Department	Electrical and Computer Engineering
Course Number	**EELE 101**
Course Title	Introduction to Electrical Fundamentals
Total Credit Hours and Format	3 Credits. (1 Lec, 1 Lab, 1 Rec) F,S
Catalog Description	PREREQUISITE: M 151 or equivalent Lecture/laboratory/recitation Introduction to electrical fundamentals including Kirchhoff's and Ohm's Laws, using meters and oscilloscopes, time-varying signals in electric circuits, inductors and capacitors, series and parallel circuits, introduction to digital circuits; introduction to C programming and microcontroller applications; problem solving including computer applications, technical communications, team work.
Faculty Coordinator	David Dickensheets
Course Designation	Required
Textbook	in-house course notes (Jim Becker)
Course Learning Outcomes	At the conclusion of EELE 101, students are expected to be able to: **Fundamental Electrical Quantities and Circuit Elements**: (1) Recall the meaning and the units of measure for charge, current, electrical potential, and power, (2) Identify the circuit symbols for voltage and current sources, resistors, capacitors and diodes, (3) Describe the electrical properties of the resistors, capacitors and diodes, **Circuit Laws**: (1) Recall the definitions of Ohm’s Law, Kirchhoff’s Voltage Law and Kirchhoff’s Current Law, (2) Be able to apply the circuit laws to find voltages and currents in multi-resistor, multi-source circuits **Waveforms and Math Skills**: (1) Describe the properties of DC and AC signals, (2) Identify the amplitude, frequency, and phase shift with respect to a reference given an equation of a waveform or a graphical representation of a waveform, (3) Write an equation describing a waveform given a graphical representation, (4) Manipulate complex numbers in rectangular and polar form. **Lab Skills**: (1) Understand the proper operation and be able to use a bench-top power supply, (2) Understand the proper operation and be able to use a digital multimeter, (3) Understand the proper operation and be able to use a function generator, (4) Understand the proper operation and be able to use an oscilloscope, (5) Be able to construct circuits using a protoboard (breadboard), (6) Understand the proper operation and be able to use a soldering iron in assembling electric circuits, (7) Be able to use MATLAB to create simple plots of measured data and mathematical expressions

	C Programming: You should be able to: (1) Understand the basic data types in C, (2) Understand how to use basic operators in C, (3) Understand how to control program flow, (4) Understand how functions work, (5) Be able to write simple programs in C
Program Outcomes	While not an indicator course, EELE 101 supports the following Electrical and Computer Engineering Outcomes: **a.** An ability to apply knowledge of mathematics, science, and engineering **b.** An ability to design and conduct experiments, as well as to analyze and interpret data. **k.** An ability to use the techniques, skills and modern engineering tools necessary for engineering practice
Topics Covered	• **Circuit Concepts:** Charge, Current, Voltage, Power; sign conventions, definitions for "source" and "load" • Voltage source, current source, resistance and Ohm's law; resistors in series and parallel • Introduction to Kirchhoff's laws (current law and voltage law) • Examples applying KCL, KVL, Ohm's Law; voltage divider, current divider • Introduction to Diodes • Sinusoidal signal properties • Review of Complex Numbers • Introduction to Capacitors and Inductors • Introduction to Amplifiers (the Op-Amp) • Analog and Digital Signals; Introduction to Digital Devices • C **programming basics** including: o Data Types and Input/Output (I/O) o Operators and Expressions o Control Flow o Functions • Introduction to Matlab • Introduction to CodeWarrior and the Freescale Freedom Board • **Lab skills**: Protoboard Connections, Power Supplies, introduction to the function generator and oscilloscope; measurements of simple circuits with resistors, diodes and capacitors; AC signal measurements
Prepared by	David Dickensheets (05/15/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 201**
Course Title	Circuits I for Engineering
Total Credit Hours and Format	4 Credits. (3 Lec, 1 Lab) F,S
Catalog Description	PREREQUISITE: EELE 101, M 172; COREQUISITE: PHSX 222 Introduction to circuit analysis, Ohm's and Kirchhoff's Laws, nodal and mesh methods, network theorems; resistors, capacitors, inductors, dependent sources, ideal op-amps; the complete response of first order circuits; complex frequency and phasors; steady-state AC circuits, coupled inductors and ideal transformers.
Faculty Coordinator	Jim Becker
Course Designation	Required
Textbook	Introduction to Electric Circuits, 9th edition, Svoboda and Dorf, 2014 PSpice for Linear Circuits, 2nd edition, Svoboda, 2007
Course Learning Outcomes	At the conclusion of EELE 201, students are expected to be able to: • Analyze resistive circuits using Ohm's Law, Kirchhoff's Laws, Network Theorems, and Mesh and Node methods. • Calculate power dissipated and energy stored in circuit elements. • Analyze circuits containing ideal operational amplifiers. • Determine complete response of first-order RL and RC circuits to both constant and sinusoidal forcing functions. • Analyze AC single phase circuits and compute real, reactive and complex power. • Breadboard electric circuits. • Use laboratory equipment such as multimeters, signal generators and oscilloscopes to analyze electric circuits.
Program Outcomes	a, b, p
Topics Covered	1) Circuit Variables and Elements 2) Series and Parallel Combinations 3) Kirchhoff's Laws 4) Mesh and Node Methods 5) Network Theorems 6) Operational Amplifiers 7) Inductors and Capacitors

	8) Complete Response of RL and RC Circuits 9) Sinusoidal Steady State Response 10) Analysis in the Frequency Domain 11) Single Phase AC Circuits 12) RMS Values 13) Power in AC Circuits
Prepared by	Jim Becker (05/06/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 203**
Course Title	Circuits II for Engineering
Total Credit Hours and Format	4 Credits. (3 Lec, 1 Lab) S
Catalog Description	PREREQUISITE: EELE 201, M 274 Natural and forced response of R-L-C circuits, frequency response of R-L-C circuits and Bode plots, frequency response, slew-rate and DC imperfections of real op-amps; Laplace Transform, Fourier series and Fourier Transform techniques in circuit analysis; basic R-L-C and op-amp filters; two port networks.
Faculty Coordinator	Jim Becker
Course Designation	Required
Textbook	Introduction to Electric Circuits, 9th edition, Svoboda and Dorf, 2014
Course Learning Outcomes	At the conclusion of EELE 203, students are expected to be able to: • Analyze passive electric circuit in the time domain and frequency domain. • Determine the transient response of RL, RC, RLC circuits. • Characterize the frequency response of circuits using Bode plots. • Apply the Laplace transform in circuit analysis. • Apply concepts related to the Fourier Series and Transform in circuit analysis. • Analyze first- and second-order passive and active filters. • Characterize basic two-port networks using appropriate parameters.
Program Outcomes	a, b, e, g, k
Topics Covered	1) Transient response of RL, RC, RLC circuits 2) Frequency response of linear circuits 3) Laplace transform and its application in circuit analysis 4) Fourier series and Fourier transform 5) Filters 6) Two Port Networks
Prepared by	Jim Becker (05/06/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 217**
Course Title	The Science of Sound
Total Credit Hours and Format	2 Credits. (2 Lec) S
Catalog Description	PREREQUISITE: M 121, M 135, or M 145, or the equivalent Introduction to the principles of musical acoustics, sound systems, and audio technology for non-engineering students. This course is particularly geared toward students in the College of Arts and Architecture and in the Music Technology program.
Faculty Coordinator	Rob Maher
Course Designation	Non-Major
Textbook	Strong, William J., and George R. Plitnik, Music Speech Audio, 4th Edition, BYU Academic Publishing, 2013. (ISBN 978-161165-006-8)
Course Learning Outcomes	At the conclusion of EELE 217, students are expected to be able to: • Demonstrate a practical understanding of the relationships among frequency, wavelength, spectrum, and musical pitch for sounds in air. • Express and knowledgeably discuss the acoustic principles of common musical instruments such as strings, winds, and percussion. • Show an awareness and understanding of sound reflection and absorption behavior in small and large rooms. • Describe the characteristics of the human hearing system and the human vocal system. • Show a basic familiarity with the components and characteristics of audio electronics (microphones, speakers, CD/DVD players, etc.).
Program Outcomes	g, h, l
Topics Covered	1. Acoustics, vibration and waves (2 weeks) a. Traveling waves, frequency, wavelength, phase, amplitude b. Standing waves: vibrating strings, organ pipes c. Fourier analysis and synthesis d. Sound intensity, sound pressure level, decibel units 2. Auditory physiology (2 weeks) a. Physiology of the ear b. Sensitivity and frequency response

	c. Perceived loudness and pitch d. Sound localization 3. Architectural acoustics, reflection, transmission, absorption (4 weeks) a. Sound propagation in small rooms b. Sound propagation in large rooms c. Acoustical properties of performance spaces 4. Musical acoustics (3 weeks) a. Scales and rhythm b. Singing voice c. Woodwinds, brass d. Strings e. Percussion 5. Audio and electroacoustics (4 weeks) a. Loudspeakers b. Microphones c. Broadcasting d. Digital audio e. Electronic musical instruments
Prepared by	Rob Maher (04/25/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 261**
Course Title	Intro To Logic Circuits
Total Credit Hours and Format	4 Credits. (3 Lec, 1 Lab) F,S
Catalog Description	PREREQUISITE: None An introductory course in the fundamental concepts of classical digital design. Course covers design and implementation of combinational logic circuits, synchronous sequential circuits and information storage circuits. Basic concepts of Hardware Description Languages(HDLs), design and simulation of digital systems using HDLs, and digital system implementation with programmable logic devices are presented.
Faculty Coordinator	Brock LaMeres
Course Designation	Required
Textbook	Introduction to Logic Circuits and Logic Design with VHDL, Brock J. LaMeres, 2015.
Course Learning Outcomes	At the conclusion of EELE 261, students are expected to be able to: 1) Describe the differences between an analog and digital system, 2) Perform number system conversions and simple binary arithmetic, 3) Read logic circuit specifications and apply them to successfully interface digital circuits, 4) Synthesize, manipulate and minimize combinational logic circuits, 5) Synthesize finite state machine circuitry from a word description or state diagram, 6) Describe the purpose and constructs of a hardware description languages, 7) Design and simulate combinational logic and finite state machines using VHDL, 8) Implement combinational logic and finite state machines using discrete parts, 9) Implement combinational logic and finite state machines on a programmable logic device using VHDL and a logic synthesizer.
Program Outcomes	o
Topics Covered	1) Analog vs. Digital 2) Number Systems 3) Digital Circuits 4) Boolean Algebra

	5) VHDL – Concurrent Modeling 6) MSI Logic 7) Sequential Logic
Prepared by	Brock LaMeres (04/22/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 308**
Course Title	Signals and Systems Analysis
Total Credit Hours and Format	3 Credits. (3 Lec) F
Catalog Description	PREREQUISITE: EELE 203, M 273 Discrete- and continuous-time signals and systems. Properties, application, synthesis and analysis for convolution, the CT and DT Fourier Series, the continuous and discrete Fourier transform, the DTFT, z and Laplace transform. Applications in differential and difference equations, sampling, and engineering data analysis.
Faculty Coordinator	Joe Shaw
Course Designation	Required
Textbook	Signals and Systems, Oppenheim, Willsky, and Hamid, 1996
Course Learning Outcomes	At the conclusion of EELE 308, students are expected to be able to: 1) understand that signals and system responses can be represented in both time and frequency domains; 2) apply convolution to determine the response of a linear time-invariant system; 3) apply the Fourier transform to determine the output of a linear time-invariant system for a given input; 4) apply the continuous-time and discrete-time Fourier transforms to engineering data analysis problems; 5) properly shift and scale time- and frequency-domain signals; 6) understand properties of periodic signals and apply Fourier series methods; 7) understand sampling in the time and frequency domain; 8) understand basic relationships of Fourier, Laplace and Z transforms.
Program Outcomes	a. ability to apply knowledge of mathematics, science, and engineering e. ability to identify, formulate, and solve engineering problems k. ability to use the techniques, skills, and modern engineering tools necessary for engineering practice r. ability to analyze and synthesize electronic devices and electrical systems
Topics Covered	1. Introduction to signals and systems 2. Linear, time-invariant systems 3. Fourier series representation of periodic signals 4. Continuous-time Fourier transform 5. Discrete-time Fourier transform 6. Time & frequency characterization of signals and systems 7. Sampling 8. Laplace transform 9. Z transform

Prepared by	Joe Shaw (04/29/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 317**
Course Title	Electronics
Total Credit Hours and Format	4 Credits. (3 Lec, 1 Lab) F
Catalog Description	PREREQUISITE: EELE 203 This is an introductory course in electronics. It introduces diodes, bipolar junction transistors, field effect transistors and bipolar and MOS analog and digital circuits.
Faculty Coordinator	Jim Becker
Course Designation	Required
Textbook	Microelectronic Circuits, 7th edition, Sedra and Smith, 2014
Course Learning Outcomes	At the conclusion of EELE 317, students are expected to be able to: • Describe two-port concepts such as input and output impedance, voltage and current gain, transresistance and transconductance. • Understand first order behavior of p-n junction diodes, BJTs and FETs. • Evaluate simple electronic circuits to determine DC bias conditions and AC behavior. • Be able to use SPICE to simulate simple electronic circuits to evaluate DC bias conditions and AC behavior. • Be able to construct simple electronic circuits in a laboratory setting and measure DC bias and AC behavior using modern test and measurement tools.
Program Outcomes	a, b, g, k, p, r
Topics Covered	1. pn junction diode forward and reverse I-V characteristics 2. Zener diodes and applications 3. Spice modeling of pn junction diodes 4. Field effect transistor (FET) 5. FET dc biasing 6. FET modeled as a two-port device 7. FET ac analysis 8. Spice modeling of FET circuits 9. Bipolar junction transistor (bjt) 10. Bjt dc biasing 11. Bjt modeled as a two-port device

	12. Bjt ac analysis 13. Common emitter, common base and common collector configurations 14. Spice modeling of bjt circuits 15. Resistive loaded and CMOS Inverters
Prepared by	Jim Becker (05/06/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 321**
Course Title	Intro To Feedback Controls
Total Credit Hours and Format	3 Credits. (3 Lec) S
Catalog Description	PREREQUISITE: EELE 308 or EMEC 303 or consent of instructor Classical continuous-time, transfer function approach to feedback control systems engineering. Approximations, linearization, and time response. Design and analysis via root-locus, Nyquist, and Bode methods. Proportional, dominant pole, lead, lag, PID, and minor loop compensation. Describing functions and nonlinear system behavior.
Faculty Coordinator	Dr. Steven R. Shaw
Course Designation	Required
Textbook	Control Systems Engineering, 7th edition, by Norman Nise, Wiley, 2015.
Course Learning Outcomes	At the conclusion of EELE 321, students are expected to be able to: 1. model linear electrical and mechanical systems using transfer functions and block diagrams 2. manipulate block diagrams 3. determine step-response of first and second order systems by inspection; make dominate pole approximations 4. determine all of the transfer functions associated with a feedback system 5. use root locus to analyze the poles as a function of a gain in the loop 6. use root locus to design series compensators to achieve stability and dominant pole characteristics 7. use Nyquist and Bode techniques to analyze feedback systems, including performance and relative stability 8. use Nyquist and Bode techniques to design series compensators to meet performance and stability requirements 9. use Bode techniques to select, design, and analyze minor loop compensation 10. use describing functions to predict the existence of limit cycle behavior for feedback systems incorporating static nonlinearities 11. use modern computation tools, e.g. Matlab, to analyze feedback control systems

Program Outcomes	EELE321 supports the following program outcomes : a. an ability to apply knowledge of mathematics and engineering a. an ability to design a system, component, or process to meet a need e. an ability to identify, formulate, and solve engineering problems g. an ability to communicate effectively k. an ability to use the techniques and capabilities provided by modern engineering tools
Topics Covered	1. Concepts of feedback control, role of controls in modern engineered systems. 2. modeling of electrical and mechanical systems, block diagrams and manipulation 3. dominant poles, system response, and stability 4. root-locus analysis, simple series compensators, root-locus design 5. principle of the argument, Nyquist analysis, relative stability 6. Bode analysis, the Bode obstacle course, Bode design, compensation revisited, minor loop. 7. introduction to behavior and control of nonlinear plants, describing functions and gain scheduling
Prepared by	Dr. Steven R. Shaw (4/26/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 334**
Course Title	Electromagnetic Theory I
Total Credit Hours and Format	3 Credits. (3 Lec) F
Catalog Description	PREREQUISITE: PHSX 222, M 273 Basic electric and magnetic fields including transmission lines. The materials covered will include both static and dynamic fields, traveling waves, and transmission line concepts such as impedance, reflection coefficient, and transient response.
Faculty Coordinator	Wataru Nakagawa
Course Designation	Required
Textbook	Fawwaz T. Ulaby, Eric Michielssen, and Umberto Ravaioli, Fundamentals of Applied Electromagnetics, 6th Ed. (Prentice Hall, 2010).
Course Learning Outcomes	At the conclusion of EELE 334, students are expected to be able to: 1) Represent fields in either the standard Cartesian, cylindrical, or spherical coordinate systems. 2) Understand the physical meaning as applied to fields of the gradient, divergence, and curl. 3) Understand the physical meaning of Coulomb's Law. 4) Be able to set up the expressions for the electric field of charge distributions and understand the source of electric fields is charge. 5) Understand the field concept of voltage and the importance of Laplace's equation. 6) Understand under what conditions Gauss' Law can be used to calculate electric fields. 7) Be able to apply the boundary conditions for electric and magnetic fields. 8) Understand the physical meaning of the Biot-Savart law.

	9) Be able to set up the expressions for the magnetic field of charge distributions and understand the source of magnetic fields is moving charge or current. 10) Understand under what conditions Ampere's Law can be used to calculate magnetic fields. 12) Be able to express Maxwell's Equations in either integral or differential form. 13) Understand Maxwell's Equations for time varying fields. 14) Understand plane wave propagation. 15) Use the Smith Chart for impedance calculations and impedance matching.
Program Outcomes	a, b, e, i
Topics Covered	1) Fields and field operators. 2) Transmission line effects and the Smith Chart 3) Static electric fields. 4) Static Magnetic fields. 5) Time-varying fields and Maxwell's Equations. 5) Plane wave propagation 6) Introduction to polarization
Prepared by	Wataru Nakagawa (5/14/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 355**
Course Title	Energy Conversion Devices
Total Credit Hours and Format	4 Credits. (3 Lec, 1 Lab) S
Catalog Description	PREREQUISITE: EELE 203 Three-phase power; electromechanical energy conversion devices and motor drives; introduction of power electronic converters for power control and motor drive applications. Laboratory experience includes power measurements; experience with transformers and motor-generator operational characteristics and DC and AC motor drives operation.
Faculty Coordinator	Hashem Nehrir
Course Designation	Required
Textbook	Theodore Wildi, Electrical Machines, Drives, and Power Systems, Sixth Edition, Pearson, Prentice Hall, 2006.
Course Learning Outcomes	At the conclusion of EE 355, students are expected to: 1) Understand the concept of real and reactive (complex) power. 2) Understand reactive compensation and design power factor correction circuits. 3) Analyze three-phase circuits. 4) Understand the concept of complex power in three-phase circuits. 5) Know principle of operation and characteristics of common energy conversion devices such as transformers, DC motors, three-phase and single-phase induction motors, and application of such devices in industrial settings. 6) Conduct experiments to obtain the characteristics of energy conversion devices. 7) Be familiar with the application of power electronics for variable-speed operation of electric motor drives. 8) Know the constant-flux (variable-frequency, variable-voltage) operation of induction motor drives. 9) Understand the operation of induction machines as induction generators in wind generation systems.
Program Outcomes	a, b, e, g, k
Topics Covered	1) Importance of Energy, sources of energy, Difference between power and energy, household energy use. 2) US power grid, power system layout, and power quality. 3) Single-phase and three-phase power, complex power, and factor improvement. 4) Principles of operation and equivalent circuit of energy conversion devices, transformers, three-phase and single-phase induction machines, stepper motors, DC machines. 5) Rotating fields in three-phase induction machines 6) Three-phase induction generators in wind generation systems 7) Application of power electronics in control of motor drives and power systems.
Prepared by	Hashem Nehrir (05/01/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 367**
Course Title	Logic Design
Total Credit Hours and Format	4 Credits. (3 Lec, 1 Lab) S
Catalog Description	PREREQUISITE: EELE 261 This course covers large scale digital system design using a hardware description language (VHDL). This course covers the VHDL language in depth and explains how to use it to describe complex combinational circuits, synchronous sequential logic circuits, and computer systems. Functional verification of VHDL designs is accomplished using a logic simulator. This course includes a weekly lab where students will get hands-on experience implementing digital systems on Field Programmable Gate Arrays.
Faculty Coordinator	Brock LaMeres
Course Designation	Required
Textbook	Introduction to Logic Circuits and Logic Design with VHDL, Brock J. LaMeres, 2015.
Course Learning Outcomes	At the conclusion of EELE 367, students are expected to be able to: 1) Understand how to describe a digital system using a Hardware Description Language. 2) Model complex combinational logic in VHDL. 3) Model complex sequential logic in VHDL including state machines and counters. 4) Incorporate pre-existing logic cores into your VHDL design. 5) Understand the HDL design flow including synthesis and place/route and its effect on timing. 6) Perform logic simulations on your digital designs (pre and post synthesis) 7) Prototype digital systems on an FPGA.
Program Outcomes	g, o, p
Topics Covered	1) VHDL – Sequential Modeling 2) VHDL – Behavioral Modeling Techniques 3) Memory 4) Programmable Logic 5) Arithmetic Logic 6) Computer Systems
Prepared by	Brock LaMeres (04/22/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 371**
Course Title	Microprocess HW and SW Systems
Total Credit Hours and Format	4 Credits. (3 Lec, 1 Lab) F
Catalog Description	PREREQUISITE: EELE 261 and knowledge of a programming language or consent of instructor Introduction to the structure of microprocessors, arithmetic and logic units, processor control, interrupts, memories, and input/output. Laboratory experience in assembly level programming of microprocessor applications.
Faculty Coordinator	Randy Larimer
Course Designation	Required EE and CpE
Textbook	Specific Microcontroller Data Sheet and Application Notes used.
Course Learning Outcomes	At the conclusion of EELE 371, students are expected to be able to: 1. Describe the basic architecture of a stored-program computer 2. Describe the addressing modes of a sample microcontroller 3. Apply the principles of top down design to microcontroller software development. 4. To write assembly language programs for the ARM Cortex M0+ core 5. To write assembly language code for high-level language structures such as If-Then-Else and Do-While 6. To describe a typical I/O interface and to discuss timing issues 7. To describe different types of memory used in microcontroller systems.
Program Outcomes	c, n, q
Topics Covered	1. Introduction 2. Microcomputer Overview 3. Memory, Addressing Modes, Data Structure, Freescale FRDM-KL25Z memory map. 4. Instruction Set 5. Input / Output 6. Structured Programming 7. Interrupts 8. Timers 9. Interfacing to an A/D Converter 10. Communications Standards (RS232, SPI, CAN, I2C)
Prepared by	Randy Larimer 04/21/2015

Department	Electrical and Computer Engineering
Course Number	**EELE 394**
Course Title	Multidisciplinary Seminars
Total Credit Hours and Format	1 Credit. (1 Sem) F,S
Catalog Description	PREREQUISITE: Junior standing Students attend seminars presented by a variety of departments and disciplines to gain an appreciation of multidisciplinary environments leading to a greater understanding of the impact of engineering solutions in a global and societal context.
Faculty Coordinator	Rob Maher
Course Designation	Elective
Textbook	N/A
Course Learning Outcomes	At the conclusion of EELE 394, students are expected to be able to: • Understand learning from seminars, presentations or events from a variety of academic disciplines and societal contexts. • Demonstrate awareness of technical, educational, and cultural events occurring on campus and locally. • Develop skills writing succinct, timely summary reports on each presentation.
Program Outcomes	g, h, j
Topics Covered	Students select, and attend on their own, 12 seminars or presentations during the semester. A student may attend no more than four seminars from any one department or organization, and no more than two performing arts presentations (music recitals, dances, plays, etc.). Performing arts presentations must have a printed program and a formal format (e.g., not a bar band show or festival-style entertainment). Seminars and presentations must be at least 50 minutes long and be informative in some sense. The presentations need not be purely technical, but acceptable events cannot be parties, receptions, social club meetings, or other informal activities that are predominantly for recreation or casual entertainment. Students may attend pre-approved off-campus meetings and seminars. The instructor will grant pre-approval for professional meetings, such as IEEE

	branch meetings and local government meetings (city and county commission, planning board, etc.). Political candidate forums organized by non-political organizations (such as League of Women Voters, etc.) may be acceptable, but must be pre-approved. A memo report is due no later than three school days following the presentation. The memo is to include at least: a brief summary of the presentation (2-3 paragraphs), and a description of the student's interest in the topic and what was learned from it.
Prepared by	Rob Maher (4/25/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 407**
Course Title	Intro To Microfabrication
Total Credit Hours and Format	3 Credits. (2 Lec, 1 Lab) F
Catalog Description	PREREQUISITE: Junior standing and PHSX 222 or PHSX 207 Provide an introduction to clean room safety protocol and micro fabrication. Lectures will introduce micro fabrication methods, models and equipment. Laboratories will perform the steps to produce and characterize a metal-oxide-semiconductor transistor.
Faculty Coordinator	Todd Kaiser
Course Designation	Elective
Textbook	Introduction to Microelectronic Fabrication 2E, Richard C. Jaeger, 2002
Course Learning Outcomes	At the conclusion of EELE 407, students are expected to be able to: 1) Understand clean room protocol 2) Operate the processing equipment 3) Understand thermal processes such as diffusion and oxidation 4) Understand methods for thin film deposition 5) Understand methods for wet and dry etching of thin films 6) Understand photolithography 7) Understand the fabrication sequence to produce simple integrated circuits 8) Be able to characterize transistors and their failure mechanisms
Program Outcomes	EELE 407 supports following Program Outcomes: a. an ability to apply knowledge of mathematics, science and engineering b. an ability to design and conduct experiments, as well as to analyze and interpret data c. an ability to design a system, component or process to meet desired needs e. an ability to identify, formulate and solve engineering problems g. an ability to communicate effectively k. an ability to use the techniques, skills and modern engineering tools necessary for engineering practice
Topics Covered	1) Lithography 2) Thermal oxidation of silicon 3) Constant source diffusion 4) Limited source diffusion 5) Ion implantation 6) Chemical vapor deposition 7) Sputtering

	8) Electron beam evaporation 9) Filament evaporation 10) Thin film etching 11) Interconnections and contacts 12) Packaging and yield 13) Material Characterization 14) Device Characterization
Prepared by	Todd Kaiser (04/27/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 408**
Course Title	Photovoltaic Systems
Total Credit Hours and Format	3 Credits. (2 Lec, 1 Lab) S
Catalog Description	PREREQUISITE: PHSX 222 Provide a basic understanding of the design, fabrication and operating principles of solar cells and how they are integrated into photovoltaic systems. Laboratories will perform the steps required to produce and characterize silicon solar cells.
Faculty Coordinator	Todd Kaiser
Course Designation	Elective
Textbook	Photovoltaics: Fundamentals, Technology, and Practice; Konrad Mertens; 2014 pveducation.org/pvcdrom
Course Learning Outcomes	At the conclusion of EELE 408, students are expected to be able to : 1) Understand the nature of sunlight 2) Understand the operation of PN junctions 3) Understand the photovoltaic effect 4) Be able to design a solar cells 5) Be able to design a photovoltaic system 6) Understand the fabrication sequence to produce simple solar cells 7) Be able to characterize solar cells and modules
Program Outcomes	EELE 408 supports following Program Outcomes: a. an ability to apply knowledge of mathematics, science and engineering b. an ability to design and conduct experiments, as well as to analyze and interpret data c. an ability to design a system, component or process to meet desired needs e. an ability to identify, formulate and solve engineering problems g. an ability to communicate effectively k. an ability to use the techniques, skills and modern engineering tools necessary for engineering practice
Topics Covered	1) Properties of light 2) PN Junctions 3) Solar Cell Operation 4) Design of Solar Cells 5) Single Crystal Silicon Cell Fabrication 6) Modules and Arrays

	7) Cell and Module Characterization 8) System Integration
Prepared by	Todd Kaiser (04/27/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 409**
Course Title	EE Material Science
Total Credit Hours and Format	3 Credits. (3 Lec) F
Catalog Description	PREREQUISITE: EELE 317 Basic material properties of dielectrics, magnetic materials, conductors, and semiconductors. Practical applications of materials to semiconductor devices.
Faculty Coordinator	Todd Kaiser
Course Designation	Required
Textbook	Principles of Electronic Materials and Devices 3E, Kasap, 2006
Course Learning Outcomes	At the conclusion of EELE 409, students are expected to be able to: 1) Understanding of the physical processes in a material which determine the specifications of a particular electronic device. 2) Be able to break a complex electronic materials problem down into smaller pieces, each of which can be more easily solved, with the interactions between each sub-problem clearly identified and quantified. 3) An understanding of the limits material properties impose upon electronic device specifications. 4) Given a design specification, a student should be able to select a set of candidate materials which can provide a solution for the design problem. From these materials, the student should then be able to find commercially available devices which use these materials. 5) Given a set of specifications claimed for a device, a student should be able to confirm the validity of those specifications based on the properties of the materials used in the device and the device geometry.
Program Outcomes	EELE 409 supports following Program Outcomes: a. an ability to apply knowledge of mathematics, science and engineering b. an ability to design and conduct experiments, as well as to analyze and interpret data e. an ability to identify, formulate, and solve engineering problems. g. an ability to communicate effectively. i. a recognition of the need for, and an ability to engage in life-long learning. k. an ability to use the techniques, skills and modern engineering tools necessary for engineering practice l. been exposed to the principles of project management and design trade-offs.

Topics Covered	1) Atomic Bonding and types of bonds 2) Kinetic Molecular Theory 3) Thermally Activated Processes 4) Solid Solutions 5) Phase Diagrams 6) Thermal Conduction in solids 7) Electrical Conduction 8) Band Theory of solids 9) Thermionic Emission and Vacuum Tubes 10) Piezoresistivity 11) Metal Semiconductor contacts 12) Thermoelectric coolers 13) Semiconductor Basics 14) Carrier Generation and Recombination 15) Semiconductor Devices 16) Dielectric Materials 17) Polarization Mechanisms 18) Piezoelectricity 19) Magnetization and Magnetic Properties 20) Magnetic Domains 21) Optical Properties of Materials
Prepared by	Todd Kaiser (04/27/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 411**
Course Title	Advanced Analog Electronics
Total Credit Hours and Format	3 Credits. (3 Lec) S
Catalog Description	PREREQUISITE: EELE 317 This course covers differential and multistage amplifiers, frequency response, feedback, analog integrated circuits, filters, and tuned circuits, analog to digital and digital to analog conversion, noise in electronics, current topics.
Faculty Coordinator	Jim Becker
Course Designation	Elective
Textbook	Microelectronic Circuits, 6th edition, Sedra and Smith, 2009
Course Learning Outcomes	At the conclusion of EELE 411, students are expected to be able to: • Analyze and design multistage amplifiers using discrete transistors to achieve a specified gain and bandwidth • Identify and analyze feedback amplifiers according to their topology • Design basic active filters to meet bandwidth and attenuation specification • Identify the stages of a 741-op amp from its circuit schematic and to articulate the purpose of each stage • Use Pspice to analyze the DC and AC behavior of basic amplifier circuits • Breadboard, troubleshoot and successful test project circuits
Program Outcomes	c, g, k
Topics Covered	1. Device structure and modeling of the MOSFET and BJT 2. Design of simple and augmented current mirrors 3. Analysis and design of differential pair amplifiers 4. Frequency response concepts (short circuit and open circuit time constant techniques) 5. Multi-stage amplifier design 6. Class A, class B and class AB output stages 7. Basic properties, configurations and stability of feedback circuitry 8. Active filter design using first and second order cascades 9. Single-parameter sensitivity analysis

	10. Wien-bridge oscillator
Prepared by	Jim Becker (05/06/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 414**
Course Title	Intro to VLSI Design
Total Credit Hours and Format	3 Credits. (3 Lec) F
Catalog Description	PREREQUISITE: EELE 262, EELE 317 Introduction to the fundamentals of CMOS VLSI circuit design. This course covers CMOS device characteristics and timing, CMOS fabrication, CAD tools, design rules, simulation and layout, CMOS combinational and sequential logic, SRAM and DRAM memory, and dynamic logic design.
Faculty Coordinator	Andy Olson
Course Designation	Elective
Textbook	"CMOS Digital Integrated Circuits," 4th ed., Kang, Sun-Mo (Steve); Leblebici, Yusuf; Kim, Chul Woo, McGraw-Hill, 2015.
Course Learning Outcomes	At the conclusion of EELE 414, students are expected to be able to: • Create an integrated circuit layout from a schematic. • Create a schematic from an integrated circuit layout. • Perform transistor level design and layout of a custom state machine. • Verify performance of CMOS circuits using hand calculations and circuit simulators such as Spice. • Describe the photo-resist based etching process. • Describe the self-aligned CMOS transistor fabrication sequence. • Design a complex CMOS logic gate from a truth table.
Program Outcomes	b, e, k, r
Topics Covered	1) Fabrication of CMOS integrated circuits 2) Basic physical operation of a MOS transistor including depletion regions, inversion layers, channel pinch-off 3) Reverse bias diode capacitance and gate capacitance. 4) Calculation of drain current using oxide capacitance, threshold voltage, mobility, body effect and channel length modulation. 5) Spice Level 1 and Bsim3 model parameters. 6) Use of MOS transistors in logic gates flip flops and memory. 7) Complex logic gates. 8) Flip-flops and latches. 9) State Machine design using CMOS Logic Gates.

	10) Integrated Circuit Layout techniques, CAD tools and computer layout checking. 11) Parasitic SCR Latch-up and substrate contacts. 12) Packaging 13) Design for test
Prepared by	Andy Olson (05/26/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 417**
Course Title	Acoustics/Audio Engineering
Total Credit Hours and Format	3 Credits. (3 Lec) F alternate years, to be offered even years
Catalog Description	PREREQUISITE: PHSX 222 Introduction to the principles of acoustics, audio engineering, and audio signal processing. Propagation of sound in enclosures. Engineering analysis of loudspeakers, microphones, and recording devices. Human psychoacoustics.
Faculty Coordinator	Rob Maher
Course Designation	Elective
Textbook	Kinsler, Lawrence E., Frey, Austin R., Coppens, Alan B., and Sanders, James V., Fundamentals of Acoustics, 4th ed., Wiley & Sons, 1999.
Course Learning Outcomes	At the conclusion of EELE 417, students are expected to be able to: • Understand the linear acoustic wave equation and explain the relationship between pressure and particle velocity for plane waves and spherical waves. • Calculate and interpret the near-field and far-field response of a circular piston radiator mounted in an infinite baffle. • Explain the basic physiology of the human hearing system and elementary psychoacoustical principles (e.g., sensitivity as a function of frequency, simultaneous masking, and difference limens). • Use geometrical measurements and material properties to calculate Sabine reverberation time for a room. • Explain the basic operation of dynamic (moving-coil) loudspeakers and condenser (capacitive) microphones. • Understand the principles of recording studio signal flow. • Discuss the strengths and weaknesses of modern perceptual audio coders such as MP3. • Describe the attributes of CD, DVD, and Blue-Ray, and the coding formats of downloadable media.
Program Outcomes	a, h
Topics Covered	1) Audio and acoustics subdisciplines, survey

	2) Fundamental quantities, Fourier review, mass and vibration 3) Damping, complex exponential solutions, forced oscillation 4) Acoustic wave equation 5) Harmonic plane waves, intensity, impedance 6) Spherical waves, sound level, dB examples 7) Radiation from small sources 8) Baffled simple source, piston radiation 9) The ear, hearing, etc. 10) Environmental acoustics and noise criteria 11) OSHA, architectural isolation 12) Architectural acoustics, reverb 13) Absorbing materials, direct-reverberant ratio 14) Audio engineering introduction 15) Microphones 16) Studio electronics 17) Loudspeakers 18) Digital audio 19) CD and DVD principles 20) Audio DSP
Prepared by	Rob Maher (4/25/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 422**
Course Title	Introduction to Modern Control
Total Credit Hours and Format	3 Credits. (3 Lec) F
Catalog Description	PREREQUISITE: EELE 321 Introduction to techniques of modern control with emphasis on discrete time, including matrices, norms, state-space, and stochastic processes. Stability, Lyapunov functions, Lyapunov stability. Observability, controllability, reachability. State feedback and observers. Model based control. Performance and robustness.
Faculty Coordinator	Dr. Steven R. Shaw
Course Designation	Elective
Textbook	*Modern Control Theory 3rd Edition,* William L. Brogan, 1990. Prentice Hall.
Course Learning Outcomes	At the conclusion of EELE 422, students are expected to be able to: 1. model linear, time-invariant systems (continuous and discrete time) in state-space form 2. understand and apply the methods of linear algebra involved in the analysis and design of modern control systems. 3. Understand and apply concepts of observability, reachability, and controllability to state-space systems. 4. Transform transfer function descriptions of systems to canonical forms (controllable, observable, Jordan). 5. Understand and apply concepts of Lyapunov stability.
Program Outcomes	EELE422 supports the following program outcomes : a. an ability to apply knowledge of mathematics and engineering b. an ability to design a system, component, or process to meet a need e. an ability to identify, formulate, and solve engineering problems g. an ability to communicate effectively k. an ability to use the techniques and capabilities provided by modern engineering tools
Topics Covered	1. development of "modern" state-space control system formulation and applications

	2. state-space representation of continuous and discrete systems 3. norms, decompositions (QR,SVD,eigenvalue), orthogonality, matrix exponential, vector spaces, matrix derivatives, and Lagrange multipliers 4. reachability, controllability, and observability 5. full-state feedback and pole placement 6. Luenberger observers 7. Lyapunov stability 8. Use of Matlab and the control system toolbox.
Prepared by	Dr. Steven R Shaw (4/26/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 432**
Course Title	Applied Electromagnetics
Total Credit Hours and Format	3 Credits. (3 Lec) S
Catalog Description	PREREQUISITE: EELE 334 or PHSX 423 Advanced study of electromagnetic wave propagation, including polarization, reflection and refraction at interfaces, and cavities and multilayer structures, to investigate a number of practical devices with applications related to electrical engineering and optics, such as waveguides, fiber optics, and antennas.
Faculty Coordinator	Wataru Nakagawa
Course Designation	Elective
Textbook	Constantine A. Balanis, *Advanced Engineering Electromagnetics, 2nd Ed.* (Wiley, 2012).
Course Learning Outcomes	At the conclusion of EELE 432, students are expected to be able to: 1) Understand plane wave propagation, including in lossy media. 2) Understand reflection and refraction at interfaces, at normal and oblique incidence, with dielectric, lossy, or conductive materials. 3) Use computational tools (e.g. Matlab) to solve simple electromagnetics problems where an analytic solution is unavailable or impractical. 4) Be able to understand polarization, including linear, circular, and elliptical states. 5) Understand guided waves, including modes, cutoff, and propagation characteristics 6) Be able to understand evanescent fields. 7) Develop a high-level understanding of wave propagation in optical fiber, and how this affects its performance in communications 8) Describe the applications of optical fiber to communications systems.
Program Outcomes	

Topics Covered	1) Electromagnetic wave propagation 2) Polarization 3) Reflection and refraction at interfaces 4) Cavities and multiple interfaces 5) Scalar and vector potentials 6) Waveguides (rectangular and cylindrical) 7) Fiber optics 8) Antennas and radiation 9) Introduction to anisotropic and nonlinear (optical) materials
Prepared by	Wataru Nakagawa (5/14/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 445**
Course Title	Telecommunication Systems
Total Credit Hours and Format	4 Credits. (3 Lec, 1 Lab) S
Catalog Description	PREREQUISITE: EELE 308, EELE 317 Introduction to analog and digital communication systems with lab. Topics include signals in communications; noise characterizations; bandwidth considerations; probability of error; analog and digital modulation; frequency domain analysis; matched filter applications. Experiments involve modulation, demodulation, A/Ds, sampling theory, and aliasing.
Faculty Coordinator	Andy Olson
Course Designation	Required
Textbook	"Digital and Analog Communications Systems",8th ed., Leon W. Couch, Prentice Hall, 2013
Course Learning Outcomes	At the conclusion of EELE 445, students are expected to be able to: • Analyze a signal in the time and frequency domains. • Describe the architecture of analog communications systems • Describe the architecture of common digital communication systems. • Analyze the noise performance of a typical communication system. • Estimate the bit error rate for a typical digital communication system. • Describe the various analog and digital modulation types such as AM, PSK.
Program Outcomes	a. b. j, k, r
Topics Covered	1. Review of signals. 2. Analysis and transmission of signals. 3. Amplitude (linear) and Angle (exponential) modulation. 4. Sampling and pulse code modulation. 5. Principles of digital data transmission. 6. Introduction to the theory of probability. 7. Analog systems in the presence of noise. 8. Digital systems in the presence of noise. 9. Link Budgets

	10. Error correcting codes
Prepared by	Andy Olson (05/26/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 447**
Course Title	Mobile Wireless Communications
Total Credit Hours and Format	3 Credits. (3 Lec) F
Catalog Description	PREREQUISITE: EELE 445 Characteristics of the radio environment, propagation, cellular concepts, channel allocation, modulation techniques, multiple access techniques, Shannon's Capacity Theorem, error-correcting codes, data compression, spread spectrum modulation, current wireless communication systems.
Faculty Coordinator	Rob Maher
Course Designation	Elective
Textbook	Wireless Communications and Networking, Prentice Hall, Jon W. Mark and Weihua Zhuang, 2003, ISBN 0-13-040905-7
Course Learning Outcomes	At the conclusion of EELE 447, students are expected to be able to: • Describe the architecture of common digital wireless communication systems. • Describe and apply the principles of a radio link budget • Use propagation models to determine wireless coverage for typical systems • Determine the bit-error rate of a digital communication system in the presence of noise. • Assess system capacity for cellular architectures.
Program Outcomes	a, c, g, k
Topics Covered	1. dB, Free Space Path Loss, the communication link model 2. Link Budgets, Radio Systems and Components, Antennas, 3. The Wireless Channel: Multipath, LTI (linear time invariant) and LTV (linear time variant) channel model 4. The Wireless Channel: Large-scale path loss, Shadowing, Path loss models 5. The Wireless Channel: Small-scale multipath fading, Rayleigh and Ricean fading 6. Digital modulation, receivers, FSK, BPSK, MPSK, MSK, GMSK, OFDM

	7. Probability of Error, Diversity Receiver, Linear Equalization 8. Cellular Systems: Frequency Reuse, Clusters 9. Cellular Systems: Signal strength and Interference, Cell splitting, Sectoring 10. Cell Capacity: Traffic intensity, Call Blocking, Channel Assignment 11. Multiple Access: Random access, FDMA, TDMA, CDMA 12. Multiple Access: PN Codes, Jam Margin, Spectral Efficiency for multiple access methods 13. First and Second Generation Cellular Systems: AMPS (historical view), GSM, IS-95, PCS 14. Mobility Management: Call admission, Handoffs, Location management 15.Third Generation Systems, LTE systems, and the Future
Prepared by	Rob Maher (4/25/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 451**
Course Title	Power Electronics
Total Credit Hours and Format	3 Credits. (2 Lec, 1 Lab) S alternate years; to be offered even years
Catalog Description	PREREQUISITE: EELE 317, EELE 321, EELE 355 Introduction to solid-state power devices; topologies, operating principles, modeling and control, and design of basic power converters; magnetic design; applications of power converters in renewable energy source power systems, electric and hybrid electric vehicles, and other residential, commercial, and industrial systems; laboratory experience with basic power converters.
Faculty Coordinator	Hongwei Gao
Course Designation	Elective
Textbook	Power Electronic Circuits, Issa Batarseh, 2004
Course Learning Outcomes	At the conclusion of EELE 451, students are expected to be able to: 1) Understand the switching characteristics of basic power switches 2) Understand the applications of power switches in basic power electronic converters 3) Understand the fundamental principles of basic power electronic converters 4) Know how to calculate the voltage, current, and the parameters of the basic power electronic converters 5) Know how to simulate the basic power electronic converter 6) Know how to design the basic power electronic converter
Program Outcomes	EELE 451 supports the following Program Outcomes: a. An ability to apply knowledge of mathematics, science and engineering b. An ability to design and conduct experiments, as well as to analyze and interpret data c. An ability to design a system, component, or process to meet desired needs k. An ability to use the techniques, skills and modern engineering tools necessary for engineering practice. r. An ability to analyze electrical and electronic systems.
Topics Covered	• Switching characteristics of solid state power devices • Operating principle, advantages, and disadvantages of basic power converters • Device ratings and selection of power devices

	• Selection or design of reactive elements • Averaged state space models of power electronic converters • Simulation of power converters • Controller design of power converters
Prepared by	Hongwei Gao (05/08/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 454**
Course Title	Power System Analysis
Total Credit Hours and Format	3 Credits. (3 Lec) F
Catalog Description	PREREQUISITE: EELE 355 Power system components, transmission system design, power flow studies, symmetrical components, faulted power systems, protection, introduction to transient stability.
Faculty Coordinator	Hashem Nehrir
Course Designation	Elective
Textbook	Power System Analysis and Design, Fifth Edition; Glover, Sarma, Overbye; Cengage Learning, 2012.
Course Learning Outcomes	At the conclusion of EELE 454, students are expected to be able to: 1) Differentiate between the different utility transformer configurations and their applications, 2) Work power problems in the per-unit system, 3) Calculate transmission line parameters and make their models, 4) Find steady-state maximum power transfer capability of transmission lines, 5) Find direction of real and reactive power flow in transmission lines, 6) Evaluate the reactive compensation need in power systems for voltage improvement, 7) Analyze faulted power systems and select proper circuit breakers and relays for protecting the system, 8) Run power flow and short circuit programs, interpret the data obtained, and use the data in system planning.
Program Outcomes	a, b, e, g, k
Topics Covered	Utility industry structure, review of power fundamentals, power transformers, per-unit systems, transmission line parameters and steady-state operation, power low and power flow control, symmetrical faults and circuit breaker selection, symmetrical components, unsymmetrical faults, introduction to power system protection.
Prepared by	Hashem Nehrir (05/01/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 455**
Course Title	Alternative Energy Power Gen
Total Credit Hours and Format	3 Credits. (3 Lec) S, alternate years; to be offered even years
Catalog Description	PREREQUISITE: EELE 355 or equivalent Exploration and analysis of alternative power generation sources and systems such as wind, solar, microturbine, and fuel cells, combined sources and their design, power electronic interfacing, and energy storage systems.
Faculty Coordinator	Hashem Nehrir
Course Designation	Elective
Textbook	Wind and Solar Power Systems, M.R. Patel, CRC, 2006 + Several scholarly papers related to the course topics
Course Learning Outcomes	At the conclusion of EELE 455, students are expected to be able to: 1. Identify wind and solar resources and interpret wind/solar energy profiles. 2. Estimate the probability density function of a wind site and estimate maximum annual energy production of a wind turbine generator for the wind site. 3. Select a proper wind turbine for a given wind site. 4. Estimate the maximum power generation point and control features of wind generation systems. 5. Identify the different type of electrical generators used in wind-turbine-generators (WTGs). 6. Identify the different solar photovoltaic (PV) cell technologies. 7. Understand peak power tracking system for PV panels. 8. Understand the need for energy storage for variable renewable energy (RE) system and identify suitable battery technologies for such systems. 9. Design a standalone hybrid RE system for a given site. 10. Estimate the cost and payback period of a hybrid RE system.
Program Outcomes	a, c, e, g, k
Topics Covered	Man and energy, Alternative energy: Opportunities and challenges, Wind energy capture and power generation, Wind energy capture and power generation, Wind speed and energy distribution, Wind turbine generator components, Electrical generator for WTG, machine dynamics, Fixed and variable speed WTG, Wind integration to the grid, Solar cells and photovoltaic power generation, PV power systems and their control, Energy storage, Power electronic interfacing, stand-alone and grid-connected systems, Plant economy, Emerging renewable energy technologies.
Prepared by	Hashem Nehrir (05/01/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 456**
Course Title	Power System Operation and Control
Total Credit Hours and Format	3 Credits. Lec, S
Catalog Description	PREREQUISITE: EELE 454 Continuation of EELE 454. Introduction to load frequency control, voltage control, economic dispatch, SCADA and synchrophasors, state estimation and power system stability.
Faculty Coordinator	Hashem Nehrir
Course Designation	Elective
Textbook	Power System Analysis and Design, Fifth Edition; Glover, Sarma, Overbye; Cengage Learning, 2012.
Course Learning Outcomes	At the conclusion of EELE 456, students are expected to: 1. Understand in considerable detail the concepts of load-frequency control. 2. Understand the basic concepts of voltage control in a power system. 3. Understand basic power system stability concepts. 4. Understand the use of SCADA and synchrophasors in power system operations. 5. Understand state estimation.
Program Outcomes	a, e, k
Topics Covered	1. Load-frequency control 2. Voltage control 3. Economic dispatch 4. SCADA 5. State estimation 6. Power system stability
Prepared by	Hashem Nehrir (05/01/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 461**
Course Title	Digital System Design
Total Credit Hours and Format	3 Credits. (3 Lec) S, alternate years; to be offered even years
Catalog Description	PREREQUISITE: EELE 308 and EELE 334 and EELE 371 Analysis and design of high speed digital systems including chip-to chip signal propagation, transmission lines, IC package interconnect, printed circuit board design, state-of-the-art simulation tools, and measurement techniques using Time Domain Reflectrometry (TDR).
Faculty Coordinator	Brock LaMeres
Course Designation	Elective
Textbook	"Signal Integrity - Simplified", Eric Bogatin, Prentice Hall PTR 2003
Course Learning Outcomes	At the conclusion of EELE 461, students are expected to be able to: 1) Design and analyze a digital chip-to-chip link. 2) Analyze the transmission line behavior when stimulated with a digital signal 3) Analyze the cross-talk between signal lines in a digital system. 4) Describe the construction of a Printed Circuit Board. 5) Use modern CAD tools to create PCB schematics and layout. 6) Describe the construction of an Integrated Circuit package. 7) Use modern CAD tools to extract the electrical parameters of an interconnect structure. 8) Use modern CAD tools simulate the performance of a digital link. Use a TDR oscilloscope to measure impedance transmission line discontinuities
Program Outcomes	
Topics Covered	1) Digital Signaling, Logic Levels, Analog Behavior of digital signals. 2) Rx/Tx On-Chip Circuitry Design and Fabrication 3) On-Chip Interconnect Design and Fabrication 4) IC Package Design and Fabrication, Inductance, Ground Bounce 5) PCB Design and Fabrication 6) Design Tools, PADs PCB Design/Layout 7) Electromagnetism, Lumped vs. Distributed Systems, Reflections, Fourier Series of Digital Pulse 8) Simulation Tools: ADS SPICE Simulator 9) Impedance, Termination Schemes, X-talk, ISI, Even and Odd Mode Impedance 10) Return Current, Ground Bounce, Simultaneous Switching Noise (SSN)

	11) Power Distribution, Decoupling, Noise Analysis, Jitter, Eye Diagrams, Random vs. Deterministic 12) Simulation Tools, ADS 2D/3D Field Solver 13) Bus Architectures, Synchronous, Source-Synchronous, Embedded Clock 14) Advanced Signaling, Pre/Post Emphasis, Differential vs. Signal EndTest Equipment, Time Domain Reflectrometry, Vector Network Analysis, Jitter Modern Digital Systems: PCI Express, DDR, Intel Quad-Pumped FSB, SRIO
Prepared by	Brock LaMeres (04/22/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 465**
Course Title	Microcontroller Applications
Total Credit Hours and Format	4 Credits. (2 Lec, 2 Lab) S
Catalog Description	PREREQUISITE: EELE 371 Lecture/laboratory exposure to micro controller hardware and software applications, serial and parallel I/O, timing, interrupts LCDs, keypads, A to D conversion, and a project realizing a real time control problem.
Faculty Coordinator	Randy Larimer
Course Designation	Required for CpE, Elective for ECE
Textbook	Specific Microcontroller Data Sheet and Application Notes used.
Course Learning Outcomes	At the conclusion of EELE 465, students are expected to be able to: 1. Design, breadboard and program a microcontroller system 2. Design, write and document assembly-language software for a microcontroller system 3. Understand and use various I/O devices such as keypads, Ato D converters, LCD modules, mechanical relays, solid state relays 4. Be able to design basic I/O drivers and microcontroller device interfacesI2C 5. Understand the basic types of memory used in microcontrollers 6. Understand the hardware and software resources required ofr real-time microcontroller applications.
Program Outcomes	c, g, k, n, o, q
Topics Covered	1. Microcontroller instruction set 2. System clock and Power on Reset 3. Addressing modes 4. I/O Ports 5. Interrupts 6. Pseudo Data Bus and Address decoding 7. Keypad scanning 8. LCD module programming 9. Analog to Digital conversion and Digital to Analog Conversion 10. Transistor and MOSFET switching circuits and I/O drivers 11. I2C Temperature Sensors and Real-Time Clocks 12. Thermoelectric modules
Prepared by	Randy Larimer 04/21/2015

Department	Electrical and Computer Engineering
Course Number	**EELE 466**
Course Title	Computational Computer Architecture
Total Credit Hours and Format	4 Credits. (3 Lec, 1 Lab) S
Catalog Description	PREREQUISITE: EELE 475 Design of custom CPU's and embedded systems using FPGAs, emphasizing computational tasks such as audio and video processing. Design and development of custom instruction sets. Engineering tradeoffs among fixed-point, floating point, and compressed representations of numerical data.
Faculty Coordinator	Ross Snider
Course Designation	Required
Textbook	Rapid Prototyping of Digital Systems: SOPC Edition. J.O. Hamblen, T.S. Hall, and M.D. Furman., Springer 2008 Material is also drawn from: Computer Architecture: A Quantitative Approach Hennessy & Patterson, Morgan Kaufmann
Course Learning Outcomes	At the conclusion of EELE 466, students are expected to be able to: 1.) Implement an embedded system in a FPGA. 2.) Implement a custom computational algorithm. 3.) Implement the appropriate data types (fixed-point vs floating-point). 4.) make the appropriate hardware/software partitioning.
Program Outcomes	n/a
Topics Covered	• Computer Organization • Programming Models • Processor Design (Instruction Set Architecture) • Quantitative Measurement • Pipelining • Memory Systems (Caches) • Multiprocessors
Prepared by	Ross Snider (5/4/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 475**
Course Title	Hardware and Software Engineering for Embedded Systems
Total Credit Hours and Format	3 Credits. (2 Lec, 1 Lab) F
Catalog Description	PREREQUISITE: EELE 367 and CSCI 112 Topics in embedded system design, real-time operating systems, high level language programming of embedded systems, software and hardware tradeoffs, and laboratory experience with embedded systems.
Faculty Coordinator	Ross Snider
Course Designation	Required
Textbook	*Hardware/Firmware Interface Design*, by Gary Stringham. (ISBN: 978-1-85617-605-7)
Course Learning Outcomes	At the conclusion of EELE 475, students are expected to be able to: 1) Be able to explain real-time concepts such as preemptive multitasking, task priorities, priority inversions, mutual exclusion, context switching, synchronization, interrupt latency and response time, and semaphores. 2) Describe how a real-time operating system kernel is implemented. 3) Explain how tasks are managed. 4) Explain how the real-time operating system implements time management. 5) Discuss how tasks can communicate using semaphores, mailboxes, and queues. 6) Be able to implement a real-time system on an embedded processor.
Program Outcomes	n, q
Topics Covered	1) Review of the C language 2) Foreground/Background Systems, Critical Sections 3) Interrupts, Multitasking, Context Switching, Scheduling 4) Reentrancy, Task Priorities, Mutual Exclusion 5) Semaphores, Intertask Communications 6) uC/OS-II Kernel and internal structure 7) Tasks, Task states, Task control blocks, Task scheduling and management 8) Message mailboxes and queues, Memory allocation.
Prepared by	Ross Snider (5/4/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 477**
Course Title	Digital Signal Processing
Total Credit Hours and Format	4 Credits. (3 Lec, 1 Lab) S
Catalog Description	PREREQUISITE: EELE 308 Analysis and design of discrete-time systems, including frequency response. Sampling and reconstruction of continuous signals. Analysis, design, and applications of FIR and IIR digital filters. Properties and applications of the discrete Fourier transform. Laboratory experience implementing off-line and real time digital signal processing algorithms.
Faculty Coordinator	Rob Maher
Course Designation	Elective
Textbook	DSP First: A Multimedia Approach, McClellan, Schafer, and Yoder, Prentice-Hall, 1998.
Course Learning Outcomes	At the conclusion of EELE 477, students are expected to be able to: • Describe the Sampling Theorem and how this relates to Aliasing and Folding. • Determine if a system is a Linear Time-Invariant (LTI) System. • Take the Z-transform of a LTI system • Determine the frequency response of FIR and IIR filters. • Understand the relationship between poles, zeros, and stability. • Determine the spectrum of a signal using the DFT, FFT, and spectrogram. • Design, analyze, and implement digital filters in Matlab. • Explain the typical features of a digital signal processing chip.
Program Outcomes	a, c, e, g, k
Topics Covered	1) The Sampling Theorem, Aliasing, and Folding. 2) Linear Time-Invariant (LTI) Systems. 3) Convolution and LTI Systems. 4) Z-Transform and Linear Systems.

	5) Properties of the Z-transform. 6) Convolution and the Z-transform. 7) FIR Filters. 8) IIR Filters. 9) Spectral analysis of periodic and non-periodic signals. 10) The Fast Fourier Transform 11) The Spectrogram.
Prepared by	Rob Maher (4/25/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 481**
Course Title	Optical Design
Total Credit Hours and Format	3 Credits. (3 Lec) S alternate years
Catalog Description	PREREQUISITE: EELE 482 or PHSX 327 Optical design using geometric optics and computer ray-tracing software. Introduces ray and wave front aberrations, control of aberrations in optical systems, designing for system requirements, and analytic tools including the moducation transfer function.
Faculty Coordinator	Joe Shaw
Course Designation	Elective
Textbook	Introduction to lens design with practical Zemax examples, J. M. Geary, 2002; Zemax Optics Studio optical design code
Course Learning Outcomes	At the conclusion of EELE 481, students are expected to be able to: 1) Use geometric optics for first-order layout of an optical system; 2) Calculate the locations of focal points, principal points, and nodal points in an optical system, and use these as parameters in the design of optical systems; 3) Calculate the locations and sizes of pupils and stops and understand their use in analyzing and designing optical systems; 4) Understand the meaning of 3rd-order ray and 4^{th}-order wave aberrations; 5) Use diagnostics such as spot diagrams, ray fans, and MTF curves to assess resolution and contrast in an optical image; 6) Use modern computer ray-trace codes to predict ray and wave aberrations in optical systems ranging from single lens elements to multiple-element lenses, telescopes, laser beam optics, etc; 7) Apply nonsequential ray tracing to analyze optical systems involving multiple reflections and beam splitting.
Program Outcomes	
Topics Covered	1. Optical surface shapes and conventions; paraxial ray tracing & y-nu ray trace method. 2. System parameters from ray tracing: marginal and chief rays, stops and pupils, optical invariant. 3. Wave-front and ray aberration theory. 4. Automated optimization of optical designs (solves, merit functions, Gaussian quadrature…).

	5. Interferometric testing of optical surfaces, components, and systems. 6. Calculating aberration coefficients from ray-trace data. 7. Lens shape & aberration balancing. 8. Use of symmetry to reduce off-axis aberrations; flattening curved wave fronts. 9. Chromatic variation of aberrations (sphero-chromatism; achromats, aplanats, apochromats…). 10. Optical Transfer Function and estimation of image contrast and resolution (Strehl ratio). 11. Optical effects of windows, field lenses, mirrors, and corrector plates. 12. Telescope design using spherical & aspherical mirrors. 13. The Hubble space telescope, its famous optical problems and how it was fixed. 14. Tolerancing of optical systems (determining sensitivities of a design to parameter changes). 15. Nonsequential ray tracing. 16. Design projects of your own choice.
Prepared by	Joe Shaw (04/29/2015)

<table>
<tr><td>Department</td><td>Electrical and Computer Engineering</td></tr>
<tr><td>Course Number</td><td>EELE 482</td></tr>
<tr><td>Course Title</td><td>Introduction to Electro-Optical Systems</td></tr>
<tr><td>Total Credit Hours and Format</td><td>3 Credits. (2 Lec, 1 Lab) F</td></tr>
<tr><td>Catalog Description</td><td>PREREQUISITE: EELE 334 or PHSX 423 or equivalent
Provides an overview of electro-optic systems and components. Lectures cover ray optics, scalar wave optics, laser and Gaussian beam optics, optical polarization and polarization devices, light sources, detectors, and electro-optic and acoustic-optic photonic devices. Laboratory experiments introduce basic photonic instrumentation and measurement techniques.</td></tr>
<tr><td>Faculty Coordinator</td><td>David Dickensheets</td></tr>
<tr><td>Course Designation</td><td>Elective</td></tr>
<tr><td>Textbook</td><td>Fundamentals of Photonics, 2nd Ed., Saleh and Teich, 2007.</td></tr>
<tr><td>Course Learning Outcomes</td><td>At the conclusion of EELE 482, students are expected to be able to:
1. Identify these primary components and their function within an optical system:
positive and negative lenses (including gradient index lenses)
gratings and prisms
polarizers (dichroic, refractive, diffractive)
wave retarders
lasers and light emitting diodes
silicon photodetectors
acousto-optic and electro-optic modulators
imaging detectors (ccd and cmos)
2. Know how to use these measurement tools to characterize an optical system:
optical power meter
pn diode detector in photoconductive mode
chopper
oscilloscope
cmos cameras
wavefront sensor
optical spectrum analyzer
3. Be able to construct and characterize basic optical systems including:
imaging systems and telescopes
Michaelson and Mach-Zehnder interferometers
Gaussian beam transforming systems
phase, amplitude and polarization modulating systems using AO and EO modulators
4. Estimate system performance parameters, such as optical power, frequency and bandwidth, electronic bandwidth, minimum detectable signal, dynamic range, modulation depth, and spatial, spectral or temporal resolution.
5. Effectively communicate the results of your analysis in the form of a written report or an oral presentation.</td></tr>
</table>

Program Outcomes	While not an indicator course, this course supports the following ABET outcomes: a. An ability to apply knowledge of mathematics, science, and engineering. b. An ability to design and conduct experiments, as well as to analyze and interpret data. e. An ability to identify, formulate, and solve engineering problems k. An ability to use the techniques, skills and modern engineering tools necessary for engineering practice.
Topics Covered	ray propagation ABCD matrices and properties Scalar wave fundamentals Plane and spherical waves, interference, interferometers Diffraction: concepts and diffraction integral; diffraction by slit and circle Gaussian beam properties, ABCD law Polarization, Jones vectors & matrices Fresnel Equations Polarizers, waveplates, isloators Electro-optic modulators Liquid crystal devices Acousto-optic modulators Light source characteristics Coherence concepts LED physics and properties; LED datasheets Laser diode physics and properties; LD datasheets Thermal detectors and photoelectric detectors Shot noise, pn-junction noise model, NEP, noise spectral properties, APD, PMT Imaging detectors: CCD, CMOS
Prepared by	David Dickensheets (05/15/2015)

Department	Electrical and Computer Engineering
Course Number	**EE 484**
Course Title	Laser Engineering
Course Designation	Elective
University Catalog Description	Semesters offered: S, alternative years; Prerequisites: Physics 212 -- The laser engineering course provides a basic understanding of the design and operational principles of lasers. Discussions of design and operation of several types of lasers will be covered including solid state lasers, gas lasers, and semiconductor lasers.
Faculty Coordinator	Dr. Kevin Repasky
Prerequisite by Topic	Modern Optics, Electromagnetic Theory
Textbook	**Laser Engineering**, Kelin J. Kuhn, Prentice-Hall, ISBN 0-02-366921-7
Course Objectives	To produce graduates who are able to understand the operation of lasers and optical amplifiers, and model and design laser systems.
Course Learning Outcomes	At the conclusion of EE 484, students are expected to : 1) Understand the operating principal of lasers and optical amplifiers 2) Model laser and optical amplifier systems 3) Design laser systems
Topics Covered	1) An Introduction To Lasers 2) Energy States and Gain 3) The Fabry-Perot Etalon 4) Transverse Modes Properties 5) Gain Saturation 6) Transient Processes 7) Introduction to Nonlinear Opitcs 8) Supportive Technologies 9) Design of Laser Systems
Class/Laboratory Schedule	EE 484 meets three times /week for 50 minutes plus a two-hour laboratory Session
Professional Component (Criterion 5)	This course strongly supports the application of science and engineering principals to the development of optical and laser systems. This course prepares students for either beginning an optics career or continuing studies in a graduate program.
ECE Program Outcomes	EE 484 supports following Program Outcomes: a. an ability to apply knowledge of mathematics, science and engineering c. an ability to design a system, component, or process to meet the desired needs
Total Credit Hours	3
Prepared by	Kevin Repasky 05/7/2015

Department	Electrical and Computer Engineering
Course Number	**EELE 487**
Course Title	Prof, Ethics & Engr Practices
Total Credit Hours and Format	1 Credit. (1 Lec) S
Catalog Description	PREREQUISITE: Junior standing Engineers from industry and others give presentations on professionalism, ethics, and engineering practices. Included are specific well-known, historical engineering ethics cases and professional practices of engineering, intellectual property issues, and new developments.
Faculty Coordinator	Rob Maher
Course Designation	Required
Textbook	Fleddermann, Charles B., "Engineering Ethics," 4th ed., Pearson Prentice-Hall, 2008.
Course Learning Outcomes	At the conclusion of EELE 487, students are expected to be able to: • Express in oral and written form an understanding and appreciation of the need for ethical and responsible professional behavior. • Describe and knowledgeably discuss the importance of safety, environmental and other societal issues to the engineering profession.
Program Outcomes	f, g, h, I, j
Topics Covered	1. Ethics and Professionalism 2. Engineering and the Environment 3. The Space Shuttle 4. Ethical Problems and Approaches 5. Ethical Conflicts and Bribes 6. Risk, Safety, and Accidents 7. Public Safety and New Technologies 8. Code of Ethics of Engineering 9. Ethics and Research 10. Ethics and Professionalism in the Workplace 11. Final Presentations and Discussion
Prepared by	Rob Maher (4/25/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 488R**
Course Title	Electric Engineering Design I
Total Credit Hours and Format	2 Credits. (2 Sem) F,S
Catalog Description	PREREQUISITE: EELE 317 and ENGR 310 Part I of a two consecutive semester senior capstone design sequence in Electrical Engineering. Students, under the guidance of a faculty supervisor, formulate a solution to a real-world design problem culminating in a critical design review.
Faculty Coordinator	Wataru Nakagawa
Course Designation	Required
Textbook	(no textbook)
Course Learning Outcomes	At the conclusion of EELE 488R, students are expected to be able to: 1) Complete the detailed design of a capstone project. 2) Perform an alternatives analysis and design matrix for key elements of the project. 3) Communicate effectively about a project using webpage, poster presentation and project demonstration 4) Complete technical documentation for the system design. 5) Demonstrate basic project management skills. 6) Work effectively in a student team.
Program Outcomes	a, c, d, e, f, g, h, I, j, k, l, r
Topics Covered	1) Project definition and level one requirements 2) Preliminary design and Preliminary Design Review 3) Critical Subsystem Demonstration 4) Detailed design and Critical Design Review 5) Final project design and documentation

Prepared by	Wataru Nakagawa (5/14/2015)

Department	Electrical and Computer Engineering
Course Number	**EELE 489R**
Course Title	Electrical Engr Design II
Total Credit Hours and Format	3 Credits. (3 Sem) F,S
Catalog Description	PREREQUISITE: EELE 488R The second of a two consecutive semester senior capstone design sequence in Electrical Engineering. Students, under the guidance of a faculty supervisor, realize, assess and document the performance of their solution to a real-world design problem.
Faculty Coordinator	Wataru Nakagawa
Course Designation	Required
Textbook	(no textbook)
Course Learning Outcomes	At the conclusion of EELE 489R, students are expected to be able to: 1) Complete, test, and demonstrate a capstone design project. 2) Develop and document the fabrication, assembly, and testing of a project. 3) Communicate effectively about a project using webpage, poster presentation and project demonstration 4) Complete technical documentation for the system. 5) Demonstrate basic project management skills. 6) Work effectively in a student team.
Program Outcomes	a, c, d, e, f, g, h, I, j, k, l, r
Topics Covered	1) Production Readiness Review and Report 2) Fabrication, Assembly, and Testing 3) Prototype rollout 4) Engineering Design Fair presentation (to faculty and general public) 5) Final project report

Prepared by	Wataru Nakagawa (5/14/2015)