

# COMPUTER ENGINEERING (COMP ENG)

## **COMP ENG 1200 Introduction to Digital Electronics** (LEC 3.0)

Introduction to electronics and digital circuit design including combinational logic and sequential circuits using circuit design tools, logic gates, integrated circuits and field programmable gate arrays. This course provides S&T equivalent credit for the Project Lead The Way Digital Electronics course.

## **COMP ENG 2001 Special Topics** (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

## **COMP ENG 2210 Introduction to Digital Logic** (LEC 3.0)

Binary arithmetic, Boolean algebra, logic and memory elements, computer organization. Prerequisite: Sophomore standing. Comp Eng 2211 is also a co-requisite for Comp Eng and Elec Eng majors.

## **COMP ENG 2211 Computer Engineering Laboratory** (LAB 1.0)

Introduction to digital design techniques, logic gates, Medium Scale Integration (MSI) parts and flipflops, Timing analysis, Programming and use of Programmable Logic Devices (PLD). Prerequisite: Preceded or accompanied by Comp Eng 2210.

## **COMP ENG 3000 Special Problems** (IND 1.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

## **COMP ENG 3001 Special Topics** (LEC 1.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

## **COMP ENG 3002 Cooperative Engineering Training** (IND 1.0)

On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisor's evaluation. Pass-fail grading option only. Prerequisite: Consent of the Electrical and Computer Engineering Department required.

## **COMP ENG 3110 Computer Organization and Design** (LEC 3.0)

Introduction to basic concepts of computer organization and design: metrics for computer performance, computer arithmetic, Von Neumann architecture, instruction implementation, control unit, pipelining, memory systems hierarchy, cache memories and basic I/O controllers. Prerequisites: COMP ENG 2210; preceded or accompanied by COMP ENG 3150.

## **COMP ENG 3150 Introduction to Microcontrollers and Embedded System Design** (LEC 3.0)

Microcontroller-based digital system design methodology and techniques. Topics include basic machine organization, interface design, and C and assembly language programming for real-time embedded systems. Prerequisites: COMP ENG 2210 and COMP SCI 1570 (or programming equivalent) each with grade of "C" or better.

## **COMP ENG 3151 Digital Engineering Lab II** (LAB 1.0)

Advanced digital design techniques, Microcontroller based design, hardware and software codesign. Prerequisites: Comp Eng 2210, Comp Eng 2211, and Comp Sci 1570 (or programming equivalent) each with grade of "C" or better. Preceded or accompanied by Comp Eng 3150.

## **COMP ENG 4000 Special Problems** (IND 1.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

## **COMP ENG 4001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

## **COMP ENG 4096 Computer Engineering Senior Project I** (LAB 0.50 and RSD 0.50)

A complete design cycle. Working in small teams, students will design, document, analyze, implement, and test a product. Topics include: Iteration in design, prototyping, group dynamics, design reviews, making effective presentations, concurrent design, designing for test, ethics and standards, testing and evaluation. Prerequisites: Comp Eng 2210, either Econ 1100 or Econ 1200, either English 3560 or English 1160, Comp Eng 3150, Comp Eng 3151, Comp Eng 3110, and Elec Eng 2200.

## **COMP ENG 4097 Computer Engineering Senior Project II** (LAB 3.0)

A continuation of Comp Eng 4096. Prerequisites: Comp Eng 4096 with a grade of "C" or better, Stat 3117 or Stat 3115 or Stat 5643, and Sp&M S 1185.

## **COMP ENG 4099 Undergraduate Research** (IND 1.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

## **COMP ENG 5000 Special Problems** (IND 1.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

## **COMP ENG 5001 Special Topics** (LEC 1.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

## **COMP ENG 5040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

## **COMP ENG 5070 Teaching Engineering** (LEC 3.0)

Introduction to teaching objectives and techniques. Topics include: using course objectives to design a course; communication using traditional and cutting-edge media; textbook selection; assessment of student learning; grading; student learning styles; cooperative/active learning; and student discipline. Prerequisite: Graduate standing. (Co-listed with Eng Mgt 5070, Env Eng 5070, Elec Eng 5070, Civ Eng 5070).

## **COMP ENG 5099 Special Research And Thesis** (IND 1.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Prerequisite: Consent of the instructor required.

## **COMP ENG 5110 Principles of Computer Architecture** (LEC 3.0)

Principles of performance measurement and instruction set design; advanced issues in pipelining; instruction level parallelism (dynamic scheduling, branch prediction, multi-issue processors); memory hierarchies for superscalar processors; multiprocessors; multi-threading; storage systems; and interconnection networks. Prerequisite: Comp Eng 3110.

**COMP ENG 5120 Digital Computer Design** (LEC 3.0)

Organization of modern digital computers; design of processors, memory systems and I/O units, hardware-software tradeoffs in different levels of computer system design. Prerequisites: COMP ENG 3150 and COMP ENG 3151.

**COMP ENG 5130 Advanced Microcomputer System Design** (LEC 3.0)

The design of digital systems based on advanced microprocessors. Introduction to microcomputer logic development systems. I/O interfaces. Assembly and high level language tradeoffs. Hardware and software laboratory projects required. Prerequisites: COMP ENG 5110.

**COMP ENG 5151 Digital Systems Design Laboratory** (LAB 1.0 and LEC 2.0)

Experimental studies of problems with high speed digital signals in circuits. Student designs, wires, tests, and programs a microprocessor based single board computer project. A FPGA design is programmed and tested. Prerequisites: COMP ENG 3150 or 5110.

**COMP ENG 5160 Embedded Processor System Design** (LEC 3.0)

Development of hardware and software for embedded systems, including real-time operating systems, advanced programming, communication schemes, hardware peripherals and sensors, control methodologies, printed-circuit board design, interrupts, microcontrollers, and hardware-software co-design. One or more team design projects. Prerequisites: COMP ENG 3150 or equivalent or 80x51 processor experience.

**COMP ENG 5170 Real-Time Systems** (LEC 3.0)

Introduction to real-time (R-T) systems and R-T kernels, also known as R-T operating systems, with an emphasis on scheduling algorithms. The course also includes specification, analysis, design and validation techniques for R-T systems. Course includes a team project to design an appropriate R-T operating system. Prerequisites: COMP ENG 3150 or COMP SCI 3800.

**COMP ENG 5210 Introduction To VLSI Design** (LEC 3.0)

An introduction to the design and analysis of digital integrated circuits (ICs). Topics include basic manufacturing techniques, transistor-level design and analysis of logic and memory circuits, logic timing, and parasitics. Computer aided design tools are used to develop circuits in the lab. Prerequisites: Elec Eng 2200 and Comp Eng 2210.

**COMP ENG 5220 Digital System Modeling** (LEC 3.0)

Digital system modeling for simulation, synthesis, and rapid system prototyping. Structural and behavioral models, concurrent and sequential language elements, resolved signals, generics, configuration, test benches, processes and case studies. Prerequisite: Comp Eng 2210 with a grade of "C" or better.

**COMP ENG 5230 Optical Computing** (LEC 3.0)

Introduction to the principles, subsystems, and architectures of optical computing. Topics include characteristics of optical devices; optical implementations of memory, logic elements, and processors; and computational structures. Prerequisite: Comp Eng 2210 or equivalent. (Co-listed with Elec Eng 5250).

**COMP ENG 5310 Computational Intelligence** (LEC 3.0)

Introduction to Computational Intelligence (CI), Biological and Artificial Neuron, Neural Networks, Evolutionary Computing, Swarm Intelligence, Artificial Immune Systems, Fuzzy Systems, and Hybrid Systems. CI application case studies covered include digital systems, control, power systems, forecasting, and time-series predictions. Prerequisite: Graduate Standing. (Co-listed with Elec Eng 5310 and Sys Eng 5211).

**COMP ENG 5410 Introduction to Computer Communication Networks** (LEC 3.0)

Design of computer networks with emphasis on network architecture, protocols and standards, performance considerations, and network technologies. Topics include: LAN, MAN, WAN, congestion/flow/error control, routing, addressing, broadcasting, multicasting, switching, and internetworking. A modeling tool is used for network design and simulation. Prerequisites: Comp Eng 3150 or computer hardware competency and Stat 3117 or Stat 3115 or Stat 5643 or equivalent.

**COMP ENG 5420 Introduction to Network Security** (LEC 3.0)

This course examines basic issues in network management, testing, and security; it also discusses key encryption, key management, authentication, intrusion detection, malicious attack, and insider threats. Security of electronic mail and electronic commerce systems is also presented. Prerequisite: Comp Eng 5410 or Comp Sci 5600.

**COMP ENG 5430 Wireless Networks** (LEC 2.0 and LAB 1.0)

Introduction to wireless communications and networking. Topics include transmission fundamentals, wireless channel, coding techniques and error control, satellite and cellular networks, cordless systems, mobile IP and management, multiple access techniques and wireless protocols, wireless LAN, IEEE 802.11, and adhoc and sensor networks. Prerequisites: Hardware competency, Elec Eng 3420 or Comp Eng 3150 and graduate standing. (Co-listed with Elec Eng 5430 and Sys Eng 5323.)

**COMP ENG 5450 Digital Image Processing** (LEC 3.0)

Fundamentals of human perception, sampling and quantization, image transforms, enhancement, restoration, channel and source coding. Prerequisites: At least one of the following: Elec Eng 3400, Elec Eng 3410, Elec Eng 3420, or prior exposure to Fourier Transforms and consent of the instructor. (Co-listed with Elec Eng 5450).

**COMP ENG 5460 Machine Vision** (LEC 3.0)

Image information, image filtering, template matching, histogram transformations, edge detection, boundary detection, region growing and pattern recognition. Complementary laboratory exercises are required. Prerequisites: At least one of the following: Elec Eng 3400, Elec Eng 3410, Elec Eng 3420, or prior exposure to Fourier Transforms and consent of the instructor. (Co-listed with Elec Eng 5460).

**COMP ENG 5510 Fault-Tolerant Digital Systems** (LEC 3.0)

Design and analysis of fault-tolerant digital systems. Fault models, hardware redundancy, information redundancy, evaluation techniques, system design procedures. Prerequisites: Comp Eng 2210 and Comp Eng 2211.

**COMP ENG 5610 Real-Time Digital Signal Processing** (LEC 2.0 and LAB 1.0)

Introduction to the use of programmable DSP chips. Includes real-time data acquisition, signal generation, interrupt-driven programs, high-level language, and assembly level routines. Applications to real-time systems are also presented. Prerequisite: Elec Eng 3400 or Elec Eng 3410.

**COMP ENG 5620 Signal Integrity in High-Speed Digital & Mixed Signal Design** (LEC 3.0)

Signal integrity ensures signals transmitted over a propagation path maintain sufficient fidelity for proper receiver operation. Compromised signal integrity is often associated with parasitics (e.g. unintentional inductance, capacitance). Theory and CAD tools used for signal integrity analysis of functioning designs. Prerequisites: Elec Eng 3600 or Comp Eng 3150, and Senior standing. (Co-listed with Elec Eng 5620).

**COMP ENG 5803 Mathematical Logic I** (LEC 3.0)

A mathematical introduction to logic with some applications. Functional and relational languages, satisfaction, soundness and completeness theorems, compactness theorems. Examples from Mathematics, Philosophy, Computer Science, and/or Computer Engineering. Prerequisite: Philos 3254 or Math 5105 or Comp Sci 2500 or Comp Eng 2210. (Co-listed with Comp Sci 5203, Philos 4354 and Math 5154).

**COMP ENG 5820 Mechatronics** (LEC 2.0 and LAB 1.0)

This course will introduce students to the basics of mechatronics (i.e., the integration of mechanical, electrical, computer, and control systems). Students will learn the fundamentals of sensors and actuators for mechanical systems, computer interfacing, microcontrollers, real-time software, and control. Prerequisite: Mech Eng 4479 or equivalent. (Co-listed with Mech Eng 5478, Aero Eng 5478 and Elec Eng 5870).

**COMP ENG 5880 Introduction to Robotics** (LEC 3.0)

This course provides an introduction to robotics, covering robot hardware, fundamental kinematics, trajectories, differential motion, robotic decision making, and an overview of current topics in robotics. Prerequisite: A "C" or better in both Math 3108 and Comp Sci 1510. (Co-listed with Comp Sci 5403 and Elec Eng 5880).

**COMP ENG 6000 Special Problems** (IND 1.0-6.0)

Problems or readings on specific subjects or projects in the department. Prerequisite: Consent of the instructor.

**COMP ENG 6001 Special Topics** (LEC 0.0 and LAB 0.0)

This course is designed to give the department an opportunity to test a new course. Variable title. Prerequisite: Consent of the instructor.

**COMP ENG 6040 Oral Examination** (IND 0.0)

After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**COMP ENG 6050 Continuous Registration** (IND 1.0)

Doctoral candidates who have completed all requirements for the degree except for the dissertation, and are away from the campus, must continue to enroll for at least one hour of credit each registration period until the degree is completed. Failure to do so may invalidate the candidacy. Billing will be automatic as will registration upon payment.

**COMP ENG 6099 Special Research and Thesis** (IND 1.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Prerequisite: Consent of the instructor required.

**COMP ENG 6110 Advanced Computer Architecture I** (LEC 3.0)

Advanced topics in computer structures, parallel processors, and computer networks. Emphasis on their design, applications, and performance. Prerequisite: Comp Eng 5110 or Comp Eng 5120.

**COMP ENG 6120 Advanced Computer Architecture II** (LEC 3.0)

Continuation of Computer Engineering 6110. Prerequisites: COMP ENG 6110.

**COMP ENG 6210 Digital Logic** (LEC 3.0)

Digital logic analysis, synthesis and simulation. Design automation of digital systems. Prerequisites: Comp Eng 2210 and Comp Eng 2211.

**COMP ENG 6220 Design Automation of VLSI Systems** (LEC 3.0)

A state-of-the-art survey of advanced VLSI design techniques, including ultra-low-voltage designs, asynchronous computing, microfluidic chips, three-dimensional integration and other More-than-Moore technologies. Prerequisites: COMP ENG 5210.

**COMP ENG 6230 Advanced VLSI Design** (LEC 3.0)

Advanced topics in chip-level VLSI design, including issues related to high-performance, low-power, analog and mixed-signal circuits, reliability, noise and coupling mechanisms, computer aided design tools, and recent advances and trends in the field. Prerequisite: Comp Eng 5210 is required.

**COMP ENG 6302 Advanced Topics in Data Mining** (LEC 3.0)

Advanced topics of current interest in the field of data mining. This course involves reading seminal and state-of-the-art papers as well as conducting topical research projects including design, implementation, experimentation, analysis, and written and oral reporting components. Prerequisite: A "C" or better grade in Comp Sci 301 Introduction to Data Mining. (Co-listed with Comp Sci 6402 and Sys Eng 6216).

**COMP ENG 6310 Markov Decision Processes** (LEC 3.0)

Introduction to Markov Decision Processes and Dynamic Programming. Application to Inventory Control and other optimization and control topics. Prerequisite: Graduate standing in background of probability or statistics. (Co-listed with Mech Eng 6447, Aero Eng 6447, Eng Mgt 6410 and Comp Sci 6202).

**COMP ENG 6320 Adaptive Dynamic Programming** (LEC 3.0)

Review of Neurocontrol and Optimization, Introduction to Approximate Dynamic Programming (ADP), Reinforcement Learning (RL), Combined Concepts of ADP and RL - Heuristic Dynamic Programming (HDP), Dual Heuristic Programming (DHP), Global Dual Heuristic Programming (GDHP), and Case Studies. Prerequisites: Elec Eng 5370 or Comp Eng 5310. (Co-listed with Elec Eng 6360, Mech Eng 6458, Aero Eng 6458 and Sys Eng 6215).

**COMP ENG 6330 Clustering Algorithms** (LEC 3.0)

An introduction to cluster analysis and clustering algorithms rooted in computational intelligence, computer science and statistics. Clustering in sequential data, massive data and high dimensional data. Students will be evaluated by individual or group research projects and research presentations. Prerequisite: At least one graduate course in statistics, data mining, algorithms, computational intelligence, or neural networks, consistent with student's degree program. (Co-listed with Elec Eng 6340, Sys Eng 6214, Comp Sci 6405, Stat 6239).

**COMP ENG 6410 Modeling Complex Systems** (LEC 3.0)

Engineering Systems of today are non-linear, distributed, global, and adaptive to their environment in both space and time, thereby creating emergent behaviors. This course covers the current modeling tools and techniques used in modeling and architecting these complex systems. Prerequisites: Graduate Standing. (Co-listed with SYS ENG 6321).

**COMP ENG 6420 Wireless Ad hoc and Sensor Networks** (LEC 3.0)

Introduction to ad hoc and sensor networks, IEEE standards, heterogeneity, quality of service, wireless channel issues, energy awareness, power and topology control, routing, scheduling, rate adaptation, self-organization, admission and flow control, energy harvesting, security and trust levels, hardware and applications. Prerequisite: Comp Eng 5430 or Comp Eng 5420 or equivalent. (Co-listed with Elec Eng 6430 and Sys Eng 6324).

**COMP ENG 6430 High Speed Networks** (LAB 1.0 and LEC 2.0)

A state-of-the-art survey of high-speed networks, modeling and simulation, quality of service (QoS) for multimedia applications and management schemes, TCP congestion control, ATM and Internet traffic management, Internet Service Architecture (ISA), and Internet routing protocols. Prerequisites: Comp Eng 5410 and hardware competency for ECE students, Comp Sci 4600 for computer science students, or consent of the instructor.

**COMP ENG 6440 Network Performance Analysis** (LEC 3.0)

Provides an introduction to performance modeling and analysis of computer networks. Topics include stochastic processes; performance measurement and monitoring; quantitative models for network performance, e.g., Markovian models for queues; simulation; and statistical analysis of experiments. Prerequisites: Comp Eng 5410 or Comp Sci 4600; Stat 3117 or 5643. (Co-listed with Comp Sci 6602).

**COMP ENG 6510 Resilient Networks** (LEC 3.0)

This course presents reliability and fault tolerance for network-centric systems, including models, metrics, and analysis techniques. This course also concentrates on security, including technical tools and methods for audit and assessment as well as management and policy issues. Prerequisites: Sys Eng 6410, Comp Eng 6410, or Comp Eng 5420. (Co-listed with SYS ENG 6322).

**COMP ENG 6810 Philosophy of Scientific Research** (LEC 3.0)

Organization and planning of research. Introduction to the philosophy and management of scientific research, particularly issues related to ethics, plagiarism, ownership of intellectual properties, research techniques, technical presentations and time management. The course will address these issues by integrating with case studies. (Co-listed with Chem Eng 6340, IDE 425, Civ Eng 6940, Env Eng 6940, Elec Eng 6810).

**COMP ENG 6880 Advanced Topics in Robotics** (LEC 3.0)

This course covers advanced topics in robotics, including perception, robotic path planning, robotic system integration, and computational intelligence topics for robotics. A term project including both written and oral components will be required. Prerequisite: A "C" or better in either Comp Sci 5403 or Mech Eng 5449 or Aero Eng 5449. (Co-listed with Comp Sci 6403 and Elec Eng 6880).