program to optimize the performance based on use systems. Use systems studied include golf courses, parks, lawns, athletic fields, bowling greens, cricket fields, and grass tennis courts. *Spring*

HORT429 **$ Alt (3)**
Computer Landscape Design
Principles and practices of computer-aided landscape design, including creating scale perimeter plot plans, using drawing tools, plant/site relationships, plant selection and use leading to a computer-generated landscape drawing. Laboratory emphasizes skill development and proficiency in integrating software and hardware to create CAD-generated landscape designs. Prior landscape drawing course work is recommended. *Spring*

HORT448 **$ Alt (4)**
Advanced Landscape Design and Graphics
Landscape design concepts relating to the more challenging problems of residential design. Field application of grading relating to contours, specifications, exploring deck design, planting combinations, and exercises in graphics and rendering for presentations. Weekly: 3 lectures and a 3-hour lab. Recommended: HORT135. *Spring*

ENGINEERING AND COMPUTER SCIENCE

Haughey Hall, Room 312
(269) 471-3420
FAX: (269) 471-3797
engr-info@andrews.edu cs-info@andrews.edu
http://www.andrews.edu/COT/

Faculty
William Wolfer, *Chair*
George S. Agoki
Gerald W. Coy
Ronald L. Johnson
Gunnar Lovhoiden
Steve Ng
Nadine Shillingford
Stephen Thorman
Henock Wondem

Academic Programs	Credits
BS: Computing	40
Computer Science Emphasis	
Software Systems Emphasis	
Minor in Computer Science	20
BS in Engineering	
Electrical and Computer Engineering Emphasis	63
Mechanical Engineering Emphasis	63
Minor in Engineering	20
MS: Software Engineering	32
MSA: Engineering Management	
See the School of Business	

Undergraduate Programs

COMPUTING

Two emphases are available in Computing—**Computer Science** and **Software Systems**.

Computer Science focuses on a study of the computing as well as on its role in an application area. Areas of interest include artificial intelligence, compilers, computer architectures, computer graphics, computer networks, operating systems, program development, and analytical theory. A degree in computing with the Computer Science emphasis prepares students for graduate study, employment in computer systems/networks, administration/development, software development/maintenance, and for careers in education.

Software Systems is an applied study of computing, focusing on the development and maintenance of software in an application area. A minor in an application area is included as part of the degree. Typical minors might include one of the sciences, behavioral science, or business. Supervised "real-world" projects are a requirement for this degree. A degree in Computing with the Software Systems emphasis prepares students for employment in developing and maintaining commercial applications and for graduate studies in applied computing such as software engineering.

BS: Computing

Major requirements—40
Common core—15
CPTR125, 151, 152, 275, 461

Computer Science Emphasis

Required courses—12
CPTR425, 436 or 437, 462, 485 or 487
Major electives—13
Chosen from CPTR courses in consultation with an advisor. A minimum of 12 upper division credits required.
Cognate requirements—32-34
MATH141, 142, 215, 286, 355; STAT340 (20)
ELCT335 (4)
BIOL165; 166 (10)*
or CHEM131, 132 (8)*
or PHYS141, 142 (8)*
or PHYS241, 242, 271, 272 (10)*
or ENGR225, 275 (8)
* This course may apply toward the general education natural science requirement

Software Systems Emphasis

Required courses—11
CPTR427, 460, 466; INFS428
Major electives—14
Chosen from CPTR courses in consultation with an advisor. A minimum of 12 upper division credits required.
Cognate requirements—32-34
MATH182, 215, 355; STAT340 (12)
Minor in an advisor-approved application area (20-22)

Minor in Computing—20

Required courses—12
CPTR125, 151, 152, 275
Minor electives—8
Chosen from CPTR courses in consultation with an advisor.

Notes:

No course grade below a C- may apply to a major or minor in Computing.

A minimum GPA of 2.25 may apply to a major or minor in Computing.

A secondary-education endorsement is available for students seeking either a major or minor in Computing. In such cases, CPTR459 must be taken. Consult the School of Education for further information.

ENGINEERING

Andrews University is presently accepting freshmen, sophomore and junior level students into a new four-year professional engineering program. This program leads to a Bachelor of Science in Engineering degree with emphases in Electrical and Computer Engineering and in Mechanical Engineering. These two emphases build on a strong traditional mathematics, science, and engineering core. The Electrical and Computer Engineering emphasis focuses on the areas of digital systems, communication systems, and computer controlled instrumentation and computer simulation. The Mechanical Engineering emphasis focuses on mechanical design and the electromechanical elements of smart machines. Some of the upper division engineering courses for these programs will not be added until the 2005-06 academic year, so consult with the department about specific course availability during this transition period.

BS in Engineering

Major requirements—63
Common core—30
ENGR120, 125, 180, 225, 275, 280, 310, 491, 492, and INDT450.
Cognates—35
MATH141, 142, 215, 240, 286; STAT340
CHEM131
PHYS241, 242, 271, 272

Electrical and Computer Engineering Emphasis

Required courses—27
CPTR151, 152, ENGR325, 335, 385, 415, 435, and 455.
Major electives—6
Chosen from upper division ENGR and CPTR courses in consultation with an advisor.

Mechanical Engineering Emphasis

Required courses—27
ENGR320, 330, 340, 350, 360, 390, 410, 420, and 440.
Major electives—6
Chosen from upper division ENGR and INDT courses in consultation with an advisor.

Minor in Engineering—20

A minimum of 20 credits chosen from ENGR and INDT courses in consultation with an engineering advisor.
Cognates: MATH182 or MATH141, 142

Graduate Programs

MS: Software Engineering

Software Engineering is an applied study of computing focusing on the software development process through the application and synthesis of principles from computer science and related fields. Emphasis is placed on practical results balanced by scientific foundation. Supervised "real-world" projects are a requirement for this degree.

Admission requirements. In addition to meeting the general graduate admission requirements on pp. 44-46 of the bulletin, students applying for admission to the MS: Software Engineering program must show evidence that they have taken academic course work and/or demonstrate proficiency in the following areas:

Calculus
Computer Organization and Assembler
Discrete Mathematics
Elementary Data Structures
Probability or Statistics
Programming proficiency in two computer languages (including C or C++)

Degree requirements—32
A minimum of 32 semester credits. At least 23 credits chosen from 500- and 600-level graduate courses. The Comprehensive Examination must be successfully completed prior to graduation. Completion of the following requirements:

Foundation—0-9
CPTR427, 460 and 461 are required unless previously taken at the undergraduate level.
Core courses—11
CPTR560, 561, 562, 637
Project or Thesis—6
Two projects (CPTR698) or a single thesis (CPTR699) is required. Thesis option if selected must involve software development.
Electives—6-15
Complete any acceptable 400-600 level CPTR; INFS428 courses chosen in consultation with an advisor.

MSA: Engineering Management Emphasis

See graduate programs for the School of Business.

Courses (Credits)

See inside front cover for symbol code.

COMPUTING AND SOFTWARE ENGINEERING

CPTR125 **$ (3)**
Introduction to Computer Programming
Programming in a selected language. May be repeated for a total of three unique languages. Satisfies general education requirements for computing majors. Only 3 credits of CPTR125 may apply toward a computing major or minor. *Fall, Spring*

CPTR151 **$ (3)**
Computer Science I
An introduction to programming methodology using C++, UNIX usage, problem-solving, algorithm development, control structures, arrays, program style, design correctness and documentation techniques, as well as a brief overview of computer systems and computer history. *Fall, Spring*

CPTR152 **$ (3)**
Computer Science II
A continuation of CPTR151 examines program specifications, design, coding, correctness, and style with additional coverage of pointers and arrays, and an in-depth study of recursion and data structures. Includes files, lists, stacks, queues, trees, graphs, and an overview of computer ethics. Prerequisites: CPTR151. *Fall, Spring*

CPTR275 **$ (3)**
Computer Organization and Assembler
Covers data representation, number base conversion, representation for integer fractions and floating numbers, Boolean algebra, truth table digital logic and circuit representations of basic computational building blocks, introduction to computer architecture; interrupt schemes; an introduction to system software including assemblers, loaders and linkers, and operating systems. Includes assembly language programming using a macro-assembler. Prerequisite: CPTR152. *Spring*

CPTR295 **(1-3)**
Directed Computer Language Study
Directed study of computer language in consultation with the instructor. Normally, the language is not included in other courses taught by the department. A programming project may be required. Prerequisites: CPTR151 or equivalent.

CPTR416 **♦ $ (3)**
Internet Technologies
A study of current technologies and their effects, including web server software, e-commerce, various scripting languages, human-computer interfacing, perception, and related issues. Prerequisite: CPTR152. *Spring, Summer*

CPTR425 **♦ $ (3)**
Programming Languages
Survey of current programming languages, including structure, runtime systems, the specification of syntax, and semantics. Definition of syntax for formal languages with emphasis on context-free languages. Techniques for scanning and parsing programming languages. Automated grammar analysis parsers. A major programming project is required. Prerequisite: CPTR275. *Fall*

CPTR427 **♦ $ (3)**
Object-Oriented Design and Programming
Emphasizes the study of object-oriented analysis and design methodologies and the application of these to the development of advanced software. Includes survey of object-oriented programming languages and environments. A major programming project is required. Prerequisite: CPTR152. *Fall*

CPTR436 **♦ $ Alt (3)**
Numerical Methods and Analysis
A study of common numerical techniques applicable on the computer. Includes interpolation, extrapolation, approximation techniques, numerical methods for linear problems, root finding, function fitting, numerical integration, location of extremes, efficiency of numerical algorithms, and minimization of computational error. Prerequisites: CPTR275 and MATH215. *Spring* (even years)

CPTR437 **♦ $ Alt (3)**
Formal Theory of Computation
Includes post productions, Turing machines, and recursive functions. Recursive and recursively enumerable sets. Undecidability results of computation. Prerequisites: CPTR152 and MATH215 or 355. *Spring* (odd years)

CPTR459 **Alt (2)**
Secondary Methods: Computer Science
Considers computer science programs in the secondary school and presents information and materials for teaching computer science in secondary school. Topics include organization and maintenance of equipment, publications, legal issues, dealing with diversity of abilities, problem-solving skills, and strategies for debugging programs. Prerequisite: CPTR275.

CPTR460 **♦ $ (3)**
Software Engineering
Surveys basic software engineering topics associated with the processes, documents, and products of the entire software life cycle. Topics include software evolution, project organization, and management, feasibility studies, product definition, design, implementation, and testing issues, and the role of the software engineer within the life cycle. Prerequisite: CPTR152. *Fall*

CPTR461 ♦ **$ (3)**
Operating Systems I
Process management, including asynchronous concurrent processes and deadlock. Virtual storage management and job and process scheduling. Multiprocessing. Disk scheduling and file and database systems. Performance and security. Prerequisite: CPTR275 or CPTR152 and ELCT335. *Fall*

CPTR462 ♦ **$ Alt (3)**
Operating Systems II
Continuation of Operating Systems I with emphasis on comparing the design and implementation of different systems. A major project including contemporary operating system development is required. Prerequisite: CPTR461. *Spring* (even years)

CPTR466 **(2)**
Software Engineering Group Project
The implementation of a group project and the study of topics related to the group project, including CASE tools, 4GL's, and graphical user interfaces. Emphasizes written documents and oral presentations associated with group project rather than lecture. Corerequisite: CPTR460. *Fall*

CPTR475 **(1-4)**
Topics in _____
Selected topics of current interest in computer science such as Robotics, advanced languages, or others. Repeatable with different subjects.

CPTR485 ♦ **$ Alt (3)**
Computer Graphics
Introduction to computer graphics examining raster and/or vector images, 2D and 3D images, polygons, transformations, segments, widowing, clipping, hidden line removal. Prerequisite: CPTR152. *Fall* (odd years)

CPTR487 ♦ **$ Alt (3)**
Artificial Intelligence
Provides the conceptual basis for understanding current trends in Artificial Intelligence. Topics include both symbolic and numeric processing, intelligent search methods, problem representation, machine learning, expert systems, and a survey of some social implications of AI. Prerequisite: CPTR152. *Fall* (even years)

CPTR495 **(1-3)**
Independent Study
Directed study of material of special interest chosen in consultation with the instructor. No more than 6 credits may be earned in CPTR495. Graded S/U.

CPTR496 **(1-3)**
Special Projects
Project chosen in consultation with instructor. No more than 6 credits may be earned in CPTR495. Graded S/U.

CPTR536 **Alt (3)**
Compiler Construction
Storage allocation for programs, subroutine linkage, and code generation and optimization. Simple translator written in course. Prerequisites: CPTR275, 425. *Spring* (odd years)

CPTR548 **Alt (3)**
Advanced Database Design and Implementation
Database design and theory. Concurrency, distributed databases, integrity, security, query optimization. A survey of the design and implementation tradeoffs involved in using various available database packages. Includes a term project and reading from the literature. Prerequisite: CPTR275, INFS428. *Fall* (even years)

CPTR550 **(3)**
Network Architecture
A study of the concepts and implementation of the client/server model of computing. Examines four implementations of the client/server model. Surveys the hardware and software used in network communications, including the specifications and protocols associated with thin and thick coax, twisted pair, fiber optics, slow IP mediums, UDP/IP and TCP/IP. Prerequisite: CPTR275.

CPTR555 **Alt (3)**
Advanced Operating Systems
May include system structures and algorithms, reliability, security, distributed systems, study of operating systems highlighting these concepts, and recently published research in these and other areas. Includes a term project and readings from the literature. Prerequisite: CPTR461. *Spring* (odd years)

CPTR556 **(3)**
Real Time Systems
A survey of the system architecture and software engineering aspects of real time systems such as operating systems, and process-control software. Includes a term project and readings from current literature. Prerequisite: CPTR275.

CPTR560 **(3)**
Advanced Software Engineering
A study of applied software product development issues, including requirement analysis, systems and software design methodologies, software-project planning models (e.g., COCOMO), implementation, testing and reuse, language, tool and hardware selection, software economics, productivity measurement, risk management, statistical process evaluation, and control. Prerequisites: CPTR460, MATH182 or 141, STAT285. *Spring*

CPTR561, 562 **(2, 3)**
Software Engineering Group Project I, II
The implementation of a group project and the study of topics related to the group project including CASE tools, 4GL's, graphical user interfaces. Generally, the project begun in CPTR561 carries over to CPTR562. Corequisites: CPTR460, 560 respectively. *Fall, Spring*

CPTR565 **(3)**
Computer Architecture
Functional analysis of computer hardware and software systems including a comparative study of past, present, and proposed architecture as well as computer performance analysis and optimization. Prerequisite: CPTR275. *Fall*

CPTR585 **Alt (3)**
Advanced Computer Graphics
Advanced topics and current research in computer imaging—may include shading, ray tracing, radiosity, color spaces, lighting models, texture mapping, and recently published research in computer imagery. Includes term project and readings from the literature. Prerequisite: CPTR485. *Spring* (even years)

CPTR587 **Alt (3)**
Advanced Artificial Intelligence
Provides a forum for exploring current topics in machine intelligence through a survey of recent research results, independent readings, and

hands-on projects. Typical topics include machine vision, speech recognition, natural language processing, and machine learning systems. Prerequisite: CPTR487. *Spring* (odd years)

CPTR625 **Alt (3)**
Analysis of Algorithms
Technique for analyzing and designing algorithms, including average/worst case analysis, assymptotics, recurrences, empirical experimentation, intractability proofs (i.e., NP-Completeness) and heuristic alternatives. Application of such techniques as divide-and-conquer, graph, greedy, dynamic programming, backtracking, branch-and-bound, and probabilistic algorithms. Prerequisites: CPTR152, MATH315, 355, STAT340.

CPTR637 **(3)**
Formal Methods
A survey of the different paradigms associated with formal methods. Applies formal methods to the specification, verification, and validation of software systems. Case studies are examined and a programming project is included. Prerequisites: CPTR460, MATH215, STAT285. *Spring*

CPTR660 **(0)**
Thesis/Project Extension

CPTR689 **(1-4)**
Topics in _____
Topics in computer science such as graphics, parallel processors, compiler design and optimization, communications and signal processing, distributed systems, graph theory, artificial intelligence, and formal theory. Repeatable with different topics to 6 credits. Prerequisite: Depends upon topic.

CPTR690 **(1-4)**
Independent Study
Directed study of material of special interest chosen in consultation with the instructor. May be repeated to 6 credits. Grade S/U.

CPTR698 **(1-4)**
Master's Research Project
Special project chosen in consultation with student's advisor and instructor. To be repeated to 6 credits. Grade S/U.

CPTR699 **(1-6)**
Master's Thesis
To be repeated to 6 credits. Graded S/U.

ELECTRONICS

ELCT141, 142 **$ (4, 4)**
Basic Electronics
Study of AC and DC electric circuit theory, characteristics of diodes, transistors, and linear integrated circuits and their behavior in simple circuits. Weekly: a 3-hour lab. Prerequisite for ELCT141: MATH166 & 167 or 168. Prerequisite for ELCT142: ELCT141. *Spring (ELCT141), Fall (ELCT142)*

ELCT235 **$ (4)**
Digital Electronics
Binary numbers and codes, Boolean algebra, logic circuits, flipflops and registers, arithmetic circuits, counters, multiplexors, demultiplexors, design of state machines, and comparison of IC logic families. Weekly: a 3-hour lab. Prerequisite: ELCT142. *Spring*

ELCT307 **$ (4)**
Instrumentation and Process Control
Theory and application of electrical transducers and recording devices. Emphasis on signal conditioning in process control applications. Measurement errors and calibration. Weekly: a 3-hour lab. Prerequisite: ELCT235. *Fall*

ELCT325 **$ (3)**
Computing, Network Operations and Maintenance
Techniques and tools of computer and network operation and troubleshooting. Weekly: a 3-hour lab. Prerequisite: ELCT235. *Spring*

ELCT328 **$ Alt (2)**
Printed Circuit Layout
Basic methods of layout and fabrication of single and double layer etched circuit boards. Weekly: a 3-hour lab. Prerequisite: ELCT235. *Spring*

ELCT335 **$ (4)**
Microprocessors
Introduction to computer organization, microprocessors, assembly language programming, memory devices, I/O devices, interfacing with emphasis on control applications. Weekly: a 3-hour lab. Prerequisite: ELCT235 or CPTR275. *Fall*

ELCT350 **$ Alt (2)**
Programmable Logic Controllers
A study of relay logic. Application and programming of industrial programmable controllers to accomplish these relay logic functions. Weekly: a 3-hour lab. Prerequisite: ELCT235. *Spring*

ELCT355 **$ (4)**
Electrical Machinery and Controls
Characteristics and applications of DC motors and generators; transformers, AC motors and generators, motor starters and controls, power factor corrections, and speed controls. Weekly: a 3-hour lab. Prerequisite: ELCT307. *Spring*

ELCT360 **$ (4)**
Communication Systems and Electronics
Filters, oscillators, frequency response plots, tuned circuits, impedance matching, and Fourier series. Amplitude, frequency, phase, and pulse modulation. Weekly: a 3-hour lab. Prerequisite: ENGT310. *Spring*

ELCT365 **Alt (3)**
Transmission Systems
Signal transmission via wire, coaxial cable, waveguide, antenna, and optical fiber media. Attenuation and distortion effects. System power budget. Prerequisite: ELCT360. *Spring*

ELCT380 **$ Alt (4)**
Amplifier and Wave-Shaping Circuits
Linear amplifiers with an emphasis on op-amp circuits and their amplitude and frequency limitations. Includes linear wave-shaping, clipping, clamping, gating, switching, and comparator circuits. Weekly: a 3-hour lab. Prerequisite: ENGT310. *Fall*

ELCT420 **(4)**
Avionics Principles and Systems
A study of operating principles and circuits of communication and navigation equipment used in general aviation. Prerequisites: ELCT335, 360, 380. May not be offered each year. *Fall*

ELCT439 **$ Alt (4)**
Embedded Systems
Microprocessor interfacing and applications in the area of process monitoring and control. Use of BASIC or C++. Weekly: a 3-hour lab. Prerequisites: ELCT335 and CPTR152. *Spring*

ENGINEERING

ENGR120 **(2)**
Introduction to Engineering
Introduces students to the engineering profession. Various engineering disciplines, job functions, engineering designs and engineering ethics will be discussed. Tips on how to succeed in the classroom, advice on how to gain actual, hands-on experience will be discussed. Introduces computer tools such as Mathcad and Microsoft Excel. *Fall*

ENGR125 **(2)**
Engineering Graphics
Fundamentals of drawing as applied to mechanical engineering problems. Orthographic projections, auxiliary and sectional views, dimensioning, oblique and isometric views. Sketching and computer-aided drafting. Weekly: 1 lecture and a 3-hour lab. *Fall*

ENGR135 **(1)**
Descriptive Geometry
Solution of basic space problems. Determination of distances and angles, intersections of lines and surfaces, intersections of lines and development of surfaces. Prerequisite: MECT121. *Spring*

ENGR180 **(4)**
Materials Science
Introduction to the study of materials used in industry. Deals with the fundamentals of structure and classification of materials. A weekly hands-on laboratory helps demonstrate the relationship of properties of materials studied in lecture. Weekly: 3 lectures and a 3-hour lab. Prerequisite: CHEM131. *Spring*

ENGR225 **$ (3)**
Circuit Analysis
Resistive circuit analysis, network theorems, dependent sources, energy storage elements, 1st and 2nd order circuit transient responses, ac circuit analysis using phasors and impedances, and ac complex power. Weekly: 2 lectures and a 3-hour lab. Prerequisite: MATH142. *Fall*

ENGR248 **(1-4)**
Workshop
Provides flexibility for the occasional workshop where it is appropriate to offer engineering credit. Workshop requirements must be approved by the department.

ENGR275 **(4)**
Electronics I
Introduction to diodes and transistors and their applications in switching and amplification circuits. Introduction to the basic op-amp circuits and their characteristics. Binary numbers and codes, Boolean algebra, logic circuits, flip-flops and registers. Digital circuit applications. Weekly: a 3-hour lab. Prerequisite: ENGR225. *Spring*

ENGR280 **(5)**
Engineering Mechanics
Principles of statics and their application to engineering problems; forces, moments, couples, friction, centroids, and moments of inertia. Vectorial kinematics of moving bodies in fixed and moving reference frames. Kinetics of particles, assemblies of particles, and rigid bodies, with emphasis on the concept of momentum. Keplerian motion, elementary vibrations, and conservative dynamic systems. Prerequisite: MATH142. *Spring*

ENGR310 **(3)**
Linear System Analysis
Convolution, analysis and spectra of continuous time domain signals, Fourier and Laplace transforms, discrete time domain signals, and the z-transform. Corequisite: MATH286. *Spring*

ENGR320 **(3)**
Manufacturing Processes
Covers traditional manufacturing practices such as machining processes (abrading, coating), and forming processes (cutting, forming, and assembling). Discusses non-traditional processes such as thermal, chemical, and pressure methods and explores special processes involved with specific materials such as plastics, woods, fibers, and other materials. Prerequisite: ENGR180. *Fall*

ENGR325 **(4)**
Electronics II
Modeling of transistors, biasing of transistors in amplifier circuits, and amplitude and frequency limitations of transistors. Linear and switching electronic circuits with an emphasis on op-amps. Weekly: a 3-hour lab. Prerequisite: ENGR275. *Fall*

ENGR330 **(3)**
Thermodynamics
Introduction to the nature of energy and study of energy transport conservation in closed and flowing systems; properties and states of solids, liquids, vapors, and gases; enthalpy; meaning and production of entropy and introduction to cyclic systems. Prerequisite: PHYS242. *Fall*

ENGR335 **(3)**
Logic Circuit Design
Modern digital logic families, state machines, design of digital logic circuits in FPGAs, and VHDL specification of logic circuits. Prerequisite: ENGR275. *Fall*

ENGR340 **(3)**
Strength of Materials
Study of stresses and strain, deformations and deflections of posts, shafts, beams, columns; combined stresses; elasticity. Prerequisite: ENGR280. *Fall*

ENGR350 **(3)**
Sensors and Actuators
Study of temperature, mechanical, and optical sensors; sensor signal conditioning; ac, dc, and stepping motors; and the motor control requirements. Weekly: 2 lectures and a 3-hour lab. Prerequisite: ENGR275. *Spring*

ENGR360 **(3)**
Fluid Dynamics
Fluid statics and dynamics of fluid motion. Conservation of mass, momentum, and energy in laminar and turbulent flow. Boundary layer flow, lift and drag forces, viscous flow in conduits, open channel flow, flow measurements. Prerequisite: ENGR330. *Spring*

ENGR370 **(2)**
Technical World and Man
Gives students a general understanding of how modern technologies

affect society. Topics include how humans respond to technological change, the social consequences of technology, and technological issues in national decisions. *Spring*

ENGR380 **(2)**
Programmable Controllers
Introduction to typical programmable logic controllers and their applications. Emphasis on programming and interfacing to electromechanical systems. Weekly: 1 lecture and a 3-hour lab. Prerequisite: ENGR275. *Spring*

ENGR385 **(4)**
Microprocessor Systems
Introduction to computer organization, microprocessors, assembly language programming, memory devices, I/O devices, interfacing with emphasis on control applications. Weekly: a 3-hour lab. Prerequisite: ENGR335. *Spring*

ENGR390 **(2)**
Mechanical Engineering Lab
Mechanical engineering lab work in thermodynamics, heat transfer, fluid mechanics, and material stress and strain. Weekly: Two 3-hour labs. Prerequisites: ENGR330, 340, Corequisites: ENGR350, 360. *Spring*

ENGR410 **(4)**
Feedback Control Systems
Study of both analog and digital feedback control systems. Performance criteria and design and analysis methods. Weekly: 3 lectures and a 3-hour lab. Prerequisites: ENGR275, 280, and 310. *Fall*

ENGR415 **(3)**
Virtual Instrumentation
Introduction to virtual instrumentation with emphasis on the sampling requirements and the signal conditioning requirements. Data logging and control applications. Prerequisite: ENGR325. *Fall*

ENGR420 **(3)**
Machine Design
The design of machine elements and the calculations necessary in determining the size and shape of machine parts. The selection of materials and the application of standard machine components. Includes bearings, gears, clutches, and couplings. Prerequisites: ENGR320, 340, 390. *Fall*

ENGR435 **(3)**
Electromagnetic Fields
Study of static and dynamic electric and magnetic fields. Unbounded and bounded fields, fields in materials, force and torque, energy and potential functions, and Faraday induction. Propagation of electromagnetic energy; plane waves, transmission lines, and waveguides; radiation from dipole antennas; introduction to arrays. Prerequisites: MATH240, PHYS242. *Fall*

ENGR440 **(3)**
Heat Transfer
Study of steady-state and transient heat conduction, black-body thermal radiation, solar radiation, forced and non-forced convection through ducts and over surfaces, and heat exchangers. Prerequisite: ENGR360. *Fall*

ENGR455 **(4)**
Communication Systems
Introduction to analog and digital communication systems; including topics in modulation; baseband and bandpass signals; power spectral density and bandwidth; random processes; noise, signal-to-noise ratio, and error probability; and system performance. Weekly: a 3-hour lab. Prerequisites: ENGR310, 325, Corequisite: STAT340. *Spring*

ENGR465 **(3)**
Operations Analysis and Modeling
The methodology of mathematical modeling and its relation to solving problems in industrial and public systems. Linear programming, scheduling, queuing, simulation, optimization, and decision analysis. Prerequisites: INDT460, STAT340. May not be offered each year. *Spring*

ENGR470 **(3)**
Finite Element Methods
Introduction of finite element methods for the solution of problems in solid mechanics and heat transfer. Techniques for obtaining approximate numerical solutions to governing differential equations in the problem areas are covered. Industrial software is applied to the analysis and design of a broad range of engineering problems. Prerequisites: ENGR340, MATH286. *Spring*

ENGR475 **(1-4)**
Topics in _____
Repeatable in different subjects (prerequisites depend on topic)

ENGR491, 492 **(2, 2)**
Senior Design Project
A significant design project which culminates in a working system or a complete description of a proposed design. Both an oral and written presentation of the results of the project is required. Prerequisite: ENGR385 or 390. *Fall, Spring*

ENGR495 **(1-3)**
Independent Study
Individual study, research, or project in some field of engineering under the direction of a member of the engineering faculty. Prerequisite: permission of the person who will direct the study.

ENGR496 **(1-4)**
Cooperative Work Experience
Work experience in industry directed by an engineering faculty member. 120 hours of work is required per credit. A report must be submitted that summarizes the work experience and indicates the value of the experience to the student. Grade S/U. Repeatable to 4 credits. Prerequisite: junior/senior standing and permission of the person who will direct the study.

ENGINEERING MANAGEMENT

ENGM520 **(3)**
Ergonomics and Work Design
The application of ergonomics and engineering principles to the design analysis and measurement of human work systems. *Summer*

ENGM555 **(3)**
Facilities Planning
Planning and design of industrial and service facilities: site selection, process layout, materials handling, and storage. *Summer*

ENGM565 **(3)**
Operations Analysis and Modeling
The development and use of mathematical models to analyze elements of production and service systems: linear programming, probabilistic models, game theory, dynamic programming, queu-

ing theory, and simulation. Prerequisites: INDT460; STAT285; MATH142 or 182. *Spring*

ENGM570 **(3)**
Project Management
Design and management of engineering projects: proposals, planning, resource requirements, organization, scheduling, and cost and schedule control. *Fall*

ENGM690 **(1-4)**
Independent Study
Individual study of research in some area of engineering management under the direction of a member of the engineering faculty.

ENGM698 **(2)**
Research
Research methods and a research project in an area of engineering management.

ENGINEERING TECHNOLOGY

ENGT310 **(3)**
Linear Systems Analysis
Convolution, analysis and spectra of continuous time domain signals, Fourier and Laplace transforms, discrete time domain signals, and the z- transform. Prerequisite: MATH182, ELCT142. *Fall*

ENGT390 **(1-3)**
Independent Study
Individual study, research, or project in some field of engineering technology under the direction of a member of the engineering technology faculty. Prerequisite: permission of person who will direct study.

ENGT395 **(1-4)**
Practicum
Lab or on-the-job experience to build skills in a specific area of engineering technology. Repeatable to 4 credits. Prerequisite: a fundamental course in the area.

ENGT396 **(1-4)**
Cooperative Work Experience
Work experience in industry directed by a faculty member. 120 hours of work is required per credit. A report must be submitted indicating what the student learned. Grade S/U. Repeatable to 4 credits. Prerequisite: Junior/Senior standing.

ENGT475 **(1-4)**
Topics in _____
Repeatable in different subjects (prerequisites depend on topic.)

ENGT491, 492 **(2, 2)**
Senior Design Project I, II
A significant design project which culminates in a working system. Prerequisite: at least one of the following courses: ELCT335, 360; MECT375 or 415. *Fall, Spring*

INDUSTRIAL TECHNOLOGY

INDT310 **(3)**
Industrial Supervision
Introduction to and overview of the fundamentals of industrial supervision. Topics include organization, duties, human relations, training, evaluation, promotion, grievances, management-employee relationships. *Spring*

INDT315 **(3)**
Succeeding in the Workplace
Focus on the development of attitudes, performance, and communication that will assist in making the transition from the classroom to the workplace an enjoyable and profitable experience. *Fall*

INDT320 **(3)**
Work Methods and Measurements
Principles and applications of basic methods and techniques for improvement of the man-job-time relationships; job standards, time and motion studies, and work-space design for efficient use of manpower. *Spring*

INDT410 **(3)**
Project Management
Methodology used successfully to carry out a technical project including proposals, planning, work breakdown, scheduling, creativity, monitoring progress, and documentation. *Fall*

INDT440 **(3)**
Quality Control
Analysis of the factors affecting product quality during manufacturing. Topics include basic statistics, sampling, control charts, measurements methods, inspection systems, reliability, and motivation programs. If this course is taken to fulfill degree requirements at the undergraduate level, it cannot also be taken at the graduate level to fulfill degree requirements for a graduate degree. Prerequisite: STAT285 or 340. *Spring*

INDT450 **(3)**
Industrial Economy
Study of engineering decision methodology and criteria used to include economic factors in determining the best alternative in the design and selection of equipment, structures, methods, and processes. Prerequisite: MATH165 or MATH141. *Fall*

INDT460 **(3)**
Production Planning and Control
Planning and coordination of manufacturing facilities and materials for economic production: forecasting, estimating, process planning, plant layout, product flow, scheduling, production controls, materials acquisition and handling, and inventory. If this course is taken to fulfill degree requirements at the undergraduate level, it cannot also be taken at the graduate level to fulfill degree requirements for a graduate degree. Prerequisites: MATH166 or equivalent, STAT285 or 340. *Fall*

MECHANICAL TECHNOLOGY

MECT120 **$ (3)**
Computer-Aided Drawing
An introduction to the use of AutoCad, graphics generation and editing, file maintenance, plotting, and 2- and 3-dimensional drawings. Weekly: a 3-hour lab. Credit may not be earned in MECT120 and MECT121. *Fall*

MECT121 **$ (2)**
Mechanical Drawing I
Fundamentals of drawing as applied to mechanical engineering problems. Orthographic projections, auxiliary and sectional views, dimensioning, oblique and isometric views. Sketching and computer-aided drafting. Weekly: a 3-hour lab. *Fall*

MECT122 **$ (3)**
Mechanical Drawing II
Limit dimensioning, drawing, and interpretation of weld symbols. Solid modeling and production drawings using CAD. Weekly: a 3-hour lab. Prerequisite: MECT121. *Spring*

MECT235 **$ (4)**
Materials Technology
Study of industrial materials. Properties of materials correlated with the internal structure. Includes metals, plastics, and ceramics. Weekly: a 3-hour lab. Prerequisites: MATH166, CHEM131. *Spring*

MECT285 **(4)**
Statics and Strength of Materials
Analysis of static force systems. Forces, moments, resultants, free-body diagrams, equilibrium, center of mass, moment of inertia, and friction. Assignments designed to develop problem-solving abilities. Study of internal stress and deformation of elastic bodies. A minimum grade of C required in order to enroll in MECT355. Prerequisite: MATH182. *Fall*

MECT326 **$ Alt (4)**
Fluid Power Systems
Principles and applications of fluid power systems to actuate and/or control machines. Electro-hydraulic-pneumatic systems studied. Principles of fluids introduced. Weekly: a 3-hour lab. Prerequisite: MECT285. *Fall*

MECT355 **(4)**
Dynamics and Kinematics
Fundamentals and applications of dynamics; displacement, velocities, acceleration, work, energy, power impulse, momentum, and impact. Also a study of the basic theories and techniques in the analysis of relative motion, acceleration, and acceleration of machine parts such as linkages, cams, gears, and other mechanisms. Prerequisites: MATH182, MECT285. *Fall*

MECT370 **$ Alt (4)**
Heat Power
Thermodynamics properties, first and second law of thermodynamics, ideal gas law, the Carnot Cycle, power and refrigeration cycles, heat transfer power and refrigeration cycles, non-flow gas processes, mixtures of ideal gasses, psychrometric chart, air conditioning, fluid statics, kinematics, dynamics. Weekly: a 3-hour lab. Prerequisite: MECT355. *Fall*

MECT375 **$ Alt (4)**
Fluid Mechanics
Dimensionless parameters, compressible flow, flow-in pipes, open channel flow, drag, lift. Weekly: a 3-hour lab. Prerequisite: MECT355. *Spring*

MECT415 **(3)**
Mechanical Design and Fabrication
The design of machine elements and the calculations necessary in determining the size and shape of machine parts. The selection of materials and the application of standard machine components. Includes bearings, gears, clutches, and couplings. Prerequisite: MECT355. *Spring*

IMAGING AND APPLIED TECHNOLOGY

Harrigan Hall, Room 227
(269) 471-3450 or (800) 909-8812
FAX: (269) 471-6655
launr@andrews.edu
http://www.andrews.edu/COT/

Faculty
Laun L. Reinholtz, *Chair*
Rodrick A. Church
Jeffrey E. Forsythe
Jake J. Fortney
Arturo S. Maxwell
James R. Newkirk
Sharon J. Prest
David B. Sherwin
Renee A. Skeete
Dustin J. Thorne
Marc G. Ullom
Jeffery E. Wines

Academic Programs	Credits
BT: Automotive Management	68
AT: Automotive Technology	40
BT: Digital Multimedia Technology	67
BT: Graphic Imaging Technology	63-66
Electronic Publishing	
Web Development	
AT: Graphic Imaging Technology	40
BS: Photographic Imaging	66
Minor in Automotive Technology	20
Minor in Digital Multimedia Technology	20
Minor in Imaging Technology	22
Minor in Photographic Imaging	20
Minor in Web Development	23

SEQUENCE OF TWO-YEAR AND FOUR-YEAR PROGRAMS

The Department of Imaging and Applied Technology plans programs using the "ladder concept," allowing a student to complete as much education as desired before entering the work force. Two- and four-year programs are available. Students completing the two-year program may go directly into a four-year program in the same area without the loss of credits. The ladder concept allows students to reach the educational goal that best fits their specific needs.

Programs

AUTOMOTIVE

Two programs are available: A four-year Bachelor in Automotive Management, and a two-year Associate in Automotive Technology. Both programs give the student beginning-level skills in automotive repair. The automotive management provides a solid background in business.