**55A.** **Clinical Inquiry in Educational Administration**
*Spring. 3(3-0)*
:: Open only to graduate students in Department of
!ducational Administration.
'linical approaches to problems of educational adminitration, with emphasis on the development of multiple
nalytic perspectives.

**55B.** **Field Research Methods in Educational Administration**
*Spring. 3(3-0)*
Aethods used in conducting field studies in educational
rganizations, with emphasis on interviews, observaion, and participant observation.

**60.** **Proseminar in Higher, Adult, and Lifelong Education**
*Fall. 3(3-0)*
?: Open only to graduate students in Higher, Adult, and
_ifelong Education._
Academic and student administration and leadership.
Adult learning. Central concepts and methods in the
`ield of higher, adult, and lifelong education.

**961.** **Seminar in Adult Learning**
*Fall. 3(3-0)*
P: EAD 861A. R: Open only to doctoral students.
Dimensions of cognitive style and their application to
various learning contexts. Personal theories of adult
learning.

**962.** **Education and Work**
*Spring. 3(3-0)*
Trends shaping the relationship between education
and work in the United States and other countries.

**963.** **Leadership in Postsecondary Education**
*Spring of even-numbered years. 3(3-0)*
P: EAD 800.
Leadership as a complex social phenomenon in higher,
adult, and lifelong educational settings. Theories of
leadership as applied to education. Enhancing leadership diversity.

**964.** **Women's Education and Professional Development**
*Fall of even-numbered years. 3(3-0)*
Gateways and barriers to women's achievement in
education and their careers.

**965.** **Diversity and Equity in Postsecondary Education**
*Fall of even-numbered years. 3(3-0)*
Promise, challenge, and management of diversity and
equity in higher education. Analysis of data and policy.
Management responses and strategies.

**967.** **Policy Challenges in Postsecondary Education**
*Spring of even-numbered years. 3(3-0)*
P: EAD 853A.
Classic and contemporary policy issues such as access,
finance, excellence, and purpose. Structures for policy-making. Agencies at federal, state, and local levels.

**970A.** **Administration and Governance of Higher Education**
*Spring of odd-numbered years. 3(3-0)*
P: EAD 800.
Principles and patterns of organization and governance characteristic of colleges and universities. Administrative, trustee, faculty, and student roles.

**970B.** **The Community College**
*Spring of odd-numbered years. 3(3-0)*
History, philosophy, organization, and role of the community college in higher education. Emphasis on programs and services in comprehensive public
community colleges.

**971A.** **Institutional Research and Improvement**
*Fall of odd-numbered years. 3(3-0)*
R: Open only to graduate students in College of Education.
Tools and methods used to conduct analyses of institutional management and policy issues.

**971B.** **Planning, Evaluation, and Decision Making in Post-secondary Education**
*Spring of odd-numbered years. 3(3-0)*
Analysis of planning, evaluation, and decision making
in the leadership and management of post-secondary
institutions. Integration of program, personnel, facility, and enrollment planning related to factors such as
budgeting and accreditation.

**971C.** **Higher Education Finance**
*Spring of even-numbered years. 3(3-0)*
Revenue sources of institutions of higher education.
Restrictions and conditions placed upon funds. Administrative structures used to obtain and manage funds.

**971D.** **Institutional Advancement in Higher Education**
*Fall of odd-numbered years. 3(3-0)*
Issues and strategies affecting institutional development. Governmental relations, admissions, alumni relations, and general administration.

**990.** **Independent Study**
*Fall, Spring, Summer. 1 to 3 credits. A student
may earn a maximum of 9 credits in all enrollments for
this course.*
Advanced individual study in an area of K-12 administration or higher, adult, and lifelong education.

**991A.** **Special Topics in K-12 Administration**
*Fall, Spring, Summer. 3(3-0) A student may
earn a maximum of 9 credits in all enrollments for this
course.*

**991B.** **Special Topics in Higher, Adult, and Lifelong Education**
*Fall, Spring, Summer. 3(3-0) A student may
earn a maximum of 9 credits in all enrollments for this
course.*

**994.** **Laboratory and Field Experience in Educational Administration**
*Fall, Spring, Summer. 1 to 6 credits. A student
may earn a maximum of 6 credits in all enrollments for
this course.*
R: Open only to doctoral students.
Supervised advanced graduate practica, observations,
internships, or externships in K-12 administration and
in higher, adult, and lifelong education.

**995.** **Research Practicum in Educational Administration**
*Fall, Spring, Summer. 1 to 4 credits. A student
may earn a maximum of 4 credits in all enrollments for
this course.*
R: Open only to doctoral students. Approval of department.
Supervised research practicum. Design, execution,
analysis, presentation, critique, and revision of research projects.

**999.** **Doctoral Dissertation Research**
*Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 36 credits in all enrollments for this course.*
R: Open only to Ph.D. students.

# ELECTRICAL ENGINEERING      EE

### Department of Electrical Engineering
### College of Engineering

**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.

**302.** **Electronic Circuits**
*Fall, Spring. 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.

**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.

**306.** **Electromagnetic Fields and Waves II**
*Spring, Summer. 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.

**311.** **Introduction to Biomedical Engineering**
*Fall. 3(3-0) Interdepartmental with Biomedical Engineering, Materials Science and Mechanics, and
Mechanical Engineering. Administered by Biomedical
Engineering.*
P: BS 111, MTH 235, PHY 184.
Physical and mechanical properties of soft and hard
tissues. Biomaterials. Biocompatibility. Biochemical
processes, biological transport, and thermodynamics.
Bioelectronics and instrumentation.

**320.** **Energy Conversion and Power Electronics**
*Fall, 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.

**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.

**331. Microprocessors and Digital Systems**
*Fall, Spring. 4(3-3)*
P: CPS 230, EE 330. R: Open only to Electrical Engineering, Computer Engineering, and Computer Science 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.

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

**360. Signals and Linear Systems**
*Fall, Spring. 4(4-0)*
P: EE 200, MTH 235. R: Open only to Electrical Engineering, Computer Engineering, and Computer Science 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.

**381. Capstone: Professionalism, Communication and Ethics (W)**
*Fall, Spring. 1(1-0)*
P: EE 200. C: EE 303 or EE 332. R: Open only to Electrical Engineering and Computer Engineering majors. Completion of Tier I writing requirement. Not open to students with credit in 3.
Examination of issues in professionalism, ethics, and technical communications related to the electrical and computer engineering.

**405. Biomedical Electronics**
*Fall of even-numbered years. 3(3-0) Interdepartmental with Biomedical Engineering. Administered by Biomedical Engineering.*
P: MTH 132, PHY 184.
Electronic components and circuits. Physiological measurements, transduction of physiological events to electrical signals. Ultrasonic techniques, biomedical applications of lasers, x-ray and magnetic resonance imaging.

**410. Digital Electronics**
*Fall, Spring. 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.

**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.

**413. Control Systems**
*Fall, 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.

**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 multidimensional search. Software algorithms.

**421. Power System Analysis**
*Spring. 4(3-3)*
P: EE 320. R: Open only to Electrical Engineering and Computer 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.

**435. Electromagnetic Waves and Applications**
*Fall. 4(3-3)*
P: EE 306. R: Open only to Electrical Engineering and Computer 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.

**457. Statistical Communication Systems**
*Spring. 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.

**466. Digital Signal Processing and Filter Design**
*Fall. 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.

**474. Principles of Electronic Devices**
*Fall, Spring. 3(3-0)*
P: EE 302, EE 305. R: Open only to Electrical Engineering and Computer 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.

**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 impatt, Gunn, photodetector, light-emitting diodes, semiconductor laser devices. Photonic device applications to fiber optic systems.

**482. Capstone: Computer System Design (W)**
*Fall. 4(3- 3)*
P: EE 303; EE 332 or CPS 320; EE 381. R: Open only to Electrical Engineering and Computer Engineering majors. Completion of Tier I writing requirement.
Design of single board computers. Microprocessor emulation systems. Bus interface requirements. Data transfer. I/O controller design. Interrupt structure. Analog/digital interfacing. Logic analyzers.

**483. Capstone: Integrated Circuit Design and Fabrication (W)**
*Fall. 4(3-3)*
P: EE 303, EE 381, EE 474. R: Open only to Electrical Engineering and Computer Engineering majors. Completion of Tier I writing requirement.
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.

**484. Capstone: Applications of Analog Integrated Circuits (W)**
*Spring. 4(3-3)*
P: EE 302, EE 303, EE 381. R: Open only to Electrical Engineering and Computer Engineering majors. Completion of Tier I writing requirement.
Circuit design using analog integrated circuits. SPICE macromodeling. Operational amplifiers, comparators, timers, regulators, multipliers and converters. Design project with hardware and software verification.

**485. Capstone: Digital Control and Robotics (W)**
*Spring. 4(3-3)*
P: EE 303, EE 330, EE 381, EE 413. R: Open only to Electrical Engineering and Computer Engineering majors. Completion of Tier I writing requirement.
Robot classifications, kinematics, trajectory planning, digital controller design. Design and implementation of sensor-based robots.

**490. Independent Study**
*Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 3 credits in all enrollments for this course.*
R: Approval of department.
Independent study of a topic in electrical engineering or computer engineering.

**491. Special Topics**
*Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course.*
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. A student may earn a maximum of 4 credits in all enrollments for this course.*
R: Approval of department.
Independent undergraduate research in contemporary areas of electrical engineering or computer engineering.

**801. Independent Study**
*Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 3 credits in all enrollments for this course.*
R: Approval of department.
Independent investigation of a topic in electrical engineering compatible with the student's prerequisites, interest, and ability.

**802.      Selected Topics**
       *Fall, Spring, Summer. 1 to 4 credits. A student
may earn a maximum of 6 credits in all enrollments for
this course.
R: Approval of department.*
Investigation of special topics in electrical engineering.

**807.      Computer System Performance and
       Measurement**
       *Spring of odd-numbered years. 3(3-0) Interde-
partmental with Computer Science. Administered by
Computer Science.
P: CPS 410, STT 441. R: Open only to Computer Science
or Electrical Engineering majors.*
Queueing network modelling, general analytic tech-
niques, workload characterization, representing spe-
cific subsystems, parameterization. Software and
hardware monitors, performance measures. Case stud-
ies, software packages.

**808.      Modelling and Discrete Simulation**
       *Fall of even-numbered years. 3(3-0) Interde-
partmental with Computer Science. Administered by
Computer Science.
P: CPS 330, STT 441. R: Open only to Computer Science
or Electrical Engineering majors.*
Simulation examples, and languages. Mathematical
models, petri nets, model validation, random variate
generation. Analysis of simulation data. Case studies.

**809.      Algorithms and Their Hardware
       Implementation**
       *Spring. 3(3-0) Interdepartmental with Com-
puter Science.*
Arithmetic, signal processing, and image processing
algorithms. Array structures: systolic architecture,
data flow structure, neural network architecture. Per-
formance analysis.

**813.      Logic Design Principles**
       *Fall. 3(3-0) Interdepartmental with Computer
Science.*
Behavioral modeling. Combinational circuit analysis
and design. Sequential-circuit analysis and synthesis.
Design for testability. Semicustom and MSI design.

**820.      Advanced Computer Architecture**
       *Fall, Spring. 3(3-0) Interdepartmental with
Computer Science. Administered by Computer Science.
P: CPS 410, CPS 420. R: Open only to Computer Science
or Electrical Engineering majors.*
Instruction set architecture. Pipelining, vector proces-
sors, cache memory, high bandwidth memory design,
virtual memory, input and output. Benchmarking tech-
niques. New developments related to single CPU sys-
tems.

**822.      Parallel Processing Computer Systems**
       *Spring. 3(3-0) Interdepartmental with Com-
puter Science. Administered by Computer Science.
P: CPS 820. R: Open only to Computer Science or
Electrical Engineering majors.*
Massively parallel SIMD processors, multiprocessor
architectures, interconnection networks, synchroniza-
tion and communication. Memory and address space
management, process management and scheduling.
Parallel compilers, languages, performance evalu-
ation.

**823.      Power System Stability and Control**
       *Fall of even-numbered years. 3(3-0)*
*P: EE 826.*
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.

**824.      Power System Operation and Control**
       *Fall of odd-numbered years. 3(3-0)*
*P: EE 421; STT 351.*
Operation planning of power systems including load-
flow, unit commitment, production cost methods. On
line operation and control including automatic genera-
tion control, economic dispatch, security assessment,
state estimation.

**825.      Alternating Current Electrical
       Machines and Drives**
       *Spring of even-numbered years. 3(3-0)*
*P: EE 320.*
Analysis, modeling and design of synchronous, induc-
tion, and switched reluctance machines. Design drives
for motion control and power system applications.

**826.      Linear Control Systems**
       *Fall. 3(3-0)*
*P: MTH 314.*
Vector spaces, representation, system description, so-
lution to the state equations, stability, controllability
and observability. Adjoints of linear maps. Eigenstruc-
ture assignment. Partial and full order observers. Dis-
turbance decoupling.

**827.      Nonlinear Systems Analysis**
       *Spring. 3(3-0)*
*P: EE 826.*
Existence, uniqueness and continuity of solutions.
Phase portraits. Limit cycles. Linearization. Stability
of equilibria and periodic orbits. Lyapunov stability.
Describing functions. Perturbation. Averaging. Singu-
lar perturbation. Control applications.

**829.      Optimal Multivariable Control**
       *Spring. 3(3-0)*
*P: EE 826.*
Performance and robustness. Minimum time, mini-
mum energy and regulator. Optimal control and mini-
mum principle. LQG, Nyquist, and H-infinity design
methods.

**831.      Analog Circuit Theory**
       *Fall of even-numbered years. 3(3-0)*
Positive real functions. Filter approximations. Passive
and active network synthesis. Nullor network analysis
and synthesis. Active filters. Stability. Sensitivity.

**832.      Analog Integrated Circuit Design**
       *Fall of odd-numbered years. 3(3-0)*
Technology. Device modeling. Circuit simulation. Inte-
grated circuit building blocks. Amplifiers, comparators,
converters. Switched-capacitor filters. Analog signal
processing circuits.

**835.      Advanced Electromagnetic Fields and
       Waves I**
       *Fall. 3(3-0)*
Electrostatics, magnetostatics, electrodynamics and
Maxwell's equations. Potential functions. Eigenfunc-
tion expansion. Green's functions. Radiation of EM
waves. EM boundary-value problems. TEM waves.
Maxwell's equations with magnetic sources.

**836.      Advanced Electromagnetic Fields and
       Waves II**
       *Spring. 3(3-0)*
*P: EE 835.*
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. Scatter-
ing of EM waves.

**841.      Fourier Optics**
       *Spring of odd-numbered years. 3(2-3)*
*P: EE 360; EE 435 or EE 835.*
Scalar diffraction theory. Fourier expansion of optical
fields. Spatial linear systems and information process-
ing. Lenses. Optical imaging systems. Holography.
Measurements of optical systems.

**842.      Quantum Electronics**
       *Fall of even-numbered years. 3(3-0)*
*P: EE 835, EE 874.*
Quantum and electromagnetic theory of lasers. Optical
resonators. Laser oscillation and amplification. Char-
acterization of lasers. Specific laser examples.

**847.      Analog and Digital Communications**
       *Fall of odd-numbered years. 3(3-0)*
*P: EE 457, EE 863.*
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, in-
tersymbol interference, spread spectrum.

**850.      Electrodynamics of Plasmas**
       *Spring of odd-numbered years. 3(3-0) Interde-
partmental with Physics, and Astronomy and Astro-
physics.
P: EE 835 or PHY 488.*
Plasma kinetic and macroscopic plasma transport the-
ory. Electromagnetic wave propagation and charged
particle diffusion processes in plasma. Electromagnetic
energy absorption via elastic and inelastic collisions.
Dc, rf, and microwave discharges.

**863.      Analysis of Stochastic Systems**
       *Fall. 3(3-0)*
*P: STT 441.*
Advanced topics in random variable theory. Stochastic
processes and stochastic calculus. Optimal systems for
filtering and detection.

**866.      Digital Signal Processing**
       *Spring. 3(3-0) Interdepartmental with Com-
puter Science.
P: EE 466, EE 863.*
Review of elementary DSP concepts. Transform algo-
rithms. Filter design and implementation. Adaptive
filters. Spectrum estimation. Applications.

**874.      Physical Electronics**
       *Fall. 3(3-0)*
Applications of quantum mechanics and statistical me-
chanics in solids. Band theory of semiconductors. Elec-
trical transport phenomena. Pn junctions.

**875.      Electronic Devices**
       *Spring. 3(3-0)*
*P: EE 874.*
Operating properties of semiconductor devices includ-
ing DC, AC, transient and noise models of FET, BJT,
metal-semiconductor contact, heterostructure, micro-
wave and photonic devices.

**885.      Artificial Neural Networks**
       *Fall. 3(3-0) Interdepartmental with Computer
Science.*
Overview of neuro-engineering technology. Basic neu-
ral network architectures. Feedforward and feedback
networks. Temporal modeling. Supervised and unsu-
pervised learning. Implementation. Basic applications
to pattern recognition.

**899.      Master's Thesis Research**
       *Fall, Spring, Summer. 1 to 8 credits. A student
may earn a maximum of 24 credits in all enrollments
for this course.*

**920.      Selected Topics in High Performance
       Computer Systems**
       *Spring. 3(3-0) A student may earn a maximum
of 9 credits in all enrollments for this course. Interde-
partmental with Computer Science. Administered by
Computer Science.
P: CPS 822. R: Open only to Computer Science or
Electrical Engineering majors.*
Design of high performance computer systems. Semi-
nar format.

*921.* **Advanced Topics in Digital Circuits and Systems (MTC)**
*Fall, Spring. 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this course. Interdepartmental with Computer Science.*
Topics vary each semester. Topics such as testable and fault-tolerant digital systems, embedded architectures.

*925.* **Advanced Topics in Power (MTC)**
*Spring. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course.*
Topics vary each semester. Topics such as advanced stability and control of power systems, power system planning, or advanced machine drives.

*929.* **Advanced Topics in Electromagnetics (MTC)**
*Fall, Spring. 3 to 4 credits. A student may earn a maximum of 10 credits in all enrollments for this course.*
Topics vary each semester. Topics such as planar waveguides and circuits, antenna theory, geometrical theory of diffraction.

*931.* **Advanced Topics in Electronic Devices and Materials (MTC)**
*Fall, Spring. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course.*
Topics vary each semester. Topics such as VLSI technology, microdevices and microstructures, properties of semiconductors.

*932.* **Advanced Topics in Analog Circuits (MTC)**
*Spring of odd-numbered years. 3(3-0) A student may earn a maximum of 3 credits in all enrollments for this course.*
Topics vary each semester. Topics such as advanced circuit analysis.

*960.* **Advanced Topics in Control (MTC)**
*Fall. 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this course.*
Topics vary each semester. Topics such as adaptive control, or nonlinear control.

*963.* **Advanced Topics in Systems (MTC)**
*Fall, Spring. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course.*
Topics vary each semester. Topics such as system identification and adaptive filtering, robot dynamics and control, or learning in artificial neural networks.

*966.* **Advanced Topics in Signal Processing (MTC)**
*Fall, Spring. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course.*
Topics vary each semester. Topics such as discrete time processing of speech signals, multidimensional signal processing, or detection and estimation theory.

*989.* **Advanced Topics in Plasma (MTC)**
*Fall of odd-numbered years. 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this course.*
Topics vary each semester. Topics such as plasma processing for IC fabrication, plasma diagnostic techniques.

*999.* **Doctoral Dissertation Research**
*Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 72 credits in all enrollments for this course.*

# ENGINEERING EGR

## College of Engineering

*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.

*200.* **Technology, Society and Public Policy**
*Fall. 2(2-0)*
*P: 2 courses in mathematics or engineering or science. R: Not open to freshmen.*
Description and analysis of certain technologies and their consequences. Development of techniques for assessing consequences as an aid to formulation of public policy.

*290.* **Independent Study**
*Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 4 credits in all enrollments for this course.*
*R: Students in College of Engineering, approval of department.*
Independent undergraduate research in engineering.

*291.* **Selected Topics**
*Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 4 credits in all enrollments for this course.*
*R: Open only to freshmen, sophomores.*
Experimental course development or special topics appropriate for freshmen and sophomores.

*393.* **Engineering Cooperative Education**
*Fall, Spring, Summer. 1(1-0) A student may earn a maximum of 6 credits in all enrollments for this course.*
*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.

*400.* **Special Problems in International Engineering**
*Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 6 credits in all enrollments for this course.*
*R: Open only to juniors, seniors, and graduate students in the College of Engineering.*
Supervised study of selected topics in engineering using laboratories, equipment , and engineering design techniques. Given at various international universities and institutes.

*475.* **Special Topics in International Engineering**
*Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 6 credits in all enrollments for this course.*
*R: Open only to juniors, seniors, and graduate students in the College of Engineering.*
Topics selected to supplement regular courses. Given at various international universities and institutes.

# ENGLISH ENG

## Department of English
## College of Arts and Letters

*090A.* **Intensive English for Non-Native Speakers**
*Fall, Spring. 0 credit. [12(20-0) See page A-2, item 3.]*
*R: Approval of English Language Center.*
Explanation and intensive practice of English skills. Focus on beginning grammar, speaking, listening, reading, and writing.

*090B.* **Intensive English for Non-Native Speakers**
*Fall, Spring. 0 credit. [12(20-0) See page A-2, item 3.]*
*R: Approval of English Language Center.*
Explanation and intensive practice of English skills. Focus on intermediate grammar, speaking, listening, reading, and writing.

*090C.* **Intensive English for Non-Native Speakers**
*Fall, Spring. 0 credit. [12(20-0) See page A-2, item 3.]*
*R: Approval of English Language Center.*
Explanation and intensive practice of English skills. Focus on advanced grammar, speaking, listening, reading, and writing.

*091.* **English Structure for Non-Native Speakers**
*Fall, Spring. 0 credit. [3(3-0) See page A-2, item 3.]*
*R: Approval of English Language Center.*
Explanation and practice of advanced grammatical structures of English in relation to written communication. Emphasis on editing skills.

*092.* **Academic Oral Skills for Non-Native Speakers of English**
*Fall, Spring. 0 credit. [3(3-0) See page A-2, item 3.]*
*R: Approval of English Language Center.*
Intensive speaking and listening practice of spoken academic English. Lecture-listening and note-taking strategies. Oral communication skills improved through discussions and classroom presentations.

*093.* **Academic Reading and Writing Skills for Non-Native Speakers of English**
*Fall, Spring. 0 credit. [6(6-0) See page A-2, item 3.]*
*R: Approval of English Language Center.*
Integrative reading and writing strategies for academic purposes. Vocabulary development, intensive and extensive reading, and critical reading skills. Academic writing style and editing strategies.

*094.* **Academic Reading Skills for Non-Native Speakers of English**
*Fall, Spring. 0 credit. [3(3-0) See page A-2, item 3.]*
*R: Approval of English Language Center.*
Intensive and extensive reading skills. Vocabulary development, pre-reading strategies, reading for comprehension, and critical reading skills.

*095.* **Academic Writing Skills for Non-Native Speakers of English**
*Fall, Spring. 0 credit. [3(3-0) See page A-2, item 3.]*
*R: Approval of English Language Center.*
Writing, editing, and revision of journals, essays and research papers.