

# Industrial Technology

College of Agricultural  
Sciences and Technology

## Department of Industrial Technology

Matthew M. Yen, *Chair*

Meg Broderick, *Administrative Support  
Coordinator*

M. Grosse Industrial Technology  
Building, Room 212, M/S IT 9  
559.278.2145

FAX: 559.278.5081

[www.csufresno.edu/indtech/](http://www.csufresno.edu/indtech/)

## B.S. in Industrial Technology

Emphases:

- CAD/CAM Systems Management
- Industrial Control Systems Management
- Quality Systems Management
- Transportation Systems Management
- Networking Systems Management

## M.S. in Industrial Technology

### Minor in Industrial Technology

### Industry and Technology Teaching Credential Waiver

### Certificate in Computer Process Control Network Administration

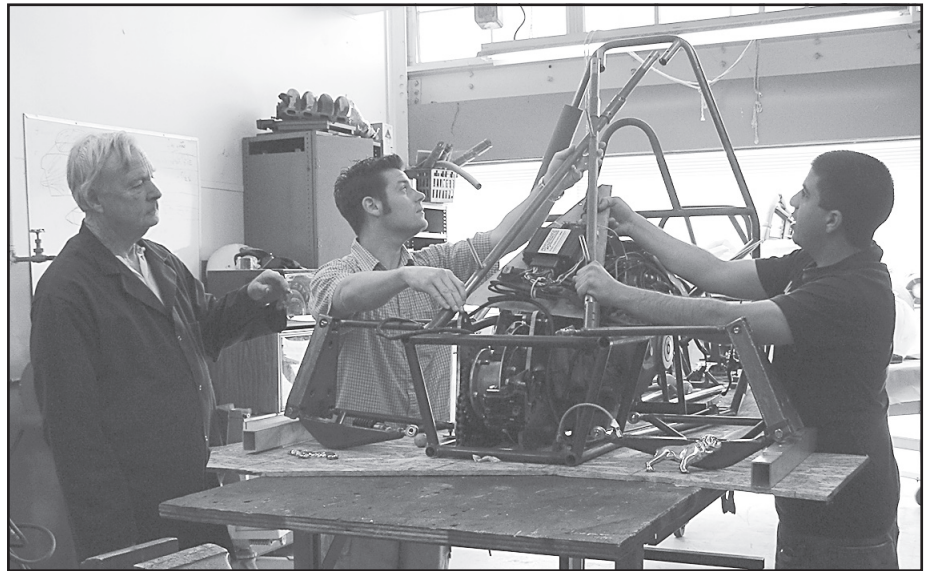
### Certificate in Networking Routing and Internetworking Technology

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## Industrial Technology

Industrial Technology (IT) at California State University, Fresno is preparing today's and tomorrow's leaders of industry. IT equips the graduate to use and manage 21st century technology. All of the courses in Industrial Technology's bachelor of science program cover state-of-the-art principles and use lab experiences to illustrate their applications. Computer software is used both as a tool and to stimulate processes. Technical concentrations build on a common core of technology and management. Our faculty members are dedicated educators who have the industrial experience necessary to do an outstanding job in the classroom.

The major focus of IT is to prepare individuals for technical and industrial management positions. Major economic sectors (i.e.,



manufacturing, agriculture, and service) have high demands for qualified technical managers who can contribute to better product reliability, efficiency, and improved productivity. Examples of positions held by IT graduates are assistant plant engineer, fleet service representative, manufacturing engineer, operations supervisor, production planning analyst, production scheduling coordinator, and quality control supervisor.

Average salaries for CSU Fresno IT graduates are commensurate with those offered to business managers and engineers in the greater Bay Area and Los Angeles areas. IT graduates typically enjoy career growth in both management and technological pathways.

Enrichment opportunities abound for IT students. Professional societies active in the program include the American Society of Automotive Engineers (SAE), Advanced Technology Enterprises (ATE), and the American Society of Quality Control (ASQC). Through participation in one or more of these groups, students learn more about their profession and interact with working professionals in their field. Internships are also available to provide on-the-job experience to interested students.

The Master of Science in Industrial Technology program prepares graduates to assume positions of leadership and management. The program consists of a common core of 18 units of technical management courses and 12 units of elective courses, depending on the individual's educational and career objectives.

## Mission Statement

The mission of the department is to serve (a) students with technical interests in automation technology and information technology; (b) regional economic needs; and (c) global manufacturing and agricultural academic advancement. The program encourages hands-on education, problem-solving, and applied research while providing services to the public, business, and industrial sectors.

The characteristics of the Industrial Technology curriculum are (a) advocating multiple cognitive-channel learning, i.e., audio, visual, and kinesthetic; (b) promoting development of "transferable" professional skills, such as written/oral communication, leadership, and people skills; (c) emphasizing cumulating experiences of knowledge applications and system integration; and (d) striving to serve manufacturing/processing/agricultural industries to achieve desired goals efficiently and with appropriate concern for the environment, ethics, quality, and human diversity.

## Instructional Facilities

The department's laboratory facilities are some of the most extensive and modern in the California State University system. The Industrial Technology Department continues to receive equipment and financial support from a number of California industries. Some facilities supported include the computer-aided design (CAD) lab, digital and analog electronics lab, hydraulics lab, process control/programmable logic controller lab, materials and fuels testing

lab, robotics/computer numerical control (CNC)/computer integrated manufacturing (CIM) lab, motors and controls lab, and computer network lab.

## Faculty

Matthew M. Yen, *Chair*

*Coordinator:*

Darnell P. Austin, *Technology Teacher Education*

Balaji Sethuramasamyraja

Tony M. Au

## Bachelor of Science Degree Requirements

*Industrial Technology Major*      *Units*

**Major requirements ..... 68**

**Technical Core.....(29)**

IT 52, 74, 102, 104, 114, 115,  
196, 199; DS 73; CHEM 3A

**Management Core ..... (18)**

IT 92, 107, 117, 118, 137,  
148

**Specialty Area ..... (21)**

Consult with a department adviser to develop 21 units of electives to satisfy the "specialty" requirements. Electives should be chosen from the following list with adviser approval: IT 30, 41, 58, 63, 110, 112, 116, 120, 121, 122, 127, 129, 131, 133, 134, 144, 146, 147, 156, 164, 165, 177, 184, 190, 191T, 194.

*Emphases:*

- CAD/CAM Systems Management
- Industrial Control Systems Management
- Quality Systems Management
- Transportation Systems Management
- Networking Systems Management

**General Education requirements ..... 51**

(Includes 12 upper-division units, to be taken no sooner than the term in which 60 units of coursework are completed.)

**Additional requirements ..... 1**

Upper-division writing skills: Students must pass the Upper-Division Writing Exam or complete IT 198W (recommended); PHYS 2A, IT 20. (*Note:* PHYS 2A and IT 20 satisfy two G.E. area requirements [B1 and D3]. Consult the

*Class Schedule* for a current list of approved G.E. courses).

**Total units ..... 120\***

\*This total indicates that PHYS 2A and IT 20 also may be applied to G.E. area requirements, and it presumes that the student has fulfilled the Upper-Division Writing Skills requirement by passing the Upper-Division Writing Exam for zero units. Contact the department chair or faculty adviser for additional details.

### Advising Notes

1. All courses (except IT 194) required for the major must receive a letter grade.
2. Students must pass the upper-division writing exam or complete IT 198W with a grade of C or higher (to be taken no sooner than the term in which 60 units are completed) to fulfill the upper-division writing skills graduation requirement.

See the catalog Web Site for recommended program at [www.csufresno.edu/catoffice/current/industrec.html](http://www.csufresno.edu/catoffice/current/industrec.html).

### Industrial Technology Minor

The Minor in Industrial Technology consists of 20 units of which 9 must be upper-division. At least 12 units must be taken in one of these specialized areas of study: CAD/CAM systems management, industrial control systems management, networking systems management, quality systems management, or transportation systems management.

*Note:* The Industrial Technology Minor also requires a 2.0 GPA and 6 upper-division units in residence.

### Certificate in Network Routing and Internetworking Technology

The Certificate in Network Routing and Internetworking consists of 16 units in industrial technology courses. The student is required to take IT 58, 63, 164, and 165. In addition, 3 units must be selected from the following: IT 116, 146, 190, 194.

### Certificate in Computer Process Control Network Administration

The Certificate in Computer Process Control Network Administration consists of 19 units in industrial technology coursework. The student is required to take IT 58, 112, 117, and 133. In addition, 3 units must be selected from the following: IT 116, 134, 156, 177, 190, or 194.

### Industry and Technology Teaching Credential Waiver Program

The following course of study will prepare students for entry into the teacher education program. Students will complete the 120 unit requirement for the Bachelor of Science in Industrial Technology (BSIT) with teacher credentialing as their optional emphasis.

1. Complete the BSIT General Education requirement (51 units)
2. Complete the BSIT Technical Core (29 units)
3. Complete the BSIT Management Core (18 units)
4. Complete the Teacher Education Credential Core (15 units):  
IT 12, 30, 58, 80; EHD 50
5. Area of emphasis (6 units)  
Select one area of emphasis below and take a minimum of 6 units in that area.
  - Engineering Design Technology: IT 41, 116, 144, 147, 177
  - Communication Technology: IT 63, 103, 116, 146, 164, 165
  - Manufacturing Technology: IT 112, 131, 133, 134, 156, 177, 184
  - Power, Energy, and Transportation: IT 106, 110, 120, 122, 127, 129
6. Additional requirements (1 unit)

Upper-division writing skills as noted under the BSIT requirements.

### Master of Science Degree Requirements

The Master of Science in Industrial Technology is a 30-unit program which offers graduate study in both industrial and educational related professional and technical fields. Emphasis is directed toward the attainment of advanced competency in the areas of industrial and technology education as well as manufacturing technology. Through selected courses, within the department and other disciplines, knowledge and experience can be acquired in research and development, management and administration, technological studies, and educational studies that are related to all areas of the field.

**Admission Requirements.** The Master of Science degree program in Industrial Technology assumes preparation equivalent to a CSU undergraduate major in technol-

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ogy education (industrial arts), industrial technology, or a related field. Students who have not completed a degree in technology education or industrial technology are expected to have completed the following courses or their equivalents prior to enrollment in courses to be applied toward the master's program: IT 41, 52, 74, 102, 114, 115; MATH 11 or DS 71.

Applicants whose preparatory education was principally in a language other than English must earn a minimum TOEFL score of 550.

**Classified Standing.** A baccalaureate degree is required and an undergraduate major in technology education, industrial technology, or a related field; a 3.0 GPA (last 60 semester units); a 450V/430Q GRE score; three letters of reference from employers or faculty at the university attended most recently; a personal statement of 500 words or less indicating reasons for pursuing a master's degree; a preadmission consultation session with the department graduate program coordinator. Students lacking in any area with compensating strengths in other areas are encouraged to apply.

**Conditional classified standing** may be granted to petitioning applicants with a 2.5 to 2.99 GPA (last 60 semester units); GRE scores on file with the university; three letters of reference; and a personal statement of 500 words or less. Students must request classified standing in the program by the semester in which a maximum of 10 units to be used toward the degree are completed.

**Program Requirements.** Under the direction of a graduate adviser, each student prepares and submits a coherent program individually designed within the following framework:

<i>Specific Requirements</i>	<i>Units</i>
<b>Required courses</b> .....	<b>15</b>
IT 223, 280, 282, 283, 285	
<b>Electives in industrial technology or related field</b> .....	<b>12</b>
(approved electives appropriate to individually designed program; a maximum of 9 units may be 100-level courses)	
<b>Culminating Experience</b> .....	<b>3</b>
IT 298 or 299	
<b>Total minimum requirements</b> .....	<b>30</b>

## Graduate Advising Notes

1. Upon admission, students should see the department graduate program coordinator for aid in program planning.
2. To progress through the graduate program, students must:
  - a. Maintain a minimum 3.0 GPA
  - b. Complete all prerequisite coursework
  - c. Attain classified standing
  - d. Meet the graduate writing skills requirement
  - e. File for advancement to candidacy
  - f. Complete the program requirements
  - g. File a master's thesis or project committee assignment form
  - h. Formally present and defend the thesis or project results
3. Classified standing must be achieved by the semester in which students take the 10th program unit. All admission requirements must be met. Students must maintain a 3.0 GPA.
4. Students must meet the university graduate writing competency requirement by passing the writing component of IT 280 or AGRI 220. Students should complete the writing requirement prior to advancement to candidacy.
5. Advancement to candidacy requires the completion of 9 program units at California State University, Fresno, a minimum GPA of 3.0, meeting the graduate writing skills requirement, and filing a Petition for Advancement to Candidacy a minimum of one semester prior to enrollment in thesis or project and by established deadline.

## COURSES

### *Industrial Technology (IT)*

**IT 12. Basic Vehicle Systems (3)**  
Design, construction, and mechanical functions of vehicle engines, fuel systems, electrical systems, power transmission, brakes, and wheel suspension; proper use and safety of tools and equipment. (2 lecture, 2 lab hours)

**IT 20. Technology and Society (3)**  
Prerequisite: G.E. Foundation A2. Critical relationship between society and technology. Technology, as it applies to contemporary issues such as technology and gender, the fate of skill and labor's power under changing

conditions, technology and war, the problem of technocracy, technology and consumer culture, and technological relations to the natural environment. G.E. Breadth D3.

**IT 30. Exploring Technology Systems (3)**  
Survey of the technology systems discipline including history (medieval apprenticeship to present), technology subsystems (information and communications, transportation, manufacturing, construction), and relationships to other disciplines, including business, industry, and education. (2 lecture, 2 lab hours; field trips)

**IT 41. Industrial Design Graphics (3)**  
Application of the fundamentals of industrial design graphics. Sketching, lettering, orthographic projection, working drawings, auxiliary views, dimensioning, developments, pictorial drawings, duplication; interrelationship to the design process. Introduction to CAD. (6 lab hours)

**IT 45. Industrial Technology Exhibits and Competitions (3)**  
Provides a structure for students to be involved in various industrial technology exhibits and competitions, industrial technology research and development, project management, and team work. *CR/NC* grading only. (6 lab hours)

**IT 52. Electricity and Electronics (3)**  
(Same as MEAG 53.) Introduction to electricity including fundamentals of electrostatics, alternating and direct current electrical circuits, electrical calculations, magnetics, circuit applications, electrical measuring, and test equipment. Schematics and wiring diagrams, standards, and codes. (2 lecture, 2 lab hours) (Course fee, \$5)

**IT 58. Applied Computer Networking I (4)**  
Internet, intranet, local area network concepts, protocols, architectures, and implementation issues. Data communication in office technology and manufacturing automation. (2 lecture, 4 lab hours; field trips) (Formerly IT 158)

**IT 60. Basic Graphic Arts (3)**  
Introduction to the graphic arts; letterpress, photo offset lithography, screen printing; layout, composition, imposition, presswork, bindery. (6 lab hours; field trips) (Course fee, \$6)

**IT 63. Applied Computer Networking II (4)**  
Prerequisite: IT 58. Understanding complex networks, such as IP, IPX, Frame Relay and ISDN. An analysis of the technology used

to increase bandwidth and quicken network response times. Network security, global intranet, custom queuing, and routed priority services. (2 lecture, 4 lab hours; field trips) (Formerly IT 163)

**IT 71. Metallurgical Processes (3)**  
(Same as MEAG 50.) Fundamentals of metallurgy; properties and characteristics of metals; survey of metal welding processes, equipment, and procedures; theory-discussion and laboratory experience in oxygen-fuel welding, cutting, brazing, and shielded metallic arc welding. (2 lecture, 3 lab hours) (Course fee, \$7)

**IT 74. Manufacturing Processes (3)**  
Study of how consumer and industrial products are manufactured, focusing on how raw materials (primarily metal and plastic) are changed into finished products. Topics include production processes of material addition, forming, casting, removal, separation, assembly, and finishing. (2 lecture, 2 lab hours) (Course fee, \$7)

**IT 80. Wood Processing Technology (3)**  
Wood properties, materials, finishing; hand, portable electric, and machine tool processing; design, production planning; safety, adhesives, and cutting principles; machine design and use. (6 lab hours) (Course fee, \$10)

**IT 92. Safety Management (3)**  
Principles of safety management in an industrial and agricultural environment; safety legislation and programs; management/supervisory and employee responsibilities and attitudes; physical hazards associated with chemicals, equipment, fire, compressed gases; other topics include eye, stress, drugs, lifting, office, and noise safety.

**IT 102. Industrial Computer Concepts and Applications (3)**  
Introduction to computer systems hardware and software, operating system basics and installation, computer maintenance and troubleshooting. (2 lecture, 2 lab hours)

**IT 103. Network Operating Systems (3)**  
Prerequisite: IT 102. Introduction to multi-user and multitasking network operating systems. Covers characteristics of the Linux, Windows 2000, NT, and XP network operating systems. Installation procedures, security issues, backup procedures, and remote access. (2 lecture, 2 lab hours)

**IT 104. Product Design (3)**  
Prerequisite: IT 115. Elements, principles, and methods of design. Emphasis will be placed on the development of models and prototypes with attention to standard components, productivity, and packaging. (2 lecture, 2 lab hours)

**IT 106. Energy Conversion and Utilization (3)**  
Fundamental sources of energy, including the following energy conversion systems: direct mechanical, external combustion, internal combustion, solar power, wind power, electrical and atomic systems. Experiments and demonstrations. (2 lecture, 2 lab hours; field trips)

**IT 107. Facilities Planning and Materials Handling (3)**  
Facility planning techniques as applied to facility location, zoning, building codes, line balancing, shipping-receiving, offices, material handling, storage, project scheduling, and computerized layout.

**IT 110. Fluid Power (3)**  
Prerequisite: IT 52. Selective study of fluid power principles and applications; hydraulics, pneumatics, and vacuum; includes pumps, controls, transmission systems, actuators, and fluidics. In-depth study of air conditioning-heating theory and applications. (6 lab hours; field trips) (Course fee, \$5)

**IT 112. Industrial Process Control Systems I (3)**  
Prerequisite: IT 52. Process control principles; components and principles; transducers, actuators, sensors, and instrumentation; computer interface software, terminologies, standards, and trends in control technologies. Programmable logic controller principles, hardware, and software. (2 lecture, 2 lab hours)

**IT 114. Industrial Materials (3)**  
Chemical and physical properties of metals, polymers, ceramics, composites. Atomic structure and phases of matter emphasizing crystalline and amorphous solids. Mechanical properties, strength and testing of materials including impact, hardness, and tensile. Metallographic, microscopic inspection of electronic, and metallic specimens. (2 lecture, 2 lab hours)

**IT 115. Design and Documentation Systems (3)**  
IT 41 recommended prior to enrollment. Design and documentation systems used in business and industry. CAD principles and applications, product development process, design process management, design review, concurrent engineering, value analysis. (2 lecture, 2 lab hours)

**IT 116. Applied Visual Programming (3)**  
Contemporary computer language used in office automation and manufacturing industry; basic concepts on structural programming, object-oriented language, programming mechanics, user interface development, and Internet applications. (2 lecture, 2 lab hours)

**IT 117. Quality Assurance (3)**  
Prerequisites: DS 73 or MATH 11. Quality assurance principles and practices in industry: quality assurance systems, acceptance sampling, testing, source surveillance; probability and statistical concepts, process control techniques and measurement procedures as applied to quality.

**IT 118. Production Operations (3)**  
Prerequisite: IT 102. A survey of production manufacturing operations: quality assurance, work sampling, testing, time and motion study; routing, scheduling, and inventory control; flow processes, material handling, and automation. (Field trips)

**IT 120. Vehicle Engine Systems (3)**  
Prerequisites: IT 12, 52 or concurrently. Advanced study of vehicle engines and support systems. Includes engine theory, fuel and electrical systems, turbochargers, LPG, diesel, computerized emission and engine controls, and dynamometer testing analysis. (6 lab hours; field trips)

**IT 121. Automotive Engine Machining (3)**  
Prerequisites: IT 12, 74. Advanced study of automotive engine machining including precision measurements, principles of engine operation, machining of engine components, crack detection, assembly procedures, lubricating and cooling systems. (6 lab hours; field trips) (Course fee, \$6)

**IT 122. Vehicle Chassis Analysis (3)**  
Prerequisite: IT 12. Advanced study of vehicle chassis components including power transmission, brake systems, wheel suspension, air conditioning, body repair and refinishing, computer controls and diagnostics. (2 lecture, 2 lab hours; field trips)

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### IT 127. Vehicle Design and Development (3)

Design and mechanical development of vehicles for intercollegiate competition events. Students will select one or more vehicle research projects: innovative future fuels, supermileage, mini baja, formula, aero design, walking robot. (6 lab hours)

### IT 129. Vehicle Diagnostic Procedures (3)

Prerequisites: IT 12, 52 or concurrently. Laboratory study and analysis of mechanical, electrical, and computer control problems. Technical reports. (6 lab hours) (Course fee, \$5)

### IT 131. Automated Systems I (3)

Prerequisite: IT 52. Number systems, Boolean logic, and fundamentals of digital devices; basic applications of logic devices in computers and control systems. (2 lecture, 2 lab hours; field trips) (Course fee, \$5)

### IT 133. Industrial Process Control Systems II (3)

Prerequisite: IT 52. Programmable logic controller principles and equipment; programming languages, procedures, and documentation; equipment and software selection and application. (2 lecture, 2 lab hours)

### IT 134. Computer-Aided Manufacturing Systems I (3)

Prerequisite: IT 74. Study, analysis, and evaluation of robotics systems. APT programming language for numerical control and application languages for robots. Use of robot vision and the geometry of computer vision applications. (2 lecture, 2 lab hours)

### IT 137. International Quality Standards (3)

Prerequisite: IT 117. ISO 9000 and related international quality systems. Implementation process. Conformance standards, quality system requirements, and the registration and audit processes.

### IT 144. Tool Design Graphics (3)

Application of graphics to industrial work holding devices; their application, drawing, and design. Construction of working drawings aided by standards, company catalogs, and handbooks. Final designs subjected to student presentation and evaluation. (6 lab hours; field trips)

### IT 146. Multimedia Development (3)

Integration of a variety of media types: graphics, animation, digital video, and sound. Emphasis placed on development and creation of multimedia as applied to various CAD/CAM projects, the process of bringing live interactivity to the Internet, Web page development, and desktop publishing.

### IT 147. Advanced CAD Applications (3)

Prerequisites: IT 115. CAD as a tool to facilitate design activities. An overview of design processes and methods. Solid modeling techniques are introduced. A team approach in system design is emphasized. (2 lecture, 2 lab hours)

### IT 148. Project Management and Control (3)

Project management process and tools, planning, scheduling, organizing, and controlling projects. Project planning and control using qualitative and quantitative methods. (2 lecture, 2 lab hours)

### IT 156. Automated Systems II (3)

Prerequisite: IT 52. Study and analysis of the characteristics and industrial applications of electric motors. Major emphasis is placed on programmable, solid state, and electromechanical motor controllers. (2 lecture, 2 lab hours; field trips) (Course fee, \$4)

### IT 164. Routers and Internetworking I (4)

Prerequisite: IT 63. Implementation of appropriate technologies to build a scalable routed network. Building of campus networks using multilayer switching technologies. Improving traffic flow, reliability, redundancy, and performance for campus LANs, routed and switched WANs, and remote access networks. (2 lecture, 4 lab hours)

### IT 165. Routers and Internetworking II (4)

Prerequisite: IT 164. Creation and deployment of a global internet. Troubleshooting an environment that uses routers and switches for multiprotocol client hosts and services. Addresses those tasks that network managers and administrators need to perform in managing access and controlling overhead traffic over LANs and WANs. Connecting corporate networks to an Internet Service Provider (ISP). (2 lecture, 4 lab hours)

### IT 177. Computer-Aided Manufacturing Systems II (3)

Prerequisite: IT 74. Computer numerically controlled hardware including milling and turning centers and flexible manufacturing systems. Programming in languages common to computer numerically controlled machine tools. Computer-controlled machining of industrial materials including aluminum, brass, steel, plastic, expanded foam, and wax. (2 lecture, 2 lab hours)

### IT 184. Advanced Manufacturing Technology (3)

Prerequisite: IT 74. Production processing, using metallic and nonmetallic materials, including product design, work cells, tooling, capacity planning, material handling, scheduling and flow chart. (2 lecture, 2 lab hours; field trips) (Course fee, \$10)

### IT 190. Independent Study (1-3; max total 6)

See *Academic Placement — Independent Study*. Approved for *RP* grading.

### IT 191T. Technical Topics in Industrial Technology (1-3; max total 6)

Prerequisite: permission of instructor. Investigation and analysis of selected subjects in industrial technology. (2-6 lab hours)

### IT 194. Cooperative Education in Industrial Technology (1-4; max total 12)

Prerequisites: courses appropriate to the work experience; permission of department cooperative education coordinator; junior standing. Integration of work experience with academic program, individually planned through program adviser. *CR/NC* grading only.

### IT 196. Senior Seminar (1)

Prerequisite: senior standing. Exploration of technology systems management trends and preparation for employment or further study in technical fields. Technology forecasting, orientation to professional certifications, employment correspondence, and interview techniques. *CR/NC* grading only.

**IT 198W. Technical Writing (3)**

Prerequisites: satisfactory completion (C or better) of the ENGL 5B and 10 graduation requirement; to be taken no sooner than the term in which 60 units are completed. Preparation of technical reports, research proposals, specifications, resumes, and correspondence using effective writing techniques, formats, and styles. Meets upper-division writing skills requirement for graduation.

**IT 199. Senior Problem in Industrial Technology (3)**

Prerequisite: successful completion of Upper-Division Writing Exam or IT 198W. Approved problem or research project, with seminar, in the area of the student's option and emphasis. Approved for *RP* grading.

**GRADUATE COURSES**

(See *Catalog Numbering System*.)

The following graduate courses are open only to students who have been accepted into a graduate program. Students who are not in graduate standing should contact the department graduate coordinator prior to enrolling.

***Industrial Technology (IT)*****IT 223. Management of New Technology (3)**

Study of new technology and its impact on people and their institutions. Topics focus on rapid technological changes as they relate to adoption, implementation, management strategies, and social issues.

**IT 280. Research Methodology (3)**

Prerequisites: MATH 11 or DS 73. Seminar in research procedures in industrial education and technology; basic bibliography, research form and methods.

**IT 282. Advanced Communication Concepts and Visual Presentations (3)**

Prerequisite: IT 115. Preparation and use of agendas, memoranda, business letters, electronic mail, fax communications. Video development and slide and transparency preparation and the incorporation of these media into presentations. Interview techniques, resume evaluations, dictation skills, professional relations with personnel, business etiquette.

**IT 283. Advanced Materials and Processes (3)**

Prerequisite: IT 114. Chemical and physical properties of metals, polymers, ceramics and composites. The atomic structure and phases of matter emphasizing crystalline and amorphous solids. Materials technology of metallic, polymeric, ceramic, and advanced composites are stressed.

**IT 284T. Topics in Industrial Technology (2-3; max total 9 toward master's degree if no area repeated)**

Advanced study in technical areas; current industrial practices, developments and trends related to design, materials, and processes.

**IT 285. Advanced Manufacturing Systems (3)**

Prerequisites: IT 74, 115. A comprehensive study of modern manufacturing systems. Topics include plant layout, material control and transfer, operations measurement, transfer lines, CNC and DNC, machine tool network, computer-integrated manufacturing, flexible manufacturing systems, group technology, robotics, and manual assembly systems.

**IT 286. Applied Spatial Technology (3)**

Survey of geo-spatial technologies, e.g. geographical information system and global positioning system. Applications of GIS/GPS, remote sensing, imaging technology, and geo-database in fields of logistics, agriculture, and business. Spatial information management for precision agriculture, agriculture business, food system, and public policy. (Formerly IT 284T)

**IT 290. Independent Study**

(1-3; max total 6 if no area repeated; max combined total with IT 270 is 12) See *Academic Placement — Independent Study*. Approved for *RP* grading.

**IT 298. Project (3)**

Prerequisites: IT 280; prior advancement to candidacy. See *Criteria for Thesis and Project*. Completion of an approved project appropriate to the candidate's area of specialization involving the development of a physical prototype or other similar professional problem-solving activity with extensive written documentation. Abstract required. Approved for *RP* grading.

**IT 299. Thesis (3)**

Prerequisites: IT 280; prior advancement to candidacy. See *Criteria for Thesis and Project*. Preparation, completion, and submission of an acceptable thesis for the master's degree. Approved for *RP* grading.

**IN-SERVICE COURSE**

(See *Catalog Numbering System*.)

***Industrial Technology (IT)***

**IT 341. Problems in Industrial Technology (2-3; max total 6 if no area repeated)**  
Prerequisite: permission of instructor. Intensive analysis of a selected area in industrial technology. Research paper, project, or reports.