

Notes	Au *	Sp *	Su *	Course#	Course Name	Course Description	Credits	Requisites	Exclusions
	x	x		2020 (also @ Marion campus, Sp)	Introduction to Analog Systems and Circuits	Circuit theory and applications of passive components and Op amps. Introduction to analog systems using differential equations and Laplace transforms.	3.0	rereq: Engr 1182.01, 1182.02, 1182.03, 1282.01H, 1282.02H, 1282.03H, 1282.04H, or 1186, 1187 and 1188 concurrent; and Math 1152, 1161.01, 1161.02, 1172, or 1181H; and Physics 1250, or 1260; and CPHR 2.00 or above.	Not open to students with credit for 2100, 2100.02, 2100.06, 2100.07, 2100.08, 2105, 2106, 2110, 2127, 2137, or 2300.
transfer credit only	-	-		2021	Introduction to Analog Systems and Circuits for Transfer Students Lecture	Lecture-only component of ECE 2020, for transfer students. Circuit theory and applications of passive components and Op amps. Introduction to analog systems using differential equations and Laplace transforms.	2.5	Prereq: Math 1152 or 1161.01 or 1161.02 or 1172 or 1181H, and Physics 1250, 1250H or 1260, and CSE 1222 or 2221 or Engr 1281.01H or 1281.02H or 1222; and Engr 1182.01 or 1182.02 or 1182.03 or 1282.01H or 1282.02H or 1282.03H, or Engr 1186 and 1187 and concur: 1188 concurrent, or 1187 and 1188 and concur: 1186; and CPHR 2.00 or above.	Not open to students with credit for 2020, 2100, 2100.02, 2100.06, 2105, 2106, 2110, 2300, 205, 292, 294.03, or 301.
transfer students only	x	x		2027	Introduction to Analog Systems and Circuits Lab for Transfer Students	Laboratory-only component of ECE 2020, for transfer students. Laboratory practice with circuit theory, analog systems, and applications of passive components and Op amps.	0.5	Prereq: 2021, and CPHR 2.00 or above.	Not open to students with credit for 2020, 2100, 2100.02, 2100.07, 2100.08, 2127, 2137, 209, 292, or 294.03.
	x	x		2050	Introduction to Discrete Time Signals and Systems	Introduction to sampled time signals and linear time invariant sampled time systems.	3.0	Prereq: 2000, or 2060, or 2061 and 2067. Prereq or concur: Math 2174 or 2568.	Not open to students with credit for 2100, 2100.01, 2100.04, 2104, or 2110.
				2051	Introduction to Discrete Time Signals & Systems Lecture	Introduction to sampled time signals and linear time invariant sampled time systems. Lecture only.	2.5	Prereq: 2000, or 2060, or 2061 and 2067. Prereq or concur: Math 2174 or 2568.	Not open to students with credit for 2100, 2100.01, 2100.04, 2104, 2110, or 2050.
in case of continued univ shutdown				2057	Introduction to Discrete Time Signals & Systems Laboratory	Introduction to samples time signals and linear time invariant sampled time systems. Lab only.	0.5	Prereq or concur: 2051.	Not open to students with credit for 2100, 2100.01, 2100.04, 2110, or 2050.
	x	x		2060 (also @ Marion campus, Sp)	Introduction to Digital Logic	Introduction to the theory and practice of combinational and clocked sequential networks.	3.0	Prereq: CSE 1222, 2221, Engr 1222, 1281.01H, or 1281.02H; and Math 1152, 1161.01, 1161.02, 1172, or 1181H; and Physics 1250, 1250H, or 1260; and Engr 1182.01, 1182.02, 1182.03, 1282.01H, 1282.02H, 1282.03H, 1282.04H, or 1186, 1187, and 1188 concurrent, or 1187, 1188, and 1186 concurrent, or major in CIS or CIS-PRE; and CPHR 2.00 or above.	Not open to students with credit for 2000, 2000.02, 2000.07, 2001, 2010, or 2017.
transfer credit only	-	-		2061	Introduction to Digital Logic for Transfer Students Lecture	Lecture-only component of ECE 2060, for transfer students. Introduction to the theory and practice of combinational and clocked sequential networks.	2.5	Prereq: Math 1152 or 1161.01 or 1161.02 or 1172 or 1181H, and Physics 1250, 1250H or 1260, and CSE 1222 or 2221 or Engr 1281.01H or 1281.02H or 1222; and Engr 1182.01 or 1182.02 or 1182.03 or 1282.01H or 1282.02H or 1282.03H, or Engr 1186 and 1187. and concur: 1188 concurrent, or 1187 and 1188 and concur: 1186, or major in CIS or CIS-PRE; and CPHR 2.00 or above.	Not open to students with credit for 2000, 2000.02, 2001, 2010, 2060, 261, 290, or 294.01.

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transfer students only	x	x		2067	Introduction to Digital Logic Lab for Transfer Students	Laboratory-only component of ECE 2060 for transfer students. Laboratory practice with and application of the theory of combinational and clocked sequential networks.	0.5	Prereq: 2061, and CPHR 2.00 or above.	Not open to students with credit for 2000, 2000.02, 2000.07, 2017, 2060, 270, 290, or 294.01.
	x	x	x	2193	Individual Studies in Electrical and Computer Engineering	Individual studies project.	0.0-10.0	Repeatable to a maximum of 12.0 cr hrs or 10 completions. This course is graded S/U. Permission of instructor required.	
	x	x		2300	Electrical Circuits and Electronic Devices	Introduction to circuit analysis; circuit analysis concepts and mechanical systems analogies; theory and applications of electronic devices; operational amplifiers; electrical instruments and measurements.	3.0	Prereq: Physics 1251 or 1261, and Math 1172 or 1544 or 2153 or 2162.01 or 2162.02 or 2182H or 4182H, and CPHR 2.0 or above, and enrollment in College of Engineering.	Not open to students majoring in ECE.
				2301	Electrical Circuits and Electronic Devices Lecture	Introduction to circuit analysis; circuit analysis concepts and mechanical systems analogies; theory and applications of electronic devices; operational amplifiers; electrical instruments and measurements. Lecture portion only.	2.5	Prereq: Physics 1251 or 1261, and Math 1172 or 1544 or 2153 or 2162.01 or 2162.02 or 2182H or 4182H, and CPHR 2.0 or above, and enrollment in College of Engineering.	Not open to students with credit for 2300, or students majoring in ECE.
in case of continued univ shutdown				2307	Electrical Circuits and Electronic Devices Laboratory	Introduction to circuit analysis; circuit analysis concepts and mechanical systems analogies; applications of electronic devices; operational amplifiers; electrical instruments and measurements. Lab only.	0.5	Prereq or concur: 2301.	Not open to students with credit for 2300, or students majoring in ECE.
	x	x		2560	Introduction to Microcontroller-Based Systems	Hardware and software organization of a typical microcontroller; machine language programming, interfacing peripheral devices, and input-output programming; real-time computer applications.	2.0	Prereq: 2000, 2001, 2060, or 2061 and prereq or concur: 2000.07 or 2017; and CSE 1221, 1222, Engr 1281.01H, 1281.02H, or 1222, and enrollment in ECE, CSE, or EngPhysics major; or prereq or concur: 2010 or 2067, and permission of department.	Not open to students with credit for CSE 2421.
	x	x	x	2998.01	Undergraduate Research	Supervised undergraduate research in various topics.	0.5-3.0	Prereq: Permission of instructor. Repeatable to a maximum of 6.0 cr hrs or 6 completions.	
	x	x	x	2998.02	Undergraduate Research	Supervised undergraduate research in various topics.	0.5-3.0	Prereq: Permission of instructor. Repeatable to a maximum of 6.0 cr hrs or 6 completions. This course is graded S/U.	
	x	x		3010	Introduction to Radio Frequency and Optical Engineering	Waves and pulses on transmission lines; charges, fields, and potentials; inductance and capacitance; Faraday's law; Maxwell's Equations; plane wave propagation, polarization, reflection, and transmission.	3.0	Prereq: 2020, 2021, 2100, 2100.02, 2100.06, or 2105; and Physics 1251 or 1261, or both 1240 and 1241; and Math 2415 or 2174; and enrollment in ECE or EngPhysics major; or prereq or concur: 2010 or 2061, and permission of department.	Not open to students with credit for 3010.01, 3010.02.
	x	x		3020	Introduction to Electronics	Electronics: diode and transistor models for amplifiers, switches, and logic gates. Multiple transistor circuit analysis, op amps, and electronic systems.	3.0	Prereq: 2100 or 2020; or 2021 or 2106, and 2027 prereq or concur; and ECE or EngPhys major, or 2110 prereq or concur and permission of department.	
	x	x		3027	Electronics Laboratory	Electronic amplification, signal processing, timing, and power regulation circuits. Experiments with electronics evaluation modules and use of an analog system lab kit for electronics testing.	1.0	Prereq: 3020; and ECE or EngPhysics major.	
	x	x		3030	Semiconductor Electronic Devices	Semiconductor materials and devices. Crystals; bandstructure; charge carrier statistics; excess carriers, transport; PN junction; Schottky barrier; bipolar and field-effect transistors; optoelectronic devices; nanoscale devices.	3.0	Prereq: 2020, 2021 or 2100; and Physics 1251, 1261, or both 1240 and 1241; and Chem 1210, 1220 or 1250; and enrollment in ECE, MSE, or EngPhysics major. Prereq or concur: Math 2415 or 2174.	

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	x	x		3040	Sustainable Energy and Power Systems I	Introduction to electrical energy systems; history, current trends, renewable and non-renewable sources, rotating machines and their operation, and smart grid initiatives.	3.0	Prereq: 2100, 2100.02, 2105, 2020, 2021, 205, 292 or 294 (Spring 2011), and enrollment in ECE or EngPhysics major.	Not open to students with credit for 341.
	x	x		3047	Electrical Energy Conversion Laboratory	Laboratory introducing basics of energy conversion processes for electrical energy supply systems utilizing conventional rotating machines and hardware-in-the-loop simulation system for sustainable energy systems.	1.0	Prerequisites: ECE 3040 or 341, and acceptance in ECE or Eng Physics majors.	Not open to students with credit for ECE 447
	x	x		3050	Signals and Systems	Linear systems and models in continuous and discrete time; convolution; Fourier series and transform; frequency response; Laplace transform; z-transform; applications.	3.0	Prereq: 2020, 2050, and 2060; or 2100; and Math 2568 (568) or 571; and prereq or concur Math 2415; and enrollment in ECE or EngPhysics major.	Not open to students with credit for 352.
take PHILOS 1332 instead, starting Au20	-	-		3080	Ethics and Professional Practice	Professional responsibilities; IEEE code of ethics; engineering as social experimentation; safety and risk; professional issues in organizations; case studies; global awareness.	1.0	Prerequisite: Jr or Sr standing, and enrollment in ECE major.	Not open to students with credit for ECE 481.
	x	x		3090	Technical Writing and Presentations	Technical writing and communications skills.	1.0	Prereq: Credit for a second writing course, and enrollment in ECE major.	
	x	x		3551	Introduction to Feedback Control Systems	The course provides fundamental concepts in feedback control systems design and analysis.	3.0	Prerequisite: ECE 3050 or 352 .	Not open to students with credit for ECE 551
	x	x		3557	Control Systems Laboratory	Utilization of real-world plants for computer control; use of a commercially available software package (Matlab) for computer-aided analysis and design	1.0	Prerequisites: ECE 551, or prerequisite or concurrent ECE 3551; and acceptance in ECE or Eng Physics majors.	Not open to students with credit for ECE 557.
	x	x		3561	Advanced Digital Design	Design and analysis of sequential circuits; digital circuit design using building blocks, programmable logic devices; design of basic computer components such as arithmetic logic units.	3.0	Prereq: 2000, 2060, 2061, 2010, 2000.02, 290, 294 (Au10) or 206 and 261. Prereq or concur: 3020 (323), and enrollment in ECE, EngPhys, or CSE majors; or prereq or concur: 2010, and permission of department.	Not open to students with credit for 561.
	x	x		3567	Microcontroller Lab	Laboratory in which a microcontroller is used to interface real-world hardware to make a functioning system.	1.0	Prereq: 2560 or CSE 2421, and enrollment in ECE, CSE, or EngPhysics major.	Not open to students with credit for 3567.01 .
Final offering Sp21	x	x		3900	Capstone Design I	Fundamentals of the engineering design process. Design principles and methodology. Project management during design.	1.0	Prereq: Sr standing and enrollment in the ECE major. Prereq or concur: 3090.	Not open to students with credit for 4900, 4900H, 4901, Engr 4901, 4903, 5901.01, or 5901.02H.
First offering Au21	x	x		3905	Capstone Design I	Fundamentals of the engineering design process. Application of design principles and methodology to conceptual and detailed technical design. Project management during design.	3.0	Option 1: Prereq or concur: 3080 or Philos 1332, and ECE 2560, 3010, 3020, 3027, 3030, 3040, 3050, and 3090, and Sr standing, and enrollment in Electrical Engineering Program of Study (EES subplan) of the ECE major. Option 2: Prereq or concur: ECE 2050 or 2100, and 3080 or Philos 1332, and ECE 3020, 3027, 3090, 3561, 3567, CSE 2231, and 2451, and Sr standing, and enrollment in Computer Engineering Program of Study (CES subplan). This course is progress graded.	Not open to students with credit for 3900, 4900, 4900H, 4901, Engr 5901.01, 5901.02H, 5902.01, or 5902.02H.
	x			4021	Analog Integrated Circuits I	Fundamentals of analog integrated circuits. CMOS transistors and diodes large-signal and small-signal operation and modeling. On-chip passive components operation and modeling. Simple and advanced current mirrors, single-ended and differential CMOS amplifiers, CMOS OTAs and Op-Amps. Integrated Circuits Fabrication, Packaging, and Testing.	3.0	Prereq: 3020	Not open to students with credit for 5021.

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	x	x	x	4193	Individual Studies in Electrical and Computer Engineering	Individual studies project.	0.0-12.0	Repeatable to a maximum of 12.0 cr hrs or 12 completions. This course is graded S/U.	
	x			4567	Design of Mobile Internet-of-Things	This course focuses on theoretical and practical insights into design of Internet of Things architectures and mobile platforms. Concepts covered in this course include general IoT architectures, sensor, processing, and communication resources, device and cloud connectivity, mobility support. Practical aspects will be studied with lab assignments and the semester-long group projects.	4.0	Prereq: 2560, 3020, and 3027	
check with advisor for final semester of offering (Au21?)	x	x		4900	Capstone Design II	Application of design principles and methodology to conceptual and detailed technical design, implementation, and testing of a capstone project.	3.0	Prereq: Option 1: 2560, 3010, 3020, 3027, 3030, 3040, 3050, 3090, and 3900, and Sr standing, and enrollment in Electrical Engineering Program of Study (EES subplan) of the ECE major. Prereq or concur: 3080 or PHILOS 1332. Option 2: 2050 or 2100; 3020, 3027, 3090, 3561, 3567, 3900, CSE 2231, and 2451, and Sr standing, and enrollment in Computer Engineering Program of Study (CES subplan). Prereq or concur: 3080 or PHILOS 1332, and 5362.	Not open to students with credit for 4900H, 4901, or Engr 4903 or 5902.01.
	x	x	x	4901	Capstone Design II Special	Application of design principles and methodology to conceptual and detailed technical design, implementation, and testing of a capstone design project. Teams of at least three arrange special projects with a faculty member.	3.0	Prereq: Option 1: 2560, 3010, 3020, 3027, 3030, 3040, 3050, 3090, 3900 and Sr standing, and enrollment in Electrical Engineering Program of Study (EES subplan) of the ECE major. Prereq or concur: 3080 or PHILOS 1332. Option 2: 2050 or 2100; 3020, 3027, 3090, 3561, 3567, 3900, CSE 2231, CSE 2451, and Sr standing, and enrollment in Computer Engineering Program of Study (CES subplan). Prereq or concur: 3080 or PHILOS 1332, and 5362.	Not open to students with credit for 4900, 4900H, or Engr 4903 or 5902.01.
First offering Sp22	x	x		4905	Capstone Design II	Application of project management, design principles and methodology to conceptual and detailed technical design, implementation, and testing of a capstone project.	3.0	Prereq: 3905.	Not open to students with credit for 4900, 4900H, 4901, Engr 5901.01, 5901.02H, 5902.01, or 5902.02H
	x	x		4905H	Design II with Honors Thesis Project	Application of design principles and methodology to conceptual and detailed technical design, implementation and testing, culminating in a capstone design project.	3.0	Prereq: Prereq: 3905, Honors standing, and permission of department	Not open to students with credit for 4900, 4900H, 4901, or 682, or ENGR 5902.01., 590.01H, 5902.01, or 5902.01H.
	x	x	x	4998.01	Undergraduate Research	Supervised undergraduate research in various topics.	0.5-3.0	Prereq: Permission of instructor. Repeatable to a maximum of 6 cr hrs or 6 completions.-	
	x	x	x	4998.01H	Undergraduate Honors Research	Supervised research in various topics for undergraduate honors students.	0.5-3.0	Prereq: Honors standing; or GPA 3.4 or above, and permission of instructor. Repeatable to a maximum of 6 cr hrs or 6 completions.	
	x	x	x	4998.02	Undergraduate Research	Supervised undergraduate research in various topics.	0.5-3.0	Prereq: Permission of instructor. Repeatable to a maximum of 6 cr hrs or 6 completions. This course is graded S/U.	
	x	x	x	4999.01	Undergraduate Thesis Research	Undergraduate Thesis (Distinction) research on topics in Electrical & Computer Engineering.	0.5-3.0	Prereq: GPA 3.0 or above, and enrollment in ECE major, and approved Thesis (Distinction) project. Repeatable to a maximum of 6 cr hrs or 6 completions.	

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	x	x	x	4999.01H	Undergraduate Honors Thesis Research	Undergraduate Honors Thesis (Distinction) research on topics in electrical & computer engineering.	0.5-3.0	Prereq: Honors Status or minimum GPA of 3.4 and approved Honors Thesis (Distinction) Project. Repeatable to a maximum of 6 cr hrs or 6 completions.	Open only to Electrical and Computer Engineering majors.
	x	x		5000	Introduction to Analog and Digital Communications	Communications channel modeling, analog communication schemes, digital communication schemes, error rate analysis, and error control coding.	3.0	Prereq: 3050, and Stat 3470 or Physics 3700; or Grad standing.	
		x		5007	Communications Laboratory	A laboratory in analog and digital data communications using a software-defined radio platform; amplitude modulation, frequency modulation, timing recovery, pulse shaping, phase shift keyed modulation.	0.5	Prereq or concur: 5000 (501), and enrollment in ECE or EngPhysics major; or Grad standing in ECE.	Not open to students with credit for 4007 or 508.
	x			5010	Wireless Propagation and Remote Sensing	Practical methods for predicting tropospheric, groundwave, and ionospheric propagation, including refraction, reflection, and extinction effects. Study of remote sensing systems and their applications.	3.0	Prereq: 3010, or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.	
		x		5011	Antennas	Electromagnetic radiation; fundamental antenna parameters; dipole, loops, patches, broadband and other antennas; array theory; ground plane effects; horn and reflector antennas; pattern synthesis; antenna measurements.	3.0	Prerequisites: ECE 3010 or 312 or graduate standing in engineering or biological sciences or math & physical sciences.	Not open to students with credit for ECE 711.
		x		5012	Integrated Optics	Fundamentals of planar lightwave circuits and guided wave devices; laser light in anisotropic media; electrooptic and nonlinear optical effects; concepts in telecommunications, RF photonics, nanobiotechnology.	3.0	Prerequisites: ECE 3010, or grad standing in engineering or biological sciences or math & physical sciences.	
		x		5013	Introduction to Radar Systems	Introduces the fundamentals of radar such as the main concepts and techniques used in modern radar systems. The class is a survey course exposing students to a wide range of radar applications and design issues.	3.0	Prereq: 3050, and 3010 or 3010.01, and Stat 3470; or Grad standing in Engr.	Not open to students with credit for 5194.01.
	x			5017	Microwave Engineering	Transmission line theory; multiconductor; S-parameters; transformers, couplers, filters, resonators, circulators; electromagnetic interference and compatibility; computer-aided design; microstrip realization and testing with a network analyzer.	4.0	Prereq: 3010, and enrollment in ECE major; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.	
	x			5020	Mixed Signal VLSI	Design and circuit analysis of basic VLSI structures such as registers, cell libraries, digital and analog I/O. Physical layout, timing analysis, PLLs, design tools.	3.0	Prerequisites: 3020, or graduate standing in engineering or biological sciences or math & physical sciences.	
	x			5021	Analog Integrated Circuits II	Advanced analog integrated circuits. Linear feedback networks design and stability analysis, multi-stage CMOS op-amp design and compensation, fully-differential op-amps and common-mode feedback networks, comparators, transconductors, bandgaps, sample and hold circuits, switched-capacitor circuits, noise analysis of CMOS circuits.	3.0	Prereq: 4021, or Grad standing in Engineering and permission of instructor.	
	x			5022	Radio Frequency Integrated Circuits	Modulation, wireless standards, transceiver architecture, transistor models, passive component models, LNA, VCO, PLL, Mixers, integrated PA, RFIC layout	3.0	Prereq or concur: 4021 or 5021, or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.	Not open to students with credit for ECE620.

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		x		5023	Introduction to Data Converters and Phase-Locked Loops	This course focuses on fundamentals of data converters and timing circuits, including discrete-time analog/mixed signal analysis and signal conditioning for asynchronous and synchronous computing. The topics include analog switches, sampling circuits, switched-capacitor amplifiers and filters, ADCs, DACs, PLLs, DLLs and discrete-time neural networks.	3.0	Prereq: 4021, or Grad standing in Engr or Physics.	
	x			5025	Power Electronics Devices, Circuits, and Applications	The course will provide an introduction to power electronic conversion principles. Analytical techniques will be developed through the study of widely used converter circuits.	3.0	Prerequisite: ECE3020 or ECE 323 or graduate standing in engineering or biological sciences or math & physical sciences.	Not open to students with credit for ECE 624, 724 or 844.
		x		5027	Microwave Active Circuits	Design principles of microwave transistor amplifiers and oscillators; low-noise, power and broadband amplifiers; linearization; computer-aided design; microstrip realizations and testing in the laboratory.	4.0	Prerequisites: Acceptance in ECE major and ECE 3020 or 323; or graduate standing in engineering or biological sciences or math & physical sciences.	Not open to students with credits for ECE723
		x		5031	Semiconductor Process Technology	Discrete and integrated circuit device design, silicon VLSI processing technologies, III-V compound semiconductor device fabrication technologies; epitaxy, doping, bandgap engineering; and device measurements and failure mechanisms.	3.0	Prerequisite: ECE 3030, or graduate standing in engineering, biological sciences, or math & physical sciences.	
		xo		5033	Surfaces and Interfaces of Electronic Materials	Provides the fundamental and practical basis for designing, processing, and characterizing the interfaces controlling the next generations of microelectronic and optoelectronic device structures.	3.0	Prereq: 3030, and Physics 1250 or 1250H; or Grad standing in Engineering, Biological Science, or Math and Physical Sciences.	
	x			5037	Solid State Electronics and Photonics Laboratory	Introduction to laboratory techniques for semiconductor device fabrication including photolithography, oxidation, diffusion, chemical processes, reactive ion etching, and metallization; fabrication and measurements of visible light emitting diodes (LED) and GaN High Electron Mobility Transistor (HEMT).	4.0	Prerequisite or concur: 3030, and acceptance in ECE, MSE or EngPhysics major; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.	
		x		5041	Electric Machines	Principles of electromechanical energy conversion; basic structures of electric machines; steady state models and performance analysis; Advanced topics on AC machine control.	3.0	Prerequisites: ECE 3040 or 341, and ECE 3020 or 323; or graduate standing in engineering or biological sciences or math & physical sciences.	Not open to students with credit for ECE 643 or ECE 743.
	x			5042	Power Systems	A power system analysis course presenting power systems loads, modeling of transformers and power system model for voltage calculation and faults.	3.0	Prerequisite: 3040, or graduate standing in Engineering, Biological Sciences, or Math and Physical Sciences.	Not open to students with credit for ECE 640, 740, or 741.
		x		5043	Power Systems - Analysis and Operation	Power systems analysis and operations, including steady-state analysis, state estimation, and economic operation.	3.0	Prereq: 3040, Sr. standing, and ECE major; or Sr standing and ISE major; and Math 2568; or Grad standing in engineering or biological sciences or math and physical sciences.	Cross-listed with ISE 5043.
		x		5047	High Voltage Engineering and Laboratory	Dielectric strength and breakdown of gases, liquids, and solids, electric field design problems in power system equipment; laboratory study of high voltage insulation.	3.0	Prerequisite: Acceptance in ECE major, and ECE 3040 or ECE 341; or graduate standing in engineering or biological sciences or math & physical sciences.	Not open to students with credit for ECE 747.
		x		5050	Humanitarian Engineering	Poverty and underdevelopment. Goal of social justice. Development strategies. Engineering for the poor, weak, and developing communities. Humanitarianism in the university and engineering enterprise.	3.0	ENGR 1182 or 1282H, or grad standing, or permission of instructor.	Not open to students with credit for ENGR 5050.

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	xe			5070	Neuroengineering and Neuroprosthetics	An overview of the broad field of Neuroengineering for graduate and senior undergraduate students with engineering or neuroscience backgrounds. Focusing on neural interfaces and prostheses, this course covers from basic neurophysiology and computational neuronal models to advanced neural interfaces and prostheses currently being actively developed in the field.	3.0	Prereq: 3050 or BiomedE 3703 or Neurosc 3010, or Grad standing in Engineering or Neurosc.	Not open to students with credit for 5194.03 or Neurosc 5070. Cross-listed in Neurosc.
		x		5078	Empowering the Entrepreneurial Electrical and Computer Engineer	This course will teach entrepreneurial minded engineers the process of value creation from their ECE relevant technology or inventions. Topics covered will include self-assessment as an entrepreneur and innovator, analysis and validation of new venture opportunities, intellectual property creation and assessment new venture planning and project management, leadership and team building.	3.0	Prereq: 3010, 3020, 3030, 3040, or 3050; or grad standing in Engineering	Not open to students with credit for 5194.13.
		x		5101	Introduction to Wireless Networking	Fundamental concepts in cellular design, Wireless-LANs, MANETs, and sensor networks will be explored. Specific topics will include propagation, fading, cellular-design, power-management, routing, scheduling, and control.	3.0	Prereq or concur: 3561 (561) or CSE 3461 (677), or Grad standing in Engineering or Math and Physical Sciences.	Not open to students with credit for CSE 5463. Cross-listed in CSE 5463.
		xo		5120	Introduction to Integrated Circuits Test and Measurement	Parametric testing techniques for analog, digital, mixed and RF ICs, DSP-based testing; noise effects on accuracy; Design-for-Test and Built-in-Self Tests.	3.0	Prereq: 3020, or 323 and 351, or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.	Not open to students with credit for 625, 694 (Sp09), or 694.04.
	x			5127	Power Electronics Lab	Laboratory introducing basic circuits of power electronics, and simulation and control hardware and software for various power and energy applications.	1.0	Prereq: ECE 3040 (341) and enrollment in ECE major, or Grad standing in Engineering.	Not open to students with credit for 628 or 647.
		xe		5131	Lasers	Atomic interaction with radiation, cavities with gain, Gaussian beams, light-emitting diodes, semiconductor lasers.	3.0	Prereq: 3010 and 3030, or graduate standing in engineering or biological sciences or math & physical sciences.	Not open to student with credit for ECE 732.
	xe			5132	Photonics	Fiber optics, optical systems and devices, optical detection, photonic band gaps, holography, and optical data storage.	3.0	Prereq: 3010, 3010.01, or 3010.02, and 3030 or 3030.01; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.	Not open to students with credit for 5132.01.
				5194.09	Optoelectronic Devices and Light Emitting Diodes	In this course, we will study the optical transitions and absorptions in semiconductors. We will discuss the optical processes in semiconductor bulk as well as low dimensional structures such as quantum well, quantum wire and quantum dot. The fundamentals, technologies and applications of light emitting diodes will be introduced. We will learn the current state-of-the-art of these devices.	3.0	Prereq: 3030 and 3010.	
				5194.11	Robust Control with Applications to Time Delay Systems	Review of time and frequency domain analysis and design of feedback systems. Internal stability, asymptotic tracking, performance. Robust stability and robust performance. strong Stabilization. Parametrization of stabilizing controllers. Delay margin. Model matching. Introduction to H-infinity control.	3.0	Prereq: 3551 or AERO 3521 or MAE 3360 or grad standing.	
				5194.14	Semiconductor Material and Device Characterization	This course will mainly cover several characterization techniques based on optical, electrical and chemical/physical methods that are used for semiconductor materials and devices. It will be discussed how material and device parameters, such as resistivity, carrier and doping density, contact resistance, mobility, series resistance, and carrier lifetime are measured using these methods.	3.0	Prereq: 3030; or Grad standing in Engineering, Biological Science, or Math and Physical Sciences.	

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Notes	Au *	Sp *	Su *	Course#	Course Name	Course Description	Credits	Requisites	Exclusions
	x	x		5200	Introduction to Digital Signal Processing	Sampling and reconstruction; discrete-time rate conversion; processing of discrete-time signals; design of discrete-time filters, selected topics in adaptive and/or multidimensional signal processing.	3.0	Prereq: 3050, and Stat 3470 or Math 4530, or Grad standing.	
		x		5206	Medical Imaging and Processing	Introduction to medical imaging techniques (CT, MRI, PET, ultrasound), including data collection, image reconstruction, physics of tissue interactions, and digital processing of medical images.	3.0	Prerequisite: ECE 352 or ECE 3050, Co- or prerequisite: ECE 582 or ECE 3090; or graduate standing in ECE, Biomedical Engineering or Biophysics	Not open to students with credit for ECE 706
		x		5207	Real-Time Digital Signal Processing Laboratory	Real-time signal processing of acoustic signals and video images; finite impulse response filters; adaptive filtering; array processing; fast Fourier transform.	0.5	Prereq or concur: 5200, and enrollment in ECE major or Grad standing in ECE.	Not open to students with credit for 4207 or 609.
		x		5227	Fundamentals of Power Management Integrated Circuits for VLSI Systems	Theory, design and applications of integrated power management integrated circuits in VLSI systems. This includes: system and circuit architectures, performance metrics, practical implementations, design considerations in VLSI systems in advanced CMOS processes, and design techniques for integrated power regulators and battery chargers. Background in basic analog design is strongly recommended.	4.0	Prereq: 4021, or Grad standing in Engineering or Physics.	
		x		5237	Photovoltaics Laboratory	Introduction to laboratory techniques for processing and fabrication of inorganic and organic solar cells, and photovoltaic testing and measurement techniques to characterize solar cells.	4.0	Prereq: 3030 or MatScEn 3271, and enrollment in ECE or MatScEn major; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences. Cross-listed in MatScEn.	
		x		5244	Si and Wide Band Gap Power Devices	Basic design and operation of Si and Wide Band Gap (WBG: SiC, GaN and ultra wide band gap semiconductors) power devices and the applications of commercial devices in power electronics applications. Trade-offs between various devices. Static and dynamic operation. Comparison of Si and SiC devices and design differences.	3.0	Prereq: 3030, or grad standing in engineering or physics.	Not open to students with credit for 5194.07 or 5234.
	x	x		5307	Introduction to Machine Learning for ECE	Introduction to Machine Learning. Coverage includes linear regression, linear classification, model and feature selection, neural networks, clustering, and principle components analysis. Python will be used for implementation examples.	4.0	Prereq: CSE 1222 or Engr 1281.xx, and Math 2568 and Stat 3470, and enrollment in ECE major; or Grad standing.	Not open to students with credit for 4194.02 (Sp19, Machine Learning), 4300, 5300, or MechEng 5194 (Au19, Applied ML for MAE).
	x	x		5362	Computer Architecture and Design	Design of general purpose digital computers including arithmetic and control units, input/output, and memory subsystems.	3.0	Prereq: 2560 and 3561, and undergraduate enrollment in ECE, CSE, or EngPhysics major; or Grad standing in Engineering.	Not open to students with credit for CSE 3421.
	xe			5400	Instrumentation, Signals, and Control in Transportation Applications	Interdisciplinary course bringing together electrical engineering tools and transportation applications. Students gain valuable experience working in teams while learning traffic flow, surveillance and control.	3.0	Prereq: 2100 or 292 or 294 (Spring 2011) or 301, and Math 2415 (415); or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.	Not open to students with credit for 675, CivilEn 6750 (675), or 4750. <i>Cross-listed in CivilEn 5750.</i>
	x			5460	Image Processing	Fundamentals and research directions in image processing: cameras, geometry, calibration, 2D and 3D image reconstruction, stereo, structure from motion, Radiometry, filtering, motion estimation, and applications.	3.0	Prerequisites: ECE 600 or ECE 5200; and Math 530 or STATS 427 or STATS 3470; or graduate standing in engineering, or biological sciences, statistics, bioinformatics, or math & physical sciences.	Not open to students with credit for ECE 707.
	x			5462	HDL Design and Verification	The detailed design and verification of major components of a computer architecture using a standard hardware description language (HDL).	3.0	Prereq: 5362, or 561 and 662, or CSE 675.01 or equiv, or Grad standing in Engineering.	Not open to students with credit for 762 or 764.

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Notes	Au *	Sp *	Su *	Course#	Course Name	Course Description	Credits	Requisites	Exclusions
	xe			5463	Introduction to Real Time Robotics Systems	Components of a robot system, robot forward and reverse kinematics; robot dynamics; robot force generation, robot trajectory generation.	3.0	Prereq: Math 2177 or 2174, or 2415 and 2568; and Physics 1250, 1250H, 1260, or 2300; and CSE 1221, 1222, Engr 1181, 1281.01H, 1281.02H, 1221, or 1222; or Grad standing in Engr; or permission of instructor. Cross-listed in MechEng.	Not open to students with credit for MechEng 5463 or 7752.
		x		5465	Advanced Microcomputers	An investigation of current microcomputer structures with emphasis on hardware implementation of I/O, direct memory access, interrupts, memory, and microprogramming.	3.0	Prerequisites: ECE 5362 or (ECE 662 and ECE 694A) or graduate standing in engineering.	Not open to students with credit for ECE 765.
		x		5466	Embedded Computer Systems	This course introduces the design principles, analysis methods and case studies of microprocessor-based and time-critical embedded systems, such as sensor and actuator networks, multimedia devices, mobile phones, and avionics. Topics include real-time operating systems, processor scheduling, performance control, resource management, power-aware design, energy optimization, etc.	3.0	Prereq: 5362, or Grad standing in Engr.	Not open to students with credit for 8194.03.
	x			5510	Introduction to Computational Electromagnetics	Numerical methods for solving Maxwell equations both static and electrostatics, introduction to finite difference, finite element and integral equation methods, and applied linear algebra.	3.0	Prereq: 3010; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.	Not open to students with credit for 715 or 813.
	x			5530	Fundamentals of Semiconductors for Microelectronics and Photonics	Crystal structure, semiconductor energy band structure, electron transport and carrier recombination, heterostructures, optical and dielectric properties	3.0	Prerequisite: ECE 3030 or ECE 432 or graduate standing in engineering or biological sciences or math & physical sciences.	Not open to students with credit for ECE 730
	xe			5550	Computational Humanitarianism	Computational models of individual and group poverty and underdevelopment; computational social justice; assessing social impact of technology; sensitivity analysis for technology prioritization and design; feedback control for computer automation of helping to meet social justice objectives; social agreement, choice, and allocation.	3.0	Prerequisite: Jr, Sr or Grad standing in College of Engineering; or permission of instructor.	Not open to students with credit for 5194.06.
	x			5551	State-Space Control Systems	Discrete-time state variable representations; pole placement via state-feedback; introduction to realization theory; observer design; introduction to Kalman filtering; linear quadratic regulator theory.	3.0	Prerequisite: ECE 3050 and Stat 3470; or Grad standing.	
		xe		5553	Autonomy in Vehicles	Autonomy in the context of modern vehicles; cruise control, anti-lock brake systems (ABS), steering control/lane keeping; introduction to automated highway systems (AHS).	3.0	Prerequisite: ECE 3551 or ECE 551 or ECE 5551 or graduate standing in engineering.	Not open to students with credit for 753.02.
		xo		5554	Powertrain Control Systems	Application of digital control system theory, from viewpoints of input-output and state variable representations, to realistic problems in automotive powertrain systems.	3.0	Prereq: 3551, 5551, or 551, or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.	Not open to students with credit for 753.01.
	x			5555	Securing Autonomous Systems	The course covers different security measures for safeguarding against cyberattacks, detecting cyberattacks, and mitigating the effects of cyberattacks on autonomous control systems.	3.0	Prerequisite: ECE 3050, or Graduate standing in Engineering, Math or Statistics	
	-	-		5557 (in limbo)	Control System Implementation Laboratory	Laboratory study of advanced feedback control techniques as applied to nonlinear and multi-output systems under computer control.	2.0	Prerequisites: ECE 5551 or ECE 551, and acceptance in ECE major; or graduate standing in engineering or math & physical sciences.	Not open to students with credit for ECE 758.
		x		5561	Introduction to Cybersecurity	Introduction to cybersecurity. Technical fundamentals of data, software, component, network, and system security. Cybersecurity from an organizational and societal view point, including human factors.	3.0	Prerequisite: Junior, senior, or grad standing, or permission of instructor.	Not open to students with credit for CSE 5471.

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		x		5567.01	Offensive Security	This course will give students an overview of existing offensive computing techniques, which include well known attacks that break confidentiality, integrity and availability of computing resources. Attacks targeting on human weaknesses without taking special care to security will also be discussed.	3.0	CSE 2431, 5431 or graduate standing	Not open to students with credit for CSE 5477.01.
		x		5567.02	Reverse Engineering and Malware Analysis	This course will give students an overview of cutting edge reverse engineering techniques as well as software security and defense practices. Programming experience in C required.	3.0	Prereq: CSE 2431, 5431 or graduate standing. Prereq or concur: ECE 5561 or CSE 5471.	Not open to students with credit for CSE 5477.02. Cross-listed with CSE 5477.02.
	x			5759	Optimization for Static and Dynamic Systems	Numerical optimization techniques as applied to selected electrical engineering application areas.	3.0	Prereq: 3050, or Grad standing in Engineering or Math and Physical Sciences.	
		x		5560	Advanced Hardware Architecture Design Techniques	This course introduces highly-practical methodologies and techniques that can be broadly used to improve the efficiency and achieve speed-area-power tradeoffs in the design of application-specific hardware implementation architectures for various algorithms. Efficient implementation architectures of commonly used arithmetic and digital signal processing functional blocks will also be discussed.	3.0	Prereq: 2050, and prereq or concur: 3561 or 3050; or Grad standing in Engr; or permission of instructor.	Not open to students with credit for 5194.08.
		x		5570	Antiracist Technology	Discrimination against racial and ethnic minorities is prevalent, systemic, and global. Racism and racial justice principles are outlined. Case studies on racist technologies, those that promote or sustain racism, are studied. Engineering design methodology is used to modify or create several new technologies that help the antiracist oppose racism.	4.0	ENGR 1182 or 1282 or graduate engineering standing or permission of instructor.	
	xo			5832	Photovoltaics and Energy Conversion	Photovoltaic materials and devices; solar cell device physics; solar cell simulation, design and operation; silicon cell technologies; thin film technologies; III-V technologies; nanostructures; terrestrial and space applications.	3.0	Prereq: 3030, or Grad standing in Engr or Physics.	
		xo		5833	Organic and Printed Flexible Electronics	Conducting organic small molecules and polymers (structural, optical and electrical properties); printable metal-oxide semiconductors; Printing techniques, organic light emitting diodes; transport and carrier injection; organic transistors; organic lasers.	3.0	Prereq: 3030, or permission of instructor for non-ECE majors; or Grad standing in engineering, biological sciences, or math and physical sciences.	Not open to students with credit for 7833 or 5194.04.
	x			6001	Probability and Random Variables	Probability, random variables, and random vectors for analysis and research in electrical engineering. Distribution functions, characteristic functions, functions of random variables and vectors, Markov chains.	3.0	Prereq: Grad standing.	Not open to students with credit for ECE 804 or 805.
	x			6010	Electromagnetic Field Theory I	Maxwell's Equations; plane waves; field representations and solutions in unbounded space; waveguides and cavities; elements of Green's Functions; cylindrical and spherical waves; electromagnetic theorems.	3.0	Prereq: ECE 5010 or ECE 713, and ECE 5011 or ECE 613, or graduate standing in engineering or biological sciences or math & physical sciences.	Not open to students with credit for ECE 719, ECE 810, or ECE 811.
	xo			6011	Bioelectromagnetics	This course provides an introduction to the inter-disciplinary field of bioelectromagnetics for graduate students. Lectures cover the interaction of electromagnetic fields with biological tissues across the frequency spectrum; bioelectromagnetic dosimetry; and various applications of bioelectromagnetics (medical, consumer, and more).	3.0	Prereq: Graduate standing in Engineering, Biological Sciences, Mathematical and Physical Sciences; or permission of instructor.	

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		xe		6030	Micro-Electro-Mechanical Systems (MEMS) Design	The field of micro-electro-mechanical systems (MEMS) is an interdisciplinary area that includes design and fabrication of sensors and actuators (transducers) that are capable of micron-size mechanical movements. Lectures cover a wide range of topics in design & fabrication. Projects include FE simulation of an inertial, optical, RF, or power MEMS devices as an integral part of this course.	3.0	Prereq: Graduate standing in engineering or physics, or permission of instructor	Not open to students with credit for ECE 6194.06.
	x	x		6070	Project Management in Electrical and Computer Engineering	Students learn project management principles and apply them to Electrical and Computer Engineering real-world projects.	3.0	Prereq: Grad standing in Electrical and Computer Engineering.	Not open to students with credit for 6194.02.
	x			6101	Computer Communication Networks	Foundational understanding of network analysis, error-control, routing, congestion-control, multi-access, and their examples in the context of the existing communication networks.	3.0	Prereq: Undergraduate course in probability or Stat 3470 or Math 530 or Stat 428 or Stat 520 or ECE 6001 or ECE 804. Cross-listed in CSE 6461	Not open to students with credit for ECE 861, ECE 862, CSE 861, CSE 862 or CSE 6461.
	xo			6102	Wireless Networks	Design principles and communication algorithms for wireless networks with a focus on MAC and routing protocols, scheduling algorithms, power control, and scaling properties.	3.0	Prereq: none	Not open to students with credit for both 867 and 894.03.
	x	x	x	6193	Individual Studies in Electrical and Computer Engineering	Individual studies project.	0.0-12.0	Prereq: Permission of instructor.	Repeatable to a maximum of 12.0 cr hrs or 12 completions. This course is graded S/U.
				6194.05	Neuroelectronics	This course gives an introduction on neuroelectronics for graduate students with engineering backgrounds. Focusing on circuits and principles, this course covers neural interfaces, neural recording and stimulation, wireless power and data transfer, and system integration and introduces cutting-edge developments on neural prosthetics.	3.0	Prereq: Graduate standing in engineering or physics, or permission of instructor.	
				6194.09	Oxide Semiconductors: Materials and Devices	We will study the fundamentals of c-axis-aligned crystalline indium-gallium-zinc oxide (CAAC-IGZO) semiconductors. Phase diagrams, crystal structures, fabrication process, defect levels, origin of main donors, and electrical conduction mechanisms will be discussed. CAAC-IGZO based field-effect transistors will be introduced. We will cover the basics of the emerging ultrawide band Ga2O3 and In2O3.	3.0		
				6194.10	Advanced Semiconductor Lasers	This course will cover the essential subjects of basic diode lasers, single-mode as well as tunable laser diodes, from theory to applications. It will cover fundamentals of modern laser diodes including vertical-cavity surface emitting lasers and interband cascade lasers. The basic principles of operation, design, and practice of widely tunable lasers will also be discussed.	3.0	Prereq: 5131.	
		xo		6202	Stochastic Signal Processing	Spectrum estimation, array processing, adaptive filtering.	3.0		Not open to students with credit for ECE 800 or 801.01.
		x		6244	Design and Process Integration for Wide Band Gap Power Devices	Design and processing of wide band gap power devices (including SiC, GaN and ultra wide band gap semiconductors) and reliability considerations. 2D device simulations, layout considerations for power chip design, optimization of performance and reliability/qualification for various voltage ranges from 600 V to 15 kV.	3.0	Prereq: Grad standing in Engineering or Physics.	Not open to student with credit for 6234.

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	xo			6511	Nonlinear Optics	Nonlinear optics for the generation, propagation, amplification, and control of laser light; all-optical switching and solitons; modern applications in high speed lightwave devices and systems.	3.0	Prerequisite: 5012, or Grad standing.	
		x		6531	Fundamentals of Semiconductor Devices	An overview of the physics, design, and engineering of semiconductor electronic and optoelectronic devices. Applications of silicon, compound semiconductor, and nanotechnology will be covered.	3.0	Prereq: 5530 (730), or permission of instructor.	Not open to students with credit for 5531.
		xe		6532	Nanofabrication & Nanoscale Devices	Fundamentals of nanostructures and devices; engineering and physics of new devices, confined structures in low dimensions and their effects on traditional devices; nanofabrication and nanomanufacturing.	3.0	Prereq: ECE 6531, 5531, or 730 or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.	Not open to students with credit for 5532 (835.03).
	xe			6533	Infrared Detector and Systems	This course will cover the basics of infrared photodetectors and systems. It will include basic geometrical optics, radiometry, figures of merit and types of infrared detectors.	3.0	Prereq: 5530, or permission of instructor.	Not open to students with credit for 5194.10.
		x		6535	Semiconductor Optoelectronic Devices	This course will cover the basics and physics of semiconductor optoelectronic devices including light-emitting diodes, semiconductor lasers, photodetectors, and solar cells.	3.0	Prereq: Grad standing in engineering or physics.	
		x		6541	Advanced Topics in Sustainable Energy and Power Systems	Advanced topics in sustainable energy and power systems; basic issues and solutions to sustainable energy; the concept of smart grid; cyber control and security.	3.0	Prereq: ECE 5025 (624) or 724.	Not open to students with credit for ECE 5541.
		x		6750	Linear System Theory	In-depth treatment of linear dynamical systems. State equations solution. Controllability and observability. Canonical forms. Internal and external stability. Linear feedback and observer design. Geometric theory.	3.0	Prerequisites: ECE 5551 or ECE 551 or graduate standing in engineering or math & physical sciences.	Not open to students with credit for ECE 5750 (750).
	x			6754	Nonlinear Systems Theory	Provides fundamental mathematical tools for the analysis of nonlinear dynamical systems. Basic techniques for the synthesis of nonlinear control systems are introduced.	3.0	none listed	Not open to students with credit for ECE 5754.
	x	x	x	6999	Research for Thesis	Research for thesis.	0.5-15.0	Repeatable to a maximum of 15.0 cr hrs or 30 completions. This course is graded S/U.	
		x		7001	Stochastic Processes, Detection, and Estimation	Stochastic processes; detection and decision theory; hypothesis testing, parameter estimation; applications to communications and signal processing.	3.0	Prerequisite: ECE 6001 or ECE 804.	Not open to students with credit for ECE 806.
	xo			7003	Wireless Communication Theory	Theory and analysis of wireless communication systems. Topics include: multipath fading channels; modulation, equalization, and coding for fading channels; MIMO systems; capacity calculations.	3.0	Prerequisite: ECE 804 or ECE 6001.	Not open to students with credit for ECE 807 or 809.
		xo		7005	Information Theory	Mathematical models for channels and sources: entropy, information, data compression, channel capacity, Shannon's theorems, rate distortion theory.	3.0	Prerequisite: ECE 804 or ECE 6001.	Not open to students with credit for ECE 801.02
		x		7010	Electromagnetic Field Theory II	Green's functions with applications; spectral representation of sources; sources in layered media and Sommerfeld integrals; time-domain fields, retarded potentials, and transients; periodic structures; integral equations.	3.0	Prerequisite: ECE 719 or ECE 6010.	Not open to students with credit for ECE 810 and ECE 811.

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		xe		7011	Computational Electromagnetics	Advanced topics in numerical methods for solving Maxwell equations, including finite element methods, integral equation methods, and their hybridization.	3.0	Prerequisite: ECE 715 or ECE 5510 or ECE 6010	Not open to student with credit for ECE 813 or ECE 814.
		xe		7013 (in limbo)	Advanced Radar Systems	Advanced and emerging topics in in radar sensing. For graduates conversant with radar systems. Combination of lectures and student projects based on tutorials. Distributed sensing, bio-insred sensing, and cognitive sensing will be covered. For each area, students will propose and study in detail a topic, and report on the theoretical foundation, state of the art, and future challenges.	3.0	Prereq: 5013 or 5194.01, or permission of instructor.	
	xe			7020	Advanced Data Converters and Phase-Locked Loops	A comprehensive overview of the most recent system architectures of data converters and phase-locked loops. Provides a good understanding how performance specifications and process technology limitations lead to implementation decisions. The presented principles are illustrated by examples and real life case studies.	3.0	Prereq: 5021 or 5023, or permission of instructor.	
		x		7022	Advanced RF Integrated Circuits	Advanced topics on RF and mm-wave circuits. Frequency synthesizers, transmitter linearization techniques (e.g. polar circuits), MIMO and phase array circuits, power D/As.	3.0	Prerequisite: ECE 620 or ECE 5022 or graduate standing in engineering or biological sciences or math & physical sciences.	Not open to students with credit for ECE 694K or ECE 694.02.
		xe		7023	High Speed Interface Circuits and Systems Design	Analysis and design of link architectures and circuits for wireline communication systems. Emphasis on design intuition, link budgeting and power/performance trade-offs in implementation of data links in advanced CMOS process. Topics include channel characterization, noise analysis, equalization, transmitter and receiver circuits, signaling schemes, clocking, synchronization and timing recovery.	3.0	Prereq or concur: 5020 and 5021, or permission of instructor.	
		xo		7027	Advanced Topics in Analog VLSI Design	Advanced topics in analog VLSI design, such as integrated data converters, or power management integrated circuits, or high-performance analog circuits. This includes: system and circuit architectures, performance metrics, practical implementations, design considerations in advanced semiconductor processes, chip design projects, and lab characterization.	4.0	Prereq or concur: 5021 and 5227; or Grad standing in Engineering, or Math and Physical Sciences, and permission of instructor. Repeatable to a maximum of 8 cr hrs	
		xe		7032	Physical Electronics of Advanced Semiconductor Devices	MOSCAPs, Gated Diode, CMOS Bulk/SOI Transistors, Photodiodes, Carrier Transport/Storage, Scaling, Mobility, CCDs, CMOS, EEPROMs, SiGe, SiC, ISFETs, BJTs, Noise and Modeling.	3.0	Prereq: 5530 (730) or 6531.	Not open to students with credit for 894 (Spring 12, Class number 26147) or 8194.04.
take PHILOS 7080 instead, starting Au20	-	-		7080	Ethics and Professionalism	Professionalism standards, ethical dilemmas, codes of ethics, moral frameworks and social justice, engineering as social experimentation, safety and risk, workplace rights and responsibilities, professional communications, research integrity, environmental ethics, global issues. Case study based approach.	1.0	Prereq: Grad standing in ECE.	This course is graded S/U.
		xo		7100	Network Optimization and Algorithms	Convex optimization, probabilistic, and algorithmic methods for the design and analysis of efficient and practical algorithms for complex and stochastic communication networks.	3.0	Prerequisite: Graduate standing.	Not open to students with credit for ECE 894R.
		xe		7103	Discrete Stochastic Processes	Stochastic processes in discrete time or space for electrical engineering. Renewal theory, Markov chains and processes, dynamic programming, basic large deviations theory and martingales.	3.0	Prerequisite: ECE 804 or ECE 6001.	Not open to students with credit for ECE 894Q or ECE 894.01.

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		xe		7200	Signal Processing	Multi-rate signal processing, filter banks, perfect reconstruction, time-frequency analysis, and wavelets and applications.	3.0		Not open to students with credit for ECE 700.
	x	x		7202	Reinforcement Learning	Fundamentals of Markov decision processes and reinforcement learning algorithms.	3.0	Prereq: Grad standing in Engineering or Math. Cross-listed in ISE.	Not open to students with credit for ISE 7202.
	x			7402	Advanced Machine Learning for Remote Sensing Image Interpretation	Introduces basic high-resolution remote sensing concepts with focus on optical remote sensing, and computational solutions for typical remote sensing problems. Students are assumed to know basic knowledge in statistical estimation, linear algebra and numerical methods for engineering. Students with prior experiences on remote sensing/machine learning/computer vision will find this easier to follow	3.0	Prereq: Graduate standing, or instructor permission. Cross-listed with CivilEn 7421.	Not open to students with credit for CivilEn 7421.
	xo			7531	Epitaxial Heterostructures (cross-listed with MSE)	Science and techniques behind thin film growth and engineering for combining different materials, altering chemical composition at the nanometer scale, while controlling defects and strain. Epitaxial crystal growth will be explained. Students will gain an understanding of the kinetics, thermodynamics, and technology involved in epitaxial heterostructures and self-assembled nanostructures.	2.0	Prereq: Grad standing.	Not open to students with credit for MSE 7531. Cross-listed in MSE.
	xo			7811	Electromagnetic Interference and Compatibility	Electromagnetic Interference and Compatibility, Signal Integrity in ICs, Conducted Emissions and Electromagnetic Radiation Susceptibility, Crosstalk and Shielding	3.0	Prerequisite: ECE 719 or ECE 6010.	Not open to students with credit for ECE 614.
	xe			7813	Advanced Antenna Theory and Design	Topics in Advanced Antenna Theory and Design	3.0	Prereq: 5011 or 613, or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences	Not open to students with credit for ECE 815.
		xo		7814	Microwave Remote Sensing	Description of microwave remote sensing systems. Theories of scattering from random media and rough surfaces.	3.0	Prereq: 6010.	Not open to students with credit for 816.
	xo			7821	Mixed Signal Verification and CAD Tools	Principles of combining analog, RF, and digital design, simulation, and verification strategies using modern CAD tools	3.0	Prerequisite: ECE 622 or ECE 720 or ECE 5020.	Not open to students with credit for ECE 894Z or ECE 822.
	xo			7822	Advanced Nonlinear Microwave Circuit Engineering	Large-signal characterization and modeling of nonlinear RF circuits; power amplifiers; oscillators; modulators; wideband linearization, power efficient design.	3.0	Prerequisite: ECE 723 or ECE 5027.	Not open to students with credits in ECE 694.02 or ECE 694K.
	xe			7831	High speed Semiconductor Devices	Principles of microwave semiconductor devices; scattering and high-field transport; Gunn effect; FET wave equation, HEMT; HBT; large signal RF modeling and measurements; noise; traps; self-heating.	3.0	Prerequisite: Grad standing in Engr or Physics.	Not open to students with credit for ECE 832.
	xe			7841	Advanced Topics in Power Electronics	Advanced topics of power electronics, beginning with utility and vehicle applications and evolving into advanced circuit topologies and control.	3.0	Prerequisite: ECE 624 or ECE 5025.	Not open to students with credit for ECE 844.
	xe			7842	Advanced Topics in Electric Machines	Advanced topics of electric machines, beginning with dynamic modeling and principles of vector control and evolving into new design and control of electric machines for advanced traction motors and renewable energy generator systems.	3.0	Prereq: 5541 (643) and 5551 (650).	Not open to students with credit for 743, 744, or 845.

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Notes	Au *	Sp *	Su *	Course#	Course Name	Course Description	Credits	Requisites	Exclusions
		xe		7843	Advanced Topics in Power Systems	Advanced topics of power system protection, beginning with equipment protection and evolving into system wide protection design and operation to accommodate smart-grid technologies.	3.0	Prerequisite; ECE 5042 or 740.	Not open to students with credit for ECE 741.
		xe		7850	Hybrid Dynamical Systems: Theory and Applications	Introduction to hybrid systems (continuous dynamics coupled with discrete logic rules). Topics include stability analysis, optimal control, model predictive control, reachability, and state estimation of hybrid systems. Emphasis will be placed on applying existing hybrid systems theories to a wide range of applications in networked control systems, smart grid, power electronics, and robotics.	3.0	Prerequisite: 6750 or 5750 (750)	
	xo			7854	Nonlinear and Adaptive Control	Advanced analysis of uncertain nonlinear systems. Design methodologies for complex interconnected nonlinear systems. Applications of nonlinear and adaptive control design to aerospace and robotic systems.	3.0	Prereq: 6754 (5754 or 754) and 6750 (5750 or 750).	Not open to students with credit for 857
	-	-		7855 (in limbo)	Large Scale and Cyber-Physical Systems	Decentralization, hierarchy and their effects on modeling, stability analysis, and optimal controller design. Hybrid system based modeling and design of Cyber-Physical Systems.	3.0	Prerequisite: ECE 5750 or ECE 750	Not open to students with credit for ECE 855.
		xe		7858	Intelligent Control	Fuzzy control, neural control, genetic algorithms, learning control, and distributed intelligent control	3.0	Prereq: 5551 (551) or equiv.	Not open to students with credit for ECE 858.
		xo		7859	Sliding mode control in electromechanical systems	Sliding modes an efficient tool to control high order dynamic plants operating under uncertainty conditions	3.0	Prerequisite: ECE 750 or ECE 5750	Not open to students with credit for ECE 859 or MECH ENG 859.
	-	-		7861 (in limbo)	Scientific Computing on Emerging Architectures	Students will be introduced to the architectural system design of emerging architectures and techniques for managing idiosyncrasies of these architectures for developing scientific computing applications.	3.0	Prerequisite: ECE 762 or ECE 5362 or CSE 2431 or CSE 5431.	Not open to students with credit for ECE 694.03 or ECE 694J.
		xo		7864	Advanced Computer Design	Parallel computer architectures, pipeline design, multiprocessor design, interprocessor communication, multi-core architectures, case studies and application examples.	3.0	Prerequisite: 5362 (662) or Grad standing.	Not open to student with credit for 864.
	xe			7866	Computer Vision	Computer vision systems, image models, feature extraction, shape representation and recognition, object modeling and recognition, matching, probabilistic and statistical modeling, semantic knowledge, face perception.	3.0	Prereq: 5460 (707).	Not open to students with credit for 863.
		xe		7868	Pattern Recognition and Machine Learning	Fundamentals of pattern recognition techniques and their application to computer and electrical engineering problems, medicine, cognitive science, and bioinformatics.	3.0	Prereq: 6001 (804).	Not open to students with credit for both 779 and 874.
	-	-		8001	Advanced Topics in Communications	Current topics in information theory and the practice of digital communications.	3.0	Prerequisite: ECE 7001 or 806.	
		xo		8019	Advanced Topics in Electromagnetics and Optics	Topics are chosen to prepare graduate students for research and application in current problems in electromagnetics and optics.	3.0	Prerequisite: ECE 719 or ECE 6010.	
	x			8101	Advanced Topics in Networks	Advanced topics and new areas of interest in the theory of networking and networked systems.	3.0	Prerequisite: ECE 804 or ECE 6001.	
	x	x	x	8193	Individual Studies in Electrical and Computer Engineering	Individual studies project.	0.0-12.0	Prereq: Permission of instructor.	Repeatable to a maximum of 12.0 cr hrs or 12 completions. This course is graded S/U.

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Notes	Au *	Sp *	Su *	Course#	Course Name	Course Description	Credits	Requisites	Exclusions
				8201	Advanced Topics in Signal Processing	Current topics in the theory and practice of signal processing.	3.0	Prerequisite: ECE 806 or ECE 7001.	
		xe		8250	Continuous Time Optimal Control			Cross-listed with ME8220.	
	xo	xo		8851	Advanced Topics in Control Theory	Current topics in control theory, optimization, and decision theory.	3.0	Prerequisite: Permission of instructor.	Repeatable to a maximum of 6.0 credit hours or 2 completions.
	-	-		8861 (in limbo)	Special Topics on Computational Modeling	The course will review the latest computational models and advanced methods for modeling processes of diverse sorts.	3.0	Prerequisite: Graduate standing in engineering or biological sciences or math & physical sciences.	
		x		8862	Special Topics in Advanced Computer Design Methodologies	Design automation, computer aided design, testing, and design for energy efficiency.	3.0	Prerequisite: Grad standing in Engineering. Repeatable to a maximum of 9 cr hrs.	
	x	x	x	8891	Seminar in Electrical and Computer Engineering	Seminar in electrical and computer engineering.	0.5-2.0	Prerequisite: Graduate standing in electrical and computer engineering. Repeatable to a maximum of 12.0 cr hrs or 6 completions. This course is graded S/U.	
	x	x	x	8898	Open Graduate Seminar	As an introduction to potential research areas, students will attend OSU sponsored talks relevant to topics in Electrical Engineering and critique them by written reports.	0.5-3.0	Prerequisite: Graduate standing in electrical and computer engineering. Repeatable to a maximum of 6.0 cr hrs or 6 completions. This course is graded S/U.	
	x	x	x	8999	Research for Dissertation	Research for dissertation.	0.5-15.0	Repeatable to a maximum of 30 completions. This course is graded S/U.	

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