

CPE 405 Information Coding Systems
Information coding for efficient data storage and communication. Design and implementation of coding methods. **3 credits**
Prerequisites: MATH 431 or CPE 260; **Corequisites:** STAT 411 or EE 361

CPE 407 Biometrics and Machine Learning
Fundamentals of Biometrics Science and Technology with a balance between the basic theoretical background (probability theory, statistics, pattern recognition, signal processing) and practical applications. Some relevant topics from Machine Learning will also be covered. This course is crosslisted with ECG 607. Credit at the 600-level requires additional work. **3 credits**
Prerequisites: CPE 260 or EE 360 or MATH 431

CPE 408 VLSI Physical Design and Testing
VLSI CAD algorithms for partitioning, floor planning, placement, routing, layout, and compaction. Test process and equipment, fault modeling and simulation, defects, Automatic Test Pattern Generation (ATPG), built-in self-test, design for testability. **3 credits**
Prerequisites: CPE 300 and EE 320

CPE 409 Embedded DSP
DSP operations in spatial and transform domains. Hardware mapping techniques. Design of accelerator circuits for embedded audio and video processing. Introduction to high-level synthesis. **3 credits**
Prerequisites: CPE 300

CPE 417 Internet of Things Systems
Principles and design of Internet of Things systems. IoT operation, sensors and node types. Data management, IoT operating systems, and security. Project-based. **3 credits**
Prerequisites: CS 135 and (CPE 200 or CS 218).

CPE 418 Cloud Computing in Engineering
The concepts, architecture and operation of cloud computing from the perspective of engineering. Includes embedded systems, smart grids, Internet of Things, robotics/drones, photovoltaic systems, cybersecurity aspects of cloud in engineering, virtualization, data center outages and fault tolerance. The use of data science on the clouds dedicated for engineering systems. **3 credits**
Prerequisites: CS 135 and Advanced Standing.

CPE 476 Mobile Robotics
Design, implementation and programming of autonomous mobile robots, kinematics and dynamics of robots, basic control theory, sensors and actuators for robots, autonomous control, localization, mapping, navigation of robots, robot application development. Project-based course. **3 credits**
Prerequisites: CS 135 and CPE 301.

CPE 477 Embedded Security and Machine Learning
Design of embedded systems focused on security and machine learning. Current embedded security features, cryptography, and security in practice. Introduction to TinyML, quantization techniques, optimization of TinyML, and online- offline-training. Project-based course. **3 credits**
Prerequisites: CPE 301

CPE 485 Deep Learning on Computing Platforms
Foundational concepts in modern artificial intelligence, focusing on deep learning, basic neural network models, and their implementation on contemporary AI computing platforms, with hands-on experience running AI workloads on GPU-accelerated cloud environments and interpreting accuracy–performance–energy tradeoffs in a computer engineering context. **3 credits**
Prerequisite: CPE 200 and (CS135 or CS 138)

CPE 486 Engineering Foundations of Machine Learning
Introduces ML through the lens of signal processing and systems concepts, bridging classical techniques with modern AI. Topics include optimization, supervised and unsupervised learning, signals versus data, denoising versus data curation, and filtering versus convolutional networks. Emphasizes practical, mathematical methods for building robust models across a range of scientific backgrounds. **3 credits**
Prerequisite: CPE 260 or MATH 431 or MATH 459. Familiarity with Python and Matlab recommended.

CPE 487 AI System Validation and Assurance
Engineering approaches to identify/mitigate risks in AI system design/deployment. Bias detection and mitigation, model interpretability, privacy-preserving methods (e.g., differential privacy, federated learning), adversarial robustness, and AI-generated content detection. Practical methods to audit AI systems, implement fairness constraints, and design explainability mechanisms that make black-box models interpretable. Emphasis on applied evaluation/implementation. **3 credits**
Prerequisite: CPE 260 or MATH 431 or MATH 459. Familiarity with Python and Matlab recommended.

COMPUTER SCIENCE

The Computer Science Courses listed here are only the courses required for the Electrical Engineering Program. For a complete list of Computer Science Courses please refer to the UNLV Catalog.

CS 135 Computer Science I

Problem-solving methods and algorithm development in a high-level programming language. Program design, coding, debugging and documentation using techniques of good programming style. Program development in a powerful operating environment. **3 credits**
Prerequisite: MATH 127 or MATH 128 or MATH 181

8. EXAMPLE 4-YEAR PLAN & DEGREE WORKSHEET

Example 4-Year Plan		
Academic Year	**Fall Semester**	**Spring Semester**
Year 1	• MATH 181 (4) • EGG 101 (1) • CS 135 (3) • ENG 101 (3) • SOCIAL SCIENCE (3) **Total Semester Hours: 14**	• MATH 182 (4) • PHYS 195/L (4) • CPE 100/L (4) • ENG 102 (3) **Total Semester Hours: 15**
Year 2	• MATH 283 (4) • PHYS 196/L (4) • EGG 202 (1) • EE 220/D (3) • CPE 200/L (4) **Total Semester Hours: 16**	• MATH 431 (3) • EE 221/L (4) • CEE 307 (3) • PHIL 242 (3) • HUMANITIES (3) **Total Semester Hours: 16**
Year 3	• MATH 432 OR MATH 459 OR CPE 260 (3) • EE 320/L (4) • EE 330 (3) • EE 360 (3) • FINE ARTS (3) **Total Semester Hours: 16**	• EE 361 (3) • EE 370 (3) • EE CORE #1 (3) • EE CORE #2 (3) • CONSTITUTION (4) **Total Semester Hours: 16**
Year 4	• MATH/SCIENCE ELECTIVE (4) • EE CORE #3 (3) • EE CORE #4 (3) • EE/CPE PROF ELECT. #1 (3) • LAB #1 (1) • LAB #2 (1) • EE 497 (1) **Total Semester Hours: 16**	• EE/CPE PROF ELECT #2 (3) • EE/CPE PROF ELECT #3 (3) • EE/CPE PROF ELECT #4 (3) • LAB #3 (1) • EE 498 (2) **Total Semester Hours: 12**

Bachelor of Science in Engineering - Electrical Engineering
2026-27 Degree Sheet

Name: _____ **NSHE ID#:** _____

UNLV General Education Core (27-39 Credits)

English: 6 Credits		SEM	CRED	GRADE
ENG 101*			3	
ENG 102*			3	

First Year Seminar: 2-3 Credits

EGG 101 and EGG 202 Recommended		SEM	CRED	GRADE

Second Year Seminar: 0-3 Credits

***Phil 242 satisfies SYS & Humanities **(Engineering Students Only)**

***0 credits if Phil 242 taken as SYS		SEM	CRED	GRADE
*				

Constitution: 4-6 Credits

Recommended: PSC 101 or HIST 100 or HIST 101+102, or HIST 101+PSC 100 or HIST 101+HIST 217. **See full approved list of Constitution options in the 2026-27 catalog.**

		SEM	CRED	GRADE

Social Science: 6 Credits (Two different areas NOT ECON)

Choose from approved list in the 2026-27 catalog

**SEE NOTE BELOW		SEM	CRED	GRADE
CEE 307			3	
			3	

Fine Arts: 3 Credits

Choose from approved list in the 2026-27 catalog

**SEE NOTE BELOW		SEM	CRED	GRADE
			3	

Humanities: 6 Credits

Choose from approved list in the 2026-27 catalog

**SEE NOTE BELOW		SEM	CRED	GRADE
			3	
***PHIL 242			3	

Departmental Requirements: 94 Credits

Math/Science: 26 Credits		SEM	CRED	GRADE
MATH 181*			4	
MATH 182*			4	
MATH 283			4	
MATH 431			3	
MATH 432 or CPE 260 or MATH 459			3	
PHYS 195*			3	
PHYS 195L*			1	
PHYS 196			3	
PHYS 196L			1	

Math/Science Electives: 4 Credits

Chem 121A/L Recommended - See approved list		SEM	CRED	GRADE
			0	
			0	

EE/CPE Fundamentals: 37 Credits		SEM	CRED	GRADE
CS 135*			3	
CpE 100*			3	
CpE 100L*			1	
CpE 200/D			3	
CpE 200L			1	
EE 220/D			3	
EE 221			3	
EE 221L			1	
EE 320			3	
EE 320L			1	
EE 330/D			3	
EE 360/D			3	
EE 361			3	
EE 370			3	
EE 497			1	
EE 498			2	

EE Core: 12 Credits (Complete 1 course in 4 areas)				
Communications		SEM	CRED	GRADE
EE 460			3	
Computers: CPE 300, CPE 301 or CPE 302				
CpE 30X			3	
Controls				
EE 472			3	
Digital Signal Processing				
EE 480			3	
Electronics: EE 420 or EE 421				
EE 42X			3	
Electromagnetics: EE 430, EE 431, EE 432 or EE 436				
EE 43X			3	
Power				
EE 340			3	
Solid State				
EE 450			3	
Photonics and Quantum Engineering				
EE 310			3	
EE 452			3	

EE Labs: 3 Credits (Min. 3 credits of Labs)				
Choose any 300 or 400 Level EE or CPE Lab				
			1	
			1	
			1	

Professional Electives: 12 Credits		SEM	CRED	GRADE
			3	
			3	
			3	
			3	

ADVISOR NOTES:

_____

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IMPORTANT NOTES:

- **Per UNLV catalog, students are solely responsible for knowing and completing their degree requirements.**
- **Academic Advisors are available to help students understand and meet graduation requirements. Meet with your advisor regularly.**
- ***Designates courses to be completed as pre-major curriculum.**
- **** A 3-credit international and 3-credit multicultural class must be completed per UNLV GEN ED. requirements. The use of "Double-Dipper" courses are recommended, see approved list.**
- **All English, math, science, engineering courses must have a grade of "C" or higher for progression and graduation.**
- **Refer to the current Undergraduate Catalog for course prerequisites. Current course prereqs. apply to all students regardless of a students catalog of matriculation.** Catalog Link
- **The College of Engineering has a 3 attempt policy for all math, science and engineering courses. Discuss with your academic advisor.**
- **Upon completion of "pre" requirements students must meet with a faculty mentor and submit paperwork for advanced standing status.**
- **2.00 or higher UNLV GPA is required for graduation**
- **All studetns must have min. 30 credits of college level Math/Science and 45 credits of engineering coursework per ABET accreditation.**
- **The last 30 credits of your degree need to be taken uninterrupted from an NSHE institution.**
- **30 credits of upper division credits (300 or 400 level courses) must be taken at UNLV per NSHE requirement.**
- **Minimum number of semester units required for a bachelor's degee from UNLV is 120. EE students will have 121 credits or more.**

Total Credits: 121 - 133

Revised : 4/24/26 (CP)