ENGINEERING, COMPUTER SCIENCE, AND ENGINEERING TECHNOLOGY

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may specialize in computer, civil, electrical, or mechanical engineering. The department at Andrews University will assist students in coordinating a program with another engineering school upon request.

Professional Engineering
(First two years)
Suggested courses to be taken during the two years at Andrews**—68**
MATH141, 142, 240, 281, 286; CHEM131,132; PHYS241, 242, 271,272; MECT121; ENGR120, 135, 225, 280; CPTR125 or 151; ENGL115; COMM104; Religion (6 credits); Social Studies and Humanities (3 credits); PE (1 credit).

ENGINEERING TECHNOLOGY

Engineering Technology–the area of the technological employment spectrum between the engineer and the skilled craftsman–includes both the engineering technician (2-year associate degree) and the engineering technologist (Bachelor of Science in Engineering Technology).

Individualized associate degree programs (AT) in engineering technology can be designed for students needing an associate degree.

BSET: Computer Engineering Technology

Major requirements—40
CPTR125 (meets BSET general education requirement), 151, 152, 461; ELCT235, 325, 335, 360; ENGT491, 492; plus 12 credits chosen from upper division CPTR and ELCT courses.

BSET: Mechatronics Engineering Technology

Major requirements—40
MECT122, 285, 355, 415; ELCT235, 307, 355; ENGT491, 492; plus 10 credits chosen from upper division ELCT and MECT courses.

Minor in Engineering Technology—20

A minimum of 20 credits chosen from ENGR, ELCT, INDT, and MECT courses in consultation with an engineering technology advisor.

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 p. 38 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 18 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—0-6
CPTR427 and 460 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—9-15
a. ***Systems*** (Choose at least two)
CPTR461, 462, 550, 555, 556, 565
b. ***General***
Complete any acceptable 400-600 level CPTR; INFS428 courses chosen in consultation with an advisor.

MSA: Engineering Management Emphasis

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

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. Prerequisite: CPTR275.

CPTR496 **(1-3)**
Special Projects
Project chosen in consultation with instructor. No more than 6 credits may be earned in CPTR495. Graded S/U. Prerequisite: CPTR275.

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* (even 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 in cluding 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, MATH281, 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 or 235, 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: MATH168. 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: ELCT335. *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. Prerequisite: ELCT335 and CPTR152. *Spring*

ENGINEERING

ENGR120 **(2)**
Introduction to Engineering
Explores specialized areas and job functions of engineers and technologists. A design project emphasizes the engineering design process. Introduces Mathcad. *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*

ENGR224 **$ (4)**
Engineering Materials
Study of the science of engineering materials. Engineering properties are correlated with internal structure and service environment. Weekly: 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

particles, and rigid bodies, with emphasis on the concept of momentum. Keplerian motion, elementary vibrations, and conservative dynamic systems. Prerequisite: MATH142. *Fall*

ENGR370 **(2)**
Technical World and Man
Gives general students an 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*

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*

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 programing, queuing 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, Spring*

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. 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