COMPUTER ENGINEERING

HANDBOOK

UNIVERSITY OF NEVADA, LAS VEGAS

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

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

1. OVERVIEW OF THE COMPUTER ENGINEERING MAJOR

Computer engineering is the application of scientific and mathematical principles to the design and analysis of hardware, software, and operating systems for a computer system. Computer engineering integrates several fields of electrical engineering and computer science, and it is one of the most vibrant and constantly changing fields in engineering. Computational capability that was only possible by machines that weighed tens of tons and required thousands of square feet of room space not long ago are now afforded by chips smaller than a thumbnail. Billion-transistor chips and terabyte storage are now a reality, and petaflop performance is within reach. On the other hand, software consideration has become an essential aspect of the design process. Devices such as cell phones, digital audio players, digital video recorders, alarm systems, x-ray machines, and laser surgical tools all require integration of hardware and software.

This discipline covers the study of hardware, software, and their integration. As such, students learn the principles of electricity, signals and systems, and technologies used in making digital devices. They further study programming languages, data structure, operating systems, and databases. The knowledge acquired in the first three years of undergraduate program will culminate in architecture and design-related courses in which students experience the cost-performance tradeoffs associated with mitigating hardware issues to software. Computer engineers are employed by manufacturing and R&D companies, federal and state government departments and research laboratories, healthcare, transportation, financial institutions, and service oriented businesses.

The degree program is accredited by the Engineering Accreditation Commission of ABET (Accreditation Board for Engineering and Technology, Inc.) http://www.abet.org. It requires 120 credit hours, including at least 27 credits from UNLV's General Education Core. Graduates of the program will receive a Bachelor of Science in Engineering with a Major in Computer Engineering.

The Department also offers a major in Electrical 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 COMPUTER ENGINEERING PROGRAM EDUCATIONAL OBJECTIVES

The Program Educational Objective of the Computer 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 Computer Engineering or a related field.
2. Can be admitted to and successfully progress through a post graduate program in Computer Engineering or related program.

2.3 COMPUTER ENGINEERING STUDENT OUTCOMES

To achieve these objectives and goals, each graduate of the Computer 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. COMPUTER ENGINEERING MAJOR ENTRANCE REQUIREMENTS

To enter the Computer Engineering (CpE) 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 CpE Major will be placed in the Computer Engineering Pre-major (CpEPRE). A student in the CpEPRE is eligible to submit an application to the Advising Center for advanced standing in the CpE Major after completing the 18 credits of the 45-credit CpEPRE curriculum listed below. Students who have not completed the CpEPRE curriculum and do not have advanced standing in the CpE Major cannot enroll in upper division Computer Engineering courses except for those listed below in the CpEPRE Extended Curriculum.

COMPUTER ENGINEERING PRE-MAJOR (CpEPRE) 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

COMPUTER ENGINEERING PRE-MAJOR (CpEPRE) EXTENDED CURRICULUM

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

Mathematics (9 Credits)
- MATH 251   Discrete Math I
- MATH 431   Mathematics for Engineers and Scientists I
  or CpE 260   or Signals and Systems for Computer Engineers
- STAT 411   Statistical Methods I

Electrical and Computer Engineering (14 Credits)
- CpE 200   Digital Logic Design II
- CpE 200L   Digital Logic Design 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. COMPUTER ENGINEERING CURRICULUM

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

- General Education: 27-30 credits
- Math, Computer Science, and Natural Science: 25 credits
- Fundamental Courses: 43 credits
- Core Courses: 12 credits
- Labs: 1 credits
- Professional Electives: 6 credits
- Math/Science Elective: 6 credits
  TOTAL: **120-122** **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/L   Introductory Engineering Experience / Lab (1-2 Credits)
- EGG 202   Second Year Hands-on Design Experiences in Engineering and Computer Science (1 Credit)
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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 Constituion
    - HIST 102 United States: 1865 to Present
    - HIST 217 Nevada History
    - PSC 100 Nevada Constitution

Social Science (6 credits)
- CEE 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
- 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 AND NATURAL SCIENCE COURSES (25 CREDITS)

MATH 181	Calculus I
MATH 182	Calculus II
MATH 251	Discrete Math I
MATH 431	Mathematics for Engineers and Scientists I
or CPE 260	or Signals and Systems for CpE
PHYS 180	Engineering Physics I
PHYS 180L	Engineering Physics I Laboratory
PHYS 181	Engineering Physics II
PHYS 181L	Engineering Physics II Laboratory
STAT 463	Applied Statistics for Engineers
or STAT 411	or Statistical Methods I

ABET Math Requirements of 1 year study or 30 credits are satisfied by taking MATH & SCIENCE electives of 6 credits.

4.3 REQUIRED COMPUTER ENGINEERING FUNDAMENTAL COURSES (43 CREDITS)

CpE 100	Digital Logic Design I
CpE 200	Digital Logic Design II
CpE 200D	Digital Logic Design II Discussion
CpE 200L	Digital Logic Design II Laboratory
CpE 300	Digital System Architecture and Design
CpE 301	Embedded Systems Design
CpE 301L	Embedded Systems Design Laboratory for CpE
CpE 302	Synthesis and Verification using Programmable Devices
CS 135	Computer Science I
CS 202	Computer Science II
CS 302	Introduction to Data Structures
CS 370	Operating Systems
EE 220	Circuits I
EE 220D	Circuits I Discussion
EE 221	Circuits II
EE 221L	Circuits II Laboratory
EE 320	Engineering Electronics I

EE 320L   Engineering Electronics I Laboratory
EE 497   Senior Design Project I
EE 498   Senior Design Project II

4.4 REQUIRED COMPUTER ENGINEERING CORE COURSES (12 CREDITS)

Each student must complete at least two courses in two out of the four core areas below:

Digital Electronic Design
- EE 421 Digital Integrated Circuit Design
- CpE 404   Modern Processor Architecture
- CpE 408   VLSI Physical Design and Testing

Computer Networks
- CpE 400   Computer Communications Networks
- CpE 405   Information Coding Systems
- CS 445 Internet Security

Computer System Design
- CpE 403   Advanced Embedded Systems
- CpE 409   Embedded DSP
- CpE 476   Mobile Robotics
- CpE 477   Embedded Security and Machine Learning

Intelligent Systems:
- CpE 407   Biometrics and Machine Learning
- CpE 417   IoT Systems
- CS 458   Introduction to Data Mining

4.5 REQUIRED COMPUTER ENGINEERING LABORATORY COURSE (1 CREDIT)

Each student must complete one credit of laboratory from the following list:
CpE 300L   Digital Systems Architecture and Design Laboratory
EE 420L   Engineering Electronics II Laboratory
EE 421L   Digital Integrated Circuit Design Laboratory

4.6 REQUIRED COMPUTER ENGINEERING PROFESSIONAL ELECTIVE COURSES (6 CREDITS)

Each student must complete 6 credits of approved professional electives that are listed in Table 1. 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 towards their CpE degree must obtain the Department Chair's and the Undergraduate Coordinator's approval.

Table 1: Professional Electives for Computer Engineering

CpE 400	Computer Communications Network	CpE 409	Embedded DSP
CpE 403	Advanced Embedded Systems	CpE 417	Internet of Things Systems
CpE 404	Modern Processor Architecture	CpE 418	Cloud Computing in Engineering
CpE 405	Information Coding Systems	CpE 476	Mobile Robotics
CpE 407	Biometrics and Machine Learning	CpE 477	Embedded Security and Machine
CpE 408	VLSI Physical Design and Testing		Learning

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

4.7 REQUIRED MATH / SCIENCE ELECTIVE COURSE (6 CREDITS)

All majors must also take 6 credits of elective math (MATH or STAT) or science (BIOL, CHEM, or PHYS) courses.

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 Work Load
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)

COMPUTER 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 Credit.**
Prerequisites: Sophomore standing and EGG 101.
Notes: Combination of EGG 101 and EGG 202 satisfies First Year Seminar requirement.

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. **1 credit.**
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: 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
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 Advanced Standing.

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 either 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

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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 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. 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 Laboratory
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.**
Prerequisite: 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. **3 credits.**
Prerequisites: EE 320 or equivalent or consent of instructor.

EE 442 Power Electronics
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 or CpE 260)

EE 450L Solid State Devices 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

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 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. 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 either 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 either 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. **3 credits.**
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. **3 credits.**
Prerequisites: CS 302 and MATH 251.

COMPUTER 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) CS 202 (3) MATH 251 (3) EGG 202 (1) 18 Credits	CS 302 (3) CPE 301+L (4) EGG 307 (3) EE 221+L (4) 14 Credits	32
YEAR III	STAT 411 (3) CPE 260 (3) CPE 300 (3) CS 370 (3) PHIL 242 (3) 15 Credits	EE 320 + L (4) CPE 302 (3) COM 216 (3) CPE Concentration Area I/1 (3) CPE LAB I (1) 14 Credits	29
YEAR IV	CPE Concentration Area I/2 (3) CPE Prof. Elective 1 (3) CPE Concentration Area II/1 (3) Fine Arts Elective/Multicultural (3) Math & Sci. Elec. I (3) EE 497 (1) 16 Credits	CPE Concentration Area II/2 (3) CPE Prof. Elective 2 (3) Math & Sci. Elec. II (3) EE 498 (2) 11 Credits	27
Credits	64	56	120

COMPUTER ENGINEERING
FIVE-YEAR PROGRAM

CPE	FALL	SPRING	Credits
YEAR I	ENG 101 (3) CPE 100 (3) MATH 181 (4) EGG 101 (FYS) (1-2) 11 Credits	ENG 102 (3) MATH 182 (4) PHY 180 +L (4) CS 135 (3) 14 Credits	25
YEAR II	PHY 181 + L (4) EGG 202 (1) EE 220/D (3) MATH 251 (3) 11 Credits	CPE 200 + L (4) COM 216 (3) CPE 260 (3) CS 202 (3) 13 Credits	24
YEAR III	CPE 301 + L (4) EE 221 + L (4) Fine Arts Elective/Multicultural (3) STAT 411 (3) 14 Credits	CEE 307 (3) EE 320 + L (4) CpE 300 (3) CS 302 (3) 13 Credits	27
YEAR IV	Constitution Requirement (4) CPE 302 (3) CS 370 (3) CPE Concentration Area I/1 (3) 13 Credits	Math & Sci. Elec. I (3) PHI 242 (3) CPE Concentration Area I/2 (3) CPE Lab (1) 10 Credits	23
YEAR V	CPE Concentration Area II/1 (3) CPE Elective 1 (3) Math & Sci. Elec. II (3) EE 497 (1) 10 Credits	CPE Concentration Area II/2 (3) CPE Elective 2 (3) EE 498 (2) Social Sci./Multicultural (3) 11 Credits	21
Credits	59	61	120

COMPUTER 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 ***

***	(Not ECON)		3	
CEE 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: 25 Credits

		Sem.	Cred	Grade
MATH 181			4	
MATH 182			4	
MATH 251			3	
MATH 431 or CpE 260			3	
STAT 463 or 411			3	
PHYS 180/L			4	
PHYS 181/L			4	

NOTES:

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

CpE Fundamentals: 43 Credits

		Sem	Cred	Grade
CpE 100			3	
CpE 200/D			3	
CpE 200L			1	
CpE 300			3	
CpE 301			3	
CpE 301L			1	
CpE 302			3	
CS 135			3	
CS 202			3	
CS 302			3	
CS 370			3	
EE 220/D			3	
EE 221			3	
EE 221L			1	
EE 320			3	
EE 320L			1	
EE 497			1	
EE 498			2	

CpE Core: 12 Credits. Must complete at least 2 concentration areas out of the following 4 areas.

		Sem	Cred	Grade
	Digital Design			
EE 421	Digital IC Design	F	3	
CpE 404	Modern Processor Arch.	S	3	
CpE 408	VLSI Phys Design & Testing	S	3	
	Computer Networks			
CpE 400	Comp. Comm. Networks	F	3	
CpE 405	Information Coding Sys.	S	3	
CS 445	Internet Security		3	
	Embedded Systems			
CpE 403	Advanced Embedded Sys.	F	3	
CpE 476	Mobile Robotics	F	3	
CpE 409	Embedded DSP	S	3	
CpE 477	Embedded Security and Machine Learning	S	3	
	Intelligent Systems (IS)			
CpE 407	Biometrics and Machine Learning	S	3	
CpE 417	IoT Systems	F	3	
CS 458	Intro. to Data Mining		3	

CE Labs: 1 Credit. Must complete 1 credit of laboratory.

		Sem.	Cred	Grade
CpE 300L				
EE 420L		F		
EE 421L				

Professional Electives: 6 Credits . 6 credits from EE/CpE

		Sem	Cred	Grade

Math/Science Elective: 6 Credits. 6 credits from math (MATH or STAT) or science (BIOL, CHEM, or PHYS)

		Sem	Cred	Grade

Total Credits: 120 (min)