INDUSTRIAL AND SYSTEMS ENGINEERING

GRADUATE PROGRAM STUDENT HANDBOOK

2016 - 2017

This Handbook provides information about the Industrial and Systems Engineering (ISE) Graduate Program curricula. All ISE graduate students should read it and fully understand its contents. Students should also read and understand the Graduate Catalog. Each ISE student is responsible for knowing the contents and following the prescribed rules and regulations documented in this handbook and the 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.

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http://www.ncat.edu/coe/departments/inen/index.html

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1. Introduction

The Department of Industrial and Systems Engineering (ISE) at North Carolina Agricultural and Technical State University (N.C. 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 (PhD) is offered in (1) Human-Machine Systems Engineering and (2) Manufacturing and Service Enterprise Engineering.

The faculty of the ISE Department has the responsibility of administering the MS and PhD 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 Graduate College (see the Graduate Catalog), and the departmental program requirements and guidelines. For assistance, the student should see his or her major professor or the departmental Graduate Program Director.

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

Department Chair:	Dr. Tonya Smith-Jackson 408 McNair Hall 336-285-3759 tlsmithj@ncat.edu
Graduate Program Director:	Dr. Steven Jiang 426-B McNair Hall 336-285-3726 xjiang@ncat.edu
Graduate Program Coordinator:	Mrs. Elizabeth Brooks 419 McNair Hall 336-285-3723 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 College requirements may be found in the Graduate Catalog of N.C. 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 handbook, the student should consult the ISE Graduate Program Director or the ISE Graduate Program Coordinator.

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 the N.C. A&T's Graduate College, and ISE graduate students must meet the requirements of both the Graduate College and the ISE Department for successful degree completion. While the Graduate College requirements may be mentioned occasionally in this document, the student should consult the Graduate 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 2016. Graduate students joining the ISE program prior to the Fall Semester of 2016 may consult the appropriate prior ISE Graduate Handbook concerning the requirements for completion of their graduate programs. If requirements are changed, students may elect to comply with the new requirements or to remain under the requirements by which they are governed at the time of the change. A student who elects to comply with the requirements of a newer handbook must do so by declaring such intent in writing at least one semester prior to graduation. This declaration must be approved by the academic department and the Graduate College. 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 Director. In addition to chairing the GPC, the Director is responsible for supervising the implementation of requirements, policies, and procedures adopted by the ISE faculty. The ISE Graduate Program Director and members of the GPC are appointed by the ISE Department Chairperson.

The Graduate Program Coordinator maintains all files for the graduate program and appropriate forms for Department and Graduate College requirements, applications for admission and financial aid, and other routine paperwork.

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

To apply for admission to the MS in Industrial and Systems Engineering, applicants should submit an application and its supporting documents on the online application portal through the Graduate College website. It is strongly recommended that all required documents be received on or before the Graduate College's priority deadlines (February 1 for fall admissions and September 1 for spring admissions). The Department will evaluate applications within approximately 14 days of their receipt from the Graduate College.

To be considered for admission to the MS in Industrial and Systems Engineering an applicant must have:

1. A Bachelor's degree from a college or university recognized by a regional or general accrediting agency and its cumulative Grade Point Average of 2.8 or above on a 4-point scale is required.
2. Evidence of English language proficiency for international applicants. Normally, an acceptable score on TOEFL, IELTS, or PTE test is required if the highest degree is from non-English speaking country. The official TOEFL score (at least 80 or higher internet-based score), or IELTS score (6.5 or higher effective July 1 2016), or PTE Academic score (53 or higher). These scores are reportable for a period of two years from the date of the exam. If the scores are older than two years, the student must re-take the exam.
3. Applicants without a BS in Industrial and Systems Engineering will need to take relevant background courses (ISEN 162: Computer programming in Visual Basic for Engineers / COMP 163: Introduction to Computer Programming, MATH 132: Calculus II, ISEN 370: Engineering Statistics, ISEN 600: Survey of Industrial and Systems Engineering Topics).

However, meeting the requirements above does not guarantee acceptance as these are minimum requirements to be considered for admission.

5. MS Program Requirements

5.1 Program Options

The Department offers three options for the MS degree: a thesis option, a project option, or a course-only option. Students are strongly encouraged to complete the MS program within one and a half years.

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 twenty seven (27) 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 (30) credit hours of courses and a comprehensive examination. For the applicants with a BS in ISE, the department also offers a one-year, course only MS program. Qualified students can take four courses in the Fall semester, four courses in the Spring semester, and two courses in the summer. No financial assistance will be provided to those students.

5.2 Graduation Requirements

The graduation requirements are given as below:
1. Credit Hour Requirements
The total credit hours are 30 for all three options. Specifically, the student must complete the following credit hour requirements:
(i) Thesis option:

- Take Core courses (12 credits): ISEN 625: Information Systems, ISEN 655: Production Planning & Scheduling, ISEN 665: Human Machine Systems, ISEN 675: Design and Analysis of Experiments
- Take 12 credits of additional ISEN courses with approval of advisor
- Thesis (6 credits): ISEN 797:Master's Thesis
- Take ISEN 992 (Graduate Seminar) twice in two semesters

(ii) Project Option:

- Take Core courses (12 credits): ISEN 625: Information Systems, ISEN 655: Production Planning & Scheduling, ISEN 665: Human Machine Systems, ISEN 675: Design and Analysis of Experiments
- Take 15 credits of additional ISEN courses with approval of advisor
- Project (3 credits): ISEN 796: Master's project
- Take ISEN 992 (Graduate Seminar) twice in two semesters

(iii) Course Option:

- Take Core courses (12 credits): ISEN 625: Information Systems, ISEN 655: Production Planning & Scheduling, ISEN 665: Human Machine Systems, ISEN 675: Design and Analysis of Experiments
- Take 18 credits of additional ISEN courses with approval of advisor
- Take ISEN 992 (Seminar) twice in two semesters
- Pass comprehensive exam

2. Seminar Course Requirements
The students, except for part-time Master's students, must attend the ISEN 992 seminar course during two semesters of his or her graduate study. This course does not count towards credit hour requirements for the program nor on the student's Plan of Study.

3. Other Graduation Requirements

If a student is admitted with the background course requirements, he or she needs to complete those courses. These courses do not count towards MS graduation requirements, and their minimum acceptable grades are "B" or better.

5.3 Academic Advisor, Major Professor, and MS Committee

All students enrolled in the graduate program must have an academic advisor. Upon admission to the program, the **Graduate Program Director** acts as the student's advisor on a temporary basis. Master's degree 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 Graduate College.

The advisory committee for a master's thesis is composed of at least three members of the Graduate Faculty, including the committee chair. At least two committee members must be Full or Associate members of the graduate faculty. The student's advisor serves as chair of the committee and is a Full member of the graduate faculty. 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 ISE Graduate Program Director. If a committee member is from another university, he/she must have graduate faculty status at his/her home institution; the program coordinator or department chair will provide evidence to the Graduate College before the appointment is approved. If the external committee member is from a non-academic organization, the appointment will be considered, and if appropriate, approved by the Graduate College after receiving a request and copy of the Curricula Vitae from the program coordinator or department chair. In all cases, it should be made clear to that person that he or she will be expected to participate in the comprehensive oral examinations.

5.4 Research Areas

There are three (3) research areas available to MS graduate students: Human-Machine Systems Engineering (HMSE), Manufacturing and Service Enterprise Engineering (MSEE**)**, and Operations Research and Systems Analysis (ORSA).

Human-Machine Systems Engineering (HMSE)

This area 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 is concerned with optimization tools and information systems. Students learn to analyze and propose solutions for general and specific optimization problems. Emphasis is placed on the use of specialized tools to help organizations make better business decisions. Students also develop abilities in the design of information systems. Graduates of the program may work in industries such as health systems, manufacturing, finance and banking, and military options.

5.5 Critical Steps

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

1. Application for Admission: Complete the application for admission through the Graduate College. The Graduate College will forward the completed application package to the Graduate Program Director who will review it along with the ISE 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 Director 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: All graduate students are required **to file a Plan of Study by the end of the second semester after admission to a program of study.** Failure to submit the Plan of Study will prevent the student from enrolling in classes for his/her third semester. The Plan of Study is established in consultation with the advisor, graduate program director and/or department chair. The Plan of Study is based on the Graduate Catalog requirements but may be structured to meet the specific needs of the student. The Plan of Study may be amended at any time before the student applies for graduation with the approval of the advisor, graduate coordinator and/or department chair. A student's Plan of Study must be approved by his/her advisor and graduate program director. Responsibility for meeting all academic requirements for a selected program rests with the student.

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 Coursework: Students are **required to complete the coursework** as listed in their approved Plan of Study. Also, students must complete all background courses during the first academic year if required.

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 Graduate College.

5.6 Project /Thesis Requirements

A flow chart for the ISE MS program can be found in Appendix H. 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 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. The student must submit a Project/Thesis Proposal Notification Form according to the instructions stated on the form before the proposal meeting is held.

6. A proposal meeting is held. The student presents his/her proposal and answers questions. The committee decides if the topic is suitable and makes suggestions on scope, solution, and so forth.

7. 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.

8. The advisor approves the initial draft of the project/thesis.

9. The student must schedule an oral examination with the individual committee members at least 7 days earlier than the deadline published by the Graduate College. Copies of the project/thesis must be submitted to the committee members at least one week prior to the scheduled oral examination date.

10. The student must submit a Project/Thesis Defense Notification Form according to the instructions stated on the form.

11. The oral examination begins with a presentation by the student of the project/thesis work, followed by questions by the advisor and committee members.

12. The committee members will read the draft and submit suggestions for changes and/or additions to the student.

13. In consultation with the advisor, the student makes the changes and/or additions and produces the final draft.

14. 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 at the satisfactory level on the oral examination will 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 discretion of the committee.

15. The approved thesis must be submitted to the Graduate College by the deadline given in the academic calendar, and must conform to the Graduate College's guidelines for theses and dissertations.

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

To apply for admission to the PhD in Industrial and Systems Engineering, applicants should submit an application and its supporting documents on the online application portal through the Graduate College website. It is strongly recommended that all required documents be received on or before the Graduate College's priority deadlines (February 1 for fall admissions and September 1 for spring admissions). The Department will evaluate applications within approximately 14 days of their receipt from the Graduate College.

To be considered for admission to the PhD in Industrial and 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 Grade Point Average of 3.5 or above on a 4-point scale.

OR

A Master of Science degree in a discipline related to Industrial and 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. Graduate Record Exam (GRE) Aptitude Exam scores.
4. Evidence of English language proficiency for international applicants. Normally, an acceptable score on TOEFL, IELTS, or PTE test is required if the highest degree is from non-English speaking country. The official TOEFL score (at least 80 or higher internet-based score), or IELTS score (6.5 or higher effective July 1 2016), or PTE Academic score (53 or higher). These scores are reportable for a period of two years from the date of the exam.

7. PhD 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	1st or 2nd semester	2nd or 3rd semester
Preliminary Exam	3rd or 4th semester	5th or 6th semester
Proposal Defense and Other Requirements (Course credits and publications)	5th semester	6th or 7th semester
Final Dissertation Defense	6th semester	7th or 8th semester

7.2 Graduation Requirements

The PhD graduation requirements are given below:

1. Credit Hour Requirement: A total of 69 credits after the BS degree, of which 18 credits are toward dissertation work, and 51 credits are toward course work. Of the 51 credits of course work, up to 24 credits of Industrial and Systems Engineering-related course work at the MS level may be applied towards the 51 course credit requirements. Specifically, the student must complete the following credit hour requirements:

   Total credit hours: 69 (post baccalaureate)

   - Take 12 credit Core courses: ISEN 625: Information Systems, ISEN 655: Production Planning & Scheduling, ISEN 665: Human Machine Systems, ISEN 675: Design and Analysis of Experiments
   - Select 12 credits from ISEN 721: Systems Engineering Models, ISEN 812: Advanced Ergonomics, ISEN 813: Cognitive Systems Engineering, ISEN 814: Advanced Topics in Human-Machine Systems, ISEN 821: Multivariate Statistics for Engineers or ISEN 833: Supply Chain Systems Engineering, ISEN 841: Integer and Network Optimization, ISEN 852: Integrated Manufacturing Control Systems, ISEN 853: Enterprise Integration
   - Take 12 credits of additional graduate level ISEN courses

- Take 12 credits of additional engineering courses at 700 or 800 level
- At least 21 course credits should be at 800 level
- ISEN Seminar (3 credits): Take ISEN 992: Doctoral Seminar in ISE three times in three semesters
- Pass qualifying exam, preliminary exam
- Dissertation (18 credits): ISEN 997: Doctoral Dissertation

2. Seminar Requirement: Students must register and complete Graduate Seminar class (ISEN992; 1 credit) in at least three semesters.

3. Quantitative Requirement: Students must complete a specified PhD level statistics class (ISEN821: Multivariate Statistics for Engineers) or optimization class (ISEN841: Integer and Network Optimization).

4. Course Credits: At least 21 course credits, including the quantitative requirement, will be at the 800 level. At least 12 of these credits must be from a specified list of courses in the area chosen by the student. In addition, 12 hours of graduate engineering courses at the 700-level or 800-level which are suggested by his/her advisor are required as electives.

5. Publication Requirements: All PhD 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 PhD student must submit at least one technical paper from his/her dissertation research for publication in a peer-reviewed journal(s) before scheduling the final defense.**

6. Qualifying Exam: Students must pass a seven (7) hour in-class written exam that covers the seven (7) subject areas of Industrial and Systems Engineering at the BS/MS in Industrial and Systems Engineering levels. Students must pass this exam in no more than two attempts. Please see Appendix F: *Preparing for the PhD Qualifying Exam Preparation Guide*, for details.

7. 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 calendar days). This exam is prepared and administered by the student's Dissertation Committee. Please see Appendix G: *PhD Preliminary Exam Preparation Guide for details*. Students who passed his/her Preliminary Exam are allowed to register dissertation hours (ISEN 997: Doctoral Dissertation).

8. Oral Proposal Defense: The student must present a proposal of dissertation research to the student's Dissertation 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 Dissertation 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.

7.3 Academic Advisor, Major Professor, and Dissertation Committee

All students enrolled in the graduate program must have an academic advisor. Upon admission to the program, the Graduate Program Director acts as the student's advisor on a temporary basis. **PhD 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 Graduate College.

The advisory committee for a doctoral dissertation is composed of at least **four** members of the Graduate Faculty. At least three committee members must be Full or Associate members of the graduate faculty. The student's advisor serves as chair of the committee and is a full member of the graduate faculty. The Advisory Committee is selected by the student in consultation with his/her advisor. The members of the committee must be approved by the graduate coordinator or department chair. The Graduate College verifies the eligibility of faculty to serve on advisory committees when the Plan of Study is submitted. The Graduate College will appoint an additional external committee member for all doctoral dissertation committees. The Graduate College faculty representative serves on the doctoral dissertation committee with all the rights and responsibilities of any other member. In addition, the Graduate College faculty representative also represents the Graduate College to (i) protect the interest of the University by ensuring that the dissertation meets the highest academic standards, (ii) provide assurance that appropriate procedures are followed; and (iii) provide an 'outside' point of view by sharing expertise with a new perspective or theoretical vantage that might not otherwise be available. Students may select at most one non-ISE faculty for his/her 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. If a committee member is from another university, he/she must have graduate faculty status at his/her home institution; the program coordinator or department chair will provide evidence to the Graduate College before the appointment is approved. If the external committee member is from a non-academic organization, the appointment will be considered, and if appropriate, approved by the Graduate College after receiving a request and copy of the Curricula Vitae from the program coordinator or department chair. In all cases, it should be made clear to that person that he or she will be expected to participate in the comprehensive oral examinations.

7.4 Research Areas

There are two research areas available to PhD students: Human-Machine Systems Engineering (HMSE) and Manufacturing and Service Enterprise Engineering (MSEE**)**. Details of each area can be seen on Section 5.4.

7.5 Critical Steps

The following are the critical steps in progression toward a PhD degree in Industrial and Systems Engineering:

1. Application for Admission: Complete the application for admission through the Graduate College. The Graduate College will forward the completed application package to the Graduate Program Director who will review it along with the ISE 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 Director 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: All graduate students are required to file a Plan of Study by the end of the second semester after admission to a program of study. Failure to submit the Plan of Study will prevent the student from enrolling in classes for his/her third semester. The Plan of Study is established in consultation with the advisor, graduate program director and/or department chair. The Plan of Study is based on the Graduate Catalog requirements, but may be structured to meet the specific needs of the student. The Plan of Study may be amended at any time before the student applies for graduation with the approval of the advisor, graduate coordinator and/or department chair. A student's Plan of Study must be approved by his/her advisor and the Graduate Program Director. Responsibility for meeting all academic requirements for a selected program rests with the student.

4. Selection of Dissertation 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: Take the Qualifying Exam and pass the exam. See Appendix F for details about the exam.

6. Complete Preliminary Exam: 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.

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.**

10. Publication: All PhD 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 PhD student must submit at least one technical paper from his/her dissertation research for publication(s) to peer-reviewed journal(s) before scheduling the final defense.**

11. Graduation: Students must apply for graduation in accordance with the deadlines established by the Graduate College.

7.6 Dissertation Research Requirements

A flow chart of the ISE PhD program can be found in Appendix K. 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.

3. The student prepares a 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 its copies are submitted to the committee members in a week before the scheduled proposal meeting date.

5. The student must submit a Dissertation Proposal Notification Form according to the instructions stated on the form before the proposal meeting is held.

6. A proposal meeting is held. The student presents his/her proposal and answers questions. The committee decides if the topic is or is not suitable and makes suggestions on scope, solutions, and so forth.

7. The advisor directs the dissertation 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.

8. The advisor approves the initial draft of the dissertation.

9. The student must submit at least one technical paper for publication in a peer reviewed journal(s) from his/her dissertation research **before scheduling the final defense.**

10. The student submits copies of the dissertation to the committee members. The student must schedule the oral examination with the individual committee members at least 7 days earlier than the deadline published by the Graduate College. Copies of the dissertation must be submitted to the committee members at least two weeks prior to the scheduled oral examination date.

11. The committee members read the draft and submit suggestions for changes and/or additions to the student.

12. The student must submit a Dissertation Defense Notification Form according to the instructions stated on the form before the dissertation defense meeting is held.

13. The dissertation defense begins with a presentation by the student of the dissertation work, followed by questions by the advisor and committee members.

14. 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 at a satisfactory level on the oral examination will 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 discretion of the committee.

15. Upon passing the Dissertation Defense, the PhD student must have the dissertation approved by each member of the student's dissertation committee.

16. The approved dissertation must be submitted to The Graduate College by the deadline given in the academic calendar, and must conform to the Graduate College’s guidelines for theses and dissertations.

17. Failure on the examination may result in dismissal from the doctoral program. The student's Advisory Committee may permit one re-examination. At least one full semester must elapse before the re-examination. Failure on the second attempt will result in dismissal from the doctoral program.

8. 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 based on the research and other funding of the department and the operating budget. Students should make known their financial needs to their major professor or to the Graduate Program Director as early as possible. 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 Chair. The students who are admitted by March 1 will have higher priority for consideration of financial support from the department. In addition, there is other financial support for African-American students interested in PhD programs through Title III Fellowships. However, all PhD students are strongly encouraged to apply for external fellowships to secure his/her own educational expenses. 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.
A list of available financial support opportunities can be found in Appendix L.

9. Graduate College Requirements

The following procedures are at the direction of the Graduate College. 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.

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 700 or higher are open to graduate students only.

Transfer of Credit

Up to 40% of the required course work can 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.

Concurrent Registration in Other Institutions

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

Schedule of Deadlines

The Graduate College 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 Graduate College and are available upon request. The student is required to be familiar with these dates.

Application for Graduation

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

Grade Point Average

A graduate student is expected to maintain a grade point average (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 College. Substandard performance is considered grounds for terminating a student's program. Any student failing to show satisfactory progress toward a graduate degree in the following semester may be terminated at the discretion of the Graduate College.

Course Repetition

Graduate courses may be repeated only once with the permission of the student's graduate program coordinator and/or department chair and approval of the Dean of Graduate Studies. Degree credit for repeated courses will be given only once, but the grade assigned for each enrollment shall be permanently recorded. Both the original grade and the grade received in the repetition will be used in calculating the overall GPA.

A student may not repeat a course in which "C" or above was earned. A student may repeat a required course in which "F" or "U" or "W" was earned. A student may not repeat the course more than once. If a student attempting a course for the second time (after a grade of F, U or W) either fails or withdraws from the course, he/she may be dismissed from the degree program. All hours attempted in graduate courses and all grade points earned are included in the computation of the cumulative average of a graduate student.

Course Load

A student using any resource of the University must register for at least one credit hour 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.

Withdrawal from an Individual Course

A student may withdraw from any course or courses by submitting a Change of Schedule form to the Office of the Registrar on or before the last day to withdraw from an individual course, as published in the Academic Calendar.
Students who withdraw from a course or courses on or before the last day to withdraw from an individual course are assigned a grade of "W." Failure to attend class does not constitute a withdrawal from that course or courses. Students are limited to a maximum of one (1) withdrawal per course, up to a maximum of sixteen (16) credit hours over the student's academic career. Upon a second attempt in a single course, the student is not permitted to withdraw from the course and must receive a grade for the course.
A student who does not officially withdraw from a course or courses will be assigned final grade in each course in which he or she was enrolled during the semester in question. Withdrawing from a course or courses may affect a student's financial aid status, will count toward the tuition surcharge threshold, and may affect the student's progress toward degree completion.
Students considering withdrawing from a courses or courses should consult their faculty advisor or academic unit advisor and the Office of Student Financial Aid.

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.

Appendix A: Industrial and 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

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

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

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

The 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, trakSTAR motion capture system, Vicon Bonita motion capture cameras, Bertec force plate, industrial Lumbar Motion Monitor (iLMM), and CYBEXNORM multi joint evaluation and exercise system. The Laboratory also employs ergonomics and bio mechanics software such as MVTA Multimedia Video Task Analysis, 3D Static Strength Prediction Program, Energy Expenditure Prediction Program, JACK, and AnyBody.

Graduate Student Office

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

Senior Design Studio

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:

1. **Cognitive Systems Engineering and Simulation Laboratory**
   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)**
   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 (DS^3L)**
   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)**
   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 Judgement and Decision Making (J/DM) Laboratory**
   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.

6. **Human Factors Analytics Laboratory**
   This laboratory focuses on application domains that benefit from large-data analysis and integration as well as mixed-methods analysis. These domains include communications, transportation, defense, learning and training, organizational design, safety and health, and complex systems requiring human-systems integration. The laboratory seeks to develop and apply innovative, yet valid and reliable methods to support modeling, specification, data reduction, mining, and framing, as well as visualization of qualitative indicators and quantitative metrics.

7. **Logistics Systems Laboratory**
   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 and Systems Engineering Faculty

Name/Title	Education	Contact Info	Primary Research Interests	Secondary Research Track
Dr. Lauren Davis, Associate Professor	North Carolina State University (PhD 2005)	lbdavis@ncat.edu (336) 285-3724 McNair 404	**Manufacturing and Service Enterprise Engineering**: Supply Chain Optimization, Optimization Models for Supply Chain Information Sharing & Negotiation, Applied OR and Stochastic Processes	Operations Research and Systems Analysis
Dr. Salil Desai, Associate Professor	University of Pittsburgh (PhD 2004)	sdesai@ncat.edu (336) 285-3725 McNair 422B	**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. Steven Jiang, Associate Professor	Clemson University (PhD 2001)	xjiang@ncat.edu (336) 285-3826 McNair 426-B	**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. Zhichao(Zinc) Li, Associate Professor	Kansas State University (PhD 2006)	zli@ncat.edu (336) 285-3728 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 (PhD 2001)	mountjoy@ncat.edu (336) 285-3730 McNair 416	**Human-Machine Systems Engineering:** Information Visualization, Human Performance, Human-Computer Interaction.	Manufacturing and Service Enterprise Engineering
Mr. Stephen Oneyear,	University of	sjoneyea@ncat.edu	**Manufacturing and Service Enterprise**	

Associate Professor	Wisconsin (MS 1973)	(336) 285-3731 McNair 425	**Engineering:** Computer Integrated Design and Manufacturing, and Production Systems Design and Analysis	
Dr. Eui H. Park, Professor	Mississippi State University (PhD 1983)	park@ncat.edu (336) 285-3732 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, Associate Professor	Purdue University (PhD 2006)	xqu@ncat.edu (336) 285-3733 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. Younho Seong, Associate Professor	State University of New York at Buffalo (PhD 2002)	yseong@ncat.edu (336) 285-3734 McNair 422-A	**Human-Machine Systems Engineering:** Human-machine interaction, Human judgment and policy analysis, Cognitive Engineering	Manufacturing and Service Enterprise Engineering
Dr. Tonya Smith-Jackson, Professor & Chairperson	North Carolina State University (PhD 1998)	tlsmithj@ncat.edu (336) 285-3759 McNair 408	**Human-Machine Systems Engineering:** Cognitive and cultural ergonomics, safety, work system analysis, inclusive design, human-systems integration.	Manufacturing and Service Enterprise Engineering
Dr. Paul Stanfield, Associate Professor	North Carolina State University (PhD 1995)	stanfiel@ncat.edu (336) 285-3735 McNair 402	**Manufacturing and Service Enterprise Engineering:** Supply Chain Systems, Remanufacturing, Military Logistics, Automated Identification, Life Cycle Management, Enterprise Information Systems, and Stochastic Scheduling	Operations Research and Systems Analysis

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: ISEN 600: Survey of Industrial and Systems Engineering Topics

Human-Machine Systems Engineering:
Human-System Interaction:
ISEN 255: Methods Engineering, ISEN 472: Cognitive Human Factors, ISEN 665: Human Machine Systems, ISEN 721: Systems Engineering Models, ISEN 735: Human Computer Interface, ISEN 813: Cognitive Systems Engineering, ISEN 814: Advanced Topics in Human-Machine Systems
Human Factors Engineering
ISEN 255: Methods Engineering, ISEN 471: Ergonomics, ISEN 673: Biomechanics, ISEN 664: Systems Safety Enginering and Risk Analysis, ISEN 812: Advanced Ergonomics
General/Statistics:
ISEN 370: Engineering Statistics, ISEN 475: Design of Experiments, ISEN 675: Design and Analysis of Experiments, ISEN 821: Multivariate Statistics for Engineers, ISEN 844: Reliability and Maintenance

Manufacturing and Service Enterprise Engineering:
Economic Analysis:
ISEN 361: Engineering Economy and Cost Analysis, ISEN 731: Engineering Cost Control
Organizational Issues in Engineering:
ISEN 633: Engineering Law and Ethics, ISEN 653: Engineering Entrepreneurship, ISEN 658: Project Management, ISEN 734: Engineering Organization, ISEN 831: Service Sector Engineering, ISEN 832: Information Technology Management
Quality Control:
ISEN 425: Quality Assurance, ISEN 628: Six Sigma Quality
Service Sector Engineering:
ISEN 831: Service Sector Engineering, ISEN 833: Supply Chain Systems Engineering
General/Analytical Operations Research:
ISEN 430: Deterministic Operations Research, ISEN 435: Stochastic Operations Research, ISEN 742: Linear Optimization, ISEN 841: Integer and Network Optimization, ISEN 843: Queuing Theory
Production Control:
ISEN 655: Production Planning & Scheduling, ISEN 745: Advanced Computer-Integrated Production Systems
Facility Design:
ISEN 465: Facilities Design, ISEN 854: Inventory and Warehouse Systems
Production Process:

ISEN 246: Industrial Design Processes, ISEN 324: Computer Aided Design and Manufacturing, ISEN 624: Information Systems, ISEN 852: Integrated Product and Process Design, ISEN 861: Nano-/Micro- and Bio-Manufacturing

Robotics and Automation:

ISEN 632: Robotics Systems and Applications, ISEN 851: Integrated Manufacturing Control Systems

Informational Technology for Manufacturing:

ISEN 745: Advanced Computer-Integrated Production Systems, ISEN 853: Enterprise Integration

General/Computers:

ISEN 380: Information Technology for ISE, ISEN 625: Information Systems

General/Simulation:

ISEN 415: Discrete Event Systems Modeling and Simulation, ISEN 615: Industrial Simulation, ISEN 822: Advanced Systems Simulation

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 MS Level Courses

ISEN 600. Survey of Industrial and Systems Engineering Topics Credit 3 (3-0)

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

ISEN 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: Senior/Graduate Standing and Consent of Instructor.

ISEN 624. Computer-Integrated Design / Manufacturing 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.

ISEN 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.

ISEN 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.

ISEN 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.

ISEN 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.

ISEN 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.

ISEN 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.

ISEN 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

ISEN 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.

ISEN 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. Prerequisite: Senior/Graduate Standing

ISEN 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.

ISEN 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.

ISEN 685. Selected Topics in ISE 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.

ISEN 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. MS and PhD Students Only.

IV. MS and PhD Level Courses

ISEN 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.

ISEN 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. Prerequisite: Graduate Standing

ISEN 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.

ISEN 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.

ISEN 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.

ISEN 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: Graduate Standing

ISEN 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.

ISEN 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.

ISEN 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.

ISEN 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.

ISEN 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.

ISEN 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.

ISEN 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: Graduate Standing and Consent of Instructor.

ISEN 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.

ISEN 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. Prerequisites: Graduate Standing and Consent of Instructor.

ISEN 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.

ISEN 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.

ISEN 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.

ISEN 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.

ISEN 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.

ISEN 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.

ISEN 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.

ISEN 885. Advanced Special Topics in ISE **Credit 3 (3-0)**
The course will address a current body of knowledge in Industrial and Systems 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

ISEN 796. Master's Project **Credit 3 (3-0)**
This course provides the student an opportunity to complete a comprehensive industrial and systems engineering project of their choice under the supervision of a faculty advisor. A project is an application of industrial and systems 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.

ISEN 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 and systems 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.

ISEN 799. Continuation/Residency **Variable Credits (1-3)**
Meets Graduate College requirement for continuous enrollment during final term prior to graduation when all degree requirements (including thesis or project) have been completed. This course is non-graded, and credit for this course does not count toward the degree. May be repeated twice.

VI. PhD Level Pass/Fail Courses

ISEN 992. Doctoral Seminar in ISE **Variable (1-3)**
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 and Systems Engineering. Pass/Fail evaluation only, no letter grade will be given. Prerequisite: Doctoral Standing in ISE.

ISEN 997. Doctoral Dissertation **Variable (1-18)**
This course provides the student an opportunity to complete a significant piece of original research, of their choice, in industrial and systems 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 Pass the preliminary exam.

ISEN 999. Continuation/Residency **Variable (1-3)**
Meets Graduate College requirement for continuous enrollment during final term prior to graduation when all degree requirements (including dissertation) have been completed. This

course is non-graded, and credit for this course does not count toward the degree. May be repeated twice.

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

1. First consider the area of Industrial and 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 the 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 cannot 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. PhD 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 as identified below. 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.
   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 conflict of interest issues.

3. Change of Dissertation Advisor
   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.

4. 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).

Appendix F: PhD 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 (ISEN 430 and ISEN 435)
   - Engineering Economy (ISEN 361)
   - Statistics (ISEN 370 and ISEN 675)
   - Human Factors (ISEN 665)
   - Methods Engineering (ISEN 255)
   - Quality Assurance (ISEN 425)

   Optional subjects (choose one)**:**
   - Facilities Design (ISEN 465)
   - Production Control (ISEN 655)

   The Qualifying Examination (QE) is seven (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 mean of the seven (7) subject areas is at least 70%.
   b. None of the seven (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 is eligible to take the Deficiency Test (DT) if the following two conditions are met: (1) the mean of the seven (7) subject areas is at least 70% and (2) five (5) of the seven (7) subject area tests are at least 50%. 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: A student who has not passed the qualifying exam and does not meet the conditions for the DT 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. Qualifying Exam Notification
   Students who intend to take the qualifying exam in a given semester need to submit the Qualifying Exam Notification Form to the Graduate Program Coordinator no later than the end of the second week of the semester.

5. Exam Date:
   The Exam Date will be announced by the beginning of the third week of the semester.

6. 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 provide written notification of intent to the Graduate Program Office by the end of the second week of the semester. A set of materials for preparation is available to students. These materials are termed "PhD Qualifying Exam Preparation Materials" and are available from the department. In addition, a booklet entitled "PhD 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: PhD Preliminary Exam Preparation Guide

1. Prerequisites to register for the Preliminary Exam:
   In order to register for the Preliminary Exam, the student must have completed the following:
   a) Qualifying Exam
   b) Any course work the student's Dissertation Committee feels must be completed in preparation for the written part of this exam.
   c) Formation of a Dissertation 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,
   a) Written Exam in his or her research area (HMSE or MSEE) to be given by the student's Dissertation Committee.

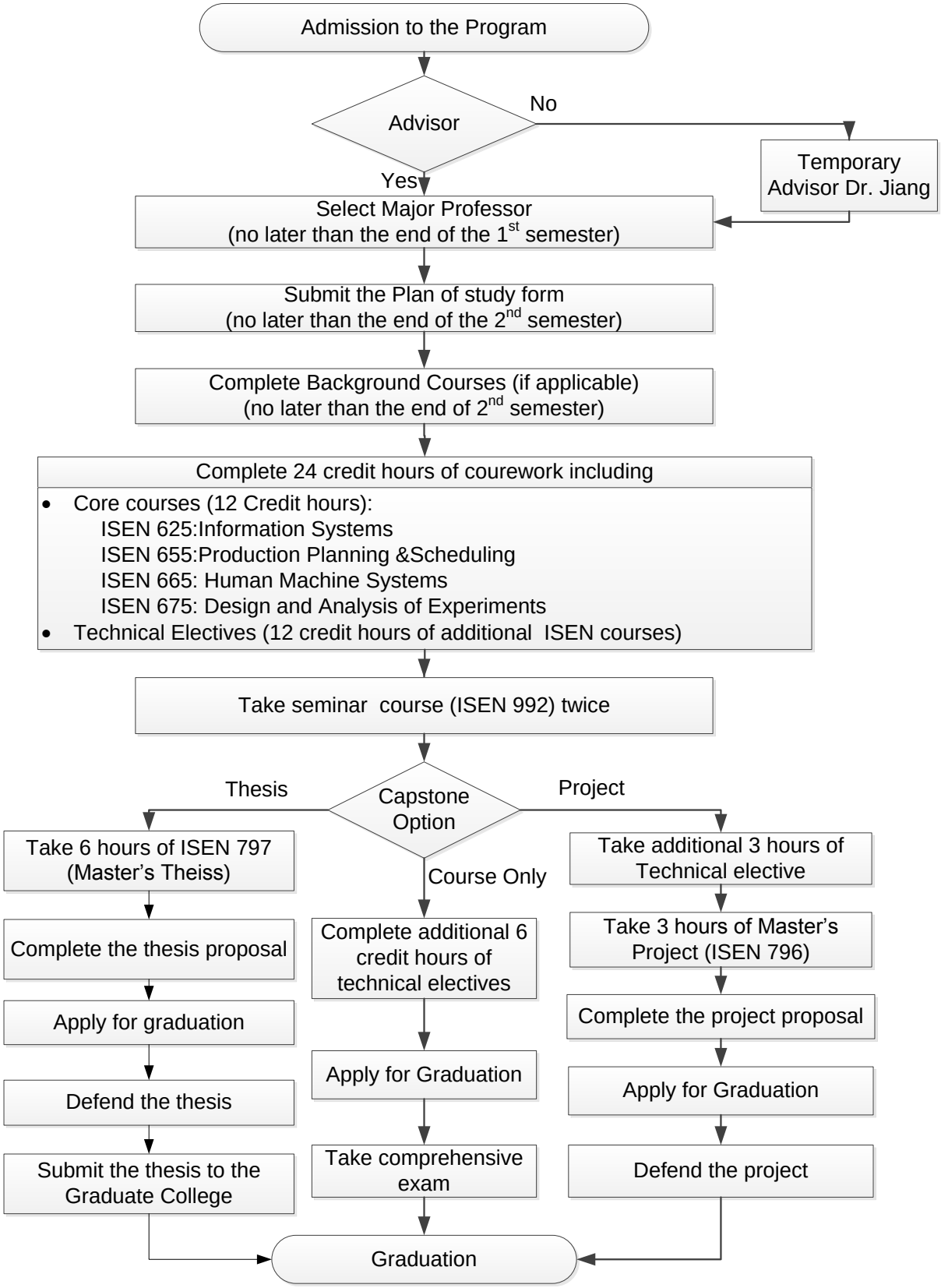
3. Written Exam:
   The Written Exam consists of in-depth questions in subject areas related to the student's chosen specialization. The student's Dissertation Advisor and the other Committee members convene a meeting early in the semester in which the student registers for the Preliminary Exam to plan for the Written Exam. Each committee member prepares and grades questions in one area for the exam. The student is given one week (7 calendar days) to complete the exam. The PhD Committee decides whether the student passed or failed the written exam, and informs the student within two weeks. The PhD 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.

4. Preliminary Exam Notification
   Students who intend to take the Preliminary exam in a given semester need to submit the Preliminary Exam Notification Form to the Graduate Program Coordinator no later than the end of the second week of the semester.

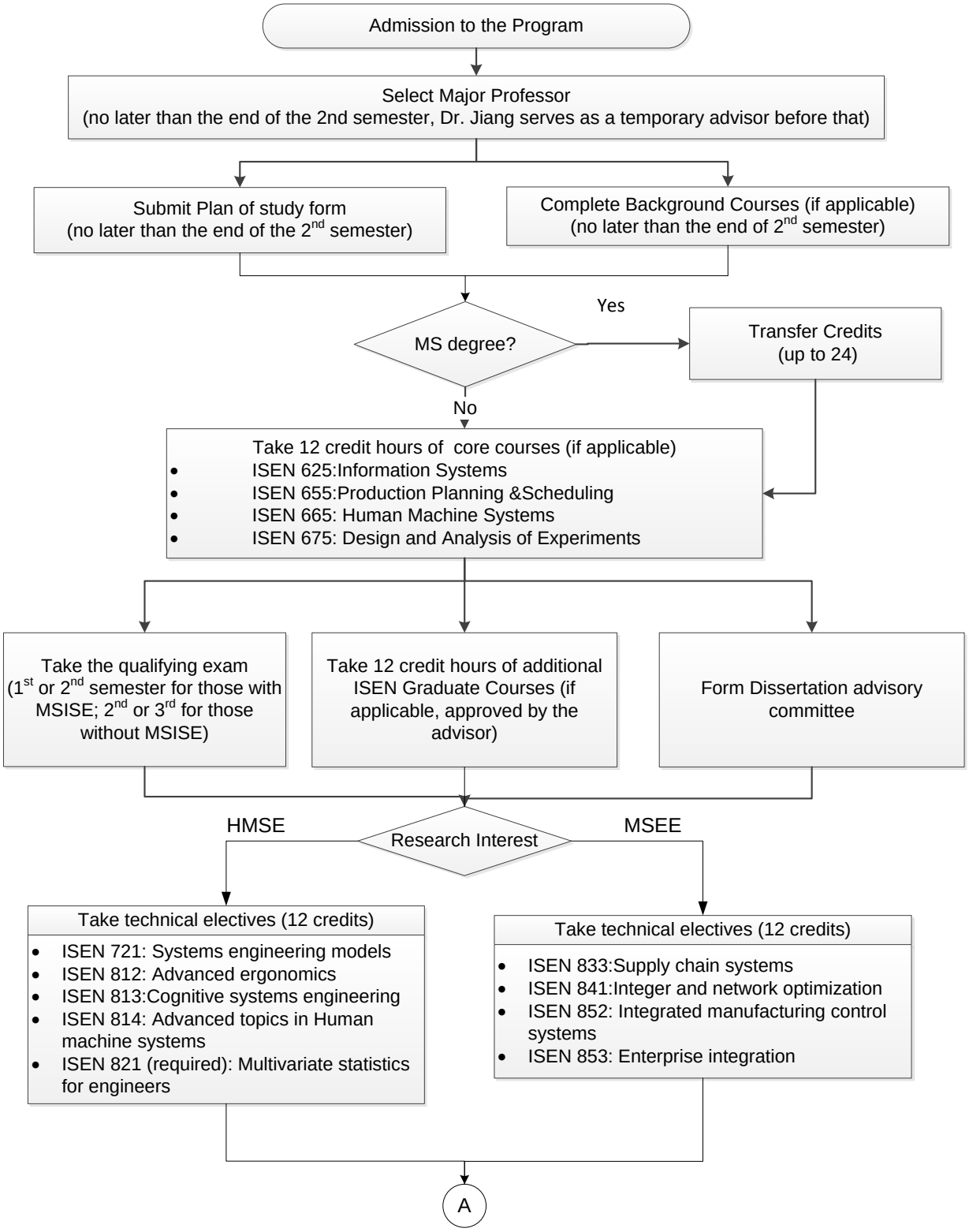
5. Passing the Preliminary Exam:
   In order to pass the Preliminary Exam, the student must pass the Written Exam.

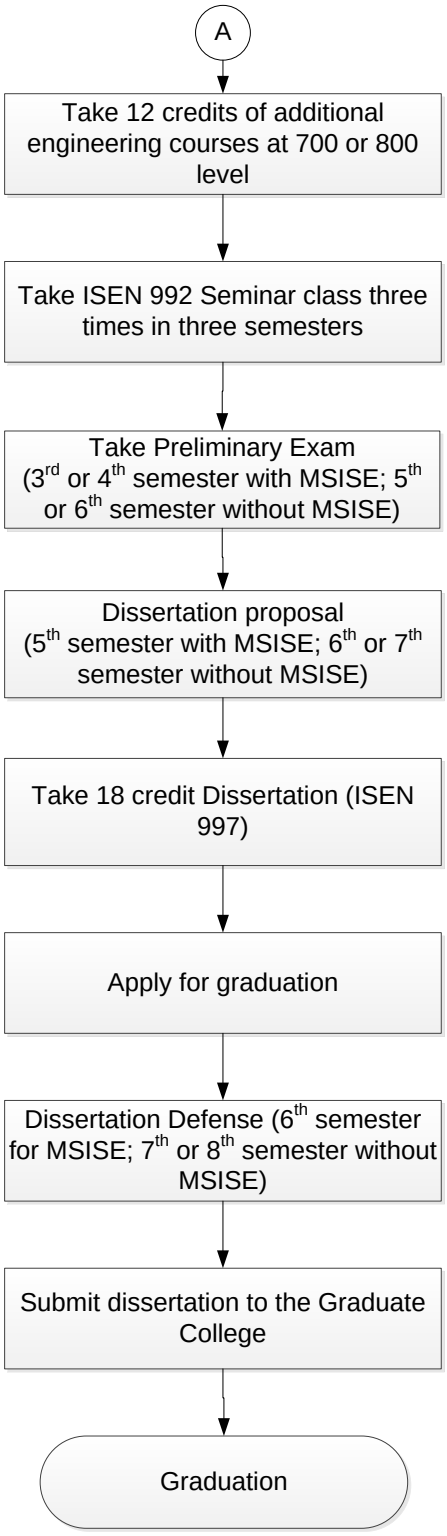
6. Preparing for the Exam:
   In preparation for the Written Exam, the student must complete course work related to the student's specialization. The student should get guidance from their Dissertation Advisor to understand if they are ready to prepare a Dissertation Proposal.

Appendix H: ISE MS Program Flow Chart



Appendix I: ISE PhD Program Flow Chart




A
Take 12 credits of additional engineering courses at 700 or 800 level
Take ISEN 992 Seminar class three times in three semesters
Take Preliminary Exam (3rd or 4th semester with MSISE; 5th or 6th semester without MSISE)
Dissertation proposal (5th semester with MSISE; 6th or 7th semester without MSISE)
Take 18 credit Dissertation (ISEN 997)
Apply for graduation
Dissertation Defense (6th semester for MSISE; 7th or 8th semester without MSISE)
Submit dissertation to the Graduate College
Graduation

Appendix J: List of Required Forms

The forms below are available on the Graduate College and the ISE Department website. Download the forms you need. Complete your information. Print the completed form. Get appropriate signatures and return to the Graduate Program Coordinator.

From Graduate College Website

- Change of Name form
- Change of Program form
- Leave of Absence Request
- PhD Application to Award Master's
- Transfer of Credit - External
- Transfer of Credit – N.C. A&T Courses
- Plan of Study
- Application for In-State Residency for Tuition Purposes Form
- Report of Dissertation Committee

From ISE Department Website

- Project/Thesis Defense Notification Form
- Dissertation Defense Notification Form
- Qualifying Exam Notification Form
- Preliminary Exam Notification Form

Appendix K: List of Scholarship and Fellowship Opportunities

- Title III PhD Fellowship
  The Title III HBGI PhD Fellowship is a prestigious award offered to qualified Ph.D. students enrolled in STEM disciplines at North Carolina A&T State University. Information about eligibility and application process can be found at: http://www.ncat.edu/divisions/academic-affairs/title-lll/HBGI%20Fellowships%20.html

- Bridge to doctoral program
  North Carolina Louse Stokes for Minority Participation manages the Bridge to the Doctorate (BD) Fellowship Program. (NCLSAMP) at N.C. A&T
  Information about eligibility and application process can be found at:
  http://www.ncat.edu/academics/schools-colleges1/grad/news/bridge_doctorate.html

- National Defense Science and Engineering Graduate (NDSEG) Fellowships
  National Defense Science and Engineering Graduate (NDSEG) Fellowships are awarded to applicants who will pursue a doctoral degree in, or closely related to, an area of DoD interest. Information about eligibility and application process can be found at: https://ndseg.asee.org/

- SMART Scholarship
  The Science, Mathematics and Research for Transformation (SMART) Scholarship for Service Program has been established by the Department of Defense (DoD) to support undergraduate and graduate students pursuing degrees in Science, Technology, Engineering and Mathematics (STEM) disciplines. The program aims to increase the number of civilian scientists and engineers working at DoD laboratories. Information about eligibility and application process can be found at: http://smart.asee.org/

- NSF GRFP Fellowship
  The NSF Graduate Research Fellowship Program (GRFP) recognizes and supports outstanding graduate students who are pursuing research-based master's and doctoral degrees in science, technology, engineering, and mathematics (STEM) and in STEM education. The GRFP provides three years of support for the graduate education of individuals who have demonstrated their potential for significant research achievements in STEM and STEM education. NSF especially encourages women, members of underrepresented minority groups, persons with disabilities, and veterans to apply. NSF also encourages undergraduate seniors to apply. Information about eligibility and application process can be found at:
  http://www.nsf.gov/publications/pub_summ.jsp?WT.z_pims_id=6201&ods_key=nsf15597

- GEM Fellowship

GEM's principal activity is the provision of graduate fellowships at the MS and Ph.D. levels coupled with paid summer internships. Information about eligibility and application process can be found at:
http://www.gemfellowship.org/students/gem-fellowship-program/

- IBM PhD fellowship
  The IBM Ph.D. Fellowship Awards Program is an intensely competitive worldwide program, which honors exceptional Ph.D. students who have an interest in solving problems that are important to IBM and fundamental to innovation in many academic disciplines and areas of study. Information about eligibility and application process can be found at:
  http://www.research.ibm.com/university/awards/phdfellowship.shtml

- NREIP Internship
  The Naval Research Enterprise Internship Program (NREIP) provides an opportunity for students to participate in research at a Department of Navy (DoN) laboratory during the summer. Information about eligibility and application process can be found at:
  https://nreip.asee.org/

Appendix L: ISE Master of Science Assessment Sheet

Student Name**:** _____ Proposal/Defense Date**:** _____ Project/Thesis**:** _____

Criterion	Metrics	Assessment				Comments
Systems Analysis	System Decomposition and Modeling	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Quantitative Analysis	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Problem/Improvement Identification	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Solution Strategies	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
Systems Design & Synthesis	Strategy	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Solution	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Integration	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Tools	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
Engineering Problem Solving	Identify Engineering Problems	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Formulate Approach	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Solve Engineering Problems	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Analyze and Interpret Results	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	

Industrial Application	Recognize Industrial Applications	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Formulate Problems	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Select appropriate ISE tools	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Apply ISE tools	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Quality of writing	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Quality of Oral Communication	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
Technical Communication (Written)	Organization	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Spelling and Grammar	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Content	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Graphic and Tabular Content	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Sources and References	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
Technical Communication (Oral)	Language and Delivery	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Supporting Material	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	

	Response to Questions	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	

Evaluator: _____

ISE Master of Science Program Rubrics for Systems Analysis

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory(3)	Exceptional (4)
System Decomposition and Modeling (SLO 2)	Decompose the system into components in an unreasonable way for quantitative analysis or modeling, and fail to state their relationship correctly	Decompose the system into components in a near-reasonable way for quantitative analysis and modeling, and correctly identify most relationships linking these components	Decompose the system into reasonable components for quantitative analysis and modeling, and correctly state their relationship in order to represent the system by linking these components	Decompose the system into components in one of the best ways for quantitative analysis or modeling and linking them to represent the system
Quantitative Analysis (SLO 4)	Use appropriate quantitative methods (such as simulation, optimization, statistical analysis, etc.) in the analysis of some system components, and fail to identify all problems and propose proper solution strategies	Use appropriate quantitative methods (such as simulation, optimization, statistical analysis, etc.) in the analysis of most system components, and then identify most problems and propose solution strategies	Use appropriate quantitative methods (such as simulation, optimization, statistical analysis, etc.) in the analysis of all system components, and then identify all problems, and propose proper solution strategies	Use effective and efficient quantitative methods (such as simulation, optimization, statistical analysis, etc.) to analyze system components, identify problems, and propose solution strategies
Problem/Improvement Identification (SLO 3)	Identify some key problems for system improvement	Identify most key problems for system improvement	Identify all key problems for system improvement	Identify all key problems for system improvement, and recognize other factors relevant to system improvement
Solution Strategies (SLO 4)	Propose solutions to most problems identified	Propose appropriate solutions to the key problems identified	Propose appropriate solutions to all key problems identified, and alternative strategies	Propose appropriate solutions to all key problems identified, and alternative strategies Recommend strategies to reduce the negative impact of other relevant factors

ISE Master of Science Program Rubrics for Systems Design and Synthesis

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory(3)	Exceptional (4)
Strategy (SLO 2)	Seek help to develop single approach strategy without any consideration for alternatives	Work primarily independently or within team to develop a simple strategy with some consideration for alternatives	Work primarily independently or within team to develop a simple strategy with alternatives	Work totally independently or within team to develop multiple layers of strategy
Solution (SLO 4)	Offer partial solution	Solution is unoriginal and show little consideration of research	Seek and accept advisory input to come up with single solution with to alternative solutions	Work independently or within team with minimal amount of advisory input to develop multiple solutions that are based on documented research
Integration (SLO 3)	Show no regard for interface of people, materials, or equipment, energy and life cycle factors	Attempt to show relationship of people, materials, equipment, energy and life cycle factors but with unsubstantiated facts	Show limited regard for interface of people, materials, or equipment, energy and life cycle factors	Show relationships of people, materials, equipment, energy and life cycle factors with required facts with minimal advisory input
Tools (SLO 3)	Demonstrate limited knowledge and understanding of IE tools	Demonstrate knowledge and understanding of IE tools	Demonstrate knowledge of IE tools, and be able to appropriately use most IE tools to formulate complete solutions	Use all appropriate IE tools necessary to formulate complete solutions

ISE Master of Science Program Rubrics for Engineering Problem Solving

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)
Identify Engineering Problems (SLO 2)	Cannot identify the nature of the problem	Identifies 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 (SLO 3)	Improper formation of an approach	Demonstrated some capability of formation of an approach but it is incomplete and superficial	Apply appropriate tools to formulate an approach but alternative approaches not considered 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 (SLO 4)	Incorrect 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 systems approach	Solutions as well as alternative solutions offered with correct IE tools utilized, demonstrating complete understanding of the IE systems approach
Analyze and Interpret Results (SLO 2)	Made errors in analytical methods and states conclusions without justification	Demonstrated some capability of using the analytical method with some errors but could not draw correct conclusions	Demonstrated good capability of using the analytical method and drawing correct conclusions but failed to state the conclusion clearly and concisely and to relate the conclusion to the problem	Demonstrated excellent capability of using the analytical method and drawing correct conclusions clearly and concisely, and related the conclusion to the problem

ISE Master of Science Program Rubrics for Industrial Application

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory(3)	Exceptional (4)
Recognize industrial applications (SLO 3)	Cannot recognize appropriate industrial applications	Recognizes basic ISE applications	Recognize industrial applications with some complexity where ISE can be applied	Recognize industrial applications with various degrees of complexity where ISE can be applied
Formulate Problems (SLO 3)	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 ISE terminology	Identifies the complete core problem and makes a concise problem statement using correct ISE terminology
Select appropriate ISE tools (SLO 3)	Selects one or none appropriate ISE tools for the application	Selects some ISE tools that are appropriate for the application	Selects most ISE tools that are appropriate for the application	Selects all ISE tools that are appropriate for the application
Apply ISE tools (SLO 3)	Poor understanding of subject matter and associated literature, poor understanding of theoretical concepts	Demonstrates basic understanding of how ISE tools work but had many issues applying them	Demonstrates good understanding of how ISE tools work and had a few issues applying them	Exhibits mastery of how ISE tools work and had no issues applying them
Quality of Writing (SLO 1)	Poor writing Numerous grammatical and spelling errors	Intermediate documentation Writing needs improvement Some grammatical and spelling errors apparent	Good documentation Writing is adequate Little grammatical and spelling errors apparent	Excellent documentation Publication quality of writing No grammatical or spelling errors
Quality of Oral Communication (SLO 1)	Unfocused presentation Inadequate / inappropriate use of vocabulary, eye contact, posture, presentation appears unpracticed; visual materials poorly support points in the presentation; speaker fails to appropriately address questions	Presentation organization lacks coherence, Speaker demonstrates certain presentation skills though many flaws are present, some use of visual aids, speaker can address some of the questions.	Presentation is appropriately organized; speaker appears proficient in presentation skills though occasional flaws are present; presentation is adequately paced with clear exposition and logical presentation; visual materials support points in the presentation; speaker addresses questions adequately	Organization of presentation reflects creation of a well-structured framework; speaker displays consistent use of correct grammar and vocabulary and professional delivery, including eye contact and physical demeanor; visual materials are effective in supporting and enhancing the presentation; speaker addresses questions carefully and thoroughly, integrating additional information in responses

ISE Master of Science Program Rubrics for Technical Communication (written).

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory(3)	Exceptional (4)
Organization (SLO 2)	Organizational pattern is not observable, and no conclusions can be deduced.	Organizational pattern is intermittently observable, and conclusions can be deduced or is basically understandable but is not strongly supported.	Organizational pattern is clearly and consistently observable, and conclusions are clear and consistent with the supporting material.	Organizational pattern (specific introduction and conclusion, sequenced material within the body, and transitions) is clearly and consistent, and makes the content cohesive, with compelling conclusions (precisely stated, appropriately repeated, memorable, and strongly supported.)
Spelling and Grammar (SLO 1)	Uses language that sometimes impedes conveying technical content because of frequent errors in usage	Uses language that generally conveys technical content to readers with clarity, although writing includes some errors	Uses straightforward language that generally conveys technical contents to readers. The language in the portfolio has few errors	Uses graceful language that skillfully communicates technical content to readers with clarity and fluency, and is virtually error-free
Content (SLO 1)	Uses inappropriate and/or irrelevant content to present the problems addressed, the solution approaches, and the results	Uses appropriate and relevant content to state the problems addressed, describe the solution approaches, and present the results supporting the conclusions with unnecessary redundancy	Uses appropriate and relevant content to clearly state the problems addressed, describe the solution approaches, and present the results supporting the conclusions	Uses appropriate, relevant, and compelling content to logically convey the problems addressed and the solution approaches, and elegantly present the results supporting the conclusions
Graphic and Tabular Content (SLO 1)	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 References (SLO 4)	Demonstrates no attempt to use sources and references to support ideas in the writing, or uses sources and references that are not credible or relevant	Demonstrates an attempt to use credible and/or relevant sources and references to induce problems, develop solution approaches, and/or support conclusions	Demonstrates consistent use of credible, appropriate, relevant sources and references to induce problems, develop solution approaches, and support conclusions	Demonstrates skillful use of high-quality, credible, appropriate, relevant sources and references to induce problems, develop solution approaches, and support conclusions

ISE Master of Science Program Rubrics for Technical Communication (oral)

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory(3)	Exceptional (4)
Language and Delivery (SLO 1)	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 (SLO 4)	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 (SLO 3)	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

Appendix M: ISE Doctoral Program Assessment Sheet

Name of Student: **Semester/Year** **Date**

Criterion	Metrics	Assessment				Comments
Discipline Knowledge	Traditional Industrial and Engineering Related Knowledge	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Systems Engineering Related Knowledge	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Ergonomics, Healthcare, and Human Factors Related Knowledge	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Manufacturing, Production, and Management Related Knowledge	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
Systems Design & Synthesis	Strategy	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Solution	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Integration	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Tools	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	

Systems Analysis	System Component Decomposition	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Quantitative Analysis	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Problem Identification	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Solution Strategies	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
Technical Communication (Written)	Organization	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Spelling and Grammar	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Content	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Graphic and Tabular Content	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Sources and References	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	

Technical Communication (Oral)	Language and Delivery	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Supporting Material	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	
	Response to Questions	Unsatisfactory (1)	Developing (2)	Satisfactory (3)	Exceptional (4)	

Evaluator: _____

ISE Doctoral Program Rubrics for ISE Discipline Knowledge.

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory(3)	Exceptional (4)
Traditional Industrial Engineering Related Knowledge (Operation research, statistics, and quality control etc.)	Decompose the system into components in an unreasonable way for the quantitative analysis, and fail to state their relationship correctly	Decompose the system into components in a near-reasonable way for the quantitative analysis, and correctly identify most relationships linking these components	Decompose the system into reasonable components for the quantitative analysis, and correctly state their relationship in order to represent the system by linking these components	Decompose the system into components in one of the best ways for the quantitative analysis and linking them to represent the system
Systems Engineering Related Knowledge (System methods and other interdisciplinary topics)	Use appropriate quantitative methods (such as simulation, optimization, statistical analysis, etc.) in the analysis of some system components, and fail to identify all problems and propose proper solution strategies	Use appropriate quantitative methods (such as simulation, optimization, statistical analysis, etc.) in the analysis of most system components, and then identify most problems and propose solution strategies	Use appropriate quantitative methods (such as simulation, optimization, statistical analysis, etc.) in the analysis of all system components, and then identify all problems, and propose proper solution strategies	Use effective and efficient quantitative methods (such as simulation, optimization, statistical analysis, etc.) to analyze system components, identify problems, and propose solution strategies
Ergonomics, Healthcare, and Human Factors Related Knowledge	Identify some key problems for system improvement	Identify most key problems for system improvement	Identify all key problems for system improvement	Identify all key problems for system improvement, and recognize other factors relevant to system improvement
Manufacturing, Production, and Management Related Knowledge	Propose solutions to most problems identified	Propose appropriate solutions to the key problems identified	Propose appropriate solutions to all key problems identified, and alternative strategies	Propose appropriate solutions to all key problems identified, and alternative strategies Recommend strategies to reduce the negative impact of other relevant factors

ISE Doctoral Program Rubrics for Systems Analysis.

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory(3)	Exceptional (4)
System Component Decomposition	Decompose the system into components in an unreasonable way for the quantitative analysis, and fail to state their relationship correctly	Decompose the system into components in a near-reasonable way for the quantitative analysis, and correctly identify most relationships linking these components	Decompose the system into reasonable components for the quantitative analysis, and correctly state their relationship in order to represent the system by linking these components	Decompose the system into components in one of the best ways for the quantitative analysis and linking them to represent the system
Quantitative Analysis	Use appropriate quantitative methods (such as simulation, optimization, statistical analysis, etc.) in the analysis of some system components, and fail to identify all problems and propose proper solution strategies	Use appropriate quantitative methods (such as simulation, optimization, statistical analysis, etc.) in the analysis of most system components, and then identify most problems and propose solution strategies	Use appropriate quantitative methods (such as simulation, optimization, statistical analysis, etc.) in the analysis of all system components, and then identify all problems, and propose proper solution strategies	Use effective and efficient quantitative methods (such as simulation, optimization, statistical analysis, etc.) to analyze system components, identify problems, and propose solution strategies
Problem Identification	Identify some key problems for system improvement	Identify most key problems for system improvement	Identify all key problems for system improvement	Identify all key problems for system improvement, and recognize other factors relevant to system improvement
Solution Strategies	Propose solutions to most problems identified	Propose appropriate solutions to the key problems identified	Propose appropriate solutions to all key problems identified, and alternative strategies	Propose appropriate solutions to all key problems identified, and alternative strategies Recommend strategies to reduce the negative impact of other relevant factors

ISE Doctoral Program Rubrics for Systems Design and Synthesis

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory(3)	Exceptional (4)
Strategy	Seek help to develop single approach strategy without any consideration for alternatives	Work primarily independently or within team to develop a simple strategy with some consideration for alternatives	Work primarily independently or within team to develop a simple strategy with alternatives	Work totally independently or within team to develop multiple layers of strategy
Solution	Offer partial solution	Solution is unoriginal and show little consideration of research	Seek and accept advisory input to come up with single solution with to alternative solutions	Work independently or within team with minimal amount of advisory input to develop multiple solutions that are based on documented research
Integration	Show no regard for interface of people, materials, or equipment, energy and life cycle factors	Attempt to show relationship of people, materials, equipment, energy and life cycle factors but with unsubstantiated facts	Show limited regard for interface of people, materials, or equipment, energy and life cycle factors	Show relationships of people, materials, equipment, energy and life cycle factors with required facts with minimal advisory input
Tools	Demonstrate limited knowledge and understanding of ISE tools	Demonstrate knowledge and understanding of ISE tools	Demonstrate knowledge of ISE tools, and be able to appropriately use most IE tools to formulate complete solutions	Use all appropriate ISE tools necessary to formulate complete solutions

ISE Doctoral Program Rubrics for Technical Communication (written).

Indicator	Unsatisfactory (1)	Developing (2)	Satisfactory(3)	Exceptional (4)
Organization	Organizational pattern is not observable, and no conclusions can be deduced.	Organizational pattern is intermittently observable, and conclusions can be deduced or is basically understandable but is not strongly supported.	Organizational pattern is clearly and consistently observable, and conclusions are clear and consistent with the supporting material.	Organizational pattern (specific introduction and conclusion, sequenced material within the body, and transitions) is clearly and consistent, and makes the content cohesive, with compelling conclusions (precisely stated, appropriately repeated, memorable, and strongly supported.)
Spelling and Grammar	Uses language that sometimes impedes conveying technical content because of frequent errors in usage	Uses language that generally conveys technical content to readers with clarity, although writing includes some errors	Uses straightforward language that generally conveys technical contents to readers. The language in the portfolio has few errors	Uses graceful language that skillfully communicates technical content to readers with clarity and fluency, and is virtually error-free
Content	Uses inappropriate and/or irrelevant content to present the problems addressed, the solution approaches, and the results	Uses appropriate and relevant content to state the problems addressed, describe the solution approaches, and present the results supporting the conclusions with unnecessary redundancy	Uses appropriate and relevant content to clearly state the problems addressed, describe the solution approaches, and present the results supporting the conclusions	Uses appropriate, relevant, and compelling content to logically convey the problems addressed and the solution approaches, and elegantly present the results supporting the conclusions
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 References	Demonstrates no attempt to use sources and references to support ideas in the writing, or uses sources and references that are not credible or relevant	Demonstrates an attempt to use credible and/or relevant sources and references to induce problems, develop solution approaches, and/or support conclusions	Demonstrates consistent use of credible, appropriate, relevant sources and references to induce problems, develop solution approaches, and support conclusions	Demonstrates skillful use of high-quality, credible, appropriate, relevant sources and references to induce problems, develop solution approaches, and support conclusions

ISE Doctoral Program Rubrics for Technical Communication (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; enhances overall effectiveness of presentation, and/or encourages/addresses offline follow-ups

Appendix N: ISE Graduate Student Academic Expectations

As members of N.C. A&T ISE, we expect students to:

1. Take responsibility for learning by using office hours as needed and reading and studying supplemental material independently.
2. Respect the teaching-learning environment, including peers, instructors, and guests.
3. Approach all learning activities with honesty, integrity, and by upholding the Student Code of Conduct.
4. Attend all class meetings on time and for the full time allotted.
5. Engage in active learning during class meetings by focusing on the subject matter and actively participating in class discussions and activities
6. Commit to high quality deliverables such as homeworks, projects, and exams and submit these deliverables on time.
7. Allocate significant time to academic preparation by studying and reviewing material every day.
8. Utilize instructors' office hours to ensure mastery of the subject matter.
9. Value research and the importance of treating your research as a personal achievement that reflects your scholarly character.
10. Familiarize yourself with the ISE Graduate Handbook and the policies of the N.C. A&T Graduate College.
11. Honor your commitment to work the hours you are being paid to work with conscientiousness, diligence, and attentional focus.
12. Attend scheduled meetings on time and consistently.
13. Be prepared for all meetings.
14. Ask for help immediately if needed.
15. Complete all projects you are assigned.
16. Take responsibility for the organization of your work and time management.
17. Uphold professional and academic ethics.