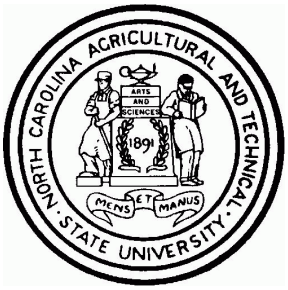

INDUSTRIAL AND SYSTEMS ENGINEERING

UNDERGRADUATE PROGRAM STUDENT HANDBOOK

2007-2008

DRAFT: 8/22/07

This is not a legal document. This handbook is subject to change upon faculty approval. All undergraduate Industrial and Systems Engineering students are advised to use this book as a guide and to regularly contact their advisors for course selection and approval of registration.

This Handbook provides information about the BSIE curriculum. All Industrial and Systems Engineering (ISE) students should read it and fully understand its contents. Students should also read and understand the University Bulletin for Undergraduate Programs at North Carolina A&T State University. Each ISE major is responsible for knowing the contents and following the prescribed rules and regulations documented in this handbook and the University Bulletin.

If you have questions, please contact your advisor.

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CHAPTER I
THE INDUSTRIAL ENGINEERING PROFESSION

(Portions of this chapter have been adapted from *Turner, Mize and Case, INTRODUCTION TO INDUSTRIAL AND SYSTEMS ENGINEERING, 3rd Ed., 1993, pp. 3-6, 16-18, 20-22, 24-34. Reprinted by permission of Prentice-Hall Inc., Englewood Cliffs, New Jersey).*

Overview of Industrial Engineering Activities

With the onset of the Industrial Revolution came the need for technically trained people who could visualize, plan and organize large and complex systems. Industrial Engineering emerged as a profession to increase the efficiency and effectiveness of these operations.

The formal definition of Industrial Engineering recently given by the Institute of Industrial Engineers (IIE) is as follows:

"Industrial Engineering is concerned with the design, improvement and installation of integrated systems of people, materials, information, equipment and energy. It draws upon specialized knowledge and skill in the mathematical, physical, social and information sciences together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems."

The word "Industrial" in the above definition also refers to service enterprises as well as manufacturing organizations that seek the skills of Industrial Engineers.

Different companies expect their Industrial Engineers (IE's) to perform different kinds of activities. The following list includes essentially all the different activities that a practicing IE might be expected to perform:

A. Related to the product or service
   1. Analyze a proposed product or service
      (a) determine whether it would be profitable
      (b) determine if compatible with existing production line
      (c) determine best product design
      (d) determine best material
   2. Constantly attempt to improve existing products or services
   3. Perform analyses relating to distribution of the product or delivery of the services

B. Related to the process
   1. Determine best process and method of manufacture
   2. Select equipment
   3. Determine best sequence of operations; balance assembly lines
   4. Determine best layout of equipment
   5. Determine best material flow and material handling procedures
   6. Determine best organization of material supply
   7. Design work place
   8. Design storage facilities

C. Related to production or operations
1. Forecast the level of activity
2. Analyze capacity and resource constraints
3. Perform operations planning:
(a) facilities arrangement and materials handling
(b) make or buy decisions
(c) plan production rates
(d) construct master production plans
(e) materials requirement planning
4. Perform inventory analyses:
(a) raw materials
(b) in-process
(c) finished goods
(d) multi-level inventory analyses
5. Perform operations scheduling:
(a) resource allocation
(b) schedule assembly operations
(c) schedule component production
(d) design procedures for schedule review and update
6. Simultaneous smoothing of production, inventory, and work force
7. Design quality control systems and inspection procedures
8. Perform methods improvement and work simplification studies

D. Related to personnel
1. Design of procedures for employee selection, testing, and training
2. Design and install job evaluation and wage incentive systems
3. Design safety procedures
4. Apply the principles of human engineering to work design
5. Coordinate the efforts of and be able to converse intelligently with individuals have diverse backgrounds and professional specialties
6. Apply the fundamentals of labor relations in dealing with worker groups

E. Related to control
1. Develop work standards
2. Design meaningful effectiveness measures for operations control
3. Design methods and systems for analyzing
4. Specify corrective action procedures for operations management and control
5. Organize and present results and recommended action to higher management
6. Determine the best management information system design

F. Related to finance and cost
1. Design budgeting system
2. Evaluate alternative economic decisions
3. Perform value engineering studies
4. Design and implement capital flow procedures
5. Design meaningful cost reduction programs

G. Related to planning
1. Participate in studies involving:

(a) long-range planning
(b) expansion decisions and capacity analyses
(c) plant location and relocation
(d) new product lines

2. Participate in studies of the organizational structure of the firm

H. Related to analyses

1. Analyze a system and construct models of it
2. State explicitly the problem being studied
3. Recognize the appropriate solution method
4. Apply fundamental solution methodologies
5. Recognize need for "experts" when problem is complex
6. Recognize all assumptions pertaining to the model and to the solution method
7. Interpret the results of the solution in terms of the original problem statement and the underlying assumptions
8. Use quantitative decision models where practicable
9. Recognize the dynamic nature of the system being studied and include this feature in proposed solutions

I. Related to design

1. "Optimally" design systems for:
   (a) information processing and control
   (b) operations planning and control
   (c) specific work activities
   (d) storage and distribution of products
   (e) transportation of people, products, and material
   (f) financial and budget control
2. Recognize the interaction of system components and attempt to optimize the performance of the entire system rather than one of its parts includes essentially all the different activities that a practicing IE might be expected to perform:

Employment Opportunities

Industrial Engineering has one of the most encouraging future outlooks regarding employment opportunities. This is attributed to increasing recognition in U.S. organizations of the value of an Industrial Engineer's role in their operations. Because of the type of education industrial engineers receive, they are often promoted to management positions within 5 to 10 years after graduation.

Professional Registration

Engineers can secure professional registration. There are several advantages to being professionally registered, which are:

1. Full membership in the profession of engineering: No engineering credential is as widely accepted in engineering as the title of Professional Engineer (PE)
2. Preparation for career unpredictability: You may find that registration is necessary in order to qualify for a particular position or that it enhances your opportunities in an existing job. If you are thinking of doing work abroad, a PE license earned in the US will carry weight. Also if you leave engineering work for a year or more the PE will help you to regain employment later as an engineer.

3. Admission to practice in some occupations: In most states, you cannot offer your services as a consulting engineer without being licensed as a PE. In many companies, engineering registration is necessary before your company will allow you to testify before a public hearing as an expert.
4. Mobility and job security: Having a PE is an additional credential valued by most employers giving you job security and even mobility.
5. Public benefit: If you have a public license to practice engineering, the public is assured that you have passed a rigorous set of procedures chosen to safeguard the health, safety and welfare of the public.

There are two major steps in securing a PE license: (i) pass the Fundamentals of Engineering (FE) exam, and (ii) after four years of engineering design experience, pass the PE Exam. The FE consists of two parts: a morning exam is common to all disciplines of engineering and an afternoon exam specific to the engineering discipline. The PE exam is given in each engineering discipline.

The FE exam is given twice a year and covers most engineering courses in your curriculum. It is advisable to take this exam when you are a senior, as most of the subject material is still clear in your mind. Also, the department offers a preparatory course for FE that is free for our students.

What can you do now, towards getting a PE? Visit the FE website and download a copy of the FE reference book (free of charge). Plan to take the FE preparatory course in the first semester of the senior year. Apply for the FE Exam, prepare for it and take the exam in your senior year.

You can obtain more information about PE registration from North Carolina Board of Examiners For Engineers and Surveyors' web site http://www.ncbels.org or by contacting them at North Carolina Board of Examiners For Engineers and Surveyors, 310 West Millbrook Road, Raleigh, North Carolina 27609, Telephone Number (919) 841-4000, Fax Number (919) 841-4012.

CHAPTER II
GENERAL INFORMATION

The University

North Carolina Agricultural and Technical State University (NC A&T) is one of sixteen constituent institutions of the University of North Carolina system. Established in 1891 as a land grant university, NC A&T is a comprehensive educational institution with an integrated faculty and student body. Degrees are offered at bachelors, masters and doctoral levels. The programs of the University focus on the broad fields of agriculture, education, engineering, technology, business, nursing, sciences, and the liberal arts. The University is a fully accredited member of the Southern Association of Colleges and Schools. The campus is in Greensboro, within 30 miles of Winston-Salem, High Point and Burlington, the major cities of the Piedmont Triad region of North Carolina.

The College of Engineering

The College of Engineering at North Carolina A&T State University is one of three state supported engineering schools. The College of Engineering is located at 1601 East Market Street in Greensboro. Academic programs exist in:

- Bioenvironmental Engineering
- Architectural Engineering
- Chemical Engineering
- Civil and Environmental Engineering
- Computer Science
- Electrical Engineering
- Computer Engineering
- Industrial and Systems Engineering
- Mechanical Engineering

The Department of Industrial and Systems Engineering

The Department of Industrial and Systems Engineering was established in 1977. Twelve full time, and two part-time professors serve the Department. There are laboratories for Product, Process, and Facility Design; Manufacturing Processes and Systems; Automated Assembly and Packaging; Logistics and Warehousing; Human Performance; Human Machine Interface and Controls; Management and Simulation Systems; and Information Systems. The Industrial and Systems Engineering Department enjoys support from the College of Engineering, the University and the local industries.

In addition to the Bachelor of Science program in Industrial Engineering, the ISE Department offers the Master of Science in Industrial Engineering as well as the Doctor of Philosophy in Industrial Engineering degrees.

Accreditation

The program of study leading to the Bachelor of Science in Industrial Engineering (BSIE) is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (EAC/ABET).

Alumni

Approximately 600 companies and government agencies visit the campus every year to recruit NC A&T students. Our graduates are employed by many reputable firms such as GE, GM, AT&T, Westinghouse and IBM. Some of our alumni are pursuing graduate studies in various universities such as George Tech, Virginia Polytechnic Institute, Ohio State, North Carolina State, Purdue, Penn. State, Oklahoma and Clemson. Many graduates are employed in government agencies such as the EPA, FAA, NASA, U.S. Army, and Naval Shipyard. Among the many companies that vigorously recruit ISE graduates from NC A&T State University are:

· General Motors	· Miller Brewing	· Intel
· Northern Telecom	· Westinghouse	· Xerox
· ALCOA	· Merck Pharmaceutical	· Texas Instruments
· BellSouth	· AT&T	· Sara Lee
· IBM	· Ford Motors	· Lucent Tech.
· Accenture	· Motorola	· Timken
· Kimberly - Clark	· Procter and Gamble	· Morgan Stanley

Student Activities

Among the professional engineering organizations in which Industrial and Systems Engineering students participate are:

- Institute of Industrial Engineers (IIE)
- Society of Manufacturing Engineers (SME)
- Human Factors and Ergonomics Society (HFES)
- Institute for Operations Research and Management Science (INFORMS)
- National Society of Black Engineers (NSBE)
- Society of Women Engineers (SWE)
- National Society of Professional Engineers (NSPE)
- American Society for Quality (ASQ)
- Association for Operations Management (APICS)
- Alpha Pi Mu Honor Society
- Tau Beta Pi Honor Society

The Department and the College support student chapters for many of these societies. In addition, there are many campus-wide extra-curricular activities, including sports, publications, music, drama, student government and religious groups.

Classes

The Department limits class sizes to encourage better student-teacher interaction.

Faculty

All full-time, non adjunct faculty members have earned doctorates in Industrial Engineering. Their teaching and research interests are diverse and reflect a range of interests within the IE discipline. Additionally, persons from industry with specialized expertise present seminars and may teach courses in their areas. The following are full-time professors in the ISE Department:

- **Davis, Lauren,** BS, Computational Mathematics, Rochester Institute of Technology; MSIME, Rensselaer Polytechnic Institute; Ph.D. North Carolina State University; Assistant Professor; Rm. 404 McNair Hall, lbdavis@ncat.edu
- **Desai, Salil, L.,** BSME, University of Bombay; MSIE, Ph.D., University of Pittsburgh; Assistant Professor; Rm. 423 McNair Hall, sdesai@ncat.edu
- **Hong, Joseph,** BA, So-gang University, Korea; M.S., North Carolina A&T State University; Adjunct Assistant Professor; Rm. 422A McNair Hall; jhong@ncat.edu
- **Jiang, Xiaochun (Steven),** MSME, East China Institute of Technology; MS, Mfg. Engineering, Nanjing University of Science & Technology; Ph.D., Industrial Engineering, Clemson University; Assistant Professor, Rm. 403 McNair Hall; xjiang@ncat.edu
- **Mountjoy, Daniel N.,** BSE, MSE, Wright State University; Ph.D., North Carolina State University; Adjunct Associate Professor; Rm. 424 McNair Hall; mountjoy@ncat.edu
- **Ntuen, Celestine A.**, NCE, College of Education, Uyo, Nigeria; BSIE, MSIE, Ph.D., West Virginia University; Distinguished University Professor; Rm. 422-B McNair Hall; ntuen@ncat.edu
- **Oneyear, Steven**, BS, MS, Industrial Technology, University of Wisconsin; Adjunct Associate Professor; Rm. 425 McNair Hall; sjoneyear@ncat.edu
- **Park, Eui H.**, BS, Yonsei University; MBA, City University; MSIE, Ph.D., Mississippi State University; Professor; Rm. 401 McNair Hall; park@ncat.edu
- **Qu, Xiuli (Shelly),** BEEE, MSEE, University of Science and Technology Beijing; MSIE, PhD., Purdue University; Rm 424 McNair Hall; xqu@ncat.edu
- **Ram, Bala**, BSME, MSIE, Indian Institute of Technology, Madras; Ph.D., State University of New York at Buffalo; Professional Engineer; Professor; Rm. 426-B McNair Hall; ram@ncat.edu
- **Samanlioglu, Funda,** BS, Yildiz Technical University; MSIE, Ph.D. Clemson University, Assistant Professor; Rm.406 McNair Hall; fsamanli@ncat.edu
- **Sarin, Sanjiv**, BSChE, MSIE, Indian Institute of Technology, Delhi; Ph.D., State University of New York at Buffalo; Professional Engineer; Professor; Rm. 426-A McNair Hall; sarin@ncat.edu
- **Seong, Younho,** BSIE, MSIE, Incheon University; Ph.D., State University of New York at Buffalo; Assistant Professor;
  Rm. 405 McNair Hall; yseong@ncat.edu
- **Stanfield, Paul**, BSEE, MSIE, Ph.D., North Carolina State University; MBA, University of North Carolina at Greensboro; Professional Engineer; Associate Professor; Rm. 408 McNair Hall; stanfiel@ncat.edu
- **Udoka, Silvanus, J.**, BS, Weber State University; MSIE, Ph.D., Oklahoma State University; Associate Professor; Rm. 402 McNair Hall; udoka@ncat.edu

CHAPTER III
DEPARTMENT ACADEMIC POLICIES, REGULATIONS AND PROCEDURES

You are advised to refer to the University Bulletin for detailed information on University Academic Regulations. The regulations stated here are **in addition to** any University or College regulations.

1. All ISE students must satisfy the "Minimum C Grade for Select Courses" Policy of the College of Engineering. See below for details.
2. All ISE students must satisfy Prerequisite and Corequisite requirements for every course.
3. A minimum of 128 credit hours is required for graduating with a Bachelor of Science degree in Industrial Engineering. These 128 hours include Required as well as Elective courses. These are described in Chapter IV.

Minimum C Grade in Selected Courses Policy

This policy applies to all engineering programs in the college of engineering. Specifically, when an engineering program requires students to take any of the following courses, students will have to obtain a minimum grade of "C" in each such course to meet graduation requirements. Furthermore, a minimum grade of "C" on any such course will be required to satisfy prerequisite requirements of subsequent courses. This change applies to each Bachelor of Science curricula in the college of engineering - both to courses that are explicitly required and those that are recommended as elective courses. The effective date is Fall 2002. The complete set of courses with this "Minimum C" requirement is listed below:

- CHEM 106
- CHEM 107
- MATH 131
- MATH 132
- MATH 224
- MATH 231
- MATH 431
- PHYS 241
- PHYS 242
- GEEN 100
- ELEN 440
- INEN 260
- INEN 270
- MEEN 260
- MEEN 313
- MEEN 413

Advisement Process

Advisor's Role

When a student is majoring in Industrial Engineering, he or she is assigned a faculty advisor. The advisor: (a) provides information, advice, and recommendations in academic and related areas; (b) directs the students to sources which explain in detail academic regulations, course prerequisites and graduation requirements; (c) helps new students to understand the degree to which one should assume responsibility for one's own program planning; (d) provides vocational guidance and occupational information in one's area of specialty, and (e) refers the student to the appropriate individual, office or agency when further assistance is necessary. The Department Chairperson and the Undergraduate Program Coordinator are also available to students needing information about different curricula and help in forming educational plans.

Instructors are usually the best source of help to students having difficulty with particular subjects. Members of the faculty keep office hours and expect students to consult them individually whenever special assistance is needed.

The Department emphasizes that students have the primary responsibility for planning their individual programs and meeting graduation requirements.

Changes in Schedule

A change in a student's program may be made with the consent of his or her advisor and department chair. Students may drop a course without penalty up until the official deadline of withdrawal. After the time limit has expired, withdrawal from any course will result in a grade of "F."

Prerequisites/Corequisites

Prerequisites are courses or levels of achievement that a student is expected to have completed successfully by earning at least a passing grade prior to enrolling in a course. To be effective for any given semester, prerequisites have been set forth in the University Undergraduate Bulletin and this handbook .

It is the student's responsibility to satisfy prerequisites for any course enrolled. Computerized prerequisite searches will take place each semester. Failure to satisfy prerequisites will result in removal from enrollment in the course.

Those students who do not meet prerequisite or corequisite requirements should drop the course and add other courses if possible before the add/drop deadline; such students will not be allowed to attend class lectures or take tests. They will receive a grade of "F" if the course is not dropped.

Substitutions for prerequisites/co-requisites will generally not be allowed for courses listed in this Industrial and Systems Engineering Handbook.

Industrial and Systems Engineering Policy on Course Registration

All ISE students should make an appointment with their advisor before the registration period begins. Prior to the meeting, a registration plan must be completed by filling out the Advisement Registration Form made available in the ISE office. Based on the plan and any recommendations from the advisor, the student will be given their Personal Identification Number (PIN).

After gaining advisor approval, students can use the web to enter registration data into the administrative database. Failure to see the advisor or registering without approval may cause unnecessary delays in the student's graduation and the Registrar may be informed to drop such a student from all courses.

Final Exam Review Policy

Final exam papers are **not** returned to the students, but the instructor shall keep the final exam until the first month of the next regular semester. During this period, any student shall have an opportunity to review his/her exam paper. The fact that in some instances it may be impossible to provide a student with the opportunity to review his/her final exam paper is not sufficient to justify a re-examination.

Behavior and Classroom Conduct

The Department of Industrial and Systems Engineering strives to provide an educational environment conducive to learning, and promotes excellence in all areas of personal and professional development. To help the department attain success in this endeavor, ISE students are expected to be professional and courteous inside and outside the classroom, and should seek to develop collaborative relationships with faculty, staff and other students. Students should understand University policies on academic honesty and disruptive behavior (as published in the Undergraduate Bulletin), as well as the policies specific to their respective course instructors. By following the standards set forth in the Aggie Pride Compact, students will properly position themselves for success.

CHAPTER IV
BACHELOR OF SCIENCE IN INDUSTRIAL ENGINEERING CURRICULUM

Program Mission

The mission of the Bachelor of Science Program in Industrial Engineering (BSIE Program) follows from the mission of the North Carolina A&T State University, the widely accepted purpose of the industrial engineering profession, and the needs of the Industrial Engineering community in the Central Piedmont region of North Carolina and the world.

The following statement describing the University's mission and purpose is taken from the Undergraduate Bulletin (2005-2007):

> *North Carolina Agricultural and Technical State University aspires to be the premier interdisciplinary-centered university in America that builds on its comparative advantages in engineering, technology, and business; a strong civil rights legacy; and status as an 1890 land-grant institution. The challenges of preparing our students to meet the complex needs of the global society necessitate that these exemplary and relevant educational experiences are inherently global in nature and interdisciplinary in focus. The commitment to excellence and the unique NCA&TSU legacy of nurturing the individual student remain strong.*

The Institute of Industrial Engineers (IIE) is the professional society dedicated to the industrial engineering profession. The IIE's definition of industrial engineering is provided here:

> *Industrial Engineering is concerned with the design, improvement and installation of integrated systems of people, materials, information, equipment and energy. It draws upon specialized knowledge and skill in the mathematical, physical, social and information sciences together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems.*

The mission of the BSIE program at North Carolina A&T State University is to provide educational experiences in an environment that allows students to have a sense of belonging and purpose. The educational experiences are designed to produce competent industrial engineers who will serve the business and government needs with their expertise in designing, improving and installing integrated systems of people, materials, information, equipment and energy.

Program Educational Objectives

The BSIE Program Objectives are established by the faculty of the industrial engineering department. In determining these objectives, the stakeholders of the BSIE Program are consulted at least once every five years. Furthermore, the objectives are verified for consistency with the mission, goals and objectives of the University and the College of Engineering. The objectives of the BSIE Program are to produce graduates who:

1. Perform both technically and professionally for a variety of employers in the manufacturing

and service industries.

2. Use information technology tools and systems engineering methods.
3. Function in interdisciplinary, culturally and/or globally diverse teams.
4. Contribute to their communities, the profession of industrial engineering, and the University and its constituents.
5. Engage in proactive, continuous, and life long learning including the pursuit of graduate studies.

Program Outcomes

The specific program outcomes, measured in terms of the knowledge and skills the graduates of the BSIE program are expected to possess upon graduation, are given below.

North Carolina A&T State University
Department of Industrial and Systems Engineering
BSIE Program
BSIE Program Outcomes (Revised Fall 2006)

1	Apply knowledge of mathematics
2	Apply knowledge of basic sciences
3	Apply knowledge of engineering sciences
4	Apply knowledge of industrial engineering theory
5	Design experiments and collect data from a variety of sources
6	Analyze and interpret data
7	Formulate and solve engineering problems
8	Design or improve integrated systems consisting of people, materials, information, equipment and energy considering life cycle factors
9	Utilize tools of information technology
10	Employ project management skills
11	Gain industrial experience
12	Appreciate role of ethics and engineering law
13	Preserve and enhance the engineering profession
14	Recognize global environmental, economic and societal issues
15	Describe role of life long learning in a career plan
16	Ability to work in multidisciplinary teams
17	Communicate effectively

Program outcomes are achieved by exposing students to a variety of subject material across the undergraduate curriculum. The following pages list the outcomes along with some associated subjects from various courses in the BS in Industrial Engineering curriculum.

1. **Apply knowledge of mathematics**
   - Trigonometry, Analytic Geometry, Differential Equations, Differential Calculus, Difference Equations, Integral Calculus, Linear Algebra, Laplace Transforms, Roots of Equations, Vector Analysis (MATH 131, 132, 231, 431, Elective)
   - Probability theory: Probability axioms, random variables, discrete and continuous probability distributions, calculus based probability calculations, joint distributions, conditional probability and independence (INEN 270)
2. **Apply knowledge of basic sciences**
   - Chemistry: Acids & Bases, Equilibrium, Equations, Electrochemistry, Inorganic Chemistry, Kinetics, Metals and Nonmetals, Nomenclature, Organic Chemistry, Oxidation & Reduction, Periodicity, States of Matter, Solutions, Stoichiometry (CHEM 106/116)
   - Physics (PHYS 241/251, 242/252)
   - Materials science: Atomic Structure, Crystallography, Corrosion, Diffusion, Materials, Binary Phase Diagrams, Properties, Processing and Testing (MEEN 260)
3. **Apply knowledge of engineering sciences**
   - Statics: 2-Dimensional Equilibrium, 3-Dimensional Equilibrium, Centroid of Area, Concurrent Force Systems, Friction, Moment of Inertia, Vector Forces (MEEN 313)
   - Strength of Materials: Beams, Bending, Columns, Combined Stresses, Shear, Stress and Strain, Tension and Compression, Torsion (MEEN 313)
   - Dynamics: Force, Mass and Acceleration, Friction, Impulse and Momentum, Kinematics, Vibrations, Work and Energy (PHYS 241)
   - Thermodynamics: 1st Law, 2nd Law, Availability-Reversibility, Cycles, Energy, Heat and Work, Ideal Gases, Mixture of Gases, Phase Changes, Properties: Enthalpy, Entropy, Free Energy, Thermodynamic Processes (MEEN 413)
   - Fluid Mechanics: Flow Measurement, Fluid Properties, Fluid States, Impulse and Momentum, Pipe and Other Internal Flow, Similitude and Dimensional Analysis (MEEN 413)
   - Electrical Circuits: AC Circuits, Diode Applications, DC Circuits, Electric & Magnetic Fields, Capacitance and Inductance, Ideal Transformers, Fourier & Laplace Transforms, Operational Amplifiers (Ideal) – (ELEN 440)
4. **Apply knowledge of industrial engineering theory**
   - Industrial Production Processes: metal casting, forming, shaping, material removal, joining, jig, fixture and gage design, material removal rates, machining formulas. (INEN 246)
   - Methods Engineering: methods analysis, documentation, improvement, time and motion study, time study, work sampling, predetermined times standards, job evaluation, productivity measures, learning curves. (INEN 255)
   - Engineering Economy: time value of money, cash flows, evaluating alternatives based on present worth, annual worth, rate of return, payback period, cost benefit analysis, breakeven analysis, replacement analysis, depreciation methods, effect of income taxes and inflation (INEN 261)

- Cost Engineering: cost accounting, breakeven analysis, cost-volume-profit analysis, cost estimation, activity based costing, job order costing, overhead cost variance analysis, life cycle analysis (INEN 261)
- Computer Aided Design and Manufacturing: Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM), integration of CAD and CAM, process planning, Numerical Control (NC) programming and operation, Group Technology (GT), rapid prototyping, integrated production planning and control, integrated manufacturing data systems (INEN 324)
- Quality Assurance: statistical control charts, attributes and variable sampling plans, quality philosophies, process capability, quality function deployment, ISO 9000, quality auditing (INEN 325)
- Operations Research: Linear programming, simplex algorithm, transportation problem, network flow, dynamic programming, integer programming, multiple criteria, nonlinear programming models, Poisson process, Markov chains, queuing models and their applications, decision analysis, inventory models, risk analysis, project networks, system reliability. (INEN 330, 335)
- Production Control: Demand forecasting, aggregate production planning, inventory control, project planning, line balancing and job scheduling, materials requirements planning, enterprise resource planning, supply chain management (INEN 355)
- Plant Layout and Material Handling: Distance metrics, location analysis, material flow analysis, relationship charts, systematic layout plans, evaluation of layouts, material handling technology and equipment selection, warehousing, automated storage and retrieval systems, determination of system capacities. (INEN 365)
- Ergonomics: Psychomotor work capabilities, mental information processing, human error, energy measures, psychological measures, anthropometry, biomechanics and manual material handling, environmental stressors, work station design, toxicology, human-machine trade-offs, safety and risk factor identification, design of hand tools (INEN 371, 372)
- Discrete Event Simulation: Random variate generation, Monte Carlo and discrete event simulation, simulation languages, use of simulation modeling in design and improvement of production and service (INEN 415)
- Automation and Production Systems: Programmable controllers and robotics, design for manufacturing and assembly, material selection, flexible manufacturing systems, group technology, just-in-time manufacturing, process planning, economics of manufacturing (INEN 446)

5. Design experiments and collect data from a variety of sources

- Knowledge of experimental designs: Latin Squares, complete and incomplete block designs, one, two, and three variable factorials, fractional factorials, and 2k designs. (INEN 375)
- Select independent and dependent variables (INEN 375, 495)
- Select sample size, types of sampling, sampling distributions (INEN 270)
- Select suitable test apparatus and measuring instruments (CHEM 116, PHYS 251, 252, INEN 255, 325, 371, 372, 375)
- Survey research (INEN 375)

- Library research
- Internet research

6. Analyze and interpret data

- Frequency distributions (INEN 270)
- Measures of central tendencies (INEN 270)
- Estimation of parameters and confidence intervals (INEN 270)
- Measurement errors, precision and accuracy (INEN 270)
- Testing of hypothesis (INEN 270, 375)
- Type I and II errors (INEN 270, 375)
- Regression analysis (INEN 375)
- Suitable graphical tools to analyze data (INEN 270, 375)
- Data summarization and interpretation applications (INEN 255, 325, 371, 372, 375, 495)

7. Formulate and solve engineering problems

- Distinguish between what is known and unknown about the given problem
- Identify chemical or physical science principles that govern the performance of a given system
- Mathematical models of real life problems (INEN 261, 330, 335, 325, 355)
- Non-mathematical models of real life problems (INEN 365, 371, 372, 415, 424)
- Analytical solutions (INEN 261, 270, 325, 355)
- Computational and numerical solutions (INEN 330, 415, 485)
- Experimental solutions (INEN 255, 371, 372, 375)
- Select among analytical, computational and experimental approaches (INEN 495)
- Balance accuracy required, time available and level of effort in solving a problem (INEN 495)
- Role of judgment and experience in solving engineering problems (INEN 495)

8. Design or improve integrated systems consisting of people, materials, information, equipment and energy considering life cycle factors

- Understand and apply the engineering design process (GEEN 100, INEN 415, 424, 495)
- Think creatively (GEEN 100, 495)
- Use engineering standards (INEN 325, 365, 371, 372, 380, 424, 495)
- Environmental impact of design (INEN 495)
- Sustainability, manufacturability and reliability of design (INEN 495)
- Health and safety impact of design (INEN 371, 372, 495)
- Economic justification (INEN 261, 495)
- Aesthetics of the design (INEN 495)
- Ethical, social and political impact (INEN 489, 495)

9. Utilize tools of information technology

- Algorithm Flowchart, Spreadsheets, Pseudocode, Data Transmission & Storage (GEEN162)
- Network systems (INEN 380)
- Automatic identification systems (INEN 380)
- Human-computer systems (INEN 380)
- Application information interchange (INEN 380)
- Statistical software (INEN 270, 375)

- Optimization software (INEN 330)
- Programmable Logic Controllers (INEN 446)
- Simulation software(INEN 415)
- NC Programming (INEN 324)
- Database systems for storing and retrieving data (INEN 380, 355)
- Computer aided drafting (GEEN 103)
- Computer aided manufacturing (INEN 324)
- General purpose high level programming language (GEEN 162, INEN 380)

10. Employ project management skills

- Set milestones (INEN 289, 495)
- Monitor progress (INEN 289, 495)
- Time management (INEN 289, 495)

11. Gain industrial experience

- Operation of machines (INEN 246)
- Professional practice (INEN 495, Co-op experience)

12. Appreciate role of ethics and engineering law

- NSPE Code of Ethics (GEEN 100)
- Apply NSPE code of ethics to ethical dilemmas (GEEN 100, 495)
- Relations with Clients, Relations with Peers, Relations with Public (INEN 489)
- Americans with Disabilities Act (INEN 255)

13. Preserve and enhance the engineering profession

- Professional licensing (GEEN 100, 489)
- Participation in engineering associations (GEEN 100, INEN 255, INEN 489)
- Identify current problems of interest to the profession (INEN 489)

14. Recognize global environmental, economic and societal issues

- International trade agreements (INEN 355, 389)
- Role of government in international commerce, trade barriers, United Nations Regulatory Agencies (INEN 355, 389)
- Labor laws in various parts of the world (INEN 389)
- Technological capabilities of different countries (INEN 389)
- Global agreements on environmental protection (INEN 389)
- Value of foreign language skills (Humanities Electives, INEN 389)
- Historical impact of engineering and technology in development of modern society (INEN 389)
- Identify current socio-economic issues on the regional, national and international level (INEN 389)
- Concern for natural environment (INEN 389)
- Analyze a current political issue from a systems standpoint (INEN 389)

15. Describe the role of life long learning in a career plan

- Awareness of technology obsolescence (INEN 380, 489)
- Demonstrate ability to independently learn new concepts (INEN 330, 335)
- Identify methods for continuing education (INEN 489)

16. Ability to work in multidisciplinary teams

- Industrial relations, organizational structures (INEN 289)
- Inter-personal skills (INEN 289)
- Leadership (INEN 289)
- Recognize differences in interpersonal styles (INEN 289)
- Disagrees with others in a non-judgmental way (INEN 289)
- Respect diversity of backgrounds and opinions (INEN 289)
- Share responsibility with team members (INEN 289, 371, 372, 495)

17. Communicate effectively

- Paraphrases information in oral presentations (INEN 261, 495)
- Listens carefully and responds to questions appropriately (INEN 495)
- Uses visual aids to engage audience (INEN 495)
- Writes without spelling or grammatical errors (UNST 110, Elective, INEN 495)
- Write logically using evidence for support (UNST 110, Elective, INEN 495)
- Using animation as a communication tool (INEN 415)
- Utilizes visualization and sketching skills to illustrate concepts (INEN 365, 495)
- E-mail (GEEN 103, 162, INEN 380)
- Graphical communication (INEN 102)

BS in Industrial Engineering Curriculum: Fall 2007

Freshman Year

	Semester 1 (Fall) Courses	Cr		Semester 2 (Spring) Courses	Cr
UNST 100	University Experience	1	UNST 130	Analytical Reasoning	3
UNST 110	Critical Writing	3	UNST 140	The African American Experience	3
UNST 120	The Contemporary World	3	CHEM 106	Gen. Chemistry VI	3
GEEN 100	Engineering Design and Ethics	2	CHEM 116	Gen. Chemistry VI Lab.	1
GEEN 162	Computer Programming in VB for Eng	2	INEN 102	Graphic Visualization for IE	2
GEEN 110	Colloquium I	0	GEEN 120	Colloquium II	0
MATH 131	Calculus I	4	MATH 132	Calculus II	4
	Semester Total	**15**		**Semester Total**	**16**

Sophomore Year

	Semester 3 (Fall) Courses	Cr		Semester 4 (Spring) Courses	Cr
	Cluster Theme Elective[1]	3		Cluster Theme Elective[1]	3
	Cluster Theme Elective[1]	3	INEN 255	Methods Engineering	3
INEN 246	Industrial Production Proc	3	INEN 289	Engineering Teams & Leadership	1
MATH 431	Introduction to Differential Equations	3	MATH 231	Calculus III	4
PHYS 241	General Physics I	3	MEEN 260	Material Science	2
PHYS 251	General Physics I Lab.	1	PHYS 242	General Physics II	3
			PHYS 252	General Physics II Lab.	1
	Semester Total	**16**		**Semester Total**	**17**

Junior Year

	Semester 5 (Fall) Courses	Cr		Semester 6 (Spring) Courses	Cr
	Cluster Theme Elective[1]	3	INEN 330	Operations Research I	3
ELEN 440	Electrical Circuits	3	INEN 372	Human Factors Engineering II	2
INEN 261	Engineering Econ and Cost Analysis	3	INEN 324	Computer Aided Design and Mfg	3
INEN 270	Engineering Statistics	3	INEN 380	Information Technology for IE	3
INEN 371	Human Factors Engineering I	2	INEN 389	Systems Approaches for IE	1
MEEN 313	Statics / Mechanics of Materials	3	INEN 365	Facilities Design	3
	Semester Total	**17**		**Semester Total**	**15**

Senior Year

	Semester 7 (Fall) Courses	Cr		Semester 8 (Spring) Courses	Cr
INEN 325	Quality Assurance	3	MEEN 413	Thermo-Fluid Sciences	3
INEN 335	Operations Research II	3	INEN 446	Automation and Production Systems	3
INEN 355	Production Control	3	INEN 489	Professionalism and Ethics for IE	1
INEN 415	Discrete Event Simulation	3	INEN 495	Design Projects in Industrial Engineering	3
INEN 375	Design of Experiments	3	INEN 6xx	IE Technical Elective 1[2]	3
INEN 500	General Engineering Topics Review	1	INEN 6xx	IE Technical Elective 2[2]	3
	Semester Total	**16**		**Semester Total**	**16**
				Program Total	**128**

[1]Students must choose one cluster theme and select 12 hours in that cluster.

[2]IE Technical Electives (INEN6xx) may include: INEN 618, INEN 625, INEN 628, INEN 632, INEN 635, INEN 648, INEN 653, INEN 658, INEN 664, INEN 685

CATALOG DESCRIPTIONS OF REQUIRED COURSES

University Studies Requirements

Starting in the Fall semester of 2006, general education requirements at NC A&T are met through taking a selection of courses approved by the University Studies (UNST) Program. These courses are meant to be interdisciplinary in nature, and promote critical thinking, effective communication, an appreciation for diverse cultures, and a commitment to ongoing civic engagement and social responsibility.

Undergraduate students are required to take 13 credit hours of UNST foundation courses (UNST 100, 110, 120, 130 and 140) as well as 12 credit hours of cluster theme electives. The foundation courses must be taken within the first 32 hours of study at NC A&T, and cluster theme electives cannot be taken until the foundation courses have been successfully completed. In order to satisfy UNST program requirements, **all 12 hours of electives must come from within the same cluster theme**. Students should direct their attention to the Undergraduate Bulletin for more details on available cluster themes, the UNST Program, and its requirements. Transfer students should meet with the transfer student advisor to determine the transferability of general education credits from their former institution(s).

Required UNST Courses

UNST 100 University Experience 1(1-0)
This seminar emphasizes the role of the University Studies Program and presents a broad overview of the curriculum structure and rationale, including an introduction to a variety of interdisciplinary themes within the University Studies program. Introductory discussions on ethics, wellness and healthy lifestyles, diversity and civic engagement will be included.

UNST 110 Critical Writing 3(3-0)
This course introduces students to reading comprehension and the writing process. Students will read and evaluate selected texts and apply critical thinking through writing and speaking. Students will engage in formal and informal writing, revise drafts and respond to constructive feedback related to critical thinking skills, use of grammar and conventions of standard written English. All students will develop a writing portfolio for course assessment.

UNST 120 The Contemporary World 3(3-0)
This course examines the social, economic, political and cultural roots of the contemporary world. It focuses on the major developments, events, and ideas that have shaped world societies since the beginning of the twentieth century. Close attention will be given to concepts and categories that allow students to grasp the nature and development of the contemporary world, thus providing them with a framework for understanding the contemporary global experience. The course helps students to develop critical thinking skills in their oral and written work and to use information technology effectively.

UNST 130 Analytical Reasoning 3(3-0)
This course engages students in scientific, quantitative and logical reasoning processes to prepare them to integrate and solve problems encountered in everyday life. Students will consider concepts from logic and the scientific disciplines including life, social and physical sciences. The scientific method and a variety of analytical approaches are explored including numerical, graphical, verbal/logical, and algebraic reasoning.

UNST 140 The African American Experience 3(3-0)
This interdisciplinary course introduces students to the important contributions made and challenges faced by people of African descent in America and the global community. This course will focus on oral, written and visual means of expression as a basis for discussion, analysis and debate.

Basic Science Courses

CHEM 106 General Chemistry VI 3(3-0)
A course which emphasizes basic principles and important theoretical concepts of chemistry. Topics will include atomic structure, electronic configuration, the wave mechanical model of the atom, chemical bonding, states of matter, chemical equilibria, systems of acids and bases, and electrochemistry. Prerequisite: 2 units of high school algebra or equivalent and 1 unit of high school chemistry or CHEM 099. Corequisite: CHEM 116.

CHEM 116 General Chemistry VI Laboratory 1(0-3)
A course which emphasizes quantitative studies of chemical reactions such as acid-base studies, redox reactions, and equilibrium reactions. Emphasis is also placed on the development of manipulative skills in the laboratory. Corequisite: CHEM 106.

PHYS 241 General Physics I 3(3-1)
This is the calculus-based study of physics, which covers the fundamental principles of mechanics, thermodynamics, electromaganetism, wave motion, sound, and optics.. Corequisite: MATH 132, PHYS 251.

PHYS 242 General Physics II 3(3-1)
This course is a continuation of PHYS 241 and continues coverage of the fundamental principles of mechanics, thermodynamics, electromagnetism, wave motion, sound, and optics. Corequisite: PHYS 252.

PHYS 251 General Physics I Laboratory 1(0-2)
This is a laboratory course where a selected group of physics experiments will be performed. Emphasis is placed on the development of experimental technique, analysis of data, and physical interpretation of experimental results. Corequisite: PHYS 241.

PHYS 252 General Physics II Laboratory 1(0-2)
This course is a continuation of Physics 251. Corequisite: PHYS 242.

MEEN 260 Materials Sciences 2(2-0)
This is a basic course in materials science that covers the fundamental nature of materials including their physical, mechanical and chemical characteristics. Topics include: atomic arrangements and atomic bonding; phase diagrams; engineering properties; selection of materials for specific applications. Prerequisite: CHEM 106, MATH 131.

Mathematics Courses:

MATH 131 Calculus I 4(4-0)
Limits and continuity of functions, the derivative, applications of the derivative, the definitive integral and applications of the definite integral. Prerequisite: MATH 110 or appropriate approval.

MATH 132 Calculus II 4(4-0)
Topics in analytic geometry, differentiation and integration of exponential, logarithmic, trigonometric, inverse trigonometric and hyperbolic functions, additional techniques and applications of integration, indeterminate forms, improper integrals, Taylor's Formula and infinite series. Prerequisite: MATH 131.

MATH 231 Calculus III 4(4-0)
This course will cover plane curves and polar coordinates, vector and solid geometry, vector-valued functions, partial differentiation, multiple integral, applications of multiple integrals and vector analysis. Prerequisite: MATH 132.

MATH 431 Introduction to Differential Equation 3(3-0)
This course will cover first order differential equations, higher order linear differential equations, matrices and determinants, systems of linear algebraic equations, systems of linear differential equations, and Laplace transforms. Prerequisite: MATH 132.

General Engineering Courses

GEEN 100 Engineering Design and Ethics 2(2-0)
This course introduces students to engineering and computer science disciplines and functions, professional licensure, the Fundamentals of Engineering exam, code of ethics, safety, the design process, creative thinking, teamwork, and technical writing. A case study on ethics and the application of the design process through a team project are required.

GEEN 110 Colloquium I 2(0-4)
Contemporary issues, corporate information sessions, campus resources, information literacy, and professional society activities will be discussed. This is the first of two freshman colloquia.

GEEN 120 Colloquium II 2(0-4)
Contemporary issues, corporate information sessions, campus resources, information literacy, and professional society activities will be discussed. This is the second of two freshman colloquia.

GEEN 162 Computer Programming in VisualBasic for Engineers 2(0-4)
This course introduces computer programming using VisualBasic. Topics include flow chart construction and interpretation, procedural control flow, user and application interface development, and spreadsheets.

Engineering Science Courses

ELEN 440 Electrical Circuits and Systems 3(3-0)
This course is designed to introduce the basic concepts of electrical engineering to non-electrical major students and also to cover the electrical circuits topics, which are part of the Fundamentals of Engineering (FE) Examination. These include: basics of electric circuit analysis, application of Ohm's law, Kirchhoff's laws, loop and nodal analysis, Thévenin's and Norton's theorems, resistive, capacitive and inductive circuits, diodes and operational amplifier circuits, electric power concepts including single phase and three phase circuits, power calculation, AC/DC motors and transformers, transient and steady state solutions to first order linear circuits. Prerequisites: PHYS 242, MATH 431.

MEEN 313 Statics and Mechanics of Materials 3(3-0)
This is an introductory course in statics and mechanics of materials for non-mechanical engineering majors. It provides a just-in-time approach to the study of characteristics of forces and couples, and their effects on equilibrium, strains, and stresses in solid bodies. Relationships between loads and deformations are also presented. The course is designed to help prepare students for the Fundamentals of Engineering Exam. Prerequisites: MATH 131, PHYS 241

MEEN 413 Thermo-Fluid Sciences 3(3-0)
This is an introductory course in the thermo-fluid sciences for non-mechanical engineering majors. The basic principles of fluid mechanics and thermodynamics are covered with an emphasis on problem solving techniques. The course is designed to help prepare students for the Fundamentals of Engineering Exam. Prerequisites: MATH 231, PHYS 242.

Industrial and Systems Engineering Courses

INEN 102 Graphical Visualization for Industrial Engineers 2(1-2)
This course introduces computer-aided drafting in two dimensions, multi-view drawings, plant and building layouts, reading blueprints and interpreting engineering drawings, flow process charts, and plotting functions in 2 and 3 dimensions. Prerequisites: None.

INEN 246 Industrial Production Processes 3(2-2)
This course introduces various types of manufacturing processes including metal casting, forming, shaping, material removal and joining. The course also covers basic jig, fixture and gage design. Material removal rates and machining formulas are also explored. Laboratory projects are required. Prerequisites: INEN 102 or GEEN 103.

INEN 255 Methods Engineering 3(2-2)
This courses introduces the concepts of methods analysis, documentation and improvement, time and motion study, determination of time standards using time study, work sampling and predetermined times standards. The course also discusses job evaluation, productivity measures, and learning curves. Laboratory projects are required. Prerequisite: INEN 246.

INEN 261 Engineering Economy and Cost Analysis 3(3-0)
This course introduces the concept of time value of money, cash flows, and the methods of evaluating alternatives based on present worth, annual worth, rate of return, payback period and cost benefit analysis. The course also introduces breakeven analysis, replacement analysis, depreciation methods and the effect of income taxes and inflation on economy studies. Prerequisite: MATH 131.

INEN 270 Engineering Statistics 3(3-0)
This course introduces data presentation and analysis, frequency distributions, probability concepts and axioms of probability. Random variables, discrete and continuous probability distributions, calculus based probability calculations, joint distributions, conditional probability and independence are covered. Independence of events is applied to engineering system reliability. Students are introduced to concepts of sampling, sampling distributions, estimation, confidence intervals, hypothesis testing, and regression analysis. Prerequisite: MATH 132.

INEN 289 Engineering Teams and Leadership 1(1-0)
This course covers organizational structures, project management, teamwork, inter-personal skills, and leadership in an engineering organization. A freshman level assessment will be administered. Prerequisites: GEEN 100, UNST 110

INEN 324 Computer Aided Design and Manufacturing 3(2-2)
This course covers Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM), and their integration. Topics include computer-aided design, process planning, Numerical Control (NC) programming and operation, Group Technology (GT), rapid prototyping, integrated production planning and control, and integrated manufacturing data systems. Design projects will be required. Prerequisites: INEN 246.

INEN 325 Quality Assurance 3(3-0)
This course introduces the concepts of quality control and assurance. Topics include statistical control charts, attributes and variable sampling plans, quality philosophies, process capability, quality function deployment, ISO 9000 and quality auditing. Prerequisite: INEN 270.

INEN 330 Operations Research I 3(3-0)
Deterministic models of operations research are discussed with special emphasis on linear programming. Topics covered include formulation and computer solution of mathematical programs, simplex algorithm, transportation problem, and network flow. Prerequisite: MATH 431.

INEN 335 Operations Research II 3(3-0)
This course introduces the concepts of probabilistic operations research models and solution techniques. Specific topics include Poisson processes, Markov chains, queuing models and their applications, decision and risk analysis, and dynamic programming. Prerequisites: INEN 270 and MATH 431.

INEN 355 Production Control 3(3-0)
This course introduces the concepts of demand forecasting, aggregate production planning, inventory control, project planning, line balancing and job scheduling. Relationships with demand-driven methods, enterprise resource planning, and supply chain management are covered. Prerequisite: INEN 330.

INEN 365 Facilities Design 3(2-2)
The course presents a study of the theory and practice of facilities design: activity and flow analysis, space requirements, layout techniques, material handling, warehousing, location selection, and problem-solving with computer-aided layout techniques. Design projects in plant layout required. Prerequisite: INEN 255.

INEN 371 Human Factors Engineering I 2(1-2)
This course introduces ergonomics and biomechanics concepts. Topics include psychomotor work capabilities, anthropometry, environmental stressors, physical workload, safety, hazard and risk factor identification, work station design, and material handling. Data collection methods and report writing are emphasized. Lab projects are required. Prerequisite: Junior standing as IE major.

INEN 372 Human Factors Engineering II 2(1-2)
This course introduces elements of cognitive human factors. Topics include human sensation and perception, cognition, information processing, attention, signal detection theory, mental workload, and decision-making. Lab projects are required. Prerequisite: Junior standing as IE major.

INEN 375 Design of Experiments
3(3-0)
This course introduces various experimental designs to analyze data for research projects, process improvements, human factors studies and surveys. Designs covered include complete and incomplete randomized designs, Latin squares and factorial designs. Suitable laboratory

apparatus is used to study the effect of design parameters on selected responses. Statistical software is utilized to analyze results. Parametric statistics such as analysis of variance are introduced. Prerequisite: INEN 270.

INEN 380 Information Technology for Industrial Engineers 3(2-2)
This course introduces the planning and design techniques used for enterprise information systems. The course addresses basic concepts of database systems, network systems, system analysis and planning, and human-computer systems. The role of computers in industrial and systems engineering is stressed. Prerequisite: GEEN 162.

INEN 389 Systems Approaches for Industrial Engineers 1(1-0)
This course introduces current techniques for systems design, analysis and improvement. A sophomore level assessment will be administered. Prerequisites: Junior standing as IE major and consent of instructor.

INEN 415 Discrete Event Simulation 3(2-2)
Concepts of random variate generation, Monte Carlo and discrete event simulation are introduced. Simulation languages are introduced in this course. One general simulation language is taught in depth. The use of simulation modeling in design and improvement of production and service is emphasized. Industrial Engineering design projects are required. Prerequisites: INEN 380, Senior standing as IE major.

INEN 446 Automation and Production Systems 3(2-2)
This course introduces the concepts of automation such as programmable controllers and robotics, design for manufacturing and assembly, material selection, flexible manufacturing systems, group technology, just-in-time manufacturing, process planning, and economics of manufacturing. Prerequisite: INEN 324.

INEN 485 System Integration 3(3-0)
This course covers applications and case studies that address cost, human factors, energy, information, and materials as it applies to the design of production and service systems. Group work will be emphasized. Selection of appropriate analytical, computational and experimental techniques will be required. Prerequisites: INEN 365, 371, 372, Senior standing.

INEN 489 Professionalism and Ethics for Engineers 1(1-0)
This course covers professional licensing, professional practice, ethics, laws and regulations such as the Americans with Disabilities Act, and the role of continuing education. A junior level assessment will be administered. Prerequisite: Senior standing.

INEN 495 Design Projects in Industrial Engineering 3(0-6)
This course requires students to work on a real-world design project from industry. The project requires students to analyze, design, and recommend through economic justification the best design alternative. A final report and an oral presentation are required. Students demonstrate the feasibility of their designs in terms of safety, aesthetics, reliability, cost, social and ethical values.

This course is only open to ISE majors. Prerequisites: Senior standing as IE major, INEN 261, INEN 330, INEN 365, INEN 371, INEN 415.

INEN 500 General Engineering Topics Review 1(0-2)
This course includes the review of material included in the Fundamentals of Engineering (FE) exam. Prerequisite: Senior standing as IE major.

INEN 501 Fundamentals of Engineering Examination Preparation for Industrial Engineers 1(0-2)
This course prepares industrial engineering students to take the Fundamentals of Engineering Examination. Prerequisite: INEN 500.

ELECTIVE COURSES

The following courses have been approved by the faculty of the Department of Industrial and Systems Engineering as meeting elective requirements for the undergraduate Industrial Engineering Curriculum. Please note that all courses have prerequisite requirements that must be satisfied.

Industrial and Systems Engineering Electives

Select ISE Technical Electives from the following courses:

INEN 618 Total Quality Improvement 3(3-0)
This course provides a systematic engineering approach to understanding the philosophy and application of Total Quality Improvement (TQI). It also introduces students to Continuous Improvement (CI) techniques used by management as a means of improving engineering processes in order to become and remain competitive in the global marketplace. The CI techniques and concepts in this course include strategic planning, benchmarking, ISO 9000, teamwork, customer satisfaction, employee involvement, quality tools, and business process reengineering. Design projects are required. Prerequisite: Senior/Graduate Standing.

INEN 625 Information Systems 3(3-0)
This course introduces the planning, design, implementation and evaluation of industrial information systems. Analysis and design techniques, organization of data, current software tools, client-server architectures, and current database technologies are presented. The role of information systems in global manufacturing, distribution, and services is addressed. Design projects are required. Prerequisite: Senior/Graduate Standing.

INEN 628 Six Sigma Quality 3(2-2)
This course covers the current Six Sigma Body of Knowledge for process engineering and improvement as well as Lean concepts and tools. Topics covered include problem identification and implementation of improved operations and processes. This course prepares students to take the Six Sigma Certification Exam. A project is required. Prerequisite: Consent of instructor.

INEN 632 Robotic Systems and Applications 3(2-2)
This course addresses design, analysis, implementation and operation of robotics in production systems. End effectors, control systems, vision systems, sensors, off-line programming, and

simulation of robotic systems are covered. Methods for designing robotic work areas are emphasized. Design projects are required. Prerequisite: Senior/Graduate Standing.

INEN 635 Material Handling Systems Design 3(2-2)
This course focuses on design, and analysis of materials handling and flow in manufacturing facilities and warehouses. Principles, functions, equipment and theoretical approaches in materials handling are discussed. Tools for the automation of materials handling are introduced. Design projects are required. Design projects are required. Prerequisite: Senior/Graduate Standing.

INEN 648 Industrial Biomechanics 3(3-0)
This course explains and analyzes the mechanical behavior of the musculoskeletal system and component tissue during industrial work situations. Topics include: biomechanical and musculo-skeletal models, mechanical work capacity, and bioinstrumentation. Applications to human-machine systems design and analysis are emphasized. Prerequisite: Senior/Graduate Standing.

INEN 653 Engineering Entrepreneurship 3(2-2)
This course focuses on innovation and entrepreneurial skills development oriented toward an engineering enterprise. The course covers key entrepreneurial areas of intellectual property; evaluation of market viability of new product ideas; shaping product ideas into the right products or services for the right markets; developing strategies for product positioning, marketing and operations; acquiring the resources needed to start a new venture; and leadership roles for the founders of engineering ventures. A project is required. Prerequisite: Consent of instructor.

INEN 658 Project Management 3(3-0)
This course addresses project proposal preparation, resource and cost estimation, project planning, organizing and controlling, network diagrams, and computerized project planning systems. Prerequisite: Senior/Graduate Standing.

INEN 664 Human Performance, Risk Analysis & Systems Safety 3(3-0)
This course addresses the relationship between system safety, risk and human performance at work. Quantitative and qualitative methods of investigating and analyzing accidents, system failures and risk in human-machine system environment are discussed. Design projects that incorporate the Occupational Safety and Health Act are emphasized. Prerequisite: Senior/Graduate Standing.

INEN 685 Selected Topics in Engineering Variable Credits (1-3)
Selected engineering topics of interest to students and faculty. The topics will be selected before the beginning of the course and will be pertinent to the programs of the students enrolled. Prerequisite: Senior/Graduate Standing.