Electrical Engineering
and
Engineering Physics

Undergraduate Advising Handbook

Department of Electrical Engineering
College of Engineering and Computer Science
Wright State University
311 RC (937) 775-5037

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1. PURPOSE

The purpose of the Department of Electrical Engineering Undergraduate Handbook is to provide electrical engineering (EE) and engineering physics (EP) students and faculty advisors with answers to questions that frequently arise during the advising process, The book is to be used to complement the Undergraduate Catalog, quarterly Class Schedule (newsprint) and EE or EP Program Guides. Information on courses offered or scheduled for coming quarters sometimes changes following departmental action. Accordingly, students should always refer to the latest scheduling information in the Class Schedule when updating plans. Once in a while, a required course is replaced by an updated course in the newer program guides. Students should anticipate that changes will occur and gather information from the most current publications. Copies of the most recent version of the Handbook may be obtained from the department office.

2. COLLEGE OF ENGINEERING AND COMPUTER SCIENCE

2.1 DEPARTMENTS AND DEGREE PROGRAMS

The College of Engineering and Computer Science offers eight undergraduate baccalaureate degree programs. Each department administers two of these eight as listed below:

Department of Biomedical, Industrial and Human Factors Engineering
207 Russ Center (EMS) 937-775-5044
B.S. degrees in Biomedical Engineering & Industrial & Systems Engineering

Department of Computer Science and Engineering
303 Russ Center 937-775-5131
B.S. degrees in Computer Science & Computer Engineering

Department of Electrical Engineering
311 Russ Center 937-775-5037
B.S. degrees in Electrical Engineering & Engineering Physics

Department of Mechanical and Materials Engineering
209 Russ Center 937-775-5040
B.S. degrees in Mechanical Engineering & Materials Science & Engineering

The undergraduate engineering degree programs are accredited by the Accreditation Board for Engineering and Technology (ABET), Inc. The college also offers graduate programs in each listed discipline.

2.2 OTHER OFFICES

Office of the Dean	405 Russ Center	
	Phone: 937-775-5001	Fax: 937-775-5009
Department of Physics	248 Fawcett	
	Phone: 937-775-2954	Fax: 937-775-3301
Office of Admissions	E148 Student Union	
	Phone: 937-775-5700	Fax: 937-775-5795
Office of the Registrar	E244 Student Union	
	Phone: 937-775-5588	Fax: 937-775-5795

2.3 COLLEGE POLICIES AND PROCEDURES

2.3.1 Admission to an Engineering Major

Students must complete 45 quarter credits of college level work; complete specific core courses, depending on their major, with C's or better in each course; and, have a cumulative GPA of at least 2.25 at WSU and in all academic work. (Policy #1010)

2.3.2 Transfer Students

Students must meet same criteria as above. Transfer credit for 100 and 200 level courses will be accepted from U.S. accredited colleges and universities. Transfer credit for 300 and higher level engineering courses will be accepted only from U.S. colleges and universities offering four-year ABET accredited engineering programs. (Policy #1010)

2.3.3 General Education Requirements

Students must complete general education requirements as outlined in the university catalog. Students will follow the gen ed program in effect at the time they are admitted to WSU as a degree-seeking student.

2.3.4 Course Prerequisites

Students may be denied admission to, or withdrawn from, any course for which the prerequisites have not been met. (Policy #1010)

2.3.5 Permission of the Instructor

Students who do not have the prerequisites for a course may petition the department for permission to enroll in the course. The petition must be presented to the department not less than 14 days before the first day of the course. (Policy #1015)

2.3.6 Academic Honesty

The college will always impose the most severe penalty possible for academic dishonesty and permanently dismiss students found guilty of two acts of dishonesty. Students are asked to sign an Academic Honesty Policy Form. (Policies #1010 and #1011)

2.3.7 Withdrawal Policy

Students who receive three or more W's in the last four quarters for courses taught by the college must receive signatures from their advisor and the department chair before they may register for classes. A complete withdrawal from all classes for any one quarter counts as a single W. (Policy #1020)

2.3.8 Transfer Between Majors in the College

Prior to transfer, students must have a cumulative GPA of 2.00 for all courses taken in the college, and must meet core requirements for admission to the college. Students must complete an Undergraduate Transfer Application. (Procedure #5030)

2.3.9 Proficiency Examination Procedures

Students may request a proficiency examination in any course offered by the college. An appropriate faculty member will decide

whether a proficiency exam is appropriate based on the student's experience and/or knowledge. No more than one proficiency exam will be permitted in any course and a student who has failed to satisfactorily complete a course will not be given an exam in that course. (Procedure #5040)

2.3.10 Probation

Students are placed on academic probation when their GPA drops below 2.00. Students on probation must see an advisor to register for classes. (Policy #1010, Procedure #5010, Univ Catalog)

2.3.11 Dismissal from the University

Students may be dismissed if they remain on academic probation for more than two quarters. Students who are dismissed are not permitted to enroll for any courses for a full calendar year (four consecutive quarters including summer quarter). (Policy #1010, Procedure #5010, Univ Catalog)

2.3.12 Continuing Students

Continuing students are defined as students who do not have a period of four consecutive quarters during which they are not enrolled at WSU and may meet university graduation requirements that were in effect (or subsequent) when they entered the university. Non-continuing students must meet university requirements in effect when they are readmitted. Students must meet degree program requirements in effect when they are admitted to a department. Departments may revise a student's requirements if the student has not completed the program in seven years. (Univ Catalog)

2.3.13 Student Classification

Undergraduate students are classified by the total number of credit hours earned at WSU plus transfer hours. Freshman = 0-44.9; Sophomore = 45-89.9; Junior = 90-134.9; Senior = 135. This classification is independent of the student's position in the degree program. For example, a student may have a hundred or more hours of credit, but be a freshman in the degree program in terms of completing the required courses listed on the program guide. Students use the university classification system for enrollment in classes at the beginning of each quarter, i.e. Seniors first followed by Juniors, etc. (Univ Catalog)

2.3.14 Repeating Courses

Students may repeat any course in which they earned a grade of D, F, or X if the course was taken as part of the first 45 hours earned (including transfer hours). The course may be repeated until a grade of C is achieved. Only the last attempt for each course will be counted in the cumulative grade point average as long as it is completed no later than the quarter in which the first 60 credit hours are earned. However, each grade received will become a part of the permanent record. After the first 45 hours (including transfer hours), students may repeat any course in which they have earned a grade of D, F, or X, but each grade will be counted as part of the cumulative GPA. (Univ Catalog)

2.3.15 Auditing Courses

If class space permits, students may audit a course with written approval from the instructor before enrolling in the class. Students may not change from audit to credit or from credit to audit after the first week of class. (Univ Catalog)

2.3.16 Dean's List

Students who attain a 3.40 or higher GPA for at least 12 hours of graded classes (pass/unsatisfactory classes do not apply) during a quarter are placed on the Dean's List. These students receive a special card of congratulations from the dean and their department chair. (Univ Catalog).

2.3.17 Graduation Requirements

To be eligible for the BS degree, students must:

1. complete all of the requirements in one of the college's degree programs.
2. fulfill the university's general education requirements.
3. complete the residency requirement of 45 credit hours at Wright State University, 30 of which must be earned in courses numbered 300 or above. At least 15 of the last 45 hours of the degree must be taken in residence.
4. complete all academic work with at least a 2.0 cumulative grade point average and at least a 2.0 cumulative grade point average in all engineering and computer science courses taken at Wright State University.

Students should meet with their academic advisor before their last quarter to be sure they will complete all requirements for graduation (Univ Catalog).

2.3.18 Second Bachelor's Degree

Students must earn at least 45 credit hours beyond the minimum requirements for the first degree. At least the last 45 credit hours of coursework are to be taken at WSU, 23 of which must be in courses numbered 300 or above. Students must complete at least 45 credit hours, none of which may be applied toward the first degree. (Procedure #5020, Univ Catalog)

3. ELECTRICAL ENGINEERING DEPARTMENT

3.1 DEPARTMENT DIRECTORY

3.1.1 Office of the Chair 311 RC Ph: 937-775-5037 / Fax: 937-775-3936

Dr. Kefu Xue	Chair
Barry Woods	Assistant to the Chair
Vickie Slone	Administrative Specialist
Tony Tritschler	Laboratory Services Coordinator

3.1.2 Faculty

Henry Chen, Professor, Ph.D., Minnesota, 1989. Research interests include: very large scale integrated circuit design, built-in self-test design, test generation and scheduling, reduced instruction set computer architecture and fault tolerant computing.
325 RC; 775-5056; henry.chen@wright.edu.

Kuan-Lun Chu, Assistant Professor, Ph.D., University of Illinois at Urbana-Champaign, 2007. Research interests include: micro fuel cells, alternative energy systems and micro-electro-mechanical systems.
338 RC, 775-4491, kuan-lun.chu@wright.edu

John Emmert (Marty), Associate Professor, Ph.D., University of Cincinnati, 1999. Research interests include: physical design automation for VLSI, VLSI systems, physical VLSI design, reconfigurable systems, digital CD, VHSIC hardware description language (VHDL), verilog, digital design, VLSI interconnections, analog integrated circuit design, signal processing, digital control systems.
415 RC, 775-5023, marty.emmert@wright.edu.

Fred Garber, Associate Professor, Ph.D., Illinois, 1983. Research interests include: communication systems, target recognition, information theory, and pattern theory.
312 RC; 775-5033; fred.garber@wright.edu.

Russell Hannen, Associate Professor Emeritus, Ph.D., Ohio State, 1960. Research interests include: electric car technology.
022 RC, 775-5183.

Lang Hong, Professor, Ph.D., Tennessee, 1989. Research interests include: computer vision, image processing and pattern recognition, robotic sensing and control, multisensor systems, stochastic systems, system modeling and estimation, and multitarget tracking.
329 RC; 775-5053; lang.hong@wright.edu.

Marian Kazimierczuk, Professor, Ph.D., Warsaw Technical, 1978. Research interests include: radio frequency and power electronics, semiconductor device modeling, circuit theory and computer-aided design.
418 RC, 775-5059; marian.kazimierczuk@wright.edu.

Pradeep Misra, Associate Professor, Ph.D., Concordia, 1987. Research interests include: multivariable control theory, robotics and applied numerical analysis.
424 RC, 775-5062; pmisra@cs.wright.edu.

Kuldip Rattan, Professor, Ph.D., Kentucky, 1975. Research interests include: control theory, robotics, microprocessor applications and bioengineering.
108 RC, 775-5052; kuldip.rattan@wright.edu.

Saiyu Ren, Assistant Professor, Ph.D., Wright State University, 2008. Research interests include: RF and mixed signal integrated circuit design with applications to wireless transceivers, communications and signal processing.
328 RC, 775-5051, saiyu.ren@wright.edu.

Brian Rigling, Associate Professor, Ph.D., Ohio State University, 2003. Research interests include: sensors, signal processing, communications, and synthetic aperature radar.
313 RC, 775-5100, brian.rigling@wright.edu.

Arnab Shaw, Professor, Ph.D., Rhode Island, 1987. Research interests include: estimation theory, spectrum estimation and neural network based speech processing.
427 RC, 775-5064; arnab.shaw@wright.edu.

Raymond Siferd, Professor Emeritus, Ph.D., Air Force Institute of Technology, 1977. Research interests include: very large scale integrated circuit design, signal processing and analog integrated circuit design.
324 RC, 775-5058; ray.siferd@wright.edu.

Zhiqiang Wu, Associate Professor, Ph.D., Colorado State University, 2002. Research interests include: 3G cellular, CDMA systems, multicarrier architectures, and frequency domain processing.
335 RC, 775-5060; zhiqiang.wu@wright.edu.

Kefu Xue, Associate Professor and Chair, Ph.D., Pennsylvania State, 1987. Research interests include: digital image processing, computer vision and special purpose architecture for signal processing.
425 RC, 775-5037; kefu.xue@wright.edu.

Xiaodong Zhang, Assistant Professor, Ph.D., University of Cincinnati, 2001. Research interests include: intelligent control, integrated health management. Distributed and cooperative control and smart adaptive systems.
335 RC, 775-4463**,** xiaodong.zhang@wright.edu.

Yan Zhuang, Assistant Professor, Ph.D., Johannes Kepler University Linz, Austria, 2000. Research interests include: RF/microwave technology, magnetic materials, nano-composite materials, high speed si-based electronics, MEMs/NEMs, micro aerial vehicle, sensors.
421 RC, 775-4556, yan.zhuang@wright.edu.

3.2 FACILITIES

The Department of Electrical Engineering maintains eight instructional laboratories. They include a circuits laboratory, three electronics laboratories, a communication systems laboratory, two control systems laboratories, a very large scale integrated (VLSI) circuits laboratory and a robotics / digital control systems laboratory. In addition, there are seven research laboratories equipped to meet ongoing needs. They include laboratories for research in

digital signal and image processing, microwaves, power electronics, communication systems, robotics and VLSI circuits.

Students have access to a wide range of computer systems in the Russ Engineering Center interconnected by local and wide-area networks. In addition, students may use the computing facilities in the University Computing Center (UCC) that include banks of personal computing machines. The UCC also includes terminals to access mainframes for larger scale applications.

4. ELECTRICAL ENGINEERING PROGRAM

4.1 PROGRAM OBJECTIVES AND ACCREDITATION

The Bachelor of Science degree program in Electrical Engineering (EE) at Wright State University is accredited by ABET Engineering Accreditation Commission.

The program educational objectives for the EE program, in support of the missions of the University and College, are to produce engineers who

- can identify and solve engineering problems using current electrical engineering techniques and practices, drawing on a strong foundation in mathematics, science, and engineering.
- will have rewarding careers as engineering professionals designing, developing, and improving products or services.
- will be successful in career development and professional growth through graduate school, industrial training, workshops, professional conferences, or continuing education.
- can effectively collaborate and communicate with colleagues and clients; will engage in multidisciplinary teamwork and exercise leadership that address issues in an ethical and responsible manner.

4.2 PROGRAM GUIDE

Each year, the faculty evaluates the electrical engineering curriculum to ensure its currency and relevance. Upon completing that review, an updated program guide is published. That guide includes courses required to complete the program and the recommended pattern for taking the courses. The Program Calendar, reflecting a model course sequence, is included as Attachment I. A description of each EE course appears in Section 4.12.

Upon admission to the Department of Electrical Engineering, each student is provided a current program guide. Prior credits accepted toward the degree are annotated on the guide and the student is assigned a faculty advisor. Because the curriculum and graduation requirements sometimes change, it is important that students meet with their advisor or the Assistant Chair periodically to review progress.

Students normally follow the program guide they are provided when admitted to the department. However, a student may choose to follow a more current guide, but may not choose to follow an older guide. A student following a guide more than seven years old may be required to take additional courses to ensure currency and competency at graduation. If a student transfers from one major to another, that student will normally be placed on a program guide that is current in the transfer quarter.

4.3 GENERAL EDUCATION REQUIREMENT

As one of the Wright State baccalaureate degree requirements, each student must complete the General Education requirement outlined in the University Catalog. MTH 229 and 230 meet the mathematical skills requirement and PHY 240, 242, 244 and their associated laboratory courses meet the natural sciences requirement.

4.4 WRITING ACROSS THE CURRICULUM

Students admitted Fall quarter 1996 and thereafter need to complete eight courses classified as writing intensive as a degree requirement. Four of these must be from the general education area, and two must be from the major. Transfer students should contact their advisor for writing intensive requirements.

4.5 PREREQUISITE COURSES

Prerequisite courses are those required for completion prior to attempting a following related course. Students must earn a passing grade in prerequisite courses before attending the following related course. This policy is important because the faculty has carefully structured the curriculum so that courses build upon one another. Students who have not met the prerequisite may be dropped from the course at the instructor's discretion.

4.6 TECHNICAL ELECTIVES

These electives are defined as any course numbered 200 and above in the Colleges of Engineering and Computer Science, Science and Mathematics or Business and Administration and approved by the student's advisor. CS 205, CS 206 and redundant courses such as MTH 200, 228 and 300, MS 204, EE 401, EE 402 and courses co-listed with EE courses may not be used as technical electives.

4.7 ENGINEERING ELECTIVES

These engineering electives are defined as any course numbered 300 or higher in the College of Engineering and Computer Science and approved by the student's advisor. At least one design sequence, as set forth in the Program Guide, must be completed. 20 credit hours of the Engineering Electives must have an EE prefix.

4.8 ALTERNATE COURSES

The following alternate course selections may be substituted for the stated program requirement:

Requirement	Optional Substitution	
CEG 221	ME 315	
STT 363	EE 326	
Fine Arts or Great Books	UH 201	(for students in the University Honors Program)
SOC 200 or PLS 200 or	UH 202	(for students in the University Honors Program)

4.9 COMPUTER SCIENCE MINOR

Students may earn a minor in Computer Science for Engineers and Scientists by completing CEG 220, 221 and 242, CEG 233, CS 400 and one of CEG 433, 460 or CS 405.

4.10 ABET DESIGN CREDIT CONTENT

Engineering design is emphasized in courses marked with a "D" in the design (D) column of the Program Guide. Design course sequences integrate the elements of design and provide a major design experience culminating in a Senior Project “capstone” course.

4.11 HONORS PROGRAMS

The EE Department recognizes students of superior quality and motivation by encouraging participation in honors programs. These programs provide students opportunities to develop interests and skills by taking course work more challenging than the regular curriculum.

There are three kinds of honors programs available for EE majors. They are as follows:

1. "With Honors in Electrical Engineering" (departmental honors)
2. "General Studies Honors"
3. "University Honors".

The undergraduate catalog describes the General Studies Honors and University Honors programs further. For specific questions, contact the Honors Department (243 Millett Hall) at 775-2660.

4.12 UNDERGRADUATE COURSE DESCRIPTIONS

160-4 ..... Digital Design with HDL
Introduction to combinational and synchronous sequential digital system design and optimization. Hardware description language (HDL) with CAD tools are used for design and simulation in a field programmable gate array (FPGA) based lab.

301-4 ..... Circuit Analysis I
Basic elements and laws, circuit analysis techniques and concepts, energy storage elements, first and second order circuits, sinusoidal steady-state analysis. Prerequisites: MTH 233, PHY 242; Corequisite or Postrequisite: EE 302.

302-1 ..... Circuit Analysis I Laboratory
Computer assisted analysis, RLC circuits, operational amplifiers and circuits, Thevenin and Norton equivalents, maximum power transfer, AC networks. Prerequisite or Corequisite: EE 301.

303-3 ..... Circuit Analysis II
Circuit review, alternating current concepts, computer aided circuit analysis, two-port networks, power. Prerequisites: EE 301 and EE 302; Corequisite or Postrequisite: EE 304.

304-1 ..... Circuit Analysis II Laboratory
Application of AC concepts, computer aided circuit analysis, two-port networks and power theory. Prerequisite: EE 301 and 302; Prerequisite or Corequisite: EE 303.

321-4 ..... Linear Systems I
Considers systems in a broad context including linear, nonlinear; variant, invariant; and analog and discrete. Various approaches to system and signal modeling are also discussed with emphasis on the Fourier transform technique. Prerequisite: EE 301 and 302.

322-4 ..... Linear Systems II
Discrete time signals and systems, the z-transform, input/output theory and discrete Fourier transform, IIR and FIR filter design, relationships, sampling. Prerequisite: EE 321.

325-4 ..... Numerical Methods for Engineers
Root location, polynomial interpolation, numerical methods for linear systems analysis, matrix methods in circuit analysis, frequency domain circuit analysis techniques. Prerequisites: EE 321, MTH 253 and CEG 220 (or proficiency in Pascal or FORTRAN).

326-4 ..... Random Signals and Noise
Provides a practical introduction to the concepts of random events, characterization of stochastic signals, first and second order moment descriptions of random processes and input/output descriptions of random signals and noise in linear systems. Prerequisites: EE 321.

331-3 ..... Electronic Devices
Introduction to basic solid-state electron devices. Fundamentals necessary for comprehension and further study of modern engineering electronics. Major topics include carrier flow in semiconductors, p-n theory, semiconductor diodes, bipolar junction transistors, field effect transistors, biasing and introduction to amplifiers. Prerequisites: EE 301 and 302; Corequisite: EE 332.

332-1 ..... Electronic Devices Laboratory
Applications of diodes and transistors in analog circuits, design of bias circuits. Prerequisites: EE 301 and 302; Corequisite: EE 331.

345-4 ..... Electromagnetics
Electrostatics and magnetics; induced electromotive force. Maxwell's equations and their physical interpretation and application. Prerequisite: EE 301, MTH 232.

410-4 ..... Introduction to MEMS
This course covers the history, design and fabrication of micro-electro-mechanical systems (MEMS), and the basic operating theory of selected MEMS transducers. Typical fabrication methods covered include surface micromachining, bulk micromachining and micromolding.

412-4 ..... Industrial Controls and Automation
For each student to gain a working knowledge of industrial controls and automation. Focus is on developing an understanding of wiring diagram creation, hardware section and programmable logic controller design and operation; includes laboratory. Prerequisites: EE/CEG 260 or EE 401 and 402.

413-3 ..... Control Systems I

This is an introductory course providing students with a general control background. Major topics include block diagrams and signal-flow graphs, electromechanical modeling including state variable representation, time response, root locus and introduction to design. Prerequisites: ME 213 and EE 321; Corequisite or Postrequisite: EE 414.

414-1 .....Control Systems I Laboratory
Application and testing of control systems theory with electromechanical systems. Prerequisite or Corequisite: EE 413.

415-3 ..... Control Systems II
Using Control Systems I background, this course concentrates on controller design in both the time and frequency domains, using Nyquist, Bode, root locus and state variable techniques. Digital control concepts are introduced. Prerequisites: EE 322, 413 and 414; Corequisite or Postrequisite: EE 416.

416-1 .....Control Systems II Laboratory
Application and testing of control systems theory with electromechanical systems. Prerequisite: EE 413 and 414; Prerequisite or corequisite: EE 415.

417-3 ..... Digital Control Systems
Sampled spectra and aliasing, analysis and design of digital control systems using root locus and transform techniques; discrete equivalents of continuous controller and quantization effects; introduction to programmable logic controllers. Prerequisites: EE 322 and EE 415.

419-4 ..... Introduction to Intelligent Control Systems
Foundations and philosophy of fuzzy logic and applications to control theory. Relationship between classical PID control and fuzzy rule-based control. Techniques for rule construction and adaptive fuzzy logic controllers. Case studies of fuzzy logic control applications; 3 hours lecture and 2 hours lab. Prerequisites: EE 413 and 414.

420-1 .....Digital Control Systems Laboratory
Sampling, temperature control, position control on a microprocessor-based system, PLC implementation, quantization error computational delay, frequency response. Prerequisites: CEG 411 and EE 416, Corequisite: EE 417.

421-4 .....Communication Theory
Analysis of linear systems by the Fourier transform and time convolution integral methods. Introduction to information theory. Comparative evaluation of various analog and pulse modulation techniques. Selected topics from radar theory and electro-optics as well as an introduction to random process theory. Prerequisite: EE 321.

431-3 ..... Electronic Circuits
Theory and application of basic engineering electronics developed for discrete and integrated circuits. Topics included bipolar and field effect transistor amplifier analysis and design, frequency response, multistage and feedback amplifiers. Prerequisites: EE 321, 331 and 332; Corequisites: EE 302, 304 and 432.

432-1 .....Electronic Circuits Laboratory
Design of single and multiple stage amplifier circuits, feedback amplifiers, circuits to meet frequency response specifications and output stages. Prerequisites: EE 331 and EE 332; Corequisite: EE 431.

436-4 ..... Digital Signal Processing
Introduction to the principles and applications of digital signal processing (DSP) from the design and implementation perspective. Major topics include analog-to-digital/digital-to-analog converters and digital filters, Fourier analysis algorithms and real-time applications all implemented on a TMS320C30 floating point DSP chip. Prerequisites: EE 322 and CEG 220 or CS 240.

437-4 ..... Modern Signal Processing
Introduction to advanced digital signal processing design concepts. Focus on time and frequency domain algorithms. Methods include multi-rate signal processing. Filter banks, time-frequency analysis and wavelets. Examples taken from audio signal processing. Prerequisite: EE 322.

440-4 ..... Introduction to Nanoscience and Nanotechnology
Introduction to nanoscience and technology. Topics include introduction to quantum mechanics fabrication, characterization, materials, electronic properties, optical properties, magnetic properties, devices, MEMS and NEMS. Prerequisites: PHY 240, PHY 242 and PHY 244.

442-4 ..... Transmission Lines, Waveguides & Radiating Systems
Plane waves in free space and matter. Transmission line equations and application of Smith chart. Wave propagation in rectangular waveguides. Introduction to radiating systems including dipole and loop antennas. Rudimentary design of typical systems containing transmission lines, waveguides, and antennas. Prerequisite: EE 345.

444-4 .....Linear Integrated Circuits
Theory and applications of linear integrated circuits. Topics include ideal and real operational amplifiers, frequency response and compensation, active filters, comparators and waveform generators; 3 hours lecture, 2 hours laboratory. Prerequisites: EE 431 and 432.

446-4 ..... Microwave Circuit Design
Review of Smith chart, introduction to microstrip lines, impedance matching, power gain equations, stability considerations, design methods for amplifiers and oscillators. CAD is used. Prerequisite: EE 346.

447-4 .....Antenna Theory and Design
Linear dipole antennas, antenna arrays, thin-wire antennas, moment method analysis examples (vee dipole, folded dipole, etc), broadband and frequency-independent antennas. Computer-aided design and analysis of wire antennas, feed networks and antenna arrays using antenna CAD software. Prerequisite: EE 346.

451-4 ..... Digital Systems Design
(Listed jointly with CEG 360) Design of digital systems. Topics include digital arithmetic, systems. Topics include digital arithmetic, register-level design, memory devices and their logic, and controller and processor design; 3 hours lecture, 2 hours lab. Prerequisite: EE 260.

454-4 ..... VLSI Design
(Listed jointly with CEG 454) Introduction to VLSI system design. Topics include CMOS devices and circuit design techniques, basic building blocks for CMOS de-

sign, fabrication processing and design rules, chip planning and layout, system timing and power dissipation, simulation for VLSI design, and signal processing with VLSI; 3 hours lecture, 2 hours laboratory. Prerequisites: EE 431, EE 432 and EE 451.

456-4 ..... Introduction to Robotics
(Listed jointly with CEG 456, ME 456) An introduction to the mathematics, programming, and control of robots. Topics include coordinate systems and transformations, manipulator kinematics and inverse kinematics, trajectory planning, Jacobians and control. Prerequisite: Senior standing and MTH 253; proficiency in Pascal, C or FORTRAN programming.

459-4 ..... Integrated Circuit Design Synthesis with VHDL
Application of VHSIC hardware description language (VHDL) to the design, analysis multi-level simulation and synthesis of digital integrated circuits. A commercial set of CAD tools (Mentor Graphics) will be used in the laboratory portion of the course. Prerequisites: CEG 220 (C programming or equivalent) and EE/CEG 260.

462-4 .....Digital Integrated Circuit Design with PLDs & FPGAs
Design and application of digital integrated circuits using programmable logic devices (PLDs) and field programmable gate arrays (FPGAs). A commercial set of CAD tools (Mentor Graphics and Xilinx) will be used in the laboratory portion of the course. Prerequisite: EE 451/CEG 360.

470-4 ..... Introduction to Sensors
The course offers an overview of basic sensor technology to provide the engineering student with practical working knowledge of sensors. Course will include basic operating principles, basic electronics and measurement principles. Prerequisites: EE 303 and PHY 315.

473-4 ..... Communication Systems Design
Concepts and techniques of probability theory are reviewed and extended to random process and information theory. Baseband digital PCM technique, selected digital RF modems and introduction to communication networks are presented. Prerequisites: EE 421 and STT 363.

475-4 .....Introduction to Radar Systems
Study of the radar equation, antenna patterns, target cross sections and system losses, radar measurements, pulse Doppler and coherent techniques, detection probability and signal-to-noise ratio, side lobe clutter, synthetic arrays, and pulse compression techniques. Prerequisite: EE 322.

476-4 ..... Wireless Communication II
This course introduces advanced wireless communication techniques. Topics include: spreading spectrum technology and CDMA, multi-user detection and interference cancellation, multi-carrier transmission and ultra-wideband transmission technology, cognitive radio and dynamic spectrum access. Prerequisite: EE 473 and EE 474.

478-3 .....Coding Theory
Introduction to the essentials of error-correcting codes, the study of methods for efficient and accurate transfer of information. Topics to be covered include basic concepts, perfect and related codes, cyclic codes, and BCH codes. Prerequisite: MTH 253 or MTH 355 (or equivalent). Colisted as MTH 456 and CEG 478**.**

499 Special Problems in Engineering
1 to 4. Special problems in engineering design. Independent study project under the guidance of a faculty member. Topics vary. Prerequisite: At least a 3.00 GPA.

5. ENGINEERING PHYSICS PROGRAM

5.1 PROGRAM OBJECTIVES AND ACCREDITATION

The Bachelor of Science degree program in Engineering Physics (EP) at Wright State University is accredited by ABET Engineering Accreditation Commission.

The program educational objectives for the EP program, in support of the missions of the University and College, are to produce engineers who

- can identify and solve engineering and scientific research problems using current engineering physics techniques and practices, drawing on strong foundation in mathematics, science, and engineering.
- will have rewarding careers as engineering research professionals designing, developing, and improving products or services.
- will be successful in career development and professional growth through graduate school, industrial training, workshops, professional conferences, or continuing education.
- can effectively collaborate and communicate with colleagues and clients; will engage in multidisciplinary teamwork and exercise leadership that address issues in an ethical and responsible manner.

5.2 PROGRAM GUIDE

Each year, the Engineering Physics Program Committee evaluates the engineering physics curriculum to ensure its currency and relevance. Upon completing that review, an updated program guide is published. That guide includes the courses required to complete the program and the recommended pattern for taking the courses. The EP Program Calendar, reflecting a model course sequence, is included as Attachment II. A description of each physics and engineering physics course referenced in the EP Guide is found in Section 5.11.

Upon admission to the Department of Electrical Engineering, each student is assigned an appropriate program guide. Credits acceptable toward the degree are annotated on the guide and the student is assigned a faculty advisor. The annotated guide is updated by the faculty advisor as additional courses are completed and becomes the basis for certifying that graduation requirements are completed. Because the curriculum and graduation requirements sometimes change, it is important that students meet with their advisor periodically to review progress.

Students normally follow the program guide they are provided when admitted to the department. A student may also choose to follow a more current guide. A student may not choose to follow an older guide. A student following a guide more than seven years old may be required to take additional courses to ensure currency and competency at graduation. If a student transfers from

one major to another, that student will be placed on a program guide that is current in the transfer quarter.

5.3 GENERAL EDUCATION REQUIREMENT

As one of the Wright State baccalaureate degree requirements, each student must complete an array of courses under the General Education requirement outlined in the University Catalog. The array is tailored to meet the needs of the engineering student. The results of that tailoring are included in the EP Program Guide discussed above. Specifically, MTH 229 and 230 meet the mathematical skills requirement and PHY 240, 242, 244 and their related laboratory courses meet the natural sciences requirement.

5.4 WRITING ACROSS THE CURRICULUM

Students admitted Fall quarter 1996 and thereafter need to complete eight courses classified as writing intensive as a degree requirement. Four of these must be from the general education area, and two must be from the major. Transfer students should contact their advisor for writing intensive requirements.

5.5 PREREQUISITE COURSES

Prerequisite courses are those required for completion prior to attempting a following related course. Students must earn a passing grade in all prerequisite courses before attending the following related course. This policy is important because the faculty has carefully structured the curriculum so that courses build on one another. Students who register for a class without the proper prerequisites may be dropped from the course at the discretion of the instructor or department.

5.6 TECHNICAL ELECTIVE REQUIREMENT

A minimum of 28 credit hours is required. Any course numbered 200 or higher offered by the Colleges of Engineering and Computer Science, Science and Mathematics or Business and Administration and approved by the faculty advisor may serve as a technical elective. Redundant courses such as MS 201, MTH 228, ME 213 and EE/CEG 260 may not be used to satisfy technical elective requirements. Three of the following courses must be included among selections for a technical elective:

EP	322	Applied Optics
ME	317	Fluid Dynamics
ME	318	Heat Transfer
EP	432	Lasers
CEG	411	Microprocessor-Based Systems Design
EP	401	Physics or Semi-Conductor Devices
EP	402	Semiconductor Device Processing
EGR	482	Engineering Fundamentals
CS	400	Data Structures and Software Design
EP	401	Physics of Semiconductor Devices
EP	380	Sensors
EE	440	Nanotechnology
EE	410	MEMS
EE	444	Linear Integrated Circuits

5.7 ALTERNATE COURSES

Alternate courses or a selection of courses may be used to fulfill program requirements for starred courses on the EP Program Guide. These are:

a) ME 315, Thermodynamics, may be substituted for PHY 420;
b) other senior project courses which may be substituted for EP 494 include: EP 499 for students in university or department honors programs, PHY 494, PHY 499, ME 490, ME 491, the four electrical engineering design sequences and EE 499, Design Clinic. The project proposal must be approved by the program faculty before registering for a projects course;

5.8 ENGINEERING DESIGN

Engineering design is emphasized in courses marked with a "D" in the design (D) column of the Electrical Engineering Program Guide. Design concepts are introduced in 1st and 2nd year courses which are prerequisite to the more advanced courses and design concepts in the 3rd and 4th years. The engineering physics design project integrates the elements of design in a major design experience. Alternative design sequences provide a major design experience culminating with a capstone course.

5.9 HONORS PROGRAMS

The Department of Electrical Engineering recognizes students of superior quality and motivation by encouraging participation in honors programs. These programs provide students opportunities to develop interests and skills by taking course work more challenging than the regular curriculum.

There are three kinds of honors programs designed for EP majors. They are as follows:

1. "With Honors in Engineering Physics" (departmental honors)
2. "General Studies Honors"
3. "University Honors"

The Undergraduate Catalog describes the general studies honors and university honors programs further. For specific questions, contact the Honors Department (243 Millett Hall) at 775-2660.

5.10 ENGINEERING PHYSICS PROGRAM COMMITTEE

The Engineering Physics Program Committee is charged with maintaining the currency and relevance of the engineering physics curriculum, evaluating formal requests for deviations from the approved curriculum and ensuring that program graduates satisfy the requirements of the curriculum. The committee is headed by Dr. Gregory Kozlowski and includes faculty from both the Physics and Electrical Engineering Departments.

5.11 SELECTED ENGINEERING PHYSICS AND PHYSICS UNDERGRADUATE COURSE DESCRIPTIONS

PHY 260-4 ..... Introduction to Modern Physics
Introduces phenomenology and theoretical concepts of modern physics, such as special theory of relativity and quantum theory; atomic and molecular structure and spectra; x-rays and solid state physics; nuclear structure, reactions, and natural radioactivity; and instrumentation for nuclear physics material properties, and nuclear engineering research. One hour is devoted to demonstrations and recitations. Prerequisite: PHY 210, 211 or 244; MTH 230.

PHY 316-3 .....Physics Instrumentation Laboratory II
Experiments emphasizing electronic instruments applied to areas such as mechanics, atomic physics, and nuclear physics. Lectures on applications of integrated circuits to experimentation, data analysis and data presentation. Prerequisite: PHY 315 or equivalent (EE 331).

EP 322-4.....Applied Optics
Study of optical instruments by means of both geometrical and physical optics. Theory and application of interferometry and light detection devices. Brief introduction to lasers and holography; 3 hours lecture, 2 hours lab. Prerequisite: PHY 244 or equivalent; MTH 253.

PHY 371-3 and PHY 372-3 .....Analytical Mechanics
Intermediate problems in statics, kinematics**,** and dynamics; equilibrium of forces, rectilinear motion, curvilinear motion, central forces, constrained motion, energy and moments of inertia, and the Lagrange method. Prerequisite: PHY 210, PHY 211 or PHY 244; MTH 232. Corequisite: MTH 233.

EP 400-3..... Properties of Semiconductor Materials
Covers crystal structure; selected topics in quantum theory; electron band structure; charge carriers in semiconductors; generation, recombination and motion of charge carriers; electrical and optical properties; and structure and characteristics of p-n junctions. Prerequisite: PHY 240, 242, 244 & CHM 121.

EP 401-3.....Semiconductor Device Physics
Covers structure and characteristics of bipolar transistors, field effect transistors and other selected devices. Design and computer modeling of devices. Prerequisite: EP 400 or PHY 400.

EP 402-3..... Semiconductor Device Processing
Survey of the individual processes used in fabricating semiconductor devices. Integration of these processes to produce MOS and bipolar structures. Computer design aids. Prerequisite: EP 400 and EP 401; or PHY 400 and PHY 401; or ME 370.

EP 432-3..... Lasers
Introduction to the physics of lasers including emission and absorption processes in lasing, the factors controlling laser gain, the properties of optical resonators, and a survey of salient features for features for principal types of lasers. Prerequisites: PHY 242 and PHY 244; PHY 260 or CHM 121.

PHY 440-4 ..... Introduction to Nanoscience and Nanotechnology
Introduction to nanoscience and technology. Topics include introduction to quantum mechanics, fabrication, characterization, materials, electronic properties, optical properties, magnetic properties, devices, MEMS and NEMS.

PHY 450-3 / 451-3 / 452-4 .....Electricity and Magnetism
Fundamental laws of electricity and magnetism from the viewpoint of fields Maxwell's equations, transient steady state currents, electric and magnetic properties of matter, and electromagnetic radiation. Prerequisite: PHY 210, 211 or 242; MTH 232, 233.

PHY 460-4 ..... Introduction to Quantum Mechanics
Mathematical structure of quantum mechanics. Applications to selected one- and three-dimensional problems with emphasis on atomic structure. Prerequisite: PHY 260, 372; MTH 333.

PHY 461-4 .....Introduction to Solid State Physics
Selected properties of solids and their quantitative explanation in terms of simple physical models. Applications of quantum mechanics to solids; 3 hours lecture, 2 hours lab. Prerequisite: PHY 316, 460.

EP 494-3.....Engineering Physics Projects
Independent design/development/research projects in engineering physics. A detailed written final report and seminar presentation are required. A project proposal must be approved by the program faculty before registration.

EP 499-3..... Honors Engineering Physics Projects
Independent design/development/research projects in engineering physics for departmental honors students. A final report, seminar presentation and journal submission are required. A project proposal must be approved by the program faculty before registration.

6. ADMINISTRATIVE ISSUES

6.1 TRANSFER CREDIT

Some students have earned credits at other colleges or universities and wish to transfer those credits to Wright State and the electrical engineering or engineering physics degree program. The Office of the Registrar makes the decision whether or not a course is acceptable for transfer to the university transcript. Transferability of credits for a particular course rests with the college and/or department within the University requiring that course. To maintain consistency, departmental transfer credit evaluations are accomplished in the Office of the Dean or the Office of the Chair. The evaluation results are annotated on the student's program guide. There are articulation agreements between Wright State University and a few colleges (such as Sinclair Community College) that have selected courses pre-approved for transfer credits. These courses are usually at the freshman or sophomore levels. The college does not award transfer credits for engineering courses numbered 300 or above unless those credits were earned under a Bachelor of Science engineering program accredited by ABET. This policy flows from the need and desire to maintain the integrity of the ABET accredited engineering degrees at WSU.

Transfer credit may not be given for course work outdated by rapidly changing technology.

6.2 ADVISING SYSTEM

Each student is assigned a faculty advisor when admitted to the department. The advisor and student should meet periodically to discuss progress, review the Program Guide and schedule classes. It is important for the student and advisor to develop a good rapport as progress is made toward graduation. The advisor can be an excellent source of information and provide a sounding board for developing a successful program. The student should schedule an appointment with the advisor to make sure the meeting takes place at a time convenient to both parties.

6.3 REGISTRATION PROCEDURES

6.3.1 Closed Electrical Engineering Classes

A class taught by a faculty member of the Electrical Engineering Department may close because the class limit has been reached. In that case, students may place their name on a waiting list that is maintained in the department office. As vacancies arise, students will be contacted on a first listed, first served basis and given registration instructions by a staff member.

6.3.2 Independent Study

Electrical engineering students with a GPA of 3.0 or above may register in EE 499 for conducting an independent investigation under the guidance of a faculty member. A maximum of four credit hours may be awarded for such study. The process includes: a written and signed contract between the faculty member and the student (contract forms are available in the department office), contract approval by the department chair and assistant chair.

6.3.3 Graduate Level Courses

Under the "Senior Permission" program, seniors at Wright State who have completed 162 credit hours toward the baccalaureate degree and have earned a cumulative GPA of 3.0 or above may apply for permission to elect selected graduate courses for graduate or undergraduate credit. The process includes approval from the student's advisor, department chair and the School of Graduate Studies. Forms for this action are maintained in the Graduate Studies Office.

6.3.4 Early Registration

Wright State University provides each student an opportunity to register many weeks before classes start each quarter. Registration periods are printed in the quarterly Class Schedule (newsprint). Many classes have limited enrollment. Therefore, students with time constraints (such as those with full-time employment or those approaching graduation) should take advantage of the early registration process to avoid being "closed out" of a class.

6.3.5 Drop Date

See the online quarterly bulletin of classes for current drop dates.

6.4 ACADEMIC PROBLEM RESOLUTION

It is usually best to informally resolve problems at the lowest possible level in any organization. It follows that when a student encounters an academic problem, that problem should first be discussed with the faculty member involved

Academic problems concerning rules of the department, college or university may be addressed through the petitions process. The process includes preparing the petition (it is useful to cite the rule that is causing the problem) and submitting the petition to the Office of the Registrar. The petition will be forwarded to the appropriate standing petitions committee where faculty and staff members will evaluate it. The committee's decision will be communicated in writing to the petitioner. The committees usually meet once a month so immediate action is not the norm.

6.5 APPLYING FOR DEGREES

Before graduating, a student must apply for a degree. Applications are to be filed by the end of the early registration period for the quarter in which graduation will take place. This is usually about 30 days before the graduation quarter begins. The quarterly Class Schedule contains details. The application process includes submitting a completed form to the Office of the Registrar. That form then goes to the student's advisor, department chair, college dean and the registrar for graduation certification. Because it takes some time to post grades and check graduation requirements, transcripts reflecting degrees awarded are not usually issued before 30 days after the end of the quarter. Should the first graduation attempt be unsuccessful, students must reapply for a degree on each successive attempt. Students who expect to complete their degree requirements during winter or spring quarters may participate in the June commencement exercises. Those who expect to complete their degree requirements during the summer or fall quarters may participate in the December commencement exercises.

6.6 FINANCIAL AID

Wright State University offers a variety of financial assistance programs such as grants, loans, cooperative education and student employment. Application forms and information about these programs are available from the Office of Financial Aid, E136 Student Union (937-775-5721).

6.6.1 Cooperative Education

The Cooperative Education (Co-op) Program at Wright State University provides students the opportunity to integrate classroom theory with practical, career-related work experience. Engineering co-op students usually alternate on-campus study with related jobs, primarily in local industries. Through the co-op program, students can gain valuable experience, test career interests, learn more about the engineering field and develop job-related skills as well as earn money to meet college expenses. Appointments for interested students may be scheduled with a member of the Career Services staff in E334 Student Union (937-775-2556).

6.6.2 Continuing Student Merit Scholarships

Students with good grades ($\geq$ 3.0 GPA) may apply for a number of different merit scholarships sponsored by faculty and staff, corporate interests and individuals. Applications are available in the Office of Financial Aid and are usually due by March 15th of each year. A faculty committee selects awards.

6.7 IEEE STUDENT CHAPTER

The Department of Electrical Engineering supports a student chapter of the Institute of Electrical and Electronics Engineers (IEEE), the largest professional society in the world. The Chapter provides a forum for students to meet, organize professional activities and exchange ideas of common professional interest. For example, student members organize tours of companies

and participate in the paper presentation contest organized by the Dayton section of IEEE. Membership also entitles the student to receive the periodical, IEEE Spectrum. Those interested in the benefits and privileges of membership should visit the IEEE website at http://www.IEEE.org . You may apply for membership online.