1. *Course number and name*
   ENGR 451: Digital Signal Processing

2. *Credits and contact hours*
   3 credit hours; three 50-minute lecture sessions/week, or two 1-hr-15-minute lecture sessions/week, depending on semester

3. *Instructor's or course coordinator's name*
   Instructor: Tom Holton, Ph.D.
   Course coordinator: Tom Holton, Professor of Electrical and Computer Engineering

4. *Text book, title, author, and year*
   Holton, T. *Digital Signal Processing Course Notes*: www.sfsu.edu/~ee/451

   a. *Other supplemental materials*
      References:
      - Oppenheim, A.V., Schafer, R.W. and Buck, J.R. (2010): Discrete-time Signal Processing, 3rd Edition. Prentice-Hall.
      - Ifeachor, E.C. and Jervis, B.W. (2001): Digital Signal Processing: A Practical Approach, 2nd Edition. Addison-Wesley.
      - Mitra, S. K. (2010): Digital Signal Processing: A Computer-Based Approach. 4rd ed. McGraw-Hill.
      - Proakis, J.G. and Manolakis, D.G. (2006): Digital Signal Processing, 4th Edition. Macmillan.

5. *Specific course information*
   a. *Brief description of the content of the course (catalog description)*
      Properties of linear time-invariant systems. Convolution. Linear constant-coefficient difference equations. Frequency-domain representation of discrete-time signals. Discrete Fourier series and transform. Sampling and reconstruction of analog signals: aliasing, upsampling and downsampling. z-transforms and inverse z-transforms. Design and implementation of FIR and IIR filters. Minimum-phase, maximum-phase and all-pass systems. Discrete Fourier series and transform. Fast Fourier transform algorithms. Circular convolution. Applications in sound and image processing. Required laboratory with computer simulations using Matlab.

   b. *Prerequisites or co-requisites*
      ENGR 305 (Systems Analysis); ENGR 213 (Introduction to C Programming for Engineers) or CSC 210 (Introduction to Computer Programming) or
      ENGR 290 (Matlab), all with grades of C- or better.

   c. *Indicate whether a required, elective, or selected elective course in the program*
      Required for Electrical Engineering
      Required for Computer Engineering

6. *Specific goals for the course*
   a. *Specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.*
      - The student will demonstrate the ability to analyze discrete-time systems to determine their linearity, time invariance, causality and stability.
      - The student will demonstrate the ability to perform convolution.
      - The student will demonstrate the ability to determine the frequency response of a discrete-time system.
      - The student will demonstrate the ability to determine the impulse response of a discrete-time system.
      - The student will demonstrate the ability to design and analyze sampled-data systems.
      - The student will demonstrate the ability to analyze discrete-time upsampling and downsampling systems.
      - The student will demonstrate the ability to compute z-transforms, inverse transforms and regions of convergence.
      - The student will demonstrate the ability to determine the block-diagram representation of FIR and IIR systems from z-transform, impulse response or difference equations.
      - The student will demonstrate the ability to design IIR discrete-time filters based on analog filters.
      - The student will demonstrate a knowledge of circular correlation and fast Fourier transforms.
      - The student will design, debug and test MATLAB algorithms to carry out design and analysis of specified discrete-time problems.

   b. *Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.*
      Course addresses ABET Student Outcome(s): a, c, e, k.

7. *Brief list of topics to be covered*
   - Introduce basic concepts of discrete-time signals and systems.
   - Properties of linearity, time-invariant systems
   - Convolution
   - Discrete Fourier transform
   - FIR and IIR filters
   - Sampling of continuous-time signals (A/D and D/A)
   - Upsampling/Downsampling
   - z-Transform
   - Structures of discrete-time filters
   - Discrete Fourier Transform (DFT)
   - Fast Fourier transform (FFT)

- Circular convolution

1. *Course number and name*
   ENGR 478: Design with Microprocessors

2. *Credits and contact hours*
   4 credits
   Contact hours: two 75-minute lecture sessions/week and one 2-hour-45-minute lab session/week

3. *Instructor's or course coordinator's name*
   Instructor: Xiaorong Zhang, Assistant Professor of Computer Engineering
   Course coordinator: Xiaorong Zhang, Assistant Professor of Computer Engineering

4. *Text book, title, author, and year*
   8. "Embedded Systems: Introduction to Arm® Cortex™-M Microcontrollers, Fifth Edition (Volume 1)", Jonathan Valvano, 2012

   a. *other supplemental materials*
      Lab material:
      - Tiva C Series TM4C123G LaunchPad Evaluation Kit (EK-TM4C123GXL)

      Other references:
      - Tiva TM4C123GH6PM Microcontroller Data Sheet
      - Getting Started with the Tiva TM4C123G LaunchPad Workshop Student Guide and Lab Manual
      - TivaWare Peripheral Driver Library User's Guide
      - Tiva C Series TM4C123G LaunchPad Evaluation Board User's Guide.
      - Cortex-M4 Technical Reference Manual
      - Cortex-M4 Devices Generic User Guide
      - Cortex-M3/M4F Instruction Set Technical User's Manual

5. *Specific course information*
   a. *brief description of the content of the course (catalog description)*
      Basic microprocessor/microcontroller architecture. Assembly and C language programming. System bus and interfacing with memory and I/O devices. Serial and parallel communications. Timer and counter functions. Polling and interrupt. Analog-to-digital and digital-to-analog conversion. Three-unit class work; one-unit laboratory work.

   b. *prerequisites or co-requisites*
      ENGR 356 with a grade of C- or better; ENGR 213 with a grade of C- or better or CSC 210 with a grade of C or better

   c. *indicate whether a required, elective, or selected elective course in the program*
      Required for Computer and electrical Engineering.

6. *Specific goals for the course*
   a. *specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.*

Students completing the course successfully will demonstrate

- an in-depth knowledge of a microprocessor/microcontroller.
- an ability to program in assembly and C language
- knowledge of the interactions between software and hardware.
- an ability to integrate software and hardware for microprocessor-based systems.
- an ability to interface microprocessor with other devices through serial and parallel I/O.
- an ability to deal with analog signals in digital systems.
- an ability to use timer and counter functions.
- an ability to design an expanded system by adding external circuits as required.
- an ability to use development tools.
- a skill in troubleshooting a microprocessor-based system.

b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.

Course addresses ABET Student Outcome(s): a, b, c, e, g, j, k.

7. Brief list of topics to be covered

- Introduction to embedded systems
- Introduction to TM4C123GH6PM microcontroller and
- ARM Cortex-M4 architecture and assembly language
- Assembly syntax; Functions; Logic operations
- GPIOs
- Friendly software development in C
- Switch and LED interfacing; IO synchronization
- Interrupt concept and nested vectored interrupt controller
- Edge-triggered interrupt and periodic interrupt
- Analog to digital conversion (ADC)
- Digital to analog conversion (DAC)
- Serial communication
- Serial I/O – SSI vs. UART vs. USB vs. I2C
- Power management
- Advanced Topic in Embedded System Design.

1. *Course number and name*
   ENGR 696: Engineering Design Project I (EE/CompE)

2. *Credits and contact hours*
   1 credit hour; one 2-hr, 45-min session per week

3. *Instructor's or course coordinator's name*
   Instructor: Tom Holton, Professor
   Course coordinator: Tom Holton, Professor

4. *Text book, title, author, and year*
   (none)

   a. *other supplemental materials*
      Various course handouts.

5. *Specific course information*
   a. *Brief description of the content of the course (catalog description)*
      Selection of design project, methods of research, time management, engineering professional practice and ethics. This course is 3rd in a series of courses (ENGR 300, 301, 696, and 697GW) that when completed with a C or better will culminate in the satisfaction of the University Written Eng Proficiency/GWAR.

   b. *Prerequisites or co-requisites*
      ENGR 301; 21 units completed in upper-division engineering.

   c. *Indicate whether a required, elective, or selected elective course in the program*
      Required for Electrical Engineering
      Required for Computer Engineering

6. *Specific goals for the course*
   a. *Specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.*
      - an ability to apply knowledge of mathematics, science, and engineering
      - an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
      - an ability to function on multidisciplinary teams
      - an ability to identify, formulate, and solve engineering problems
      - an understanding of professional and ethical responsibility

- an ability to communicate effectively
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- a recognition of the need for, and an ability to engage in life-long learning
- a knowledge of contemporary issues
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.
Course addresses ABET Student Outcome(s): a, c, d, e, f, g, h, i, j, k.

7. Brief list of topics to be covered

- Design process and methodology
- Scheduling and time management
- Literature, resource, and component information gathering
- Oral communication and presentation skills
- Interviewing, resume writing
- Ethics
- Professionalism

1. *Course number and name*
   ENGR 697: Engineering Design Project II

2. *Credits and contact hours*
   3 credit hours; three 50-minute lecture sessions/week, or two 1-hr-15-minute lecture sessions/week, depending on semester

3. *Instructor's or course coordinator's name*
   Instructor: Tom Holton, Instructor
   Course coordinator: Tom Holton, Professor of Electrical and Computer Engineering

4. *Text book, title, author, and year*
   none.

5. *Specific course information*
   a. *Brief description of the content of the course (catalog description)*
      Students work in teams to complete projects specified and designed the previous semester in ENGR 696. Work is done with maximum independence under supervision of a faculty advisor. Oral and written project reports required.

   b. *prerequisites or co-requisites*
      ENGR 696: Engineering Design Project I

   c. *indicate whether a required, elective, or selected elective course in the program*
      Required for Computer Engineering
      Required for Electrical Engineering

6. *Specific goals for the course*
   a. *Specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.*
      - Students will demonstrate an ability to apply knowledge of mathematics, science, and engineering
      - Students will demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data
      - Students will demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
      - Students will demonstrate an ability to function on multidisciplinary teams
      - Students will demonstrate an ability to identify, formulate, and solve engineering problems
      - Students will demonstrate an understanding of professional and ethical responsibility
      - Students will demonstrate an ability to communicate effectively
      - Students will demonstrate the possess the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
      - Students will demonstrate a recognition of the need for, and an ability to engage in life-long learning

- Students will demonstrate a knowledge of contemporary issues
- Students will demonstrate an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.
Course addresses ABET Student Outcome(s): a, b, c, d, e, f, g, h, i, j, k.

7. Brief list of topics to be covered

1. *Course number and name*
   ENGR 378: Digital System Design

2. *Credits and contact hours*
   3 credit hours; one 100-minute lecture session/week and one 2-hour-45-minute lab session/week

3. *Instructor's or course coordinator's name*
   Instructor: Hamid Mahmoodi, Professor of Electrical and Computer Engineering
   Course coordinator: Hamid Mahmoodi, Professor of Electrical and Computer Engineering

4. *Text book, title, author, and year*
   Charles H. Roth, Jr, *Digital Systems Design Using Verilog*, Cengage Learning, 2016

   a. *other supplemental materials*
      (none)

5. *Specific course information*
   a. *brief description of the content of the course (catalog description)*
      CMOS digital circuits and their electrical properties. Logic circuit design with functional units. Algorithmic sequential machine design. Design with programmable logic devices. Hardware description and simulation language.

   b. *prerequisites or co-requisites*
      grade of C- or better in ENGR 356

   c. *indicate whether a required, elective, or selected elective course in the program*
      Required for Computer Engineering; elective for Electrical Engineering.

6. *Specific goals for the course*
   a. *specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.*

- The student will demonstrate an ability to analyze combinational and sequential circuits.
- The student will demonstrate an ability to design combinational and sequential circuits.
- The student will demonstrate knowledge of structural, dataflow, and behavioral modeling of digital system.
- The student will demonstrate knowledge of Hardware Description Language (HDL) for digital system design and simulation.
- The student will demonstrate a skill in using software tools.
- The student will demonstrate a working knowledge of programmable logic devices
- The student will demonstrate a skill in using tools for digital design with programmable logic devices.

b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.
Course addresses ABET Student Outcome(s): a, b, c, e, k.

7. Brief list of topics to be covered

- Introduction to Verilog HDL
- Basic methods for circuit specification
- Programmable logic devices and FPGA's
- Design and specification of simple circuits
- Arithmetic unit design
- State Machine design
- SM Charts
- Design with FPGAs
- Lab: Computer-aided design and simulation tools; digital circuit verification and troubleshooting, synthesis and implementation to FPGA

1. *Course number and name*
   ENGR 410: Process Instrumentation and Control

2. *Credits and contact hours*
   3 credit hours; three 50-minute lecture sessions/week, or two 1-hr-15-minute lecture sessions/week, depending on semester

3. *Instructor's or course coordinator's name*
   Course coordinator: Mojtaba Azadi, Assistant Professor of Mechanical Engineering

4. *Text book, title, author, and year*
   Smith, C.A. and Corripio, A.B. Principles and Practice of Automatic Process Control, 3rd Ed., John Wiley, 2006

   a. *other supplemental materials:*

      - Seborg, D.E. et al. "Process Dynamics and Control", 4th Ed., Wiley, 2017
      - King, M. "Process Control: A Practical Approach", 2nd Ed., Wiley, 2016
      - Marlin, T. "Process Control", McGraw-Hill, 2nd Ed., 2000
      - Ogata, K. "Modern Control Engineering", 5th Ed. Prentice Hall, 2010
      - McMillan, G.K. and D. Considine. "Process/Industrial Instruments and Control Handbook", 5th Ed., McGraw-Hill, 1999

5. *Specific course information*
   a. *brief description of the content of the course (catalog description)*
      Principles of control and instrumentation. Control of level, flow, temperature, and pressure. Actuators and transducers. Process modeling

   b. *prerequisites or co-requisites*
      ENGR 300: Engineering Experimentation, ENGR 305: Linear Systems Analysis

   c. *indicate whether a required, elective, or selected elective course in the program*
      Required / Elective for Mechanical Engineering and Elective for Electrical Engineering

6. *Specific goals for the course*
   a. *specific outcomes of instruction*

      - Students learn the principles of control theory with emphasis on process control and some of its specific applications in actual industrial systems.
      - Students learn techniques of process modeling and linearization.

- Students become familiarized with standard process control configurations.
- Students learn about the state space approach to modelling and control and would be able to use MATLAB, Simulink and symbolic computations for modelling, linearization and control simulations.
- A working knowledge of basic techniques of process control and measurement and their applications in the design of process-control systems is provided to students.
- Students develop basic process control design skills including development of component specifications, control-valve sizing techniques, preparation of Piping & Instrumentation Diagrams, tuning of PID controllers and system identification.

b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.
Course addresses ABET Student Outcome(s): a, c, d, e, g, h, i, j, k.

7. Brief list of topics to be covered

- Process Control: Terminology and Definitions
- Modeling of Simple Processes and Their Linearization
- The State Space Approach
- MATLAB and Simulink for Modeling, Linearization and Control
- Discrete Time Systems and z Transform
- Control Valves
- Process Instrumentation
- Basics of Process Control
- System Identification
- PID Design and Tuning of Simple Control Loops
- Feed-Forward, Cascade and Multivariable Control
- Advanced Control Configurations

1. *Course number and name*
   ENGR 411: Instrumentation and Process Control laboratory

2. *Credits and contact hours*
   1 credit hour; one 2 hr 30 min laboratory session/week.

3. *Instructor's or course coordinator's name*
   Course coordinator: Mojtaba Azadi, Assistant Professor of Mechanical Engineering

4. *Text book, title, author, and year*
   None required.

   a. *other supplemental materials*
      - McMillan, G.K. and D. Considine "Process/Industrial Instruments and Control Handbook", 5th Ed., McGraw-Hill, 1999
      - Anderson "Instrumentation for Process Measurement and Control" 3rd ed. CRC Press, 1998.
      - Smith, C.A. and Corripio, A.B. "Principles and Practice of Automatic Process Control" 3rd ed. John Wiley, 2006.
      - Additional reading material on ISA standards and codes will be provided during laboratory briefing sessions.

5. *Specific course information*
   a. *brief description of the content of the course (catalog description)*
      Instrumentation for measurement of flow, temperature, level and pressure. Experiments on level, flow, and temperature control. P, PI, PID, and programmable logic controllers.

   b. *prerequisites or co-requisites*
      ENGR 410: Process Instrumentation and Control (maybe taken concurrently)

   c. *indicate whether a required, elective, or selected elective course in the program*
      Required/Elective for Mechanical Engineering; Elective for Electrical Engineering.

6. *Specific goals for the course*
   a. *specific outcomes of instruction.*
      - Students will acquire the ability to design basic process control configurations using standard algorithms and process instrumentation typically used in industry.
      - Students will acquire hands-on experience with basic industrial instrumentation.
      - Students will acquire a working knowledge of the basic control strategies used in the control of industrial processes.
      - Students will be able to develop P&ID and spec sheets for simple control systems.

- Students will be able to trace control loops in industrial systems.
- Students become familiarized with system simulation and control with MATLAB/Simulink.

b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.
Course addresses ABET Student Outcome(s): a, b, c, e, g, i, j, k.

7. Brief list of topics to be covered

- Calibration of Sensors
- Calibration of Final Control Elements
- Loop Tracing and ISA Standards
- Commissioning a Flow Control Loop with a Digital Controller
- Level Control Using "P" and "PI" Controllers.
- Temperature Control Loop with Cascade and Ratio Control
- Dynamics of Control Loop-Tuning
- Simulink and MATLAB Simulations

1. *Course number and name*
   ENGR 415: Mechatronics
2. *Credits and contact hours*
   3 Credit Hours , 3 hours of lecture per week.
3. *Instructor's or course coordinator's name*
   Instructor: M. Azadi, Assistant Professor of Mechanical Engineering
   Course coordinator: M. Azadi, Assistant Professor of Mechanical Engineering
4. *Text book, title, author, and year*

   Mechatronics: Electronic control systems in mechanical and electrical engineering (5th or 6th Edition) by W. Bolton. (ISBN-13: 978-0273742869)

   a. *other supplemental materials*
      - *Introductions to Mechatronics and Measurement Systems 3rd Editions*, by David G. Alcaitore and Michael B. Histand, McGraw Hill, 2007. (ISBN 0-07-296305-0)

5. *Specific course information*
   a. *brief description of the content of the course (catalog description)*
      Introduction to Mechatronics systems, sensors and actuators. Basics of a multidisciplinary field that combines electronics, mechanical design and simulation, and control systems. Simulation and design of systems with sensors, controllers and actuators. System elements including common sensors, actuators and various electronic controllers.

   b. *prerequisites or co-requisites*
      ENGR 305.

   c. *indicate whether a required, elective, or selected elective course in the program*
      Elective for Electrical and Mechanical Engineering.

6. *Specific goals for the course*
   a. *specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.*
      - The student will demonstrate knowledge of common sensor.
      - The student will demonstrate a knowledge of common actuators.
      - Students will be able to design simple linkage and gearing for actuation.
      - The student will demonstrate a knowledge of hydraulic and pneumatic.
      - The student will be able to recognize and select basic Mechanical component for design.
      - The student will be able to write a ladder logic program for a PLC and understand how to integrate a PLC into a mechatronic system.

b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.

Course addresses ABET Student Outcome(s): a, c, d, e, i, k.

7. Brief list of topics to be covered

- Introduction to Mechatronics System-– Control Architectures and Case Studies
- Mechanisms
- Mechanical components
- Electrical components
- Range of Actuators (Pneumatic, Hydraulics, Electrical)
- Range of sensors and Transducers
- Range of controller (such as Micro controllers, PLC)

1. *Course number and name*
   ENGR 416: Mechatronics Lab
2. *Credits and contact hours*
   1 Credit. one three-hour session/week

3. *Instructor's or course coordinator's name*
   Instructor: George Anwar.
   Course coordinator: M. Azadi, Assistant Professor of Mechanical Engineering

4. *Text book, title, author, and year*

   None required

   a. *other supplemental materials*
   Bolton, W.,Mechatronics,6th Edition. Addison Wesley Longman Publishing, New York, NY, 2015. (Optional References).

5. *Specific course information*
   a. *brief description of the content of the course (catalog description)*
   Experiments connected with mechatronic concepts. Programming robot tasks. Comparison and analysis of human and robot motion. Optical encoders, motor selection and tuning.

   b. *prerequisites or co-requisites*
   ENGR 415.

   c. *indicate whether a required, elective, or selected elective course in the program*
   Elective for Electrical and Mechanical Engineering.

6. *Specific goals for the course*
   a. *specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.*

   - Students will learn how to use sensor outputs to the range needed by common controllers. Students will learn when the amplification of RC or active filters are necessary for sensor use.
   - Students will learn how to program an 8-bit Atmel microcontroller using the gnu c compiler and a bootloader, and how to debug the program using the atmel simulator.
   - Students will learn how to write a ladder-logic program and run it on the school's PLC systems.

   b. *explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.*
   Course addresses ABET Student Outcome(s): a, b ,c ,d ,k.

7. *Brief list of topics to be covered*

- Sensors, amplification and filters.
- Microcontrollers(Atmel) in control and automation.
- Use of PLCs for mechatronic systems.
- Motors: DC Motors, stepper motors, hobby servo motors.

1. *Course number and name*
   ENGR 445: Analog Integrated Circuit Design

2. *Credits and contact hours*
   4 credit hours

3. *Instructor's or course coordinator's name*
   Instructor: Hao Jiang,
   Course coordinator: Hao Jiang, Associate Prof. in EE

4. *Text book, title, author, and year*
   Tony Chan Carusone, David A. Johns, and Kenneth W. Martin, "Analog Integrated Circuit Design" 2nd Edition. Wiley, 2011 (ISBN: 0470-77010-4)

   a. other supplemental materials
   1. Philip Allen and Douglas Holberg, "CMOS Analog Circuit Design" 3rd, Oxford Press, 2011
   2. Behzad Razavi "Design of Analog CMOS Integrated Circuits**"** McGraw-Hill, 2000

5. *Specific course information*
   a. *brief description of the content of the course (catalog description)*
      Integrated circuit technology, transistor characteristics and models. Analysis and design of monolithic op amps. Frequency response, negative feedback, stability, circuit simulation.

   b. *prerequisites or co-requisites*
      Grades of C- or better in Engr 353 and Engr301

   c. *indicate whether a required, elective, or selected elective course in the program*
      Elective for Electrical Engineering.

6. *Specific goals for the course*
   a. *Specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.*
      - To study basic semiconductor principles and analog IC technology.
      - To study analog IC building blocks up to the complete op amp.
      - To investigate the frequency response of analog ICs.
      - To study negative feedback, stability, and frequency compensation.
      - To design and simulate the performance of analog ICs in the laboratory.

   b. *Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.*
      Course addresses ABET Student Outcome(s): a, b ,c , k.

      - Students will demonstrate an understanding of *pn* junction properties and *i-v* characteristics.

- Students will demonstrate an understanding of CMOS transistor properties, characteristics, and models.
- Students will become conversant with analog IC technology and fabrication techniques.
- Students will demonstrate an understanding of classical single-transistor and two-transistor configurations.
- Students will demonstrate an understanding of basic analog IC building blocks (current sources, active loads, and output stages).
- Students will demonstrate an ability to perform the DC and small-signal analysis of a complete op amp.
- Students will demonstrate an ability investigate the frequency response of basic analog IC building blocks.
- Students will demonstrate an ability to investigate the small- and large-signal transient response of an IC op amp.
- Students will demonstrate an ability to identify and analyze classic negative-feedback topologies.
- Students will demonstrate an ability to assess the stability of a negative-feedback circuit.
- Students will become conversant with the most common frequency-compensation techniques.
- Students will demonstrate an ability to characterize electronic devices using circuit simulation tools.
- Students will demonstrate an ability to characterize analog building blocks using circuit simulation tools.

7. Brief list of topics to be covered

- Models for integrated-circuit active devices
- CMOS integrated-circuit technology
- Single-transistor and two-transistor amplifiers
- Current sources, active loads, and output stages
- Large-signal and small-signal analysis of an op amp
- Frequency and time responses of integrated circuits
- Negative feedback
- Frequency response, stability, and frequency compensation of negative-feedback amplifiers

1. *Course number and name*
   ENGR 448: Electric Power Systems

2. *Credits and contact hours*
   3 credit hours

3. *Instructor's or course coordinator's name*
   Instructor: Jin Ye, Ph.D.
   Course coordinator: Jin Ye

4. *Text book, title, author, and year*
   Mohan, *A First Course in Electric Power Systems*, Wiley, 2012.

   a. other supplemental materials

   J. D. Glover, T. J. Overbye, and M. S. Sarma, *Power system analysis and design 6th Edition*, Cengage Learning, 2017.

5. *Specific course information*
   a. brief description of the content of the course (catalog description)
   Introduction to electric power industry. Electric circuit and electric power. Transmission lines. Power flow. Transformers. HVDC. Power quality. Synchronous generators. Stability in Power System. Transmission line faults.

   b. prerequisites or co-requisites
   Grades of C or better in ENGR 306

   c. indicate whether a required, elective, or selected elective course in the program
   Elective for Computer and electrical Engineering.

6. *Specific goals for the course*
   a. Specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.
   - The students will demonstrate their understanding about electric power industry.
   - The students will demonstrate their understanding about electric circuit and electric power.
   - The students will demonstrate their understanding about transmission lines.
   - The students will demonstrate their understanding about power flow.
   - The students will demonstrate their ability to analyze power transformers. The students will demonstrate their understanding about High Voltage DC (HVDC) transmission systems.
   - The students will demonstrate their understanding about distribution systems, loads and power quality.
   - The students will demonstrate their ability to analyze synchronous generators.

- The students will demonstrate their ability to analyze voltage regulation and stability in power systems.
- The students will demonstrate their ability to analyze transmission line faults, relaying, and circuit breakers.

b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.

Course addresses ABET Student Outcome(s): a, b, c, k

7. *Brief list of topics to be covered*
   - Introduction to electric power industry.
   - Fundamentals of electric circuit and electric power.
   - AC transmission lines.
   - Power flow.
   - Power transformers.
   - High Voltage DC (HVDC) transmission systems.
   - Distribution systems, loads and power quality.
   - Synchronous generators.
   - Voltage regulation and stability.
   - Transmission line faults, relaying, and circuit breakers.

1. *Course number and name*
   ENGR 453: Digital IC Design

2. *Credits and contact hours*
   4 credit hours; two 75-minute lecture sessions/week and one 2-hour-45-minute lab session/week

3. *Instructor's or course coordinator's name*
   Instructor: Hamid Mahmoodi, Professor of Electrical and Computer Engineering
   Course coordinator: Hamid Mahmoodi, Professor of Electrical and Computer Engineering

4. *Text book, title, author, and year*
   Digital Integrated Circuits (2nd Edition) by Jan Rabaey et.al., Prentice Hall, 2003

   a. *other supplemental materials*
   (none)

5. *Specific course information*
   a. *brief description of the content of the course (catalog description)*
      Integrated circuit technology, transistor characteristics and models. MOS and bipolar logic families, noise margins, speed, power, fanout, interfacing, PSpice simulation. Regenerative circuits and memories. Class work, 3 units; laboratory, 1 unit. Extra fee required.

   b. *prerequisites or co-requisites*
      Grades of C- or better in ENGR 301, 353, and 356

   c. *indicate whether a required, elective, or selected elective course in the program*
      Elective for Electrical and Computer Engineering.

6. *Specific goals for the course*
   a. *specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.*
      - The student will be able to describe fundamental metrics used for quantitative evaluation of a digital circuit.
      - The student will be able to explain basics of MOS transistors and CMOS technology.
      - The student will be able to describe silicon technology scaling and trends.
      - The student will be able to design logic circuits using different logic styles such as complementary CMOS logic, pass-transistor logic, and dynamic logic styles.
      - The student will gain the skill of transistor-level analysis and design of simple and complex logic gates such as inverter, NOR and NAND gates in CMOS.
      - The student will be able to explain different designs for memory elements and design sequential logic circuits such as latches and flip-flops in CMOS.

- The student will demonstrate a skill in using modern EDA tools for full-custom IC design, including circuit simulation and layout tools.
- The student will measure and verify the performance of digital circuits in the laboratory.

b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.

Course addresses ABET Student Outcome(s): a, b, c, k.

7. Brief list of topics to be covered

- Introduction to digital integrated circuits
- Design metrics
- MOS transistor
- CMOS technology
- CMOS inverter
- Interconnects
- Combinational logic gates in CMOS
- Design of sequential logic circuits

1. *Course number and name*
   ENGR 455: Power Electronics

2. *Credits and contact hours*
   4 credit hours

3. *Instructor's or course coordinator's name*
   Instructor: Jin Ye, Ph.D.
   Course coordinator: Jin Ye

4. *Text book, title, author, and year*
   N.Mohan, *A First Course in Power Electronics*, Wiley, 2012.

   a. other supplemental materials

   Robert W. Erickson and Dragan Maksimovic, *Fundamentals of Power Electronics 2nd Edition*, Springer Science+Business Media, 2001.

5. *Specific course information*
   a. brief description of the content of the course (catalog description)
   Design of switching power-roles. Switch-mode DC-DC converters. Feedback controller design in switch-mode DC-DC converters. Rectification of utility input using diode rectifiers. Switch-mode DC power supplies. Power electronics applications.

   b. prerequisites or co-requisites
   Grades of C or better in Engr 353 and ENGR 301 and ENGR 306

   c. indicate whether a required, elective, or selected elective course in the program
   Elective for Computer and electrical Engineering.

6. *Specific goals for the course*
   a. Specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.
   - The students will demonstrate their understanding about power electronic devices.
   - The students will demonstrate their ability to analyze and design switch-mode DC-DC converters.
   - The students will demonstrate their ability to design feedback controller for switch-mode DC-DC converters.

   b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.
   Course addresses ABET Student Outcome(s): a, b, c, k

7. *Brief list of topics to be covered*

- Introduction to power electronics.
- Design of switching power-roles.
- Analysis and design of switch-mode DC-DC converters.
- Feedback controller design in switch-mode DC-DC converters.
- Rectification of utility input using diode rectifiers.
- Switch-mode DC power supplies.
- Power electronics applications.

1. *Course number and name*
   ENGR 456 Computer Systems

2. *Credits and contact hours*
   3 credits
   Contact hours; two 75-minute lecture sessions/week

3. *Instructor's or course coordinator's name*
   Instructor: Xiaorong Zhang, Assistant Professor of Computer Engineering
   Course coordinator: Xiaorong Zhang, Assistant Professor of Computer Engineering

4. *Text book, title, author, and year*
   "Computer Organization and Embedded Systems, Sixth Edition", Carl Hamacher, Zvonko Vranesic, Safwat Zaky, and Naraig Manjikian, published in 2011

   a. *other supplemental materials*
      ARM Architecture Reference Manual

5. *Specific course information*
   a. *brief description of the content of the course (catalog description)*
      Basic structures of computers. Computer performance measurements. Assembly language programming and basic processor organization. Addressing methods and program sequencing. Various machine instruction sets. Simple and pipelined data paths. Hardwired and micro programmed control. Memory system configuration.

   b. *prerequisites or co-requisites*
      ENGR 356 with a grade of C- or better; ENGR 213 with a grade of C- or better or CSC 210 with a grade of C or better

   c. *indicate whether a required, elective, or selected elective course in the program*
      Required for Computer Engineering, Elective for Electrical Engineering.

6. *Specific goals for the course*
   a. *specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.*

      - The student will demonstrate knowledge of the overall structure of a computing system.
      - The student will demonstrate an ability to design arithmetic circuits.
      - The student will demonstrate knowledge of simple and pipelined datapaths
      - The student will demonstrate knowledge of hardwired and microprogrammed control.
      - The student will demonstrate knowledge of memory hierarchy and its operations.

- The student will demonstrate a good understanding of the ARM processor.
- The student will demonstrate an ability to compare performance measurements.
- The student will demonstrate knowledge of instruction formats and addressing modes.
- The student will demonstrate knowledge of the basic concepts in assembly language programming.

b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.
Course addresses ABET Student Outcome(s): a,c,e.

7. Brief list of topics to be covered

- ***System Level Organization:*** CPU, memory systems (main memory, cache, virtual memory), storage technologies, I/O devices & processes, busses.
- ***Micro-Architecture Level:*** Data paths and components, micro-operations, memory interfacing, the fetch/execute cycle, processor control & sequencing, interrupts, rudimentary pipelining.
- ***Instruction Set Architecture Level:*** Instruction types and formats, opcodes, operands, immediate values, addressing modes, flow of control, branching and procedure calls.
- ***Assembler Language Level****:* Syntax, directives vs. instructions, assemblers, linkers, loaders, semantics of simple programs, stack management, procedure calls, interrupt handling.