



GRADUATE STUDENT HANDBOOK

*MS and Ph.D. Programs
in
Industrial and Systems Engineering*

**DEPARTMENT
OF
INDUSTRIAL and SYSTEMS ENGINEERING
419 McNair Hall**

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1. Introduction

The Department of Industrial and Systems Engineering (ISE) at North Carolina A&T State University (NC A&T) offers graduate programs with specialization areas in Human-Machine Systems Engineering, Manufacturing and Service Enterprise Engineering, and Operations Research/Systems Analysis. Master of Science (MS) degrees are offered in all specialization areas and Doctor of Philosophy (Ph.D.) is offered in Human-Machine Systems Engineering and Manufacturing and Service Enterprise Engineering.

The faculty of the Department of Industrial and Systems Engineering has the responsibility of administering the MS and Ph.D. programs including: admitting students; determining course requirements; administering comprehensive examinations, and supervising graduate student research and dissertation/thesis/project work. The programs are administered by the Graduate Program Committee and the department and follow all departmental requirements and guidelines. A graduate student assumes full responsibility for current knowledge of the policies, procedures, and regulations of the School of Graduate Studies (see the Graduate Program Catalog), and the departmental program requirements and guidelines. For assistance, the student should see his or her major professor or the departmental Graduate Program Coordinator.

The administrative staff of the academic programs of the ISE Department includes:

Department Chairperson:	Dr. Paul Stanfield 408 McNair Hall 336-334-7780 ext. 533 stanfiel@ncat.edu
Graduate Program Coordinator:	Dr. Eui H. Park 401 McNair Hall 336-334-7780 ext. 520 park@ncat.edu
Administrative Assistant:	Ms. Elizabeth Brooks 419 McNair Hall 336-334-7780 ext. 526 ebrooks@ncat.edu

2. Purpose of the Graduate Handbook

The Graduate Handbook provides detailed requirements for all of the graduate degrees offered by the ISE department as well as descriptions of the procedures for completing the requirements of each degree program. Each graduate student should read and conform to the policy contained in this handbook. Additional information concerning Graduate School requirements may be found in the Graduate Programs Catalog of NC A&T. If there is any doubt regarding the interpretation of any regulation or requirement

in this handbook, or if there are questions about the graduate program involving matters not covered in this manual, the student should consult the ISE Graduate Program Coordinator, Dr. Eui H. Park, or the ISE Graduate Student Program Administrative Assistant, Ms. Elizabeth Brooks.

This handbook includes the requirements, policies, and procedures adopted by the ISE faculty for successful completion of graduate degrees. The requirements set forth apply only to graduate programs in Industrial and Systems Engineering. Further requirements have been established by NC A&T's School of Graduate Studies, and ISE graduate students must meet the requirements of both the Graduate School and the ISE department for successful degree completion. While Graduate School requirements may be mentioned occasionally in this document, the student should consult the Graduate Programs Catalog for a complete description of these requirements.

The requirements, policies, and procedures set forth in this document apply to students joining the ISE Graduate Program in or after the Fall Semester of 2011. Graduate students joining the ISE program prior to the Fall Semester of 2011 may consult the appropriate prior ISE Graduate Handbook concerning the requirements for completion of their graduate programs. It is the responsibility of each ISE graduate student to understand and adhere to all applicable policies, procedures, and requirements included in the latest Graduate Catalog.

The provisions of this handbook do not constitute a contract, expressed or implied, between any applicant or student and the ISE Department or North Carolina A&T State University. The University and the Department reserve the right to change any of the provisions, schedules, programs, courses, rules, regulations, or fees whenever university or departmental authorities deem it appropriate to do so.

3. Administration of the ISE Graduate Programs

All requirements, policies, and procedures for the ISE Graduate Program are approved by the ISE faculty at faculty meetings where a quorum is present. Recommendations regarding the operation of the graduate program are reviewed by the Graduate Program Committee (GPC) and, if approved, are forwarded to the ISE faculty for their consideration. The GPC is also charged with the responsibility for resolving conflicts that may arise regarding policy or procedural issues. The GPC is chaired by the ISE Graduate Program Coordinator. In addition to chairing the GPC, the Coordinator is responsible for supervising the implementation of requirements, policies, and procedures adopted by the ISE faculty. The ISE Graduate Program Coordinator and members of the GPC are appointed by the ISE Department Chairperson.

The program administrative staff member who maintains all files for the graduate program is the source of information on the graduate program including, but not limited to, appropriate forms for graduate program and graduate school requirements, applications for admission and financial aid, and other routine paperwork related to the graduate program.

4. Admission to the Master of Science Program in Industrial & Systems

Engineering (MSISE)

To apply for admission to the MSISE program, application forms should be downloaded from the website of the School of Graduate Studies (www.ncat.edu/~grad). The application and supporting materials must be submitted to the School of Graduate Studies. The Department processes applications within approximately 14 days of their receipt from the School of Graduate Studies.

Applicants with their highest degree from non English speaking countries must complete the Test of English as a Foreign Language (TOEFL) exam and obtain a required minimum scores according to graduate school standards.

5. Admission to the Doctor of Philosophy Program in Industrial & Systems Engineering

To apply for admission to the Ph.D. program in Industrial & Systems Engineering, application forms should be downloaded from the website of the School of Graduate Studies (www.ncat.edu/~gradsch). The application and supporting materials must be submitted to the School of Graduate Studies. The Department processes applications within approximately 14 days of their receipt from the School of Graduate Studies.

To be considered for admission to the Ph.D. in Industrial & Systems Engineering an applicant must have:

1. At least one degree in Engineering or Computer Science.
2. A Bachelor of Science degree in Engineering or Computer Science from an EAC-ABET accredited program with a cumulative Credit Point Average of 3.5 or above on a 4-point scale.

OR

A Master of Science degree in a discipline related to Industrial & Systems Engineering, from a college or university recognized by a regional or general accrediting agency, with a cumulative Grade Point Average of 3.3 or above on a 4-point scale.

3. A Graduate Record Exam (GRE) Aptitude Exam score
4. A minimum of written score of 550, a computer score of 213, or an internet score of 79 on the TOEFL if their highest degree is from a non-English speaking country.

6. MSISE Program Requirements

6.1 Program Options

The Department offers three options for the MS degree: a thesis option, a project option, or a course-only option as summarized in Table 1.

Thesis Option

This option consists of twenty-four (24) credit hours of course work and six (6) hours of thesis. An original research topic must be chosen in conjunction with the student's advisor and the student's research must result in the preparation of a scholarly thesis. The student's committee members must approve his or her thesis topic at a proposal defense. A written thesis report and a final oral thesis defense are also required. This option is intended for students with strong research interests who may desire to pursue further graduate studies.

Project Option

This option consists of thirty (30) credit hours of courses and three (3) hours of project. The student's committee members must approve the project topic at a proposal defense. A written project report and a final oral defense are required.

Course-Only Option:

This option consists of thirty three (33) credit hours of courses and one (1) credit hour of comprehensive examination.

6.2 Graduation Requirements

Admission Status

Students must apply for and secure "unconditional" admission status before they commence project or thesis work.

Credit Hour Requirements

The student must complete the following credit hour requirements:

- (i) Project Option: 30 credit hours of course work and 3 credit hours of project
- (ii) Thesis Option: 24 credit hours of course work and 6 credit hours of thesis
- (iii) Course Option: 33 credit hours of course work and 1 credit hour of an M.S. comprehensive exam

700-Level/800-Level Course Requirements

The student is strongly encouraged to meet the following 700-level/800-level course requirements: *Project Option*: 12 credit hours; *Thesis Option*: 9 credit hours; *Course Option*: 12 credit hours. *The student's advisor and the Graduate Program Committee must approve any exception.* INEN 792, INEN793, INEN 794, INEN 796, and INEN 797 may not be counted towards completion of the 700-level/800-level course requirements.

Seminar Course

The student must register and attend the INEN 792 course during two semesters of his or her graduate study. This course does not count towards credit hour requirements.

Assistantship Course

Students employed as a teaching assistant or research assistant should enroll in INEN793: Supervised Teaching or INEN794: Supervised Research. These courses do not count towards credit hour requirements.

Table 1: MS in Industrial & Systems Engineering Program Requirements

Requirement Category	Credits			HMSE	MSEE	ORSA
	Thesis	Project	Course			
Background Courses*	-			GEEN162/163 MATH132 INEN270 INEN600	GEEN162/163 MATH132 INEN270 INEN600	GEEN162/163 MATH132 INEN270 INEN600
Core	12			INEN625; INEN655; INEN665; INEN675		
Specialty Core (take at least 3 courses)	9			INEN648 INEN664 INEN721 INEN735 INEN821 (reqd.)	INEN628 INEN653 INEN658 INEN731 INEN831 INEN833 INEN853	INEN615 INEN658 INEN721 INEN742 INEN841 INEN843 INEN844
Seminar	-			INEN792 (Seminar) in two semesters		
Electives (with consent of Advisor)	3	9	12	Any other INEN6xx, 7xx, 8xx course; Graduate level Psychology courses	Any other INEN6xx, 7xx, 8xx course; Up to 6 Cr. of graduate-level courses	Any other INEN6xx, 7xx, 8xx course
Thesis/ Project/ Exam	6	3	1	INEN797 (Thesis), INEN796 (Project), INEN791 (Course option, MS Comprehensive Exam)		
TOTAL	30	33	34			

Other Graduation Requirements

The other requirements include background courses* (for conditional admission), core courses, special core courses and free electives. These requirements are listed in Table 1. The requirements depend on the student's chosen specialization as discussed in Section 6.4.

* These are the minimum background requirements that are checked for students meeting admission criteria. These courses do not count towards M.S. graduation requirements, and their minimum acceptable grades are "B" or better.

6.3 Academic Advisor, Major Professor, and Ph.D. Committee

All students enrolled in the graduate program must have an academic advisor. Upon admission to the program, the **Graduate Program Coordinator** acts as the student's advisor on a temporary basis. Masters students **must** choose a major professor by the end of their second semester. Thereafter, their major professor also serves as their Academic Advisor. The major professor must be a graduate faculty as designated by the School of Graduate Studies.

The masters committee consists of a major professor and two committee members, and the major professor serves as the chair of the committee. Students may select a non-ISE faculty for their committee, but the student may not have more than one outside member.

Any outside member for a student's committee must be approved in advance by the departmental Graduate Program Committee.

6.4 Specializations

There are three (3) specializations available to M.S. graduate students: Human-Machine Systems Engineering (HMSE), Manufacturing and Service Enterprise Engineering (MSEE), and Operations Research and Systems Analysis (ORSA). **The requirements for each specialization are shown in Table 1.**

Human-Machine Systems Engineering (HMSE)

This area of specialization is concerned with human-computer interface (HCI) and cognitive systems engineering. The HMSE research and educational programs are a combination of social sciences and engineering. There is a strong emphasis on quantitative methods and computer modeling in these programs.

Manufacturing and Service Enterprise Engineering (MSEE)

This area focuses on the design and improvement of manufacturing, service, and supply chain enterprises. MSEE focuses on the engineering of complex organizational and logistics systems, which is a rapidly growing area in a global economy. This area of study requires process understanding as well as an understanding of the application of technical skills. Required technical skills include the use of quantitative and computational models and tools. The MSEE specialization area provides the student with the flexibility to choose courses in preparation for technical, managerial or academic careers. Graduates of the program become leaders in such diverse areas as advanced manufacturing, health systems, finance and banking, military operations, and retail/distribution.

Operations Research and Systems Analysis (ORSA)

This area of specialization is concerned with optimization tools and information systems. Students learn to analyze and propose solutions for general and specific optimization problems. Students may develop abilities in the design of information systems. (M.S. only)

6.5 Critical Steps

The following are the critical steps in the progression toward a Master's degree in Industrial & Systems Engineering:

1. Application for Admission: Obtain and complete the application for admission and return the forms to the School of Graduate Studies. The School of Graduate Studies will forward the completed application package to the Graduate Program Coordinator who will review it along with the Graduate Program Committee.
2. Initial Contact: All students enrolling for the first semester of graduate study in the ISE Department must consult with the Graduate Program Coordinator who serves as the temporary advisor for all graduate students prior to the selection of their

permanent advisor. This selection normally takes place in the first semester after the student's academic and research interests are better defined.

3. Plan of Study: Prior to pre-enrollment for the second semester or the 10th credit hour (whichever comes first), the student is required to select and confer with an advisor, who should provide overall guidance and may also suggest specific details to tailor course work in support of the student's educational objective. The purpose of the Plan of Study is to ensure that the courses planned and completed will adequately prepare the student with the proper background necessary to successfully complete all the requirements of the program. Any change(s) needed to the Plan of Study must be approved by the Advisor and the committee members, and an amended Plan of Study must be filed.
4. Selection of Advising Committee: Once an advisor is selected, the student must confer with him/her for assistance in the formation of a project/thesis committee. Once established, the committee as a whole is responsible for recommending any changes in its composition. The committee shall consist of an advisor and two or three additional faculty members with research interests related to the field of study of the student. A student may choose no more than one member from a department outside the ISE Department.
5. Complete Course work: Students are **required to complete the course work** as listed in their approved Plan of Study. Also, students who are admitted as provisional students must complete all background courses during the first academic year.
6. Propose, Complete and Defend Thesis/Project Work: Students are encouraged to complete a project/thesis proposal defense before completion of 18 graduate course credit hours. The project/thesis must be completed and project/thesis **final defense** successfully completed before the advisory committee, and a report must be prepared to the satisfaction of the committee.
7. Time between Proposal Defense and Final Defense: The time between proposal defense and final defense should **be no less than 90 days**.
8. Graduation: Students **must apply for graduation** in accordance with the deadlines established by the School of Graduate Studies.

6.6 Project /Thesis Requirements

The steps in completing project/thesis requirements are given below:

1. With the consent and advice of his/her advisor, the student selects a tentative project/thesis topic. See Appendix D for detailed guidelines for selection of a thesis topic.

2. In consultation with the advisor, the student selects committee members. See Appendix E for guidelines on changing the composition of a committee, if it becomes necessary.
3. The student prepares a typed project/thesis proposal outlining the proposed work. Thesis proposals are expected to review the state-of-the-art, and should clearly indicate that a substantial literature search has been completed. A thesis proposal will not be considered complete without a list of relevant reviewed references.
4. The advisor approves the proposal and its copies are submitted to the committee members at least one week before the proposal defense.
5. A proposal meeting is held. The student presents his/her proposal (less than about 20 minutes for projects, 40 minutes for theses) and answers questions. The committee decides if the topic is suitable and makes suggestions on scope, solution, and so forth. If the decision is favorable, the committee becomes the project/thesis committee. The student must submit a Project/Thesis Proposal Notification Form according to the instructions stated on the form.
6. The advisor directs the project/thesis research and initial writing. Other committee members are also available for guidance and advice. The advisor may schedule a committee meeting for progress review when research is well underway.
7. The advisor approves the initial typed draft of the project/thesis.
8. The student must schedule an oral examination with the individual committee members. Copies of the project/thesis must be submitted to the committee members at least one week prior to the scheduled oral examination date.
9. The oral examination begins with a presentation by the student of the project/thesis work (30 - 40 minutes), followed by questions by the advisor and committee members.
10. The committee members will read the draft and submit suggestions for changes and/or additions to the student.
11. In consultation with the advisor, the student makes the changes and/or additions and types the final draft.
12. The student leaves the room, the committee decides on a pass, fail, or retest, and the student is informed. It is the policy of this department that students who do not perform well on the oral examination do not pass. The committee has the option of failing these students or requiring a retest. In the case of a retest, the student must again appear for an oral examination no sooner than two weeks following the original examination. This procedure may be repeated at the option of the committee.

- Bound copies of the project/thesis report are supplied to each committee member and the ISE department. The copy for the department must be hard-bound. For a thesis, three copies must be deposited with the Dean of Graduate Studies. Please consult with the School of Graduate Studies for details on this requirement. Project reports need not be submitted to the School of Graduate Studies.

7. Ph.D. Program Requirements

7.1 Expected Timetable

Students are expected to complete the various requirements according to the schedule below. Please note that this is a schedule for full-time students only. Part-time students may take longer to complete each of the requirements.

	With MS in ISE	Without MS in ISE
Qualifying Exam	1 st or 2 nd semester	3 rd or 4 th semester
Preliminary Exam	3 rd or 4 th semester	5 th or 6 th semester
Other Requirements (Course credits, Supervised Teaching /Supervised Research, Statistics, Seminar)	5 th semester	6 th or 7 th semester
Final Dissertation Exam	6 th semester	7 th or 8 th semester

7.2 Graduation Requirements

The Ph.D. graduation requirements are given below:

- Credit Requirement: A total of 81 credits after the B.S. degree, of which 18 credits are toward dissertation work, and 63 credits are toward course work. Of the 63 credits of course work, up to 24 credits of Industrial & Systems Engineering-related course work at the MS-level may be applied towards the 57 course credit requirements.
- Supervised Teaching/Supervised Research Requirement: Students must complete 3 credits of either supervised teaching or supervised research. Students may meet this requirement by either teaching an undergraduate course in the department (Supervised Teaching) or completing a semester-long research effort at a research laboratory in industry or government (Supervised Research). Registering for and completing either the INEN993 or INEN994 course as a part of a Graduate Teaching Assistant or Graduate Research Assistant assignment does not count towards this requirement.
- Seminar Requirement: Students must register and complete Graduate Seminar class (INEN992; 1 credit) in a least two semesters except for students who enter the Ph.D. program without an MS degree. These students must register and

complete the Graduate Seminar class in at least four semesters (2 semesters of INEN 792 and two semesters of INEN 992).

4. Quantitative Requirement: Students must complete a specified Ph.D.-level (INEN821) statistics class or (INEN841) optimization class, depending on track as shown in Table 2.
5. Course Credits: At least 24 course credits, including the quantitative requirement, will be at the 8xx level. At least 9 of these credits must be from a specified list of courses in the area of specialization (HMSE or MSEE) chosen by the student. In addition, six hours of non ISE graduate courses suggested by his / her advisor are required as electives, which will make a minimum of 30 credit hours for course work.
6. Publication Requirements: All Ph.D. students are strongly encouraged to publish at least three technical papers at peer-reviewed conference proceedings. It is recommended to have at least one technical paper each year from the second year of his/her doctoral studies. **In addition, a Ph.D. student must submit a technical paper for publication to peer-reviewed journal.**
7. Qualifying Exam: Students must pass a 6 hour in-class written exam (1 credit) that covers the seven (7) subject areas of industrial & Systems engineering at the B.S./MS in Industrial & Systems Engineering levels. Students must pass this exam in no more than two attempts. Please see Appendix F: *Preparing for the Ph.D. Qualifying Exam Preparation Guide*, for details.
8. Preliminary Exam: Students must pass a written exam in the area of his/ her own specialization. The written exam is in a take-home format (7 days). This exam is prepared and administered by the student's Ph.D. Committee. Please see Appendix G: *Ph.D. Preliminary Exam Preparation Guide for details*.
9. Oral Proposal Defense: The student must present a proposal of dissertation research to the student's Ph.D. committee. The student is permitted to proceed to this part of the Preliminary Exam only if he/she passes the written exam. The student must prepare and submit the dissertation proposal to the committee at least one week before the proposal defense date. The dissertation proposal Defense is scheduled by the department and is open to all students and faculty. The Ph.D. Committee decides the outcome of the defense and informs the student of this outcome within 24 hours.

If the student fails the Dissertation Proposal Defense, the committee allows the student one more attempt. The date and time of this exam is determined by the Committee; however, the exam must be completed within one semester, unless the committee determines that the student should take one or more courses before attempting the Dissertation Proposal Defense again. A representative from the School of Graduate Studies serves as an observer during the oral part

of the dissertation proposal. The student and / or the advisor notify the School of Graduate Studies at least two weeks in advance of the time and place of the dissertation proposal.

10. Supervised Teaching/Supervised Research Requirement: Please see Appendix H for details.

The above requirements are summarized in the Table 2.

Table 2: Ph.D. in Industrial & Systems Engineering Program Requirements

Requirement Category	Credits	HMSE	MSEE
Specialty Core (take at least 3)	9	INEN721 INEN812 INEN813 INEN814	INEN852 INEN833 INEN853
Quantitative Requirement	3	INEN821	INEN841
Intermediate level Industrial & Systems Engineering Courses (up to 18 credit hours)	18	Any course in Industrial & Systems Engineering at the graduate-level completed by the student as part of their MS degree.	
Other Intermediate-level Engineering or Industrial & Systems Engineering related Courses (up to 6 credit hours)	6	Any course in Engineering or Industrial & Systems Engineering related course at the 600-level completed by the student as part of their MS degree.	
Supervised Teaching/ Research	3	INEN993 or INEN994	
Seminar Requirement	2	INEN992	
Electives (with consent of Advisor)	12	Engineering Courses at the 700-level or 800-level	
Qualifying Exam	1	INEN991	
Preliminary Exam	3	INEN995	
Dissertation	18	INEN997	
TOTAL	75		

7.3 Academic Advisor, Major Professor, and Ph.D. Committee

All students enrolled in the graduate program must have an academic advisor. Upon admission to the program, the **Graduate Program Coordinator** acts as the student's advisor on a temporary basis. Ph.D. students **must choose** a major professor by the end of the second semester. Thereafter, the major professor also serves as the student's Academic Advisor. The major professor must be a graduate faculty as designated by the School of Graduate Studies.

The Ph.D. committee consists of a major professor and three committee members, and the major professor acts as the chair of the committee. Students may select a non-ISE faculty for his/her committee, but the student may not have more than one outside member on this committee. If a student would like to have a non-ISE faculty member as a major advisor, he/she must select another ISE faculty member as a co-advisor. Any outside member for a

student's committee must be approved in advance by the departmental Graduate Program Committee.

7.4 Specializations

There are two areas of specialization available to Ph.D. students: Human-Machine Systems Engineering (HMSE), and Manufacturing and Service Enterprise Engineering (MSEE). **The requirements for each specialization are shown in Table 2.**

7.5 Critical Steps

The following are the critical steps in progression toward a Ph.D. degree in Industrial & Systems Engineering:

1. Application for Admission: Obtain and complete the application for admission and return forms to the School of Graduate Studies. The School of Graduate Studies forwards the completed application package to the Graduate Program Coordinator who reviews it with the assistance of the Graduate Program Committee.
2. Initial Contact: All students enrolling for the first semester of graduate study in the ISE Department must consult with the Graduate Program Coordinator who serves as the temporary advisor for all graduate students prior to the selection of their major professor. This selection must take place no later than the end of the second semester after the student's academic and research interests are better defined.
3. Plan of Study: Prior to pre-enrollment for the second semester or the 10th credit hour (whichever comes first), the student is required to select and confer with an advisor who provides overall guidance and may also suggest specific details to tailor course work in support of the student's educational objective. The purpose of the Plan of Study is to ensure that the courses planned and completed adequately to prepare the student with the proper background necessary to successfully complete all the requirements of the program. Any change(s) needed to the Plan of Study must be approved by the Advisor and the committee members, and an amended Plan of Study must be filed.
4. Selection of Ph.D. Committee: Once an Advisor is selected, the student must confer with him/her for assistance in the formation of a Dissertation Committee. Once established, the committee as a whole is responsible for recommending any changes in its composition. The committee consists of an Advisor and three additional faculty members with research interests related to the field of study of the student. A student may choose no more than one member from a department or organization outside the ISE Department.
5. Complete Qualifying Exam: Register for the INEN991 course, take the Qualifying Exam and pass the exam. See Appendix F for details about the exam.

6. Complete Preliminary Exam: Register for the INEN995 course, take and pass the Preliminary Exam. See Appendix G for details about the exam.
7. Complete Course Work and Other requirements: The student is required to complete the course work as listed in his/her approved Plan of Study.
8. Complete Oral Proposal Defense: See section 7.6 for details about the exam.
9. Complete and Defend Dissertation Research: The dissertation final defense before the advisory committee must be successfully completed, and a report must be prepared to the satisfaction of the committee. The time between proposal defense and final defense should be no less than 180 days.
9. Publication: It is strongly urged that research work be submitted for publication in peer-reviewed journals.
10. Graduation: Students must apply for graduation in accordance with the deadlines established by the School of Graduate Studies.

7.6 Dissertation Research Requirements

The steps in completing dissertation requirements are given below:

1. With the consent and advice of his/her advisor, the student selects a tentative research topic. See Appendix D for detailed guidelines for selection of a dissertation topic.
2. In consultation with the advisor, the student selects committee members. See Appendix E for guidelines on changing the composition of a committee, if necessary.
3. The student prepares a typed dissertation proposal outlining the proposed work. Dissertation proposals are expected to review the state-of-the-art, and should clearly indicate that a substantial literature search has been completed. A dissertation proposal will not be considered complete without a list of relevant, reviewed references.
4. The advisor approves the proposal and copies are submitted to the committee members.
5. A proposal meeting is held. The student presents his/her proposal (less than 45 minutes) and answers questions. The committee decides if the topic is or is not suitable and makes suggestions on scope, solutions, and so forth. If the decision is favorable, the committee becomes the dissertation committee. The student must submit a Dissertation Proposal Notification Form according to the instructions stated on the form.

6. The advisor directs the project/thesis research and initial writing. Other committee members are also available for guidance and advice. The advisor may schedule a committee meeting for progress review when research is well underway.
7. The advisor approves the initial typed draft of the dissertation.
8. The student submits copies to the committee members. The student must schedule the oral examination with the individual committee members. Copies of the dissertation must be submitted to the committee members at least two weeks prior to the scheduled oral examination date.
9. The committee members read the draft and submit suggestions for changes and/or additions to the student.
10. In consultation with the advisor, the student makes the changes and/or additions and has the final draft typed.
11. The oral examination begins with a presentation by the student (60 minutes) of the dissertation work, followed by questions by the advisor and committee members.
12. The student leaves the room, the committee decides on a pass, fail, or retest, and the student is informed of the decision. It is the policy of this department that students who do not perform well on the oral examination do not pass. The committee has the option of failing these students or requiring a retest. In the case of a retest, the student must again appear for an oral examination no sooner than two weeks following the original examination. This procedure may be repeated at the option of the committee.
13. Bound copies of the dissertation report must be supplied to each committee member and the ISE Department. The copy for the department must be hard bound. As specified in the Graduate School Bulletin, three copies must be deposited with the Dean of Graduate Studies. Please consult with the School of Graduate studies for details on this requirement.

8.0 Financial Support

Limited financial support is available from the department for positions as Graduate Teaching Assistants or Graduate Research Assistants. A description of the policies, which apply to all graduate assistantships, is provided in the graduate catalog in the section titled, Types of Available Funds. The number of assistantships available varies from semester to semester as the research and other needs of the department and the operating budget changes. Students should make known their financial needs to their major professor or to the Graduate Program Coordinator. The major professor may have support available for his/her students. The final decision on the award of an assistantship to any student is made by the Department Chairperson. In addition, there

are other financial supports for African-American students interested in the Ph.D. programs through two types of fellowships: Title III and Sloan.

Students should not depend on assistance from North Carolina A&T State University in making their financial plans. Assistantships are strictly dependent on the availability of funds.

9. Graduate School Requirements

The following procedures are at the direction of the School of Graduate Studies. Students must conform to these guidelines.

Changes in Requirements

Generally, a student is permitted to graduate according to the requirements specified either in the catalog current during the year of his/her first application for candidacy or in the catalog current in his/her application for graduation. **If more than six (6) years pass between the student's application for candidacy and his/her application for graduation, the university reserves the right to require the student to satisfy the regulations in effect at the time of his/her application for graduation.**

Schedule of Deadlines

The School of Graduate Studies provides schedules of specific dates for completing various requirements for a degree program. These notices are not sent to individuals automatically; however, they may be found in the calendar of the School of Graduate Studies and are available upon request. The student is required to be familiar with these dates.

Course Levels

At the university, three-digit numbers are used to designate all course offerings. The three digits indicate the classification level of the course. Courses numbered 600 through 699 are open to seniors and to graduate students. Courses numbered 700 through 999 are open to graduate students only.

Transfer of Credit

Up to six semester hours of course work may be transferred from another university if this work was not part of any prior undergraduate degree requirement and if, in the opinion of the advisor, the content adequately replaces current graduate offerings in the student's curriculum. Course work being considered for transfer credit should be at a level comparable to our 700- or 800- level courses.

Time Limitation

The graduate program **must be completed within six (6) consecutive calendar years.** Programs remaining incomplete **after this time interval are subject to cancellation, revision, or special examination for outdated work.** In the event that studies are interrupted for duty in the armed services, the time limit shall be extended for the length of time the

student was on active duty providing the student resumes graduate work no later than one year following release from military service.

Concurrent Registration in Other Institutions

A student registered in a degree program in the School of Graduation Studies may not enroll concurrently in another graduate school except upon permission, **secured in advance**, from the Dean of the School of Graduate Studies.

Application for Graduation

A **candidate for graduation must file an application for graduation according to the schedule released by the School of Graduate Studies (typically in the first week of the final semester)**. The application forms are available from the School of Graduate Studies. The student's advisor must approve the application before it is sent to the School of Graduate Studies. A copy of the completed application should be filed with the Department of Industrial & Systems Engineering. Failure to meet the deadline may result in a delayed graduation date for the candidate.

Grade Point Average (GPA)

A graduate student is expected to maintain a GPA of 3.00 or above in: (i) each registered semester, and (ii) in his/her overall cumulative grade point average at North Carolina A&T State University. A graduate student who fails to meet these standards is reviewed by the Graduate Program Committee. Substandard performance is considered grounds for terminating a student's program. Any student failing to show satisfactory progress toward a graduate degree may be terminated at the discretion of the Graduate Program Committee.

Course Load

A student using any resource of the University must register for at least one credit hour of INEN799 (Continuation of Master's Project/Thesis), or INEN999 (Continuation of Dissertation) during the semester of the thesis/project or the dissertation. No assistantship can be provided for a non-registered student. A normal maximum load for a graduate student is 9 hours per semester and 3 hours for each summer session. A half-time graduate teaching or research assistant (20 hours/week) may not take more than 10 hours during regular semesters and 3 hours during summer session. A maximum load for the quarter-time assistant (10 hours/week) is 13 semester hours.

Appendix A: Industrial & Systems Engineering Laboratories

In conjunction with the departmental focus on systems engineering and information systems, departmental instructional laboratories are integrated using information technology into a single “virtual enterprise.” The enterprise system allows all laboratories to use common database(s) and similarly functioning application programs as if they were separate operations within a single manufacturing or service supply chain. Instructional laboratories are located in adjacent rooms in Graham Hall to serve the Engineering, Manufacturing, Assembly/Packaging, and Distribution departments of the virtual enterprise.

Product, Process, and Facility Design Systems Laboratory (202 Graham)

This laboratory allows the student to participate in activities associated with the “Engineering Department”. These functions include solid modeling and rapid prototyping for product design; process planning and robotics/vision for process design; and layout and material handling for facility design. The laboratory is equipped to teach concurrent engineering methods and includes a training area with 14 high speed computers. Additional equipment includes a Feedback Serpent SCARA Robot, a Cognex Camera and Vision System, a Z-Corp rapid prototype 3D printer, and computers with Access to AutoCAD, SolidWorks, and facility planning software.

Manufacturing Processes and Systems Laboratory (200 Graham)

This laboratory offers a broad educational opportunity for manufacturing processes including machining, casting, fabrication, and plastics molding and extrusion. Hands-on learning and experimentation is stressed with machines available for use with manual and automatic control. Computer-based quality control tools are available to study product quality and perform parametric analysis. Major equipment in this laboratory includes an Amatrol Plastics Manufacturing System for Blow Molding, Extrusion Molding, and Injection Molding, an Articulated Arm CMM, Mitutoyo Computer SPC Metrology System, an EMCO Compact 5 CNC lathe, an EMCO Unimat PC DCC lathe, a Jet bandsaw, and a ZYCO Laser Telemetric System. Several high speed PCs are connected to the virtual enterprise and are able to run CNC code generating software.

Automated Assembly and Packaging Systems / Advanced Manufacturing Laboratory (201 Graham)

This laboratory houses a flexible manufacturing cell capable of producing a variety of small milled and assembled parts. The cell consists of an Automatic Storage and Retrieval System, an Adept Viper robot, an EMCO CNC mill, an Adept Cobra robot and vision system, and a Flexible Conveyor System. The operations of the cell are integrated using a Visual Basic program interfaced to an Allen-Bradley PLC and Microsoft SQL Server. In addition, the laboratory has a number of Allen-Bradley Programmable Logic Controllers with table top simulators and programming software. Computers and software to develop industrial man-machine interfaces that can connect to manufacturing information systems are also housed in this laboratory. The laboratory also contains equipment for high precision machining.

Ergonomics and Biomechanics Laboratory

(317 Cherry)

This laboratory provides rich educational opportunities and conducts both empirical and theoretical research projects in the fields of ergonomics and biomechanics. Research studies in the lab often reveal factors linked to increased risks for musculoskeletal disorders. Our effort focuses on developing and testing strategies to minimize such risks by targeting those risk factors. The Laboratory houses a wide range of bioinstrumentation, including the Delsys Bagnoli 16-channel electromyography (EMG) system, DataLOG portable data acquisition unit, trak STAR motion capture system, Vicon Bonita motion capture cameras, Bertec force plate, industrial Lumbar Motion Monitor (iLMM), and CYBEX NORM multi-joint evaluation and exercise system. The Laboratory also employs ergonomics and biomechanics software such as MVTA Multimedia Video Task Analysis, 3D Static Strength Prediction Program, Energy Expenditure Prediction Program, JACK, and AnyBody.

Graduate Student Office

(219 Cherry)

This room serves as a study and storage area for graduate students not assigned to other departmental or research laboratories.

Senior Design Room

(110 Cherry)

This room host a number of undergraduate student activities, including office hours and study sessions led by graduate teaching assistants.

Departmental laboratories devoted to research include:

Human-Machine Systems Engineering Laboratories (HMSEL)

(For virtual tour: <http://gandalf.ncat.edu/ihms>)

1. Cognitive Systems Engineering and Simulation Laboratory (221 IRC)

This laboratory is for the study of human cognition and the use of the properties in human cognition to design, analyze, and validate behaviors of engineered systems. These properties include the performance of humans when interacting with engineered systems; the adjustment and adaptation of human and artifact behaviors in changing task environments; the understanding of command and control; and the underlying mitigating factors in diagnosing human-systems failures under various organizational designs. Research in CSE is focused on developing empirical models of analytical simulation, collaborative sensemaking, engineered work domains, human error and safety, computational modeling, workload, and the application of evolutionary algorithms to simulate human cognitive processes.

2. Human Systems Integration Laboratory (HSIL) (222 IRC)

This laboratory provides facilities for experimental and analytical testing and the evaluation of human capabilities and performance in system designs. Prototypes are designed and used in simulated environments to demonstrate Human System Integration principles. HSIL has a state-of-the art usability laboratory, an audio and speech intelligibility booth, iViewXTM head and eye tracking equipment with gaze analysis capability, diving simulators, human signal acquisition systems (EEG, EMG,

etc.), and a virtual JACKTM Simulator for work envelop and anthropometric compatibility design. Typical research efforts include: workload,; application of Living Systems theory to adaptive HCI; acoustic influence operations with the use of human neurophysiological data to classify workload under stress and to understand semantic information processing; and display design.

3. Decision Support System and Simulation Laboratory (DS³L) (211 Hines)

The laboratory is concerned with decision support system development and information display and visualization modeling. Some of the available equipment includes: Rapid Prototyping software, Microsaint, assorted personal computers, custom design and a variety of development software for simulation and information display and visualization.

4. Perception and Visual Cognition Laboratory (PVCL) (212 Hines)

This laboratory is involved with modeling and the simulation of visual cognition and perception to examine how they affect human performance in automated systems. The existing equipment includes ISCAN eye perception laboratory equipment including all of the accessories to this equipment.

5. Human Judgment and Decision Making (J/DM) Laboratory (222 IRC)

This laboratory was founded to investigate judgment and decision making in complex dynamic environments. The work in this laboratory involves situations in which individuals try to understand an environment in order to understand situations, and to execute multiple decisions in context over time while interacting with complex automated systems. The laboratory seeks to develop models and prototypes that aid the understanding of human interaction with complex systems and the prediction of and support for human judgment and decision making behavior.

Logistics Systems Laboratory (319 Cherry)

This laboratory allows focus on logistics systems, with emphasis on humanitarian, healthcare and military systems. The laboratory contains several computer sub-networks designed to solve complex optimization/simulation problems. Equipment in this laboratory includes fixed and portable bar-code readers, network controllers, bar coding software, printers, and radio frequency tags and data communications hardware

Appendix B: Industrial & Systems Engineering Faculty

Name/Title	Education	Contact Info	Primary Research Interests	Secondary Research Track
Dr. Lauren Davis, Associate Professor	North Carolina State University (Ph.D. 2005)	ldbavis@ncat.edu (336) 334-7780 x518 McNair 404	Manufacturing and Service Enterprise Engineering: Supply Chain Optimization, Optimization Models for Supply Chain Information Sharing & Negotiation, Applied or Stochastic Processes	Operations Research and Systems Analysis
Dr. Salil Desai, Associate Professor	University of Pittsburgh (Ph.D. 2004)	sdesai@ncat.edu (336) 334-7780 x530 McNair 423	Manufacturing and Service Enterprise Engineering: Nano/Micro and Bio Manufacturing, Drug Delivery & Tissue Engineering, Multiphysics Modeling, Design for X, and CAD/CAM.	Operations Research and Systems Analysis
Dr. Xiaochun Jiang, Associate Professor	Clemson University (Ph.D. 2001)	xjiang@ncat.edu (336) 334-7780 x522 McNair 426-A	Human-Machine Systems Engineering: Human Computer Interaction, Visual, Auditory and Haptic Display, Multivariate Statistics, Modeling Humans in Quality Control and Process Systems	Manufacturing and Service Enterprise Engineering
Dr. Zongliang Jiang, Assistant Professor	North Carolina State University (Ph.D. 2007)	zjiang@ncat.edu (336) 334-7780 x527 McNair 406	Human-Machine Systems Engineering: Physical Ergonomics, Occupational Biomechanics, Ergonomic Job Analysis and Intervention, Optimization-based Biomechanical Modeling	Manufacturing and Service Enterprise Engineering
Dr. Zhichao(Zinc) Li, Assistant Professor	Kansas State University (Ph.D. 2006)	zli@ncat.edu (336) 334-7780 x535 McNair 403	Manufacturing and Service Enterprise Engineering: Precision and ultra-precision manufacturing in semiconductor industry including process development, modeling, and simulation and traditional and non-traditional machining processes	Operations Research and Systems Analysis

Dr. Daniel Mountjoy, Associate Professor	North Carolina State University (Ph.D. 2001)	mountjoy@ncat.edu (336) 334-7780 x529 McNair 416	Human-Machine Systems Engineering: Information Visualization, Human Performance, Human-Computer Interaction.	Manufacturing and Service Enterprise Engineering
Dr. Celestine Ntuen, Distinguished University Professor	West Virginia University (Ph.D. 1984)	Ntuen@ncat.edu (336) 334-7780 x531 McNair 422-B	Human-Machine Systems Engineering: Human-Computer Interaction, Wargames, Cognitive Systems Engineering, and System Simulation	Manufacturing and Service Enterprise Engineering
Mr. Steve Oneyear, Associate Professor	University of Wisconsin (MS 1973)	sjoneyea@ncat.edu (336) 334-7780 x528 McNair 425	Manufacturing and Service Enterprise Engineering: Computer Integrated Design and Manufacturing, Production Systems Design and Analysis, and Quality Assurance	
Dr. Eui Park, Professor	Mississippi State University (Ph.D. 1983)	park@ncat.edu (336) 334-7780 x520 McNair 401	Human-Machine Systems Engineering: Cognitive Systems Engineering, System Simulation, Production Systems Design and Analysis, and Quality Assurance	Manufacturing and Service Enterprise Engineering
Dr. Xiuli Qu, Assistant Professor	Purdue University (Ph.D. 2006)	xqu@ncat.edu (336) 334-7780 x546 McNair 424	Manufacturing and Service Enterprise Engineering: OR applications in health care delivery, supply chain management, transportation and homeland security	Operations Research and Systems Analysis
Dr. Bala Ram, Professor	State University of New York at Buffalo (Ph.D. 1983)	ram@ncat.edu (336) 334-7780 x516 McNair 426-B	Manufacturing and Service Enterprise Engineering: Manufacturing Engineering, Materials Handling, Industrial Simulation, A ppplied Operations Research and Information Systems	Operations Research and Systems Analysis
Dr. Younho Seong, Associate Professor	State University of New York at Buffalo (Ph.D. 2002)	yseong@ncat.edu (336) 334-7780 x532 McNair 422-A	Human-Machine Systems Engineering: Human-machine interaction, Human judgment and policy analysis, Cognitive Engineering	Manufacturing and Service Enterprise Engineering

<p>Dr. Paul Stanfield, Associate Professor & Chairperson</p>	<p>North Carolina State University (Ph.D. 1995)</p>	<p>stanfiel@ncat.edu (336) 334-7780 x533 McNair 408</p>	<p>Manufacturing and Service Enterprise Engineering: Supply Chain Systems, Remanufacturing, Military Logistics, Automated Identification, Life Cycle Management, Enterprise Information Systems, and Stochastic Scheduling</p>	<p>Operations Research and Systems Analysis</p>
<p>Dr. Silvanus Udoka, Associate Professor</p>	<p>Oklahoma State University (Ph.D. 1989)</p>	<p>udoka@ncat.edu (336) 334-7780 x521 McNair 402</p>	<p>Manufacturing and Service Enterprise Engineering: Interactive Visualization and Visual Depiction, Immersive 3-D (I3D) Environments; Automation, Robotics Applications, and Integrated Manufacturing Systems Engineering; and Six Sigma and Lean Enterprises.</p>	<p>Human-Machine Systems Engineering</p>

Appendix C : Course Descriptions

I. Course Relationships

Most of the undergraduate and graduate courses offered in the Department of Industrial and Systems Engineering are presented below as sets of courses in various subject areas.

General:

Preparatory: INEN600

Integration: INEN289, INEN389, INEN585, INEN489, INEN595

Human-Machine Systems Engineering:

Human-System Interaction:

INEN255, INEN472, INEN665, INEN721, INEN735, INEN813, INEN814

Human Factors Engineering

INEN255, INEN471, INEN648, INEN664, INEN812

General/Statistics:

INEN370, INEN475, INEN675, INEN821, INEN844

Manufacturing and Service Enterprise Engineering:

Economic Analysis: INEN361, INEN731

Organizational Issues in Engineering:

INEN633, INEN653, INEN658, INEN734, INEN831, INEN832

Quality Control: INEN425, INEN628

Service Sector Engineering: INEN831, INEN833

General/Analytical Operations Research: INEN430, INEN435, INEN 742, INEN841, INEN843

Production Control: INEN655, INEN745

Facility Design: INEN465, INEN535, INEN854

Production Process: INEN246, INEN446, INEN324, INEN624, INEN852, INEN861

Robotics and Automation: INEN632, INEN851

Informational Technology for Manufacturing: INEN745, INEN853

General/Computers: INEN380, INEN625

General/Simulation: INEN415, INEN615, INEN822

II. Background Courses

See the Undergraduate Handbook for the list and course descriptions of undergraduate courses that may be assigned as background courses.

III. Advanced Undergraduate and Graduate Courses

INEN-600. Survey of Industrial Engineering Topics **Credit 3 (3-0)**

This course will introduce topics in the following areas of Industrial Engineering: Engineering Economy, Linear Programming, Production Control, Methods Engineering, and Statistical Process Control. Prerequisite: Senior/Graduate Standing.

INEN-615. Industrial Simulation **Credit 3 (2-2)**

This course addresses discrete-event simulation languages. One general purpose simulation language is taught in depth. The use of simulation in design and improvement of production and service systems is emphasized. Term papers and projects will be required. Prerequisite: Consent of Instructor.

INEN-624. Computer-Integrated Design / Manufacture **Credit 3 (2-2)**

This course addresses Computer-based tools and techniques for integrated product and process design. Topics include numerical computer-aided design and process planning, group technology, numerical control, computer numerical control, and direct numerical control, rapid response technologies, integrated manufacturing planning, execution, and control and computer-integrated manufacturing. Design projects are required. Prerequisite: Senior/Graduate Standing.

INEN-625. Information Systems **Credit 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 **Credit 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 **Credit 3 (2-2)**

This course addresses design, analysis, implementation and operation of robotics in production systems. End effectors, vision systems, sensors, stability and control off-line programming, and simulation of robotic systems are covered. Methods for planning robotic work areas are emphasized. Design projects are required. Prerequisite: Senior/Graduate Standing.

INEN-633. Engineering Law and Ethics**Credit 3 (2-2)**

This course introduces engineers to law and ethics. Topics include contract law and practices, product liability, intellectual property and patent law, research and development contracts, environmental law, interstate commerce regulations, labor law, workers' compensation, safety regulations, ethical issues involving conflict of interest, and confidentiality. Prerequisite: Senior/Graduate Standing.

INEN-648. Biomechanics**Credit 3 (3-0)**

This course covers human biomechanical and physiological behavior during work. Quantitative methods using engineering mechanics principles and computer simulation are emphasized. Prerequisite: Senior/Graduate Standing.

INEN-653. Engineering Entrepreneurship**Credit 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-655. Production Planning & Scheduling**Credits 3 (3-0)**

This course focuses on the design, control and underlying behavior of manufacturing and service systems with emphasis on quantitative and information technology methods. Topics covered in this course include demand forecasting, inventory management, aggregate planning, operations scheduling, Material Requirements Planning and Manufacturing Resource Planning, Just-in-Time, Theory of Constraints and Supply Chain Management. Projects will be required. Prerequisite: Senior/Graduate Standing

INEN-658. Project Management**Credit 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. Systems Safety Engineering and Risk Analysis**Credit 3 (3-0)**

This course presents the principles and methods of system safety management and risk analysis. Quantitative and qualitative methods and their applications in safety and risk analysis of human-machine systems are emphasized.

INEN-665. Human Machine Systems**Credit 3 (2-2)**

This course emphasizes the application of perceptual, cognitive, and physical ergonomics principles to the design of human-machine systems. Topics covered include physiological limitations, cognitive and perceptual issues, task complexity and the demands on physical/cognitive resources, human-machine system integration, and usability and evaluation methods. Design projects are required. Prerequisites: Senior/Graduate Standing in ISE or Consent of Instructor.

INEN-675. Design and Analysis of Experiments**Credit 3 (3-0)**

This course addresses various experimental designs, to analyze data for research projects, process improvements, human factors studies, and surveys. Designs covered include Latin Squares, complete and incomplete block designs, one, two, and three variable factorials, fractional factorials, nested designs, and 2k designs. Suitable laboratory apparatus will be set up to study the effect of design parameters on selected response. Statistical software will be utilized to analyze results. Parametric statistics such as analysis of variance (ANOVA) are introduced. Prerequisite: Senior/Graduate Standing.

INEN-685. Selected Topics in Industrial Engineering**Variable Credit (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.

INEN-694. Special Projects Variable**Credit (1-3)**

Study arranged on a special engineering topic of interest to student and faculty member, who will act as advisor. Topics may be analytical and/or experimental and encourage independent study. Prerequisite: Consent of the instructor. M.S. and Ph.D. Students Only

IV. MS and Ph.D. Level Courses**INEN-721. Systems Engineering Models****Credit 3 (3-0)**

This course presents an overview of modern quantitative and computational techniques for system modeling, design and control. Topics include fuzzy set theory, neural network, control theory, optimization search methods, Petri-nets, and knowledge-based systems. Prerequisite: Graduate Standing.

INEN-731. Engineering Cost Control**Credit 3 (3-0)**

This course is designed to emphasize the use of cost data by engineers in support of the financial management function. Cost functions, cost behavior, cash control, budgeting, and cash flow analysis are discussed.

INEN-734. Engineering Organization**Credit 3 (3-0)**

This course presents theories of organizational structures, motivation, leadership, delegation, incentives and rewards systems, teams, strategic planning, and personnel evaluation. Prerequisites: Graduate Standing and Consent of Instructor.

INEN-735. Human-Computer Interface**Credit 3 (3-0)**

This course provides a fundamental coverage of topics in human-computer interface (HCI). The primary emphasis is on the impact of human characteristics and the use of information processing models for HCI-design, usability evaluation, virtual reality, and multimedia systems. Prerequisite: Graduate Standing.

INEN-742. Linear Optimization**Credit 3 (3-0)**

This course addresses formulation, solution techniques and application techniques of linear programming problems. Topics covered include simplex method, revised simplex method, duality, sensitivity analysis, large scale linear programs, column generations, Dantzig-Wolfe decomposition, interior point methods, and computer solutions. Prerequisites: Consent of Instructor.

INEN-745. Advanced Computer-Integrated Production Systems **Credit 3 (3-0)**

This course addresses the principles relating to integration issues for an automated manufacturing enterprise. Topics include control architectures, communication networks and standards for graphical information interchange. Current research areas will be discussed. Design projects are required. Prerequisites: INEN-624 and INEN-635.

INEN-812. Advanced Ergonomics**Credit 3 (3-0)**

This course covers quantitative and qualitative analysis of human motions in space and time. Sample topics include human physiology, anthropometry, human figure modeling, and human performance for a set of task requirements and specifications. Design projects are required. Prerequisite: Graduate Standing.

INEN-813. Cognitive Systems Engineering**Credit 3 (3-0)**

This course examines the principles, theories, and applications of the cognitive basis of system design. Topics include models of human and machine information processing, mental models, human error, human-centered design, abstraction hierarchy, ecological interface, cognitive task analysis, multi-flow models, activity-behavior models, and theories of complexity in human-machine systems. Prerequisites: Graduate Standing and Consent of Instructor.

INEN-814. Advanced Topics in Human-Machine Systems**Credit 3 (3-0)**

This course examines advanced topics in human-machine systems. Topics covered include supervisory control, human aspects of fixed and programmable automation, theories and models of complex systems, collaborative work support systems, human attention and cognitive control of dynamic actions, and tele-operations. Applications include supervisory control in transportation, process, space operations, waste and hazardous handling, manufacturing, and other applications of automated systems. Prerequisites: Graduate Standing and Consent of Instructor.

INEN-821. Multivariate Statistics for Engineers**Credit 3 (3-0)**

This course focuses on methods for statistical analysis of multivariate data. Topics include: dimensionality, multidimensional classification and clustering, unstructured multi-response sampling, analysis of covariance structures, such as principal components, factor analysis and canonical correlation analysis, and multivariate normal distribution and analysis of multivariate means. Prerequisites: Graduate Standing and Consent of Instructor.

INEN-822. Advanced Systems Simulation**Credit 3 (3-0)**

This course discusses advanced statistical issues in the design of simulation experiments: variance reduction, regeneration methods, performance optimization and run sampling. Continuous simulation models are introduced. High fidelity simulation software and high-level architecture for constructing large simulation models is introduced. Prerequisites: Graduate Standing and Consent of Instructor.

INEN-831. Service Sector Engineering**Credit 3 (3-0)**

This course focuses on the application of modeling and analysis of enterprises in the service sector of an economy. Topics include the role of the service sector in an economy, special characteristics of service operations, structuring the service enterprise, facility design for services, service quality, and quantitative models for managing services. Applications in the financial services, health care, and other sectors will be emphasized. Prerequisites: Graduate Standing and Consent of Instructor.

INEN-832. Information Technology Management**Credit 3 (3-0)**

This course focuses on productivity measurement and improvement of information technology and information system services. Other topics covered include the planning and control of human resources and budgets, as well as the planning of innovation, entrepreneurship and research and development, and the forecasting and justification of technology. Prerequisites: Consent of Instructor.

INEN-833. Supply Chain Systems Engineering**Credit 3 (3-0)**

This course addresses the analysis and design of logistics and supply chain systems. Topics covered include: logistics and supply chain characterization, site location, mode selection, distribution planning, vehicle routing, demand management, replenishment management, geographic information systems and real-time logistics control issues. Prerequisites: Graduate Standing and Consent of Instructor.

INEN-841. Integer and Network Optimization**Credit 3 (3-0)**

This course addresses formulation and solution techniques for integer programming problems and network optimization problems. Topics covered include integer programming models, branch and bound method, transportation, assignment, and transshipment problems, and network flow problems such as shortest-path, maximum-flow, activity networks, minimum-cost network flow, and minimum spanning tree. Consent of Instructor.

INEN-843. Queuing Theory**Credit 3 (3-0)**

This course presents stochastic models and solution techniques for such models. Specific topics include elements of queuing systems, measures of performance, arrival processes, steady state analysis, stationary arrivals, controlling service processes, priority queues, and queuing networks. Prerequisites: Graduate Standing and Consent of Instructor.

INEN-844. Reliability and Maintenance**Credit 3 (3-0)**

This course reviews the statistical concepts and methods underlying procedures used in reliability engineering. Topics include the nature of reliability and maintenance, life failure and repair distributions, life test strategies, and complex system reliability including: series/parallel/ standby components with preventive maintenance philosophy. Analytical models are emphasized. Prerequisites: Graduate Standing and Consent of Instructor.

INEN-851. Integrated Manufacturing Control Systems**Credit 3 (3-0)**

This course provides an advanced study of systems used for manufacturing execution and shop floor control. Traditional control and adaptive control algorithms and applications for manufacturing are explored. Integrated control system functions include scheduling, execution planning, supervisory control, human machine interface, process control, quality control, and information acquisition. Prerequisites: Graduate Standing and Consent of Instructor.

INEN-852. Integrated Product and Process Design**Credit 3 (3-0)**

This course provides an integrated approach to the design and manufacture of a new product. Topics include product requirements, concept generation and selection, design, product optimization, tolerances, prototype development, design for manufacturability and assembly, process optimization, and quality function deployment. Prerequisite: Graduate Standing.

INEN-853. Enterprise Integration**Credit 3 (3-0)**

This course is directed toward development and contribution to the advancement of a unified framework for conceptualizing, designing, modeling, and operating advanced integrated manufacturing systems. It builds upon emerging developments in computer and communications technologies and conceptual breakthroughs regarding the nature and behavior of integrated enterprises. Prerequisites: Graduate Standing and Consent of Instructor.

INEN-854. Inventory and Warehouse Systems**Credit 3 (3-0)**

This course investigates the integration of inventory and warehouse systems. Quantitative models for inventory and warehouse layout/location are developed and solved. Computational tools and equipment in inventory and warehouse systems are reviewed. Application of supply chain and information technology concepts to strategic inventory and warehouse system integration is addressed. Prerequisite: Graduate Standing.

INEN-861. Nano-/Micro- and Bio-Manufacturing**Credit 3 (3-0)**

This course addresses the translation of fundamental nano-and biotechnology concepts to practical industrial applications. Topics include the design, prototyping and development of nano/micro- and bio-manufacturing techniques. Supporting infrastructure, measurement tools, characterization devices, and positioning systems needed for nano/micro- and bio-manufacturing are discussed. Current state-of-the-art research areas are discussed. Prerequisites: Graduate Standing and Consent of Instructor.

INEN-885. Advanced Special Topics in Industrial Engineering Credit 3 (3-0)

The course will address a current body of knowledge in Industrial Engineering with a research orientation. Term papers and projects will be required. Prerequisites: Graduate Standing and Consent of Instructor.

V. MS Level Pass/Fail Courses**INEN-791 Masters Comprehensive Exam****Credit 1(1-0)**

This course will guide the student to take the M.S. Comprehensive Exam. The examination will be administered towards the end of the semester. Pass/Fail evaluation only, no letter grade will be given. Prerequisite: Graduate Standing.

INEN-792. Industrial Engineering Master's Seminar**Credit 1 (1-0)**

This course introduces contemporary industrial engineering topics via talks by individuals from industry, government, and academe. Prerequisites: Graduate Standing in ISE.

INEN-793. Master's Supervised Teaching**Credit 3 (3-0)**

This course provides students with the experience of assisting in instruction and evaluation of lecture and laboratory components of industrial engineering courses. Prerequisites: Graduate Standing in ISE

INEN-794. Master's Supervised Research**Credit 3 (3-0)**

This course provides students with the experience of assisting in all aspects of planning and completing research projects. Prerequisites: Graduate Standing in ISE.

INEN-796. Master's Project**Credit 3 (3-0)**

This course provides the student an opportunity to complete a comprehensive industrial engineering project of their choice under the supervision of a faculty advisor. A project is an application of industrial engineering methods and techniques to a specific problem. Students are required to complete a project proposal and a final defense in accordance with departmental guidelines. Prerequisites: Graduate Standing in ISE

INEN-797. Master's Thesis Variable**Credit 1-6**

This course provides the student an opportunity to complete a piece of original research, of their choice, in industrial engineering, under the supervision of a faculty advisor. Students are required to complete a thesis proposal and a final defense in accordance with departmental guidelines. Prerequisites: Graduate Standing in ISE

INEN-799. Continuation of Master's Project / Thesis**Credits 1 (1-0)**

This course will enable master's students who have completed all required coursework and all project/thesis credits, to complete their project/thesis work. Prerequisites: Graduate Standing in ISE.

VI. Ph.D. Level Pass/Fail Courses**INEN-991. Doctoral Qualifying Examination****Credit 1 (1-0)**

This course will guide student to take the departmental Qualifying Examination. The examination will be administered towards the end of the semester. Pass/Fail evaluation only, no letter grade will be given. Prerequisite: Doctoral Standing in ISE.

INEN-992. Doctoral Seminar in Industrial Engineering**Credit 1 (1-0)**

The course will present potential dissertation topics and research work-in-progress by faculty members and doctoral students, and talks by eminent practitioners and researchers on classical and contemporary topics in Industrial Engineering. Pass/Fail evaluation only, no letter grade will be given. Prerequisite: Doctoral Standing in ISE.

INEN-993. Doctoral Supervised Teaching in IE**Credit 3 (3-0)**

This course will introduce the student to teaching courses under the guidance of a faculty member. This course will give the student experience in course planning, lecture preparation, classroom teaching, and student evaluation. Pass/Fail evaluation only; no letter grade will be given. Prerequisite: Doctoral Standing in ISE.

INEN-994. Doctoral Supervised**Credit 3 (3-0)**

This is supervised research under the direction of a member of the Graduate Faculty. This research should lead to the identification of a dissertation topic. Pass/Fail evaluation only; no letter grade will be given. Prerequisite: Doctoral Standing in ISE.

INEN-995. Doctoral Preliminary**Credit 3 (3-0)**

This course is for doctoral students who are preparing to take a written examination in their area of specialization. In this course dissertation supervisors will guide their students towards completing the Preliminary Exam. Pass/Fail evaluation only; no letter grade will be given. Prerequisites: Doctoral Standing in ISE and INEN 991.

INEN-997. Dissertation Variable**Credit 1-6**

This course provides the student an opportunity to complete a significant piece of original research, of their choice, in industrial engineering, under the supervision of a faculty advisor. Students are required to complete a dissertation proposal and a final defense in accordance with departmental guidelines. Prerequisites: Doctoral Standing in ISE and INEN 995.

INEN-999. Continuation of Dissertation

Credit 1 (1-1)

This course will enable doctoral students who have completed all required coursework and all dissertation credits, to complete their dissertation research. Prerequisites: Doctoral Standing in ISE.

Appendix D: Guidelines for Students Seeking a Project/Thesis/Dissertation Topic

1. First consider the area of Industrial & Systems Engineering you find most interesting: Manufacturing Systems, Ergonomics, Production Control, Operations Research, Engineering Economy, Quality Control and all of the other courses you have taken, are taking, or will take, offer possible choices. Thus, to find a topic that you are interested in working on, first pick the area of study you like most.
2. Check the appropriate technical journals. Try to pick a specific subject matter in the area, such as Scheduling in Production Control, and look through the journal articles published on this subject. Often, authors point out unanswered questions in their articles. Such questions can become the basis for your research. Seek the assistance of faculty for any of these steps.
3. After completing the above process (both steps), visit with the professor who normally teaches courses in your area of interest. Bring a list of the literature you have reviewed, as well as any ideas you may have come across for possible topics. Sometimes, a professor may have a topic in mind for a thesis, and is waiting for a graduate student to express an interest. But you can not count on this situation! You have the responsibility of identifying a topic, while the professors provide advice to help you determine a topic of interest. During this process, keep the following in mind:
 - a) You must find the topic;
 - b) No faculty is required to direct your thesis; it is solely the decision of the faculty to serve as advisor based on his/her research interests and prior commitments;
 - c) You are responsible for your project/thesis and its progress; faculty do not (and should not) do your research, do not write your thesis, do not take the responsibility for your mistakes, nor are they responsible for seeing that you finish your degree by your personal deadline;
 - d) The date of completion is a function of how many hours you work on your thesis, the quality of work you put into it, and how well your research progresses; research has uncertainty, and that is why it is research, and your advisor can not determine how long it will take you to finish your degree.
4. Ph.D. students should consider topics related to their MS thesis work, if appropriate.

Appendix E: Guidelines for Change of Project/Thesis/Dissertation Committee

This situation should normally not arise. However, these guidelines are stated in the event of such an unlikely situation.

A student who wants to change his/her project/thesis advisor and/or the composition of his/her committee should follow the following guidelines:

1. Changes in Committee:

Once established, the committee shall be responsible for recommending changes in its composition. A student may petition the committee providing reasons and justification for any desired changes in its composition. When necessary, the student may be required to appear in person before the committee to make arguments in favor of their position. The committee shall do everything necessary to ensure that the student's concern is heard fairly; when necessary, individual committee (faculty) members may be excused from the proceedings to avoid a possible conflict of interest. The Advisor will communicate the committee's decision to the student in a timely manner. If the change of committee members is permitted, the student may seek a replacement member. In the event the Advisor is involved in the dispute, a member of the committee will be appointed to make this decision, to avert any conflict of interest.

2. Solicitation of individual faculty members as replacements in the Committee:

It shall be the duty of all ISE faculty members prior to committing to a solicitation by a student to serve as either an Advisor or committee member, to ensure that the solicitation is for the formation of a new committee. In cases where the solicitations are for replacement of committee personnel, the faculty member should verify and ensure that the case has been properly channeled through the student's Advisor and other committee members, and that a decision has been made for replacement before engaging in any significant dialogue with the student.

If a replacement is sought for the Advisor, a new research topic that is in line with the new advisor's research interests and expertise may be required. In the event that the student desires to maintain the same topic, it shall be his/her responsibility to convince the committee that a change of Advisor is justifiable.

3. Requirements for the student in the event of a change:

If a change is approved by the student's committee, and replacement is made, the student will be required to present his/her project/thesis proposal for the approval of the new committee (even if a proposal defense has been previously completed).

For the sake of professional courtesy and to ensure a smooth transition, each faculty member who is contacted by a student to serve as a replacement in the committee should confer with the student's current Advisor and/or colleague to be replaced and ensure that there are no conflicts of interest issues.

Appendix F: Ph.D. Qualifying Exam Preparation Guide

1. Format of Exam:

The Qualifying Examination (QE) format consists of six required subjects and an optional subject as follows:

Required subjects (take all six):

- Optimization (INEN 430 and INEN 435)
- Engineering Economy (INEN 361)
- Statistics (INEN 370 and INEN 675)
- Human Factors (INEN 665)
- Methods Engineering (INEN 255)
- Quality Assurance (INEN 425)

Optional subjects (choose one):

- Facilities Design (INEN 465)
- Production Control (INEN 655)

The Qualifying Examination (QE) is 7 hours in duration, split into 2 separate sessions (4 hours in the morning and of 3 hours in the afternoon). Each test will have three problems (without an extra problem) to be answered in 50 minutes. Its testing schedule is as follows:

Part I: Optimization, Engineering Economy, Statistics, and Human Factors

Part II: Methods Engineering, Quality Assurance, and an optional subject.

2. What student may bring to the exam:

As this exam is an open-book test, students may bring books, calculator, and other necessary materials. Access to computers is not permitted.

3. Exam Evaluation

Passing Score Criteria: A score is considered passing if both of the following are satisfied.

- a. The average of the 7 subject areas is at least 70%.
- b. None of the 7 subject area scores is below 50%.

Any other score is considered non-passing. There are three post-conditions for non-passing scores: (a) the student qualifies for a "Deficiency Test"; (b) the student may retake the exam during the next semester; and (c) the student may not retake the exam, and is dismissed.

Deficiency Test: A student may take a Deficiency Test (DT) if no more than 2 subject area scores are below 50% or/and his/her average score is less than 70%. DT will be given during the first week of the subsequent semester. The format of the DT is similar to the QE with the following changes: (a) it covers only the subject areas identified as deficient (at most, two) and (b) the duration is 50 minutes per subject area. The new score(s) will then be used to determine if the student has passed the exam according to the *Passing Score Criteria*.

Retaking the Exam: If more than 2 subject area scores are below 50%, the student must retake the exam within two semesters of the first attempt. No more than one retake is allowed.

Dismissal: If the student does not pass the exam on the second attempt, (that is, the student does not pass the retake), then the student will be dismissed from the doctoral program.

Number of Attempts: Students can attempt the exam two times at most.

4. Exam Date:

The Exam is given on the Friday immediately before Thanksgiving holiday in each Fall semester, and on the Friday after Good Friday holiday in each Spring semester.

5. Preparing for the Exam:

You may plan to sit in on the courses that cover examination subject areas. Develop your study resources as you progress in your preparation and plan to take the resources you are familiar with to the examination. During the semester in which you take the exam, you MUST register for the INEN991 course. A set of materials for preparation is available to students. These materials are termed "Ph.D. Qualifying Exam Preparation Materials" and are available from the department. In addition, a booklet entitled "Ph.D. Qualifying Sample Exam" is also available from the department. Please be aware that the preparation materials and the sample examination should be used only to understand the format and the approximate level of complexity of the examination. Planned preparation for the exam is vital to your success in the examination.

Appendix G: Ph.D. Preliminary Exam Preparation Guide

1. Prerequisites to register for the Preliminary Exam (INEN995):

In order to register for the Preliminary Exam, the student must have completed the following:

- (i) Qualifying Exam
- (ii) Any course work the student's Ph.D. Committee feels must be completed in preparation for the written part of this exam.
- (iii) Formation of a Ph.D. Committee as reflected in their current Plan of Study.

In addition, the student's Dissertation Advisor must ensure that the student is well-prepared to begin writing a dissertation proposal.

2. Format of Exam:

This exam has one part,

- (i) Written Exam in area of specialization (HMSE or MSEE) to be given by the student's Ph.D. Committee

3. Written Exam:

The Written Exam consists of in-depth questions in subject areas related to the student's chosen specialization. The student's Dissertation Advisor and the other Committee members convene a meeting early in the semester in which the student registers for the Preliminary Exam to plan for the Written Exam. Each committee member prepares and grades questions in one area for the exam. The student is given one week to complete the exam. The Ph.D. Committee decides whether the student passed or failed the written exam, and informs the student within two weeks. The Ph.D. committee typically schedules the Written Exam in the second month of the semester (Fall Break and Spring Break periods are suggested).

If the student fails the Written Exam, the committee gives the student one more attempt in the form of a fresh exam. The date and time of the exam is determined by the Committee, but the exam must be completed within the same semester, unless the committee determines that the student should take one or more courses before he/she retakes the exam.

5. Passing the Preliminary Exam:

In order to pass the Preliminary Exam, the student must pass the Written Exam.

6. Preparing for the Exam:

In preparation for the Written Exam, the student must complete course work related to the student's specialization. The student should get guidance from their Dissertation Advisor to understand if they are ready to prepare a Dissertation Proposal.

Appendix H: Supervised Teaching and Supervised Research for Ph.D. Program Credit

All Ph.D. students are required to take either Supervised Teaching or Supervised Research for credit during one semester. Please note that this is different from the requirement that all Graduate Teaching and Research Assistants must register for Supervised Teaching or Supervised Research in semesters in which they receive financial support. Students who wish to pursue an academic career after the Ph.D. are advised to register for and complete Supervised Teaching, and students who anticipate pursuing a career in research are advised to register for and complete Supervised Research. The following are the guidelines for initiation and grade evaluation for these two courses.

Steps	Supervised Research	Supervised Teaching
Planning	<ul style="list-style-type: none"> • Complete Qualifying Exam. • Talk to Dissertation Advisor about possible research agencies. • Work out details of a minimum of one-semester research effort at the agency site, with the agency. 	<ul style="list-style-type: none"> • Complete Qualifying Exam. • Talk to Dissertation Advisor about possible courses to teach. • Work out details of course to be taught with the Graduate Program Coordinator.
Registering	<ul style="list-style-type: none"> • Get a letter of approval from Dissertation Advisor about the research experience, including the name of the agency supervisor and the research planned. • Register for INEN993 in the semester in which the research experience assignment is to be completed. 	<ul style="list-style-type: none"> • Get a letter of approval from Dissertation Advisor about the teaching assignment, including the name of a faculty supervisor assigned for the course; as far as possible the Dissertation Advisor also serves as the faculty supervisor. • Register for INEN 993 in the semester in which the teaching assignment is to be completed.
Tasks	<ul style="list-style-type: none"> • Complete a review of INEN994 overview slide set. • Work on research tasks. • Provide monthly progress reports to your Dissertation Supervisor. • Prepare and submit final report of research work to Dissertation Advisor and agency supervisor. 	<ul style="list-style-type: none"> • Complete a review of INEN993 overview slide set. • Prepare a course outline. • Teach class and submit grades for students.
Evaluation	<ul style="list-style-type: none"> • Dissertation Advisor and supervisor at agency jointly evaluate performance; monthly progress reports and the final report are used. • Dissertation Advisor assigns course grade. 	<ul style="list-style-type: none"> • Two faculty selected by chair evaluate teaching performance and provide input to student and faculty supervisor. • Student Opinion form summary is provided to student and faculty supervisor. • Faculty Supervisor assigns course grade.

Appendix I: Guidelines for Qualifying Research Experience Requirement for Ph.D. Students

This requirement is for students who are admitted into the program without an appropriate research experience at the MS degree level.

1. Identification of requirement:

Students are identified as subject to this requirement at the time of admission or when they commence the program by the Graduate Program Committee. The student is also assigned a faculty member to supervise the completion of this requirement.

2. The requirement:

The student must complete a research proposal, resembling a M.S. thesis proposal, under the supervision of the assigned faculty member, and the proposal must include the following elements

- introduction to the research
- literature survey
- research methodology or approach
- preliminary results
- expected results from research

The student is required to register for INEN796 (Master's Project) in the second semester of this one and one-half semester effort.

3. Time line and approval:

The student must complete the work in the second semester of their enrollment in the Ph.D. program. Specifically, the student must submit their work by the end of Spring Break for those entering the Ph.D. program in the Fall, by the end of the first session of Summer for those entering in Spring, and by the Fall Break for those entering in Summer. The research proposal must be submitted to the Graduate Program Committee for approval. Continuation in the Ph.D. program is contingent on approval of this report by the Graduate Program Committee.

Appendix J: List of Required Forms

These forms are available at the departmental website(www.ncat.edu/~ise). Download the forms you need. Complete your information. Print the completed form. Get appropriate signatures and return to the Graduate Program Secretary.

1. Specialization Form
2. Change of Status
3. Ph.D. Course Waivers
4. Plan of Study (MS)
5. Plan of Study (Ph.D.)
6. Request for Supervised Teaching
7. Request for Supervised Teaching
8. Proposal Notification
9. Application for Graduation
10. Final Clearance Checklist
11. Thesis/Dissertation Cover Sheet
12. Thesis Exam Report Form