



INDUSTRIAL AND SYSTEMS ENGINEERING

UNDERGRADUATE PROGRAM STUDENT HANDBOOK

2012 - 2013

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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 BSISE 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 AND SYSTEMS ENGINEERING PROFESSION

(Portions of this chapter have been adapted from *Turner, Mize, Case, and Nazemtz, 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 and Systems 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 and Systems Engineering emerged as a profession to increase the efficiency and effectiveness of these operations.

The formal definition of Industrial and Systems 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 and Systems Engineers.

Different companies expect their Industrial and Systems Engineers (ISE's) to perform different kinds of activities. The following list includes essentially all the different activities that a practicing ISE 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 workload among resources
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 and Systems 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 and Systems Engineer's role in their operations. Because of the type of education industrial and systems engineers receive, they are often promoted to management positions within 5 to 10 years after graduation (substantiated by a US Department of Labor report).

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.

A further benefit worth mentioning is that PE-licensed ISEs earn approximately \$10,000 more per year than their colleagues without a PE license.

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:

- Architectural Engineering
- Bioengineering
- Biological Engineering
- Chemical Engineering
- Civil Engineering
- Computer Engineering
- Computer Science
- Electrical Engineering
- Industrial and Systems Engineering
- Interdisciplinary General Engineering
- Mechanical Engineering

The Department of Industrial and Systems Engineering

The Department of Industrial and Systems Engineering was established in 1977. Within the department are laboratories for Product, Process, and Facility Design; Manufacturing Processes and Systems; Automated Assembly and Packaging; Logistics and Warehousing; Human Performance; Human Machine Interface; 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 and Systems Engineering, the ISE Department offers the Master of Science in Industrial and Systems Engineering as well as the Doctor of Philosophy in Industrial and Systems Engineering degrees.

Accreditation



The program of study leading to the Bachelor of Science in Industrial and Systems Engineering (BSISE) 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. Some of our alumni have pursued graduate studies at 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 recruit ISE graduates from NC A&T State University are:

- | | | |
|--------------------|--------------------------|---------------------|
| • General Motors | • Miller Brewing | • Intel |
| • General Electric | • Altria Client Services | • Xerox |
| • Toyota | • Deer-Hitachi | • Texas Instruments |
| • Boeing | • AT&T | • Sara Lee |
| • IBM | • Ford | • Cargill |
| • Accenture | • Rolls Royce | • Shell |
| • Kimberly - Clark | • Procter and Gamble | • Morgan Stanley |
| • Chase Manhattan | • Cummins | • SAS |

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 ISE 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; Associate Professor; Rm. 404 McNair Hall, lbdavis@ncat.edu
- **Desai, Salil, L.**, BSME, University of Bombay; MSIE, Ph.D., University of Pittsburgh; Associate Professor; Rm. 423 McNair Hall, sdesai@ncat.edu
- **Jiang, Xiaochun (Steven)**, MSME, East China Institute of Technology; MS, Nanjing University of Science & Technology; Ph.D., Clemson University; Associate Professor, Rm. 426-A McNair Hall; xjiang@ncat.edu
- **Jiang, Zongliang**, BS, Shanghai Jiao Tong University ; MS, PhD, North Carolina State University ; Assistant Professor ; Rm. 406 McNair Hall; zjiang@ncat.edu
- **Li, Zhichao (Zinc)**, BS, MS, Tianjin University of Technology and Education ; Ph.D., Kansas State University ; Assistant Professor; Rm. 403 McNair Hall; zli@ncat.edu
- **McBride, Maranda**, BS, MS, Ph.D., North Carolina A&T State University ; Associate Professor ; Rm. 405 McNair Hall ; mcbride@ncat.edu
- **Mountjoy, Daniel N.**, BSE, MSE, Wright State University; Ph.D., North Carolina State University; Adjunct Associate Professor; Rm. 416 McNair Hall; mountjoy@ncat.edu
- **Ntuen, Celestine A.**, NCE, College of Education, Uyo, Nigeria; BSISE, MSIE, Ph.D., West Virginia University; Distinguished University Professor; Rm. 422 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, Ph.D., Purdue University; Assistant Professor; 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
- **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**, BSISE, MSIE, Incheon University; Ph.D., State University of New York at Buffalo; Associate Professor; Rm. 422-A 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 126 credit hours is required for graduating with a Bachelor of Science degree in Industrial and systems engineering. These 126 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	· PHYS 242
· CHEM 107	· GEEN 100
· MATH 131	· ECEN 200/340
· MATH 132	· INEN 360
· MATH 224	· INEN 361
· MATH 231	· INEN 370
· MATH 431	· MEEN 260
· PHYS 241	· MEEN 313/335

Advisement Process

Advisor’s Role

When a student is majoring in Industrial and Systems 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 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 AND SYSTEMS ENGINEERING CURRICULUM

Program Mission

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

The following statement describing the University's mission is taken from the Strategic Plan (2011-2020):

North Carolina Agricultural and Technical State University is a public, doctoral/research, 1890 land-grant university committed to exemplary teaching and learning, scholarly and creative research, and effective engagement and public service. The university offers degrees at the baccalaureate, master's and doctoral levels and has a commitment to excellence in a comprehensive range of academic disciplines. Our unique legacy and educational philosophy provide students with a broad range of experiences that foster transformation and leadership for a dynamic and global society.

The Institute of Industrial Engineers (IIE) is the professional society dedicated to the industrial and systems engineering profession. The IIE's definition of industrial and systems 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 BSISE 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 BSISE Program Objectives are established by the faculty of the Department of Industrial and Systems Engineering. In determining these objectives, the stakeholders of the BSISE 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 BSISE 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 and systems engineering, and the University and its constituents.
5. Engage in proactive, continuous, and life long learning including the pursuit of graduate studies.

The following matrix shows the connections between Industrial and Systems Engineering courses in the BS curriculum and the Program Objectives.

INEN Course Number	Program Objectives				
	1	2	3	4	5
	Perform both technically and professionally for a variety of employers in the manufacturing and service industries.	Use information technology tools and systems engineering methods.	Function in interdisciplinary, culturally and/or globally diverse teams.	Contribute to their communities, the profession of industrial and systems engineering, and to the University and its constituents.	Engage in proactive, continuous, life-long learning including the successful pursuit of graduate studies.
102	X	X			
246	X	X			
255	X	X			X
289	X		X		
324	X		X		X
361	X	X			
370	X				X
380	X	X			
389	X	X			
400	X				X
415	X	X			X
425	X		X		X
430	X	X			X
435	X				X
446	X	X			
455	X	X	X		X
465	X	X			
471	X	X	X		
472	X	X	X		X
475	X	X			
489	X			X	X
495	X	X	X	X	

Program Outcomes

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

North Carolina A&T State University
Department of Industrial and Systems Engineering
 BSISE Program
 BSISE Program Outcomes (Revised Fall 2010)

a	Apply knowledge of mathematics, science, and engineering
b	Design experiments, collect, analyze and interpret data from a variety of sources
c	Design or improve integrated systems or processes consisting of people, materials, information, equipment and energy considering life cycle factors
d	Ability to work in multidisciplinary teams
e	Formulate and solve engineering problems
f	Preserve and enhance the engineering profession, including ethical and legal practices
g	Communicate effectively
h	Recognize global environmental, economic and societal issues
i	Describe role of lifelong learning in career plan
j	Gain industrial experience
k	Utilize tools of information technology and project management skills

Program outcomes are achieved by exposing students to a variety of subject material across the undergraduate curriculum. The table below shows where each outcome is to be assessed for undergraduate program improvement purposes. Standard rubrics used to assess each outcome are provided on the following pages.

ISE (ABET) Program Outcome	a	b	c	d	e	f	g	h	i	j	k
Freshman-Level Classes											GEEN 162
Sophomore-Level Classes	INEN 246		INEN 255	INEN 289	INEN 255	INEN 289	INEN 289		INEN 380	INEN 246	INEN 380
Junior-Level Classes	INEN 435	INEN 370	INEN 465		INEN 430	INEN 389	INEN 389	INEN 361		INEN 471	INEN 435
Senior-Level Classes	INEN 425	INEN 475	INEN 446	INEN 595	INEN 415	INEN 489	INEN 489	INEN 495	INEN 489	INEN 495	INEN 415 INEN 495

Outcome a: Apply knowledge of mathematics, science, and engineering.

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)
Mathematical Modeling	Does not understand the connection between mathematical models and the physical processes and systems in engineering.	Chooses a mathematical model or scientific principle that applies to an engineering problem but has trouble in model development.	Chooses a mathematical model or scientific principle that applies to an engineering problem producing tangible results	Combines mathematical models and or scientific principles to formulate models of integrated systems of people, material, equipment, and information relevant to Industrial and Systems Engineering.
Application	Does not understand the application of calculus and linear algebra in solving engineering problems.	shows nearly complete understanding of applications of calculus and/or linear algebra in problem solving.	shows complete understanding of applications of calculus and/or linear algebra in problem solving.	Applies concepts of integral and differential calculus and/or linear algebra to solve problems.
Terms	Mathematical terms are interpreted incorrectly or not at all.	Most mathematical terms are interpreted correctly.	shows appropriate engineering interpretation of mathematical and scientific terms	Shows appropriate engineering interpretation of mathematical and scientific terms and able to extend beyond scientific basis
Theory	Does not appear to grasp the connection between theory and the problem.	Some gaps in understanding the application of theory to the problem.	shows satisfactory understanding of academic theories	Translates academic theory into engineering applications.
Calculation	Calculations not performed or performed incorrectly by hand or does not know how to use math software.	Significant errors in calculations by hand and applying math software.	shows the successful and appropriate use of mathematical software	Executes calculations correctly by hand and using mathematical software.
Analysis	No application of statistics to analysis of data.	Uses statistical analysis of data as the basis for workmanlike judgments, drawing plausible conclusions from the work. Analysis has minor errors.	Uses statistical analysis of data as the basis for competent judgments, drawing reasonable and appropriately qualified conclusions from the data	Uses statistical analysis of data as the basis for deep and thoughtful judgment, drawing insightful, carefully qualified conclusions from this work.

Outcome b: Design experiments, collect, analyze and interpret data from a variety of sources.

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)
Effectiveness of experimental design and/or procedures	Very ineffective. Would not allow experimenters to achieve all goals. Seeks no extra information for experiments other than what is provided by the instructor.	Develops a simplistic experimental plan of data gathering, does not recognize entire scope of study (e.g. not all parameters affecting the results were investigated.)	Mostly effective. Would allow experimenter to achieve most goals.	Formulates an experimental plan of data gathering to attain all stated objectives.
Execution of Procedures	Data are poorly documented. Does not follow experimental procedure.	Data collected are not all documented, units are missing or some measurements are not recorded.	Demonstrated adequate ability to conduct experiments. Collected most of the needed data.	Develops and implements logical experimental procedures. Carefully documents data collected.
Data Analysis	Statistical methods were completely misapplied or absent.	Statistical methods were attempted. Some methods were applied but with significant errors or omissions.	Most methods were correctly applied but more could have been done with the data.	Statistical methods were fully and correctly applied.
Interpretation of data	Makes no attempt to relate data to theory.	Applies appropriate theory to data when prompted to do so, but interprets physical significance of theory or variable involved; makes errors in unit conversions.	Applied theory to data correctly and interpreted most data correctly. Some conclusions may be questionable or over-interpreted.	Analyzes and interprets data carefully using appropriate theory. If required, translates theory into practice. Is aware of measurement error and is able to account for it statistically.

Outcome c: Design or improve integrated systems or processes consisting of people , materials , information, equipment, and energy considering life cycle factors.

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Outstanding (4)
Strategy	No strategy apparent	Seeks help to develop single approach strategy	Works primarily independently or within team to develop a simple strategy with some consideration for alternative	Works totally independently or within team to develop multiple layers of strategy
Solution	Offers no solution or partial solution	Solution is unoriginal and shows little consideration of research	Seeks and accepts advisory input to come up with single solution with minor reference to alternative solutions	Works independently or within team with minimal amount of advisory input to develop multiple solutions that are based on documented research
Integration	Shows no regard for interface of people, materials, or equipment, energy and life cycle factors	Attempts to show relationship of people, materials, equipment, energy and life cycle factors but with unsubstantiated facts	Shows limited regard for interface of people, materials, or equipment, energy and life cycle factors	Shows relationships of people, materials, equipment, energy and life cycle factors with required facts with minimal advisory input
Tools	Demonstrates no knowledge of IE tools	Demonstrates knowledge of IE tools but mis-applies or chooses wrong tools	Demonstrates knowledge of IE tools	Uses all appropriate IE tools necessary to formulate complete solutions
Documentation	Design is done incompletely without proper supporting equations and lack of documentation	Design is complete with minimal supporting equations or incorrect equations and incomplete documentation	Design is done completely but lacks proper supporting equations and documentation	Design is complete with all supporting equations with no errors and complete documentation

Outcome d: Ability to work in multidisciplinary⁺ teams.

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)
Participation in meetings	Understands the importance of participating in meetings*	Present at most meetings*	Present at some meetings* and contributes to carrying forward the meetings*	Present at most meetings* and contributes to carrying forward the meetings*
Contribution	Understands the importance of individual contributions in team work	Makes little contributions to the work of the team	Makes some contribution to the work of the team	Makes pivotal contributions to the work of the team
Support	Understands the importance of supporting the work of fellow team members	Provides little support for work of fellow team members	Provides some support for work of fellow team members	Plays vital role in supporting the work of fellow team members
Initiative	Understands the importance of individual contributions to the planning of team's tasks	Makes little contribution in planning the activities of the team	Makes some contributions in planning the activities of the team	Plays a vital role in planning the activities of the team

+ in this rubric teams are assumed to be composed of members primarily from a single academic major

* face-to-face or virtual

Outcome e: Formulate and solve engineering problems.

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)
Identify Engineering Problem	Cannot comprehend nature of the problem	Recognizes the basic nature of the problem but cannot state in concise language what the core issue(s) are	Correctly identifies the basic problem and attempts to develop a problem statement using IE terminology	Identifies the complete core problem and makes a concise problem statement using correct IE terminology
Formulate Approach	Cannot describe problem and unable to begin formation of an approach	Solution approach format is incomplete and/or superficial but is correct to the level identified	Solution approach format using correct tools but alternative approaches not developed and minimal supporting documentation offered	Approach is properly formatted in IE terminology and supported with documentation as well as alternative formulations offered
Solve Engineering Problems	No solution offered	Partial solutions offered with insufficient depth to show mastery of concept	Solutions offered and supported with correct and proper IE tools utilized with minimal regard to a complete system approach	Solutions as well as alternative solutions offered with correct IE tools utilized demonstrating complete understanding of the IE system approach

Outcome f: Preserve and enhance the engineering profession including ethical and legal practices.

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)
Ethical Self-Awareness	Student not able to articulate core beliefs and values.	Student able to articulate core beliefs and values and their origins.	Student able to articulate core beliefs and values and perform self-analysis.	Student able to articulate core beliefs and values and perform self-analysis with exceptional depth and clarity.
Identification of Ethical / Legal Issues	Student fails to identify ethical/legal issues.	Student partially identifies ethical/legal issues.	Student identifies all intended ethical/legal issues.	Student identifies all intended ethical/legal issues, and discusses the relevance of these issues to the case.
Stakeholder Positions	Student does not identify/consider stakeholder(s) positions related to the ethical/legal issue(s).	Student correctly identifies/considers a single potential stakeholder's position related to the ethical/legal issue(s).	Student correctly identifies/considers more than one potential stakeholders' positions related to the ethical/legal issue(s).	Student correctly identifies/considers a wide range of potential stakeholders' positions related to the ethical/legal issue(s).
Resolution	Student fails to provide a potential resolution to the problem.	Students provides problem resolution, but does not consider alternatives.	Student considers alternative ways to resolve the issue with some discussion of merit of each alternative.	Student considers more than two alternative ways to resolve the issue(s), and discusses their potential effects on all stakeholders.

Outcome g: Communicate effectively (written).

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory(3)	Exceptional (4)
Spelling and Grammar	Uses language that sometimes impedes meaning because of frequent errors in usage.	Uses language that generally conveys meaning to readers with clarity, although writing includes some errors.	Uses straightforward language that generally conveys meaning to readers. The language in the portfolio has few errors.	Uses graceful language that skillfully communicates meaning to readers with clarity and fluency, and is virtually error-free.
Content	Uses inappropriate and/or irrelevant content to develop ideas in most parts of the work.	Uses appropriate and relevant content to develop and/or explore simple ideas through parts of the work.	Uses appropriate and relevant content to explore ideas within the context of the discipline and shape the whole work.	Uses appropriate, relevant, and compelling content to illustrate mastery of the subject, conveying the writer's understanding, and shaping the whole work.
Graphic and Tabular Content	No figure or table is used when such usage is necessary, or uses figures/tables that are completely inappropriate and/or irrelevant.	Uses figures and/or tables that are inadequate, irrelevant, and/or not well integrated/referenced.	Uses adequate and relevant figures and/or tables that are integrated and/or referenced, with possibly redundant information or with little value added to the overall content.	Uses adequate, relevant, and compelling figures and/or tables that are well integrated and referenced, enhancing the overall content.
Sources and Evidence	Demonstrates no attempt to use sources to support ideas in the writing, or uses sources that are not credible or relevant.	Demonstrates an attempt to use credible and/or relevant sources to support ideas that are appropriate for the discipline and genre of the writing.	Demonstrates consistent use of credible, relevant sources to support ideas that are situated within the discipline and genre of the writing.	Demonstrates skillful use of high-quality, credible, relevant sources to develop ideas that are appropriate for the discipline and genre of the writing.
Organization and Central Message	Organizational pattern is not observable within the presentation, and no central message can be deduced.	Organizational pattern is intermittently observable within the presentation, and central message can be deduced or is basically understandable but is not often repeated and is not memorable.	Organizational pattern is clearly and consistently observable within the presentation, and central message is clear and consistent with the supporting material.	Organizational pattern (specific introduction and conclusion, sequenced material within the body, and transitions) is clearly and consistently observable and is skillful and makes the content of the presentation cohesive, with a compelling central message (precisely stated, appropriately repeated, memorable, and strongly supported.)

Outcome g: Communicate effectively (oral).

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory(3)	Exceptional (4)
Language and Delivery	Language choices are unclear and inappropriate to audience, and minimally support the effectiveness of the presentation. Delivery techniques detract from the understandability of the presentation, and speaker appears uncomfortable.	Language choices are mundane and commonplace and partially support the effectiveness of the presentation. Language in presentation is appropriate to audience. Delivery techniques make the presentation understandable, and speaker appears tentative.	Language choices are thoughtful and generally support the effectiveness of the presentation. Language in presentation is appropriate to audience. Delivery techniques make the presentation interesting, and speaker appears comfortable.	Language choices are imaginative, memorable, and compelling, and enhance the effectiveness of the presentation. Language in presentation is appropriate to audience. Delivery techniques (posture, gesture, eye contact, and vocal expressiveness) make the presentation compelling, and speaker appears polished and confident.
Supporting Material	Insufficient supporting materials make reference to information or analysis that minimally supports the presentation or establishes the presenter's credibility/authority on the topic.	Supporting materials make appropriate reference to information or analysis that partially supports the presentation or establishes the presenter's credibility/authority on the topic.	Supporting materials make appropriate reference to information or analysis that generally supports the presentation or establishes the presenter's credibility/authority on the topic.	A variety of types of supporting materials (explanations, examples, illustrations, statistics, analogies, quotations from relevant authorities) make appropriate reference to information or analysis that significantly supports the presentation or establishes the presenter's credibility/authority on the topic.
Response to Questions	Fails to answer questions or gives answers that are inappropriate or irrelevant to audience questions.	Gives ambiguous or unclear answers that do not address audience questions completely, and provide no means to offline follow-ups.	Gives adequate answers that address most or all audience questions, and/or provides means to offline follow-ups.	Gives answers that address all audience questions in a way that is insightful, inspiring and compelling and enhances the overall effectiveness of the presentation, and/or encourages/provides means to offline follow-ups.

Outcome h: Understanding of the impact of engineering solutions in global, environmental, economic and societal issues.

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)
Global issues	Students have little knowledge of global issues.	Students identify/describe some global issues related to their area.	Students identify most global issues related to the problem to be solved, but only consider some pertinent global issues to determine the solution approach.	Students examine and weigh the impact of all pertinent global issues to determine the best approach.
Environmental issues	Students have little knowledge of environmental issues.	Students identify/describe some environmental issues related to their area.	Students identify most environmental issues related the problem to be solved, but only consider some pertinent environmental issues to determine the solution approach.	Students examine and weigh the impact of all pertinent environmental issues to determine the best approach.
Economic issues	Students have little knowledge of economic issues.	Students identify/describe some economic issues related to their area.	Students identify most economic issues related to the problem to be solved, but only consider some pertinent economic issues to determine the solution approach.	Students examine and weigh the impact of all pertinent economic issues to determine the best approach.
Societal issues	Students have little knowledge of societal issues.	Students identify/describe some societal issues related to their area.	Students identify most societal issues related to the problem to be solved, but only consider some pertinent societal issues to determine the solution approach.	Students examine and weigh the impact of all pertinent societal issues to determine the best approach.

Outcome i: Describe the role of life long learning in career plan.

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)
Curiosity	Explores a topic at a surface level, providing little insight and/or information beyond the very basic facts indicating low interest in the subject.	Explores a topic with some evidence of depth, providing occasional insight and/or information indicating mild interest in the subject.	Explores a topic in depth, yielding insight and/or information indicating interest in the subject.	Explores a topic in depth, yielding a rich awareness and/or little-known information indicating intense interest in the subject.
Initiative	Completes required work.	Completes required work and identifies opportunities to expand knowledge, skills, and abilities.	Completes required work, identifies and pursues opportunities to expand knowledge, skills, and abilities.	Completes required work, generates and pursues opportunities to expand knowledge, skills, and abilities.
Independence	Begins to look beyond classroom requirements, showing interest in pursuing knowledge independently.	Beyond classroom requirements, pursues additional knowledge and/or shows interest in pursuing independent educational experiences.	Beyond classroom requirements, pursues substantial, additional knowledge and/or actively pursues independent educational experiences.	Educational interests and pursuits exist and flourish outside classroom requirements. Knowledge and/or experiences are pursued independently.
Transfer	Makes vague references to previous learning but does not apply knowledge and skills to demonstrate comprehension and performance in novel situations.	Makes references to previous learning and attempts to apply that knowledge and those skills to demonstrate comprehension and performance in novel situations.	Makes references to previous learning and shows evidence of applying that knowledge and those skills to demonstrate comprehension and performance in novel situations.	Makes explicit references to previous learning and applies in an innovative (new and creative) way that knowledge and those skills to demonstrate comprehension and performance in novel situations.
Reflection	Reviews prior learning (past experiences inside and outside of the classroom) at a surface level, without revealing clarified meaning or indicating a broader perspective about educational or life events.	Reviews prior learning (past experiences inside and outside of the classroom) with some depth, revealing slightly clarified meanings or indicating a somewhat broader perspectives about educational or life events.	Reviews prior learning (past experiences inside and outside of the classroom) in depth, revealing fully clarified meanings or indicating broader perspectives about educational or life events.	Reviews prior learning (past experiences inside and outside of the classroom) in depth to reveal significantly changed perspectives about educational and life experiences, which provide foundation for expanded knowledge, growth, and maturity over time.

Outcome j: Gain industrial experience.

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)
Engagement	Student does not demonstrate interest or engage with industry representatives.	Student demonstrates modest interest in industry setting. Asks some questions which expose limited understanding.	Student demonstrates interest in the industry setting. Questions and comments posed by student reveal student motivation and insight.	Student shows strong interest in industry setting and asks questions/makes suggestions requiring deeper thought and insight.
Practice Identification	Student is not able to relate industrial experience to coursework/curriculum.	Student recognizes shallow connections between industry practice and associate coursework/curriculum.	Student recognizes relevant practices employed at industry location and associates them with discussed coursework/curriculum. Student recognizes connections between courses in industry environment.	Student recognizes good practices employed at industry location beyond discussed coursework/curriculum. Student recognizes deep connections between courses in industry environment.
Problem Recognition	Student is not able to recognize genuine problems in the industry environment.	Student recognizes obvious problems and understands problems described by industry personnel.	Student able to generate list of potential problems spanning the diversity of the Industrial and Systems Engineering discipline.	Student able to generate list of potential problems spanning the diversity of the Industrial and Systems Engineering discipline. Student recognized interconnections and possible root causes of problems.
Problem Solution	Student is able to generate "common sense" solutions to stated problems.	Student is able to suggest appropriate tool or methodologies to solve the problem. Student can generate some solution alternatives.	Student is able to generate multiple solution alternatives using appropriate tool or methodology. Student can list the advantages and disadvantages of each solution and suggestion appropriate approach for the industrial setting.	Student is able to generate multiple solution alternatives using a mix of appropriate tools and methodologies. Student can list the advantages and disadvantages of each solution and suggestion appropriate approach for the industrial setting giving expected impact.
Communication	Student is not able to effectively communicate questions, best practice understanding, problem identification, and suggested solution.	Student is able to effectively communicate questions, best practice understanding, and problem identification.	Student is able to effectively communicate questions, best practice understanding, problem identification, and suggested solution according to norms /standards of BS ISE program.	Student is able to effectively communicate questions, best practice understanding, problem identification, and suggested solution according to the norms/standards of the industrial setting.

Outcome k: Utilize tools of information technology and project management skills .

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)
Goals and Objectives	There are no clear goals or goals are irrelevant to the project vision, mission or purpose. Deliverables are not specified or irrelevant.	Write goals that relate poorly to the project vision, mission or purpose. Deliverables are not specified or unclear.	Write goals that relate to the project vision, mission or purpose. Deliverables are unclear.	Write tangible goals that closely relate to the project vision, mission, or purpose, and allows for changes. Clearly specify the deliverables.
Planning	Unaware project involves a set of tasks.	Aware project involves a set of tasks. No clear definition of clear sequence or timeline.	Define tasks, sequence and timeline.	Estimate and assign resources to individual tasks. Form plans to appraise efficiency and effectiveness in completion of each task in meeting goals. Clearly define task sequence and timeline.
Initiation	Fail to find proper task to start or start task with repeated encouragement from advisor.	Start task with encouragement from advisor.	Initiate task on own and have end in mind.	Recognize a need / opportunity and initiate task on own.
Execution	Fail to complete task on time or complete task(s) with errors that prevent results from being comprehensible.	Complete task(s) with some errors.	Complete task(s) on time while making appropriate adjustments and improvements.	Task is fully completed on time. In addition, need / opportunity recognized and task initiated on own.
Documentation and Maintainability	Fails to maintain any materials or transition plans.	Maintain materials from the previous year.	Set transitional processes; Utilize past information for better future performance	Create a comprehensive transitional procedure including a standard operational manual that is updated from year to year.

Skill Tracks

In addition to program objectives and outcomes, the Department of Industrial and Systems Engineering has prioritized four key areas, *skill tracks*, to be targeted and reinforced throughout the undergraduate curriculum. The four skill tracks are (1) Writing, (2) Analytical Thinking, (3) Programming, and (4) Teamwork. The following table shows the skill tracks and the courses with which they are associated. Each of the skill tracks are assessed using standard rubrics.

	Writing	Analytical Thinking	Programming	Teamwork
Freshman	ENGL 100	GEEN 100	GEEN 162	GEEN 110
Sophomore	INEN 246	INEN 255	INEN 246	INEN 289
Junior	INEN 471/472	INEN 361, INEN 370, INEN 430	INEN 380	INEN 389
Senior	INEN 446	INEN 425	INEN 435, INEN 415	INEN 495

BS in Industrial and Systems Engineering Curriculum: Fall 2012

Freshman Year

Semester 1 (Fall) Courses			Semester 2 (Spring) Courses		
		Cr			Cr
ENGL 100	Ideas and their Expressions I	3	ENGL 101	Ideas and their Expressions II	3
CHEM 106	Gen. Chemistry VI	3		Social/Behavioral Science Elective ¹	3
CHEM 116	Gen. Chemistry VI Lab.	1	GEEN 162	Computer Programming in VB for Eng	2
MATH 131	Calculus I	4	MATH 132	Calculus II	4
GEEN 100	Engineering Design and Ethics	2	PHYS 241	General Physics I	3
GEEN 111	College of Engineering Colloquium I	1	PHYS 251	General Physics I Lab.	1
			INEN 121	ISE Colloquium	1
Semester Total 14			Semester Total 17		

Sophomore Year

Semester 3 (Fall) Courses			Semester 4 (Spring) Courses		
		Cr			Cr
PSYC 320	General Psychology	3		Humanities/Fine Arts Elective ¹	3
INEN 102	Graphic Visualization for IE	2	MATH 450	Linear Algebra and Matrix Theory	3
INEN 246	Industrial Production Proc	3	INEN 380	Information Technology for ISE	3
MATH 431	Introduction to Differential Equations	3	INEN 255	Methods Engineering	3
PHYS 242	General Physics II	3	INEN 289	Engineering Teams & Leadership	1
PHYS 252	General Physics II Lab.	1	MATH 231	Calculus III	4
Semester Total 15			Semester Total 17		

Junior Year

Semester 5 (Fall) Courses			Semester 6 (Spring) Courses		
		Cr			Cr
	Humanities/Fine Arts Elective ¹	3	INEN 324	Computer Aided Design and Mfg	3
INEN 430	Deterministic Operations Research	3	INEN 389	Systems Approaches for ISE	1
INEN 361	Engineering Econ and Cost Analysis	3	INEN 435	Stochastic Operations Research	3
INEN 370	Engineering Statistics	3	INEN 465	Facilities Design	3
INEN 471	Ergonomics	2	INEN 472	Cognitive Human Factors	2
MEEN 313	Statics / Mechanics of Materials	3	ECEN 340	Electrical Circuits	3
Semester Total 17			Semester Total 15		

Senior Year

Semester 7 (Fall) Courses			Semester 8 (Spring) Courses		
		Cr			Cr
INEN 425	Quality Assurance	3	INEN 460	Decision Support Systems for ISE	3
INEN 455	Production Control	3	MEEN 260	Material Science	2
INEN 415	Discrete Event Systems Mod. & Sim.	3	INEN 489	Professionalism and Ethics for ISE	1
INEN 475	Design of Experiments	3	INEN 495	Design Projects in ISE	3
INEN 400	General Engineering Topics Review	1		ISE Technical Elective ²	3
	ISE Technical Elective ²	3		ISE Technical Elective ²	3
Semester Total 16			Semester Total 15		
			Program Total 126		

¹ Of the nine (9) total credits of general education electives, at least three (3) credits must come from African-American studies, and at least three (3) from global studies. See your advisor for a list of courses that satisfy these requirements.

² See your academic advisor for a list of eligible courses.

CATALOG DESCRIPTIONS OF REQUIRED COURSES

General Education Requirements

Starting in the Fall 2012 semester, general education requirements at NC A&T are met through taking a selection of courses to meet the following student learning outcomes:

Student Learning Outcome	Credit Hours
Written Communication	6
Mathematical, Logical, and Analytical Reasoning	6
Scientific Reasoning	7
Social/Behavioral Sciences*	6
Humanities/Fine Arts*	6
Student Success	2

*Of the 12 total hours in social/behavioral sciences and humanities/fine arts, at least 3 hours must be completed in African-American studies courses, and 3 hours in global studies courses.

General Education and the ISE Curriculum

For ISE students, most general education requirements are met by following the prescribed curriculum. ISE students must, however, select courses to meet the following remaining requirements:

Student Learning Outcome	Credit Hours
Social/Behavioral Sciences	3 credits
Humanities/ Fine Arts	6 credits

Of these 9 credits, at least 3 hours must be completed in African-American studies courses, and 3 hours in global studies courses. Students should consult with their academic adviser to determine acceptable courses.

Basic Science Courses**CHEM 106 General Chemistry VI 3(3-0)**

This is 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)

This is 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.

MEEN 260 Materials Science 2(2-0)

This basic course in materials science covers the fundamental nature of materials including their physical, mechanical and chemical characteristics. Topics include: atomic arrangements and atomic bonding; structure property relationships, phase diagrams, engineering properties and basic failure modes. Prerequisites: CHEM 106 and MATH 131.

PHYS 241 General Physics I 3(3-1)

This is a calculus-based physics course that covers the fundamental principles of Newtonian mechanics, heat, and thermodynamics. Corequisites: MATH 132 and PHYS 251.

PHYS 242 General Physics II 3(3-1)

This course is a continuation of PHYS 241. It is a calculus-based study of physics, which covers the fundamental principles of electricity, magnetism, wave motion, 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.

Mathematics Courses:**MATH 131 Calculus I 4(4-0)**

Limits and continuity of functions, the derivative, applications of the derivative, the definite integral and applications of the definite integral will be studied. Prerequisites: MATH 102 or MATH 110 or MATH 111 or an SATM score at least 550 or an SAT Math Level II score at least 540 or an ACT Math score at least 22 or a Math Dept Precalc test score at least 17.

MATH 132 Calculus II 4(4-0)

Topics in analytical 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 will be studied. 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 integrals, 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.

MATH 450 Linear Algebra and Matrix Theory 3(3-0)

This course is an introduction to linear algebra and matrix theory; the algebra of matrices and its application to the solutions of systems of linear equations, determinants, real and complex vector spaces, bases, dimension, linear transformations, eigenvalues and eigenvectors. 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 111 College of Engineering Colloquium I 1(1-0)

This course includes lectures, seminars, and activities important to the retention and matriculation of students in the college of engineering. Students are introduced to various engineering and computer science degree programs and their respective professions, and are also provided with group advisement regarding department, college, and university-level policies and procedures.

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**ECEN 340 Electrical Circuits and Systems 3(3-0)**

This course covers power and energy concepts; basic R, RC, RL, and RCL circuits; three phase circuits; ideal transformers; diodes and ideal op amp circuits; and logic circuits. The Laplace transform method will be introduced and used to solve circuit problems. Prerequisite: PHYS 242. Corequisite: 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. Prerequisites: MATH 131 and PHYS 241

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 121 Industrial and Systems Engineering Colloquium 1(1-0)

This course includes lectures, seminars and activities important to the retention and matriculation of industrial and systems engineering students. Topics covered include learning styles, group dynamics, industrial and systems engineering history, and career development. Students are also provided with group advisement regarding department, college, and university-level policies and procedures.

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: GEEN 100.

INEN 255 Methods Engineering 3(2-2)

This course 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 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 and 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 361 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 370 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, and hypothesis testing. Prerequisite: MATH 132.

INEN 380 Information Technology for Industrial and Systems 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. Systems concepts, fundamentals of VBA, and the role of computers in industrial and systems engineering are stressed. Prerequisite: GEEN 162.

INEN 389 Systems Approaches for Industrial and Systems 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 ISE major and consent of instructor.

INEN 400 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 ISE major.

INEN 415 Discrete Event Systems Modeling and Simulation 3(2-2)

Concepts of random variate generation, Monte Carlo and discrete event simulation will be introduced. One general simulation language is taught in depth. The use of simulation modeling in design and improvement of production and service is emphasized. Projects are required. Prerequisites: INEN 380, senior standing as ISE major.

INEN 425 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. Applications in service and production systems are emphasized. Prerequisite: INEN 370.

INEN 430 Deterministic Operations Research 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 435 Stochastic Operations Research 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 370 and MATH 431.

INEN 455 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 430.

INEN 460 Decision Support Systems for Industrial and Systems Engineers 3(3-0)

This course covers the design of decision support systems for production and service systems based on quantitative models. Applications of spreadsheets, databases, and integrated software development environments are emphasized. INEN 380, INEN 430, and senior standing.

INEN 465 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 facilities layout required. Prerequisite: INEN 255.

INEN 471 Ergonomics 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 ISE major.

INEN 472 Cognitive Human Factors 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 ISE major.

INEN 475 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 370.

INEN 489 Professionalism and Ethics for Industrial and Systems 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 and Systems 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 ISE major, INEN 361, INEN 415, INEN 430, INEN 465, INEN 471.

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 and systems 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 428 Lean Six Sigma 3(3-0)

This course focuses on the practical application of lean techniques in conjunction with the Six Sigma DMAIC (define, measure, analyze, improve, control) roadmap. This involves application of process flow, quality and data analysis techniques to solve business and operations problems. This course provides the training basis for achieving the skill level of a Six Sigma Green Belt. Prerequisite: INEN 370.

INEN 434 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: INEN 465.

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 448 Occupational Biomechanics 3(3-0)

This course introduces the underlying principles behind the mechanical behavior of the musculoskeletal system during industrial work situations. Their applications in the evaluation and design of industrial jobs are emphasized. Course topics include the musculoskeletal system, biomechanical models, work capacity, and bioinstrumentation. Prerequisite: INEN 471.

INEN 450 Systems Integration 3(3-0)

This course covers applications and case studies that address cost, human factors, energy, information, and materials as applied to the design of production and service systems. Group work will be emphasized. Selection of appropriate analytical, computational and experimental techniques will be required. A design project is required. Prerequisites: INEN 465, 471, 472, and senior standing.

INEN 453 Technical Entrepreneurship 3(2-2)

This course introduces technology entrepreneurial perspective and technology venture creation. The course addresses concepts essential to the entrepreneurial process such as taking a technology idea and finding a commercial opportunity, gathering resources, leading the team, building a business plan, marketing the concept, and managing rapid growth. Prerequisite: Senior Standing.

INEN 458 Management of Engineering Projects 3(3-0)

This course provides an overview of activities required of a technical project manager. Such activities include project life cycle, team formation and leadership, planning, scheduling, budgeting, and control. Project management software is utilized. Prerequisite: Senior Standing.

INEN 485 Selected Topics in Industrial and Systems 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.