940*. ***Organizational Analysis of K-12 Schooling***
Fall. 3(3-0)
P: EAD 800 R: Graduate student
Theoretical perspectives on schools as organizations. Relationship of organization theory to administrative practice in K-12 schooling.

943*. ***Politics of Education***
Fall of odd-numbered years. 3(3-0)
R: Graduate
Education as a political enterprise. Interplay of federal relations, democratic principles, and contending sources of authority in shaping educational policy and practice.

951B*. ***Educational Finance***
Spring. 3(3-0)
R: Graduate
Political and economic contexts of educational finance. Role of government and policy criteria. Acquisition and distribution of public resources. Emerging issues in elementary and secondary education. Comparative and international analyses.
QA: EAD 951B

951F*. ***Planning Change in K-12 Education***
Fall. 3(3-0)
R: Graduate
Behavioral change processes in educational institutions. Concepts and methods tested by laboratory and field experiences.
QA: EAD 951F

ELECTRICAL ENGINEERING EE

200*. ***Electric Circuits***
Fall, Spring. 4(4-0)
P: CPS 130 or CPS 131 or CPS 230; MTH 133. R: Open only to Engineering students.
Resistive circuits. Loop and nodal analysis. Network theorems. Capacitor and inductor circuits. Transient analysis. Forced response. Sinusoidal steady-state response. Frequency response. Introduction to computer-aided analysis.
QP: MTH 113 QA: EE 300 EE 301

302*. ***Electronic Circuits***
Fall. 4(3-3)
P: EE 200. R: Open only to Electrical Engineering, Computer Engineering, and Computer Science majors.
Volt-ampere characteristics of diodes and transistors. SPICE modeling. Differential, multistage and integrated circuit amplifiers. High frequency effects. Electronic test equipment and verification of principles.
QP: EE 301 MTH 215 QA: EE 302 EE 303 EE 304

305*. ***Electromagnetic Fields and Waves I***
Fall, Spring. 3(3-0)
P: MTH 235, PHY 184. R: Open only to Electrical Engineering, and Computer Engineering majors.
Vector analysis. Static electric field and scalar potential. Dielectric materials. Electric force and energy. Potential problems. Steady currents, magnetic field and vector potential. Magnetic materials and circuits. Magnetic force and torque.
QP: MTH 310 PHY 288 QA: EE 305 EE 306

306*. ***Electromagnetic Fields and Waves II***
Spring. 4(3-3)
P: EE 305. R: Open only to Electrical Engineering and Computer Engineering majors.
Faraday's law. Maxwell's equations. EM energy conservation. Wave equations and EM waves. Transmission lines. Transient waves. Travelling and standing waves. EM plane waves. EM radiation and antennas.
QP: EE 305 EE 306 QA: EE 306 EE 307 EE 308

320*. ***Energy Conversion and Power Electronics***
Spring. 3(3-0)
P: EE 302, EE 305. R: Open only to Electrical Engineering and Computer Engineering majors.
Power and energy. Magnetics and transformers. Elementary and induction machines. Power semiconductors. Controlled rectifiers and inverters. Power supplies and motor drives.
QP: EE 301 EE 306 QA: EE 320

330*. ***Digital Logic Fundamentals***
Fall, Spring, Summer. 3(3-0)
P: CPS 130 or CPS 131 or CPS 230. R: Open only to College of Engineering majors.
Switching algebra, combinational logic, minimization. Programmable logic devices. Sequential system fundamentals, elements, circuits. Arithmetic operations and circuits. Memory elements and systems. Hierarchical structures. Design problems.
QP: CPS 251 QA: EE 330

331*. ***Microprocessors and Digital Systems***
Fall. 4(3-3)
P: CPS 230, EE 330. R: Open only to Electrical Engineering and Computer Engineering majors. Not open to students with credit in CPS 320.
Microcomputers. Microprocessor architecture. Addressing modes. Assembly language programming. Parallel and serial input and output. Interfacing to memory. Interrupts. Direct Memory Access. Coprocessors. Peripheral device controllers. Applications, design
QP: E E 330 QA: CPS 311

345. ***Electronic Instrumentation and Systems***
Fall, Spring. 3(2-3)
P: MTH 235, PHY 184. R: Open only to College of Engineering majors except Electrical Engineering and Computer Engineering.
Electrical and electronic components, circuits and instruments. Circuit laws and applications, frequency response, operational amplifiers, semi-conductor devices, digital logic, counting circuits.
QP: PHY 288 QA: EE 345

360*. ***Signals and Linear Systems***
Fall, Spring. 4(4-0)
P: MTH 235. R: Open only to Electrical Engineering and Computer Engineering majors.
Continuous and discrete signals and systems. Convolution, impulse response, system classifications, state variables, differential and difference equations. Fourier series, Fourier transform, Laplace transform. Z-transform. Transfer functions and stability.
QP: MTH 310 QA: EE 315 EE 417 EE 355

410*. ***Digital Electronics***
Fall. 3(3-0)
P: EE 302, EE 330. R: Open only to Electrical Engineering, Computer Engineering, and Computer Science majors.
Transistor switch models. Device simulation models. Logic family characteristics. Latches, flip-flops, timers, memory circuits, standard cells. Gate arrays, programmable logic devices.
QP: EE 330 EE 302 QA: EE 410

411*. ***Electronic Design Automation***
Spring. 3(3-0)
P: CPS 320 or EE 331, EE 410. R: Open only to Electrical Engineering, Computer Engineering, and Computer Science majors.
Electronic design hierarchy and the role of methodology. Application specific integrated circuits. Hardware descriptive languages. Behavioral and structural models. Semicustom design. Design algorithms. Design project, presentation and reports.
QP: CPS 311 EE 410 QA: EE 411

413*. ***Control Systems***
Spring. 3(3-0)
P: EE 360. R: Open only to Electrical Engineering, Computer Engineering, and Computer Science majors.
Analysis and design of control systems using transfer functions and state variable methods. Design of digital controllers. Microprocessor implementation.
QP: EE 315 EE 355 QA: EE 413 EE 415

418*. ***Algorithms of Circuit Design***
Fall. 3(3-0)
P: EE 302. R: Open only to Electrical Engineering and Computer Engineering majors.
Design of analog electrical circuits, filter functions, ladder synthesis, inductor simulation. Vector Newton-Raphson method. Lossy inductance and capacitance. Statistical tolerance analysis. Optimization by multi-dimensional search. Software algorith
QP: EE 302 QA: EE 418

421*. ***Power System Analysis***
Spring. 4(3-3)
P: EE 320. R: Open only to Electrical Engineering majors.
Synchronous machines: models and measurements of power components. Symmetrical components. Short circuit analysis and equipment protection. Load flow. Voltage and frequency control. Operation and planning of power systems.
QP: EE 320 QA: EE 421 EE 423

435*. ***Electromagnetic Waves and Applications***
Fall. 4(3-3)
P: EE 306. R: Open only to Electrical Engineering majors.
Open and closed-boundary waveguides. Resonators. Microwave circuit theory. Scattering parameters. Electromagnetic radiation. Properties of antennas. Wave propagation. Measurement of antenna characteristics. Computer-aided design and testing.
QP: EE 307 EE 308 QA: EE 435 EE 436 EE 438

457*. ***Statistical Communication Systems***
Fall. 4(3-3)
P: EE 360, STT 351. R: Open only to Electrical Engineering and Computer Engineering majors.
Representation, processing, filtering of random signals. System performance with noise. Optimal digital communication systems. Modulation, detection, coding, information. System design applications in telecommunications, radar, signal processing.
QP: EE 355 EE 456ORSTT 441OR QA: EE 457 EE 467

466*. ***Digital Signal Processing and Filter Design***
Spring. 3(3-0)
P: EE 360. R: Open only to seniors and graduate students in Electrical Engineering and Computer Engineering.
Discrete Fourier transforms, sampling theorem, circular convolution, Z-transforms. Design of infinite impulse resistance filters using prototypes and algorithmic methods. Design of finite impulse resistance filters by windowing, frequency sampling.
QP: EE 355 EE 315 QA: EE 466

474*. ***Principles of Electronic Devices***
Spring. 3(3-0)
P: EE 302, EE 305. R: Open only to Electrical Engineering majors.
Energy levels in atoms. Crystal properties, energy bands and charge carriers, semiconductors, transport properties of bulk materials. P-n junction diodes, bipolar transistors, field effect transistors.
QP: EE 302 EE 305 QA: EE 474

476*. ***Electro-Optics***
Fall. 3(2-3)
P: EE 306, EE 474. R: Open only to Electrical Engineering and Computer Engineering majors.
Operating principles and applications of high frequency and photonic devices including impact, Gunn, photodetector, light-emitting diodes, semiconductor laser devices. Photonic device applications to fiber optic systems.
QP: EE 474 EE 307 QA: EE 477

481*. ***Capstone: Professionalism, Communication and Ethics***
Spring. 1(1-0)
C: EE 482 or EE 483 or EE 484 or EE 485 R: Open only to seniors in Electrical Engineering and Computer Engineering.
Reinforces capstone design course with examination of issues in professionalism and ethics. Technical writing.
QP: NONE QA: NONE

482*. ***Capstone: Computer System Design***
Spring. 4(3-3)
P: EE 302; EE 331 or CPS 320; C: EE 481 R: Open only to Electrical Engineering and Computer Engineering majors.
Design of single board computers. Microprocessor emulation systems. Bus interface requirements. Data transfer. I/O controller design. Interrupt structure. Analog/digital interfacing. Logic analyzers.
QP: EE 302 CPS 311 QA: EE 431

483*. ***Capstone: Integrated Circuit Design and Fabrication***
Spring. 4(3-3)
P: EE 474; C: EE 481 R: Open only to Electrical Engineering and Computer Engineering majors.
Processing fundamentals and process simulations. Comparison of current metal oxide semiconductors and bipolar technologies and their limitations. Layout design rules and methodology. Packaging and yield.
QP: EE 474 QA: EE 871 EE 478

484*. ***Capstone: Applications of Analog Integrated Circuits***
Spring. 4(3-3)
P: EE 302; C: EE 481 R: Open only to Electrical Engineering and Computer Engineering majors.
Circuit design using analog integrated circuits. SPICE macromodeling. Operational amplifiers, comparators, timers, regulators, multipliers and converters. Design project with hardware and software verification.
QP: EE 302 QA: EE 475 EE 480 EE 304

485*. ***Capstone: Digital Control and Robotics***
Spring. 4(3-3)
P: EE 413, EE 330; C: EE 481; R: Open only to Electrical Engineering and Computer Engineering majors.
Robot classifications, kinematics, trajectory planning, digital controller design. Design and implementation of sensor-based robots.
QP: EE 415 EE 330 QA: EE 416

490*. ***Independent Study***
Fall, Spring, Summer. 1 to 3 credits. May reenroll for a maximum of 3 credits.
R: Approval of department.
Independent study of a topic in electrical engineering or computer engineering.
QA: EE 495

491*. ***Special Topics***
Fall, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 6 credits.
R: Open only to Electrical Engineering and Computer Engineering majors.
Investigation of special topics in electrical engineering or computer engineering.

499*. ***Undergraduate Research***
Fall, Spring, Summer. 1 to 3 credits. May reenroll for a maximum of 4 credits.
R: Approval of department.
Independent undergraduate research in contemporary areas of electrical engineering or computer engineering.
QA: EE 499

801*. ***Selected Topics and Special Problems***
Fall, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 9 credits.
P: Approval of Department R: NONE
Investigation of a topic in electrical engineering compatible with the student's prerequisites, interest, and ability.
QP: NONE QA: EE 801

809*. ***Algorithms and Their Hardware Implementation***
Fall. 3(3-0)
R: NONE
Algorithms: arithmetic algorithms, signal processing algorithms, and image processing algorithms. Array structures: systolic architecture, data flow structure, neural network architecture. Performance analysis.
QP: NONE QA: EE 809

813*. ***Logic Design Principles***
Spring. 3(3-0) Interdepartmental with the Department(s) of Computer Science.
R: NONE
Behavioral modeling. Combinational circuit analysis and design. Sequential-circuit analysis and synthesis. Design for testability. Semicustom and MSI design.
QP: NONE QA: EE 813

823*. ***Power System Stability and Control***
Fall of even-numbered years. 3(3-0)
P: EE 826 R: NONE
Analysis and simulation of small and large disturbance stability of power systems. Generator, exciter, voltage regulator models. Design of excitation systems and power system stabilizers.
QP: EE 826 QA: EE 823 EE 820

824*. ***Power System Operation and Control***
Fall of odd-numbered years. 3(3-0)
P: EE 421, EE 456 or STT 441 R: NONE
Operation planning of power systems including load-flow, unit commitment, and production cost methods. On line operation and control including automatic generation control, economic dispatch, security assessment, and state estimation.
QP: EE 421 EE 456STT 441 QA: EE 824

825*. ***Alternating Current Electrical Machines and Drives***
Spring of even-numbered years. 3(3-0)
P: EE 301, EE 422 R: NONE
Analysis, modeling and design aspects of synchronous, induction, and switched reluctance machines. Design drives for each machine for motion control and power system applications.
QP: MTH 424 EE 320 QA: EE 825

826*. ***Linear Control Systems***
Fall. 3(3-0)
R: NONE
Vector spaces, representation, system description, solution to the state equations, stability, controllability & observability. Adjoints of linear maps. Eigenstructure assignment. Partial & full order observers. Disturbance decoupling.
QA: EE 826 EE 829

827*. ***Nonlinear Systems Analysis***
Spring. 3(3-0)
P: EE 826 R: NONE
Existence, uniqueness & continuity of solutions. Phase portraits. Limit cycles. Linearization. Stability of equilibria & periodic orbits. Lyapunov stability. Describing functions. Perturbation. Averaging. Singular perturbation. Applications in control.
QP: EE 826 MTH 424 QA: EE 827

829*. ***Optimal Multivariable Control***
Spring. 3(3-0)
P: EE 826 R: NONE
Discuss performance and robustness; develop minimum time, minimum energy and regulator; introduce optimal control and minimum principle; develop LQG, Nyquist, and H-infinity design methods.
QP: EE 413 EE 826STT 441 QA: EE 829

831*. ***Analog Circuit Theory***
Fall of even-numbered years. 3(3-0)
R: NONE
Positive real functions. Filter approximations. Passive network synthesis. Active network synthesis. Nullor network analysis and synthesis. Active filters. Stability. Sensitivity.
QP: NONE QA: EE 831

832*. ***Analog Integrated Circuit Design***
Fall of odd-numbered years. 3(3-0)
R: NONE
Technology. Device modeling. Circuit simulation. IC building blocks. Amplifiers. Comparators. Converters. Switched-capacitor filters. Analog signal processing circuits.
QP: EE 475 QA: EE 832 EE 475

835*. ***Electromagnetic Fields and Waves I***
Fall. 3(3-0)
R: NONE
Electrostatics, magnetostatics, electrodynamics and Maxwell's equations. Potential functions. Eigenfunction expansion. Green's functions. Radiation of EM waves. EM boundary-value problems. TEM waves. Maxwell's equations with magnetic sources.
QA: EE 835

836*. ***Electromagnetic Fields and Waves II***
Spring. 3(3-0)
P: EE 835 R: NONE
Theory of guided transmission system. Microstrip lines, metallic and dielectric waveguides. EM cavities. Excitation and discontinuities of waveguides. Surface wave and radiation modes. Integrated optics. Scattering of EM waves.
QP: EE 835 QA: EE 836

Courses with an asterisk (*) have not been approved by the University Committee on Curriculum.

841*. ***Fourier Optics***
Spring of odd-numbered years. 3(2-3)
P: EE 361 and EE 435 or EE 835 R: NONE
Scalar diffraction theory. Fourier expansion of optical fields. Spatial linear systems and information processing. Lenses. Optical imaging systems. Holgraphy. Measurements of optical systems.
QP: EE 355 EE 880EE 307EE 835 QA: EE 841

842*. ***Quantum Electronics***
Fall of even-numbered years. 3(3-0)
P: EE 874, EE 835 R: NONE
Quantum and electromagnetic theory of lasers. Optical resonators. Laser oscillation and amplification. Characterization of lasers. Specific laser examples.

847*. ***Analog and Digital Communications***
Spring of even-numbered years. 3(3-0)
P: EE 457, EE 863 R: NONE
Optimum signal design in noisy channels, matched filters, quadrature sampling of band-pass signals in noise. Coherent and non-coherent binary modulation such as PSK, FSK, DPSK. M-ary modulation, intersymbol interference, spread spectrum.
QP: EE 457 EE 863 QA: EE 847 EE 848

850*. ***Electrodynamics of Plasmas***
Spring of odd-numbered years. 3(3-0)
Interdepartmental with the Department(s) of Physics, Astronomy and Astrophysics.
P: EE 835 or PHY 488 R: NONE
Plasma kinetic theory, macroscopic plasma transport theory, electromagnetic wave propagation in plasma, charged particle diffusion processes in plasma, electromagnetic energy absorption, elastic & inelastic collisions. Description of laboratory discharges
QP: EE 835 PHY 448 QA: EE 850

863*. ***Analysis of Stochastic Systems***
Fall. 3(3-0)
P: EE 406 R: NONE
Advanced topics in random variable theory. Stochastic processes and stochastic calculus. Optimal systems for filtering and detection.
QP: EE 456 QA: EE 863

866*. ***Digital Signal Processing***
Spring. 3(3-0) Interdepartmental with the Department(s) of Computer Science.
P: EE 406 or EE 863, EE 466 R: NONE
Review of elementary DSP concepts. Advanced transform algorithms. Advanced filter design and implementation. Adaptive filters. Spectrum estimation. Application examples.
QP: EE 466 EE 456 QA: NONE

874*. ***Physical Electronics***
Fall. 3(3-0)
R: NONE
Applications of quantum mechanics and statistical mechanics in solids. Band theory of semiconductors. Electrical transport phenomena. Pn junctions.
QP: NONE QA: EE 874 EE 875

875*. ***Electronic Devices***
Spring. 3(3-0)
P: EE 874 R: NONE
Operating properties of semiconductor devices including DC, AC, transient and noise models of FET, BJT, metal-semiconductor contact, heterostructure, microwave and photonic devices.
QP: EE 474 QA: EE 875 EE 876

885*. ***Artificial Neural Networks***
Fall. 3(3-0) Interdepartmental with the Department(s) of Computer Science.
R: NONE
Overview of the neuro-engineering technology. Basic neural network architectures. Feedforward and feedback networks. Modeling. Temporal modeling. (Supervised and unsupervised) learning. Implementation. Basic applications to patter recognition.
QP: NONE QA: NONE

899*. ***Master's Thesis Research***
Fall, Spring, Summer. 1 to 8 credits.
P: Approval of the Department R: Major, Electrical Engineering
Master's thesis research
QP: NONE QA: EE 899

921*. ***Advanced Topics in Digital Circuits and Systems (MTC)***
Fall, Spring. 3(3-0) May reenroll for a maximum of 6 credits. Interdepartmental with the Department(s) of Computer Science.
P: EE 809, EE 813 R: NONE
Subtitles: Testable and Fault-tolerant Digital Systems, Embedded Architectures.
QP: EE 809 EE 813 QA: NONE

921A*. ***Testable and Fault-tolerant Digital Systems***
Spring. 3(3-0) Interdepartmental with the Department(s) of Computer Science.
P: EE 813, EE 809 R: NONE
Reliability evaluation. Fault models and test pattern generation. Design for testability. Fault-tolerant design techniques, self-checking circuits and systems, system diagnosis and reconfiguration.
QP: EE 813 EE 809 QA: EE 816

921B*. ***Embedded Architectures***
Fall. 3(3-0) Interdepartmental with the Department(s) of Computer Science.
P: EE 809, EE 813 R: NONE
Embedded computers and architectures for real-time computation and/or robust control. ASICs. Bit-slice architectures. Systolic arrays. Neural networks. Genetic algorithms. Implementation technologies and design issues relating to implementation.
QP: NONE QA: NONE

925*. ***Advanced Topics in Power (MTC)***
Spring. 3(3-0) May reenroll for a maximum of 9 credits.
P: EE 823, EE 824, EE 825 R: NONE
Subtitles: Advanced Stability and Control of Power Systems, Power System Planning, Advanced Machine Drives.
QP: EE 823 EE 824 QA: EE 920

925A*. ***Advanced Stability and Control of Power Systems***
Spring. 3(3-0)
P: EE 823, EE 827, EE 829 R: NONE
Study of stability problems in power systems based on nonlinear dynamical system theory and robust control theory. Direct transient stability methods, voltage collapse, interarea oscillations. Excitation and flexible AC transmission controls.
QP: EE 823 EE 827EE 829 QA: EE 920

925B*. ***Power System Planning***
Spring. 3(3-0)
P: EE 824 R: NONE
Power system planning methods based on reliability and probability theory. Generation reliability, maintenance scheduling, production cost, transmission and generation reliability, adequacy and security, load prediction.
QP: EE 824 QA: EE 920

925C*. ***Advanced Machine Drives***
Spring. 3(3-0)
P: EE 825, EE 829 R: NONE
Advanced machine nonlinear drives based on state reconstruction and nonlinear and adaptive control. Sensors, implementation, special computer architectures.
QP: EE 825 EE 829 QA: EE 920

929*. ***Advanced Topics in Electromagnetics (MTC)***
Fall, Spring. 3 to 4 credits. May reenroll for a maximum of 10 credits.
P: EE 835 R: NONE
Subtitles: Planar Waveguides and Circuits, Antenna Theory, Geometrical Theory of Diffraction.
QP: EE 837 QA: EE 929

929A*. ***Planar Waveguides and Circuits***
Fall of odd-numbered years. 3(3-0)
P: EE 835 R: NONE
Planar open-boundary waveguides and circuits. Surface and microstrip waveguides. Propagation-mode spectrum. Spectral analysis of layered media. Sommerfeld analysis. Integral-operator description of open waveguides and planar circuits.
QP: EE 837 QA: EE 929

929B*. ***Antenna Theory***
Fall of even-numbered years. 4(4-0)
P: EE 835 R: NONE
Antennas and EM scattering. Radiation by currents and surface fields. Equivalence principle. Receiving antennas. Arrays and synthesis. Integral equations. Current and impedance of wire antennas. Slot, aperture and reflector antennas. SEM.
QP: EE 837 QA: EE 927

929C*. ***Geometrical Theory of Diffraction***
Spring of even-numbered years. 3(3-0)
P: EE 835 R: NONE
Fourier expansion and asymptotic evaluation of two-dimensional electromagnetic fields. Scattering from halp planes, wedges and cylinders. Geometrical optics and ray-tracing. Reflection and transmission matrices. Geometrical diffraction theory.
QP: EE 837 QA: EE 801

931*. ***Advanced Topics in Electronic Devices and Materials (MTC)***
Fall, Spring. 1 to 4 credits. May reenroll for a maximum of 12 credits.
P: EE 875 R: NONE
Subtitles: VLSI Technology, Microdevices and Microstructures, Properties of Semiconductors.
QP: EE 874 QA: EE 932

931A*. ***VLSI Technology***
Fall of odd-numbered years. 1 to 4 credits.
P: EE 875 R: NONE
Oxidation, doping techniques, simulation techniques, film deposition and etching, epitaxial growth, lithography, passivation, and packaging.
QP: EE 874 QA: EE 932

931B*. ***Microdevices and Microstructures***
Spring of odd-numbered years. 1 to 4 credits.
P: EE 875 R: NONE
Technology, modeling and simulation of submicron solid state devices. Microsensors and micromachining. Diamond and superconducting devices. Vacuum microelectronic structures.
QP: EE 874 QA: EE 932

931C*. ***Properties of Semiconductors***
Fall of even-numbered years. 1 to 4 credits.
P: EE 874 R: NONE
Advanced treatment of phenomena basic to semiconductor materials and devices. Carrier scattering, single particle and collective transport, quantum effects, hot electron effects, electron-photon and electron-phonon interactions.
QP: EE 874 QA: EE 931

932**.** ***Advanced Topics in Analog Circuits (MTC)
Spring of odd-numbered years. 3(3-0)
P: EE 831 R: NONE
Subtitle: Advanced Circuit Analysis.

932A**.** ***Advanced Circuit Analysis
Spring of odd-numbered years. 3(3-0)
P: EE 831 R: NONE
Advanced treatment of methods for circuit analysis. Application of graph theory to circuit analysis. Linear graphs. Mesh and node formulations. Topological formulas. Signal flow graphs.

960**.** ***Advanced Topics in Control (MTC)
Fall. 3(3-0) May reenroll for a maximum of 6 credits.
P: EE 827 R: NONE
Subtitles: Adaptive Control, Nonlinear Control
QP: EE 826

960A**.** ***Adaptive Control
Fall. 3(3-0)
P: EE 827 R: NONE
Model reference adaptive control in continuous time and discrete time. Lyapunov and hyperstability approaches, adaptive observers, self-tuning regulators, design using pole-zero assignments. Minimum variance control and LQG control.
QP: EE 827 QA: EE 965

960B**.** ***Nonlinear Control
Fall. 3(3-0)
P: EE 827 R: NONE
Relay control, stabilizing controllers. Design via variable structure, high gain, geometric, and Lyapunov-based methods. Feedback linearization and tracking controls.
QP: EE 826 QA: EE 960

963**.** ***Advanced Topics in Systems (MTC)
Fall, Spring. 3(3-0) May reenroll for a maximum of 9 credits.
P: Variable, depending upon the subtitle R: NONE
Subtitles: Robot Dynamic and Control, System Identification and Adaptive Filtering, Learning and Theory of Artificial Neural Networks.

963A**.** ***System Identification and Adaptive Filtering
Fall, Spring. 3(3-0)
P: EE 466, EE 826, EE 863 R: NONE
Model parameterization, adaptive filters, identifiability criteria, equation and output error methods, recursive algorithms, least squares and maximum likelihood identification, convergence analysis, closed-loop system identification, experiment design.
QP: EE 863 QA: EE 963

963B**.** ***Robot Dynamics and Control
Fall, Spring. 3(3-0)
P: EE 829, EE 827 R: NONE
Robot dynamics, different formulations, joint space control, task space control, force and compliance control, robust control, coordination of multiple robots, mobil robots.

963C**.** ***Learning in Artificial Neural Networks
Fall, Spring. 3(3-0)
P: EE 826, EE 827 C: EE 829 R: NONE
Advanced topics in the theory of artificial neural networks (ANNS). Analysis, design. Learning algorithms. Stability, convergence. Possible engineering applications.

966**.** ***Advanced Topics in Signal Processing (MTC)
Fall, Spring. 3(3-0) May reenroll for a maximum of 9 credits.
P: EE 863, EE 866 R: NONE
Subtopics: Discrete Time Processing of Speech Signals, Multidimensional Signal Processing, Detection and Estimation Theory.
QP: NONE QA: NONE

966A**.** ***Discrete Time Processing of Speech Signals
Fall. 3(3-0)
P: EE 866, EE 406 or EE 863 R: NONE
Digital speech models. Short term temporal processing. Linear predictive and cepstral analysis. Speech coding and synthesis. Speech recognition. Speech enhancement.
QP: EE 880 QA: EE 801

966B**.** ***Multidimensional Signal Processing
Spring. 3(3-0)
P: EE 866 R: NONE
Multidimensional signals and systems concepts. 2-D sampling. 2-D windowing. Design of 2-D filters. Fast algorithms for convolution and transforms. Sensor array processing. Interpolation.
QP: EE 880 QA: NONE

966C**.** ***Detection and Estimation Theory
Spring. 3(3-0)
P: EE 847, EE 863 R: NONE
Communication channels, noise models, hypothesis testing of signals by Bayesian minimax, and Neyman-Pearson criteria. Performance evaluation using ROC. Bayesian and maximum likelihood parameter estimation. Kalman-Bucy filtering.
QP: EE 847 EE 863 QA: EE 845

989**.** ***Advanced Topics in Plasma (MTC)
Fall of odd-numbered years. 3(3-0) May reenroll for a maximum of 6 credits.
P: EE 835, EE 850 R: NONE
Subtitles: Plasma Processing for IC Fabrication, Plasma Diagnostic Techniques.
QP: EE 850 QA: EE 989

989A**.** ***Plasma Processing for IC Fabrication
Fall of odd-numbered years. 3(3-0)
P: EE 835, EE 850 R: NONE
Process requirements. Plasma reactors. Etching and deposition applications. Broad ion beam processing.
QP: EE 850 EE 835 QA: EE 989

999**.** ***Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 12 credits. May reenroll for a maximum of 0 credits.
P: Approval of Department R: Major, Electrical Engineering
Doctoral dissertation research
QP: NONE QA: EE 999

ENGINEERING EGR

150.** ***Engineers and the Engineering Profession
Spring. 2(2-0)
R: Open only to freshmen and sophomores.
Overview of the engineering profession. Historical background. Engineering specialities. Engineers at work. Professionalislm and ethics. Communication skills. Future trends and challenges.

160**.** ***Minority Engineering Education Seminar
Fall. 2(2- 0)
R: Open only to freshmen in the College of Engineering and to freshmen no-preference students.
Issues relevant to underrepresented engineering minority groups. Diversity in engineering. Transitional problems. Communication skills. Career options.
QA: EGR 290

200W**.** ***Technology, Society and Public Policy
Fall. 2(2- 0)
P: 2 courses in mathematics or engineering or science R: Sophomores and above Engineering students
Description and analysis of certain technologies and their consequences. Development of techniques for assessing consequences as an aid to formulation of public policy.
QA: EGR 200

290.** ***Independent Study
Fall, Spring, Summer. 1 to 4 credits. May reenroll for a maximum of 4 credits.
R: Students in College of Engineering, approval of department.
Independent undergraduate research in engineering.

291.** ***Selected Topics
Fall, Spring, Summer. 1 to 4 credits.
R: Open only to freshmen, sophomores.
Experimental course development or special topics appropriate for freshmen and sophomores.
QP: EGR 290

393.** ***Engineering Cooperative Education
Fall, Spring, Summer. 1(1-0) May reenroll for a maximum of 6 credits.
R: Open only to students in College of Engineering. Educational employment assignment approved by College of Engineering.
Pre-professional educational employment experiences in industry and government related to student's major.
QA: EGR 344

ENGLISH ENG

090**.** ***Intensive English for International Students
May reenroll for a maximum of 45 credits.
R: Permission of English Language Center
Explanation and intensive practice of basic English skills. Students are tested and placed in groups, from beginning to advanced, depending on their need.
QA: ENG 091 ENG 092 ENG 093 ENG 094 ENG 095

091**.** ***English Stucture for International Students
Fall, Spring. 3(5-0)
R: Permission of English Language Center
Explanation and practice of advanced grammatical structures of English in relation to written communication. Heavy emphasis on editing skills.
QA: ENG 091

092**.** ***Academic Communication Skills for International Students
Fall, Spring. 3(5-0)
R: Permission of English Language Center
Intensive speaking and listening practice of spoken academic English, lecture-listening and note-taking strategies developed. Oral communication skills improved through discussions and classroom presentations.
QA: ENG 092

093**.** ***Academic English for International Students
Fall, Spring. 6(10-0) May reenroll for a maximum of 12 credits.
R: Permission of English Language Center
Integrative reading and writing strategies for academic purposes. Includes vocabulary development, intensive and extensive reading and critical reading skills. Develops academic writing style and editing strategies.
QA: ENG 094 ENG 095