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 (Accreditation Board for Engineering and Technology, Inc.) http://www.abet.org, spans the disciplines of electronics, computers, circuits, electromagnetic fields, 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.

<u>Goals</u>

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 credits of the 46-credit 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 180 Physics for Scientists and Engineers I
- PHYS 180L Physics for Scientists and Engineers Lab I

Mathematics (8 Credits)
- Math 181 Calculus I
- Math 182 Calculus II

Electrical and Computer Engineering (3 credits)
- CpE 100 Digital Logic Design I

Computer Science (3 credits)
- CS 135 Computer Science I

ELECTRICAL ENGINEERING PRE-MAJOR (EEPRE) EXTENDED CURRICULUM

Sciences (4 credits)
- PHYS 181 Physics for Scientists and Engineers II
- PHYS 181L Physics for Scientists and Engineers Lab II

Mathematics (10 Credits)
- MATH 283 Calculus III
- MATH 431 Mathematics for Engineers and Scientists I
- MATH 432 Mathematics for Engineers and Scientists II

Electrical and Computer Engineering (14 credits)
- CpE 200 Digital Logic Design II
- CpE 200L Digital Logic Design II Laboratory
- CpE 300 Digital System Architecture and Design
- 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:	33	credits
• Core Courses:	15	credits
• Labs:	4	credits
• Professional Electives:	9	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 - 2 Credits)
- EGG 202 Second Year Hands-on Design Experiences in Engineering and Computer Science (1 Credit)

Constitutions (4-6 credits)
- HIST 100 Historical Issues and Contemporary Man
- PSC 101 Introduction to American Politics (OR)
- a combination of one course from each of the following two lists
    - US Constitution
        - HIST 101 United States: Colonial Period to 1865
        - HIST 106 European Civilization Since 1648
    - Nevada Constitution
        - HIST 102 United States: 1865 to Present
        - HIST 217 Nevada History
        - PSC 100 Nevada Constitution

Social Science (6 credits)
- EGG 307 Engineering Economics
- See the Faculty Senate General Education web-page for courses that satisfy this requirement. (Not ECON)

Humanities (6 credits)
- PHIL 242 Ethics For Engineers and Scientists (counted towards Ethics)
- COM 216 Survey of Communication Studies

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
PHYS 180	Engineering Physics I
PHYS 180L	Engineering Physics I Laboratory
PHYS 181	Engineering Physics II
PHYS 181L	Engineering Physics II Laboratory

4.3 REQUIRED ELECTRICAL ENGINEERING FUNDAMENTAL COURSES (33 CREDITS)

Each student must complete the following courses:

CpE 100	Digital Logic Design I
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 I + Discussion
EE 361	Signals and Systems II
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 (15 CREDITS)

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

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

Electronics
- EE 420 Electronics II
- EE 421 Digital Electronics

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

Quantum Optics
- EE 310 Principles of Solid State and Optoelectronic Systems

Power
- EE 340 Power System Engineering

Solid State
- EE 450 Solid State Devices

Communications
- EE 460 Analog and Digital Communications

Controls
- EE 472 Digital Control Systems

Digital Signal Processing
- EE 480 Digital Signal Processing

4.5 REQUIRED ELECTRICAL ENGINEERING LABORATORY COURSES (4 CREDITS)

Each student must complete at least five laboratory courses from the following list:

CpE 300L	Digital Systems Architecture and Design Laboratory
CpE 310L	Embedded Systems Design Laboratory for EE
EE 340L	Power System Engineering Laboratory
EE 370L	Control System Laboratory
EE 420L	Engineering Electronics II Laboratory
EE 421L	Digital Integrated Circuit Design Laboratory
EE 450L	Solid State Characterization Laboratory
EE 460L	Communication Systems Lab
EE 480L	Digital Signal Processing Laboratory

4.6 REQUIRED ELECTRICAL ENGINEERING PROFESSIONAL ELECTIVE COURSES (9 CREDITS)

Each student must complete 9 credits of approved professional electives that are listed in Table 1. Of the 9 credits, six of the credits must be EE or CpE courses. Students are encouraged to select sequences within a particular core field. The other three credits must be mathematics or science courses (BIOL, CHEM, MATH, PHYS, STAT). Students who want to apply a professional elective that is not listed in Table 1 towards their EE degree must obtain the Department Chair's and the Undergraduate Curriculum Committee Chair's approval.

Table 1: Professional Electives for Electrical Engineering

Unless also listed below, the prerequisites for these courses do not qualify as professional electives.

CpE 400	Computer Communications Network	EE 466	Wireless and Mobile Comm.
CpE 403	Advanced Embedded Systems	EE 472	Digital Control Systems
CpE 404	Modern Processor Architecture	EE 480	Digital Signal Processing
CpE 405	Information Coding Systems	EE 482	Intro to Biomedical Signals and Systems
CpE 407	Biometrics and Machine Learning	EE 493	Independent Study
CpE 408	VLSI Physical Design and Testing	EE 495	Special Topics
CpE 409	Embedded DSP	CHEM 121	Chemistry I
CpE 476	Mobile Robotics	CHEM 121L	Chemistry I Laboratory
CpE 477	Embedded Security and Machine Learning	CHEM 122A	General Chemistry II
EE 310	Principles of Solid State and Optoelectronic Systems	MATH 271	Elementary Probability
EE 330	Engineering Electromagnetics	MATH 283	Calculus III
EE 340	Power System Engineering	MATH 330	Linear Algebra
EE 370	Control System	MATH 432	Mathematics for Engineers & Scientists II
EE 420	Electronics II	MATH 451	Foundations of Mathematics I
EE 421	Digital Integrated Circuit Design	MATH 468	Applied Finite Element Analysis
EE 430	Transmission Lines	PHYS 182	Physics for Scientists & Engineers III
EE 431	Engineering Optics	PHYS 250	Special Relativity
EE 432	Antenna Engineering	PHYS 411	Modern Physics I
EE 436	Active and Passive Microwave Eng.	PHYS 461	Light and Physical Optics
EE 442	Power Electronics	PHYS 462	Modern Optics
EE 446	Photovoltaic Devices and Systems	PHYS 483	Special Topics in Physics
EE 450	Solid State Devices	STAT 467	Intro. to Mathematical Statistics
EE 451	Electronic & Mag. Materials & Devic.	STAT 493	Applied Regression Analysis
EE 452	Intro to Optical Electronics	STAT 495	Nonparametric Statistics
EE 453	Introduction to Nanotechnology	MGT 497	Business Plan Creation
EE 460	Analog and Digital Communication	EGG 460	Technology Commercialization
EE 462	Advanced Digital Communication		

4.7 REQUIRED MATH / SCIENCE ELECTIVE COURSE (4 CREDITS)

All majors must also take an elective math (MATH or STAT) or science (BIOL, CHEM, or PHYS) course.

4.8 GRADE REQUIREMENTS

All EE, CpE, ME, CS, BIOL, CHEM, MATH, PHYS, and STAT courses must be completed with a grade of C or better.

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

7. COURSE DESCRIPTIONS IN ELECTRICAL ENGINEERING

ELECTRICAL ENGINEERING

All prerequisites must be completed with a grade of C or higher.

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 Credits.**
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**
Corequisite: EE 220D; **Prerequisite**: MATH 182

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 180 or PHYS 151)

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 181 with a minimum grade of C or better.

EE 320 Engineering Electronics I
Circuit design and analysis using diodes and transistors. Introduction to semiconductor physics. Circuit simulation with SPICE. **3 credits**
Prerequisites: CHEM 121, EE 221, PHYS 181, PHYS 181L, and (MATH 431 or CpE 260)

EE 320L Engineering Electronics I Laboratory
Laboratory-based analysis and design of electrical and electronic systems. **1 credit**
Corequisite: EE 320; **Prerequisites:** CHEM 121, EE 221, MATH 431 or CpE 260, PHYS 181, and PHYS 181L

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**
Corequisite: MATH 432 and EE 330D; **Prerequisites:** EE 221, PHYS 181, and MATH 431

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 and energy conversion principles, modeling and analysis of synchronous generators, transmission lines, transformers, AC and DC machines, brief introduction to power system analysis including power flow, fault calculation and economic dispatch. **3 credits**
Corequisite: EE 330; **Prerequisite:** EE 320

EE 340L Power System Engineering Laboratories
Measurement of different electric powers, measurement of equivalent circuit parameters and characteristics of electric generators, transformers, transmission lines, AC and DC motors, use of software packages for fault calculation and load flow. **1 credit**
Corequisite: EE 340; **Prerequisite:** EE 320L

EE 360 Signals and Systems I
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**
Corequisite: EE 360D and (MATH 432 or MATH 459); **Prerequisites:** (EE 221 or EE 292) and (MATH 431 or CpE 260)

EE 360D Signals and Systems I 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; **Prerequisites:** (EE 221 or EE 292) and (MATH 431 or CpE 260)

EE 361 Signals and Systems II

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)

EE 370 Classical Feedback and Control Systems

Introduction to control systems. Feedback control characteristics, performance, stability. Analysis, synthesis, and design of feedback control systems including digital techniques. **3 credits**
Prerequisites: EE 360 and (MATH 459 or MATH 432)

EE 370L Classical Feedback and Control Systems Laboratory

Introduction to using MATLAB to model/simulate control systems, feedback control characteristics, performance, stability, analysis, synthesis and design of feedback control systems including digital techniques. **1 credit**
Corequisite: EE 370; **Prerequisites:** EE 360 and (MATH 459 or MATH 432)

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: EE 310

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: EE 310

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

EE 420L Electronics II Laboratory

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

EE 421 Digital Integrated Circuit Design

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**
Prerequisites: CpE 100 and EE 320

EE 421L Digital Integrated Circuit Design Laboratory

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

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)

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)

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)

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
Topics include: Diode circuits and rectifiers, power semiconductor diodes and transistors, thyristors and static switches, controlled rectifiers, AC voltage controllers, DC choppers, inverters, AC and DC drives, power supplies, protection of devices and circuits. **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 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 Introduction to Optical Electronics

Topics include: modulation of light, display devices, lasers, photodetectors, fiber optics, engineering applications, and systems. **3 credits**
Prerequisite: EE 330

EE 453 Introduction to Nanotechnology

Overview of Nanotechnology, Physics of the Solid State, Properties of Individual Nanostructures, Bulk Nanostructured materials, magnetic nanoparticles, Quantum Wells, Wires and Dots, Self-Assembly and Catalysis, nanoscale Biological materials. **3 credits**
Prerequisite: EE 320

EE 460 Analog and Digital Communications

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

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. **1 credit**
Corequisite: EE 360

EE 462 Advanced Digital Communications

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

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**
Prerequisites: 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

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 Introduction to Biomedical Signals and Systems
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 361

EE 493 Independent Study
Independent study of a selected engineering topic. May be repeated once for credit. **1-3 credits**
Prerequisite: Senior standing in Electrical Engineering

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**
Prerequisite: Senior Standing and consent of faculty advisor

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 presentations. **2 credits**
Prerequisite: EE 497 and final semester senior

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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 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**
Corequisite: CpE 200D; **Prerequisite:** CpE 100

CpE 200D Digital Logic Design II Discussion

HDL tools and assembly language.
Corequisite: CpE 200

CpE 200L Digital Logic Design II Laboratory

Sequential circuits, finite state machines (FSMs), and integer arithmetic circuits. Timing analysis. Programmable logic devices (PLDs). Hardware Description Language (HDL). Assembly language. Modeling, verification, simulation and testing of design solutions using programmable logic devices and hardware description language (HDL). **1 credit**
Corequisite: CpE 200; **Prerequisite:** CpE 100

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

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. **Credits 1**
Corequisite: CpE 300; **Prerequisite:** CpE 200L

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 301L Embedded Systems Design Laboratory for CpE

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. Advanced projects using sensors, actuators, and communication protocols. **1 credit**
Corequisite: CpE 301; **Prerequisites:** CpE 200L

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. Advanced projects using sensors, actuators, and communication protocols. **1 credit**
Prerequisite: 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. **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, simulators, and emulators. RTOS (real-time operating systems) 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) and EE 220

CpE 407 Biometrics and Machine Learning

This course is designed to cover 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. **3 credits**
Prerequisites: 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. **Credits: 3**
Prerequisites: CS 135 and (CpE 200 or CS 218).

CPE 476 Mobile Robotics

Design, implementation and programming of autonomous mobile robots (UAVs and Rovers), kinematics and dynamics of robots, basic control theory, sensors and actuators for robots, autopilots and autonomous control, and robot application development. **3 Credits.**
Prerequisites: CS 135 and (CS 218 or CpE 200).

CPE 477 Embedded Security and Machine Learning

Design of hardware and software for embedded systems focused on security and machine learning. Introduction to embedded security, Cryptography, current embedded security features, and security in practice. Introduction to TinyML, quantization techniques, optimization of TinyML, and online- offline-training. Project-based, requiring the design/construction of an embedded system. **3 Credits.**
Prerequisites: CpE 301

COMPUTER SCIENCE

The Computer Courses listed here are only the courses required by the Computer Engineering Program. For a complete list of Computer Science Courses please refer to the 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. 3 hours lecture and 3 hours recitation. **3 credits**
Prerequisite: MATH 127 or MATH 128

CS 202 Computer Science II

Data structures and algorithms for manipulating liked lists. String and file processing. Recursion. Software engineering, structured programming and testing, especially larger programs. **3 credits**
Prerequisite: CS 135

CS 302 Data Structures

Introduction to sequential and linked structures. File access including sequential indexed sequential and other file organizations. Internal structures including stacks, queues, trees and graphs. Algorithms for implementing and manipulating structured objects. Big-O notation. **3 credits**
Prerequisites: CS 202 and MATH 181

CS 326 Programming Languages, Concepts, and Implementation

Design, evaluation and implementation of programming languages. Includes data types and data abstraction, sequence control and procedural abstraction, parameter passing techniques, scope rules, referencing environments and run-time storage management. Study and evaluation of a number of current programming languages. **3 credits**
3 credits: CS 302 and (CS 219 or CpE 300)

CS 370 Operating Systems

Operating systems organization, sharing and allocation of system resources, protection mechanisms and integration of system components. **3 credits**
Prerequisites: CS 302 and (CS 219 or CpE 300)

CS 465 Computer Networks

Data communication fundamentals. The hardware components, topology, interconnections, software, protocols and uses of computer networks. The OSI protocol. The physical datalink, network, transport, session, presentation and application layers. **3 credits**
Prerequisite: CS 370

CS 472 Software Product Design and Development I

A formal approach to current techniques in software design and development. Students work in teams in the organization, management, and development of a large software project. **3 credits**
Prerequisites: CS 326 and CS 370

CS 445 - Internet Security

Internet security theory and practice, advanced IP concepts, the concepts of stimulus and response in the context of securing a network, network packet and traffic analysis, internet protocol (IP) vulnerabilities, packet filtering, intrusion detection, internet exploits, exploit signatures, internet forensics, network security investigation. **Credits 3**
Prerequisites: CS 370.

CS 458 Introduction to Data Mining

Introduction to basic concepts in data mining. Topics include association-rule mining, information extraction, web mining, categorization, and clustering. **Credits 3**
Prerequisites: CS 302 and MATH 251.

8. EXAMPLE COURSE SCHEDULES AND DEGREE WORKSHEET

ELECTRICAL ENGINEERING
FOUR-YEAR PROGRAM

EE	FALL	SPRING	Credits
YEAR I	ENG 101 (3) Constitutional Requirement (4) MATH 181 (4) EGG 101/101L (1-2) CPE 100 (3) 15 Credits	ENG 102 (3) MATH 182 (4) PHY 180 +L (4) CS 135 (3) Social Science (3) 17 Credits	32
YEAR II	PHY 181 + L (4) CPE 200+L (4) EE 220/D (3) MATH 283 (4) EGG 202 (1) 16 Credits	Fine Arts Elective/Multicultural (3) COM 216 (3) MATH 431 (3) EGG 307 (3) EE 221+L (4) 16 Credits	32
YEAR III	MATH 432 (3) EE 360/D (3) EE 320+L (4) EE 330/D (3) PHIL 242 (3) 16 Credits	EE 370 (3) EE 361 (3) EE Core Area I (3) EE Core Area 2 (3) EE Lab I & II (2) 14 Credits	30
YEAR IV	EE Core Area 3, 4, 5 (9) EE Lab 3, 4 (2) EE 497 (1) 12 Credits	EE Prof. Elective 1, 2, 3 (9) Non EE Prof. Elec. (4) EE 498 (2) 15 Credits	27
Credits	59	62	121

ELECTRICAL ENGINEERING
FIVE-YEAR PROGRAM

EE	FALL	SPRING	Credits
YEAR I	ENG 101 (3) Constitution Requirement (4) MATH 181 (4) EGG 101/101L (1-2) 12 Credits	ENG 102 (3) MATH 182 (4) PHY 180 +L (4) CPE 100 (3) 14 Credits	26
YEAR II	PHY 181 + L (4) EGG 202 (1) CS 135 (3) MATH 283 (4) 12 Credits	CPE 200 + L (4) EE 220/D (3) MATH 431 (3) PHI 242 (3) 13 Credits	25
YEAR III	MATH 432 (3) EE 221 + L (4) Fine Arts Elective (3) COM 216 (3) 13 Credits	EGG 307 (3) EE 320 + L (4) EE 360/D (3) Social Sci. (3) 13 Credits	26
YEAR IV	EE Core 1, 2 (6) EE 361/D (3) EE 330/D (3) EE Lab 1, 2 (2) 14 Credits	EE 370 (3) Math/Sci Elective (4) EE Core 3 (3) EE Lab 3 (1) 11 Credits	25
YEAR V	EE Core 4, 5 (6) EE Lab 4 (1) EE 497 (1) EE Elective 1 (3) 11 Credits	EE Elective 2, 3 (6) EE 498 (2) 8 Credits	19
Credits	62	59	121

ELECTRICAL ENGINEERING DEGREE WORKSHEET
2022 – 2023 CATALOG

UNLV General Education Core (27-30 credits)
English: 6 Credits

		Sem	Cred	Grade
ENG 101			3	
ENG 102			3	

Seminars: 2-3 Credits.

EGG 101/101L			1-2	
EGG 202			1	

Constitution: 4-6 Credits. Choose from: PSC 101(4), HIST 100(4), or a combination from US Const: HIST 101 (3) or 106 (3); NV Const: HIST 102 (3), HIST 217 (3), or PSC 100(1).

Social Sciences: 6 Credits *

***/*			3	
EGG 307			3	

***Social Science course from an area other than economics

Humanities: 6 Credits *

$	(Multi& Int)		3	
PHIL 242**			3	

$ humanities courses to satisfy Multi-cultural and International requirement

Fine Arts: 3 Credits of appreciation or introduction courses in art, music, theater, and dance*.

			3	

Departmental Requirements:
Major-Related Fields: 26 Credits

		Sem	Cred	Grade
MATH 181			4	
MATH 182			4	
MATH 283			4	
MATH 431			3	
MATH 432 or 459			3	
PHYS 180/L			4	
PHYS 181/L			4	

Computer Science Requirements: 3 Credits

		Sem	Cred	Grade
CS 135			3	

NOTES:

$ or * =	A 3-credit multicultural and International requirement must be completed

EE Fundamentals: 33 Credits

		Sem	Cred	Grade
CpE 100			3	
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: 15 Credits. Must complete at least 1 course in 5 areas.

		Sem	Cred	Grade
	Communications		3	
EE 460				
	Computers		3	
CpE 30X				
	Controls		3	
EE 472				
	DSP		3	
EE 480				
	Electronics		3	
EE 42X				
	E&M		3	
EE 43X				
	Power		3	
EE 340				
	Solid State		3	
EE 450				
	Quantum Optics			
EE 310			3	

EE Labs: 4 Credits. Must complete at least 4 credits of laboratories

		Sem	Cred	Grade
CpE 300L				
CpE 310L				
EE 340L				
EE 370L				
EE 420L				
EE 421L				
EE 450L				
EE 460L				
EE 480L				

Electrical Engineering Professional Electives: 9 Credits.
9 credits from EE/CpE or approved courses only (no exceptions allowed).

		Sem	Cred	Grade

Math/Science Elective: 4 Credits. 4 credits from math (MATH or STAT) or science (BIOL, CHEM, or PHYS)

		Sem	Cred	Grade
**				

** CHEM 121/L recommended

Total Credits: 121 (min)