

THE UNIVERSITY *of* TENNESSEE

DEPARTMENT of INDUSTRIAL and SYSTEMS ENGINEERING College of Engineering

GRADUATE HANDBOOK

M.S. and Ph.D. in Industrial Engineering and
Concentration on Engineering Management
M.S. in Reliability and Maintainability Engineering

CONTENTS

1. INTRODUCTION	1
1.1 Registering for Classes	1
1.2 Academic Advisors	1
1.3 Graduate Student Offices, Desk Space, and Computer Facilities.....	2
2. ASSISTANTSHIPS AND FINANCIAL SUPPORT	2
2.1 Graduate Research Assistants	3
2.2 Graduate Teaching Assistants.....	3
2.3 Graduate Teaching Associates	3
2.4 Graduate Assistants.....	3
3. MASTER OF SCIENCE DEGREE.....	4
3.1 Master of Science Degree Requirements	4
3.1.1 Industrial Engineering.....	5
3.1.2 Engineering Management Concentration	6
3.1.3 Reliability and Maintainability Engineering.....	8
3.2 Five-Year BS-MS Program.....	10
3.3 Dual MBA-MS Program.....	11
3.4 Transfer Credits	10
3.5 Master’s Advisory Committee	12
3.6 Admission to Candidacy	13
3.7 Master’s Degree Final Examination	13
3.8 Time Limit for MS degree	15
4. Ph.D. DEGREE.....	15
4.1 Doctoral Degree Program Requirements	15
4.1.1 Credit Hour Requirements	15
4.1.2 Residency Requirement	16
4.2 Transfer Credits	17
4.3 Ph.D. Advisory Committee.....	17
4.4 Comprehensive Examination	18
4.5 Proposal Defense	18
4.6 Admission to Candidacy	19

4.7 Doctoral Research and Dissertation.....19

4.7.1 Dissertation19

4.7.2 Defense of Dissertation.....19

4.8 Time Limit for PhD degree.....20

5. APPENDICES..... 20

5.1 Design or Capstone Project Requirements and Guidelines20

5.2 Departmental Documentation Forms21

1. INTRODUCTION

This Departmental Graduate Handbook provides information about the graduate programs in the Industrial and Systems Engineering Department at The University of Tennessee for new and continuing graduate students in the department. Policies concerning Degree Programs, examinations, and financial assistance are covered in this handbook. Additional information is available in publications from the University Graduate School. The Handbook is consistent with all established Graduate School Policies noted in the *Graduate Catalog* (<http://catalog.utk.edu/index.php?catoid=12>). It provides, where appropriate, amendment and specific ways in which those policies are carried out.

Graduate students are expected to be aware of and satisfy all regulations governing their work and study at the University of Tennessee. For additional information about University policies please refer to *Hilltopics Student Handbook* (<http://dos.utk.edu/hilltopics/>) and the *Appeals Procedure* (<http://gradschool.utk.edu/GraduateCouncil/AcadPoli/appealprocedure.pdf>).

1.1 Registering for Classes

The Graduate Advisor assists new graduate students with initial course selection and with identification of potential academic advisors. The *Schedule of Classes* for each semester can be obtained online at https://bannersb.utk.edu/kbanpr/bwckschd.p_disp_dyn_sched. Registration is also accomplished online. To be forced into an IE class that is filled, permission must be obtained from the course instructor. Registration for courses requiring an advisor, such as a directed studies course, an internship course, or a research course must be done through the Department Academic Office. Furthermore, departmental approval is necessary if an Industrial and Systems engineering graduate student wishes to register in any freshman or sophomore level course.

Information concerning registration is available at the Office of the University Registrar's website <http://registrar.utk.edu>. Additional information regarding registration, enrolment, and minimum number of hours required for full-time status with and without assistantships can be found at <http://catalog.utk.edu/content.php?catoid=12&navoid=1061>.

1.2 Academic Advisors

All admitted student are required to discuss their Degree Program with their Academic Advisor. The selection of an advisor should be done by the end of the first semester for Master's students or by the end of the second semester for Ph.D. students. In consultation with the Academic Advisor all graduate students must select an Advisory Committee chaired by the Academic Advisor.

The selection of academic advisors is done through communication between student and suitable departmental faculty either prior to or upon arrival at the Knoxville Campus. To facilitate this, the Academic Office will send every semester a list of admitted students to all faculty

members. Only exceptionally will students be allowed to change academic advisors once they have started working on degree requirements and particularly if they are receiving financial support from the advisors.

Initially, a student may be assigned as *temporary advisor* a faculty member who gives direction to the student during the time in which there is no degree program. When new students come to the department, they may or may not have already interacted with some members of the faculty. If they come to the department with an interest in working under the direction of a particular faculty member, then that faculty member can become the temporary advisor to the student. Or, if a new student already has a specific research interest, then the student can ask a faculty member in that area of research to act as a temporary advisor. As a default, the Department's Graduate Advisor will act as the temporary advisor.

1.3 Graduate Student Offices, Desk Space, and Computer Facilities

Limited office space is available for graduate students. Offices are assigned according to departmental teaching and research needs. Assignments are usually completed by the second week of each semester. Requests for office space should be made to the Associate Department Head by a student's academic advisor.

The department maintains computers and facilities for Industrial and Systems Engineering faculty, staff, and students. Microcomputers for student use are located in John Tickle Building 403. All computer users are asked to avoid waste (e.g., unnecessary printouts, use of laser printer for draft documents, etc.) and to be considerate of others using the facilities. The university has several computer centers available to all students, such as one located in the John C. Hodges library.

2. ASSISTANTSHIPS AND FINANCIAL SUPPORT

There are four different categories of Graduate Student Assistantships: Graduate Teaching Assistants (GTA), Graduate Research Assistants (GRA), Graduate Teaching Associate, and Graduate Assistants, or a mix of them, without exceeding a total effort of 50%. A description of general policies that apply to all graduate assistantships is provided in the Graduate Catalog in the section titled [*Policy for the Administration of Graduate Assistantships*](#). This section covers topics such as the rights, responsibilities, evaluation, supervision, training, and work assignments of graduate assistants. A short description of each assistantship including relevant position duties follows.

Financial support in the form of tuition and maintenance fee waivers and assistantships is available from the department, subject to availability of funds. The number of assistantships available varies from year to year due to changes in operating budget, departmental needs, and research funds. The available positions are filled on a competitive basis. Students should assess

their own financial needs and express desire to compete for financial support to their major professor or the Department Head. Individual project Principal Investigators may select from *Regularly Admitted* students those for GRA appointments. The final decision on the award of an assistantship to any student is made by the Department Head.

All Master's students receiving financial support from the Industrial and Systems Engineering department are required to select and complete the Thesis Option. Students enrolling under the non-thesis option are not eligible for assistantships.

2.1 Graduate Teaching Assistants

These assistants work under the direct supervision of faculty members and may be assigned only to duties related directly to instruction. These include such activities as assisting in the preparation of lectures, leading discussion sections, conducting laboratory exercises, grading papers, and keeping class records. They may not be given primary teaching and/or evaluation responsibilities, nor should they be given duties to support faculty research or those basically clerical in nature.

2.2 Graduate Research Assistants

These assistants perform duties in support of university research, which may or may not be related directly to the student's thesis or dissertation. An assistant works under the direct supervision of the administrator of the research contract, who often may be his/her, major professor. Research assistantships may be financed through funds from gifts, grants, state appropriations designated for research or through the university's internally sponsored programs. The Department Head is responsible for assuring that GRAs receive ample opportunities to make continuing progress toward their degrees.

2.3 Graduate Teaching Associates

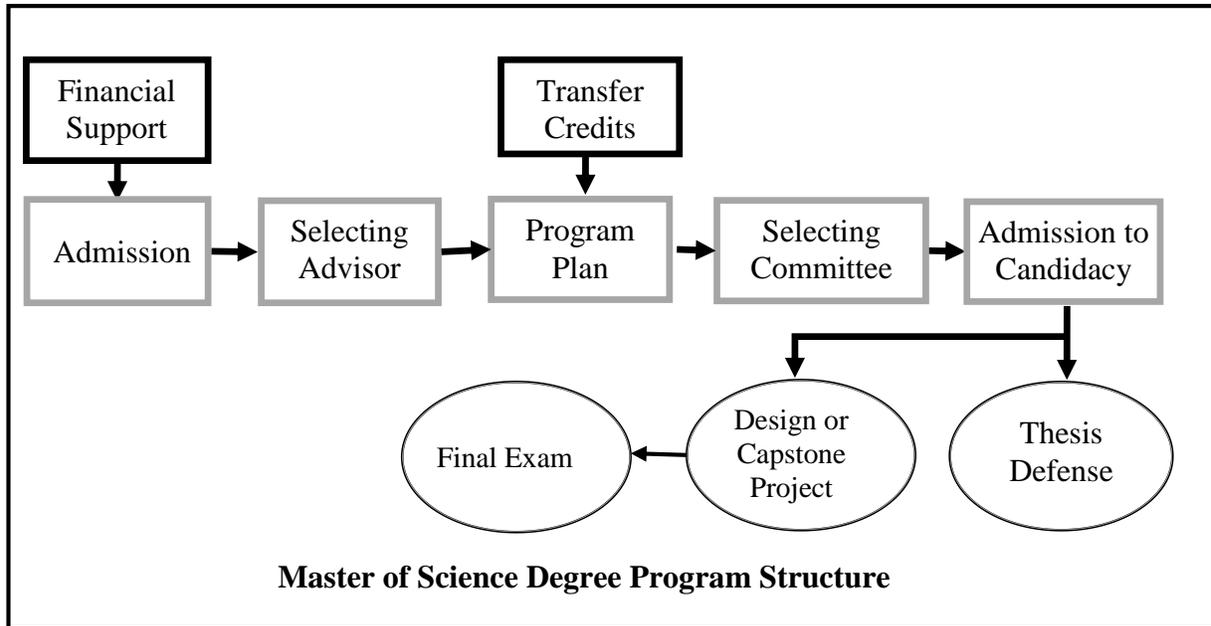
These assistants are advanced graduate students who are given primary responsibility for teaching undergraduate courses. A graduate teaching associate may not be assigned the sole primary responsibility for teaching a graduate course.

2.4 Graduate Assistants

These assistants are appointed to perform various types of duties other than those related directly to teaching or research. Most commonly, these duties relate to supervisory or administrative functions of the university.

3. MASTER OF SCIENCE DEGREE

The overall process including all major steps to earn a Master of Science degree is shown in the following flowchart.



3.1 Master of Science Degree Requirements

There are three areas of study for the Master of Science program in the Department of Industrial and Systems Engineering: Industrial Engineering, Engineering Management concentration, and Reliability and Maintainability Engineering. The prerequisites, additional admission requirements, and graduate course hour requirements (thesis and non-thesis options) for each of the three areas of study are listed in this section.

The following three prerequisite courses are required for all three areas if not included in a previous undergraduate degree program in an *engineering discipline*.

IE 200 Engineering Statistics

IE 301 Operations Research in Industrial Engineering I

IE 405 Engineering Economic Analysis

Note: IE 301 is not required for the EM concentration.

Off-campus students (distance education) enrolled in the industrial engineering area of study who do not have an introduction to operations research course in their undergraduate program must take ENMG 537 (Analytical Methods for Engineering Managers) instead of IE 301.

Students with a non-engineering Bachelor degree admitted by the department may be required to take additional prerequisite courses. Typically, a calculus-based physics course and a linear algebra course will be required, along with the pre-requisites if any for these two courses.

Students may select either a thesis or non-thesis option. M.S. students with Graduate Assistantships must select the thesis option. For the Industrial Engineering area of study and Engineering Management Concentration, the thesis option requires 26 hours of course work and 6 hours of thesis, and the non-thesis option requires 29 hours of course work and a 3-hour design project. For the Reliability and Maintainability Engineering area, the thesis option requires 24 hours of course work and 6 hours of thesis, and the non-thesis option requires 27 hours of course work and a 3-hour design project. The course credit hour requirements for the thesis and non-thesis options in each of the three areas, as well as any additional prerequisites, are discussed in more detail in the following subsections.

3.1.1 Industrial Engineering

The semester graduate course hour requirements for the thesis and non-thesis options for the industrial engineering area of study are summarized below.

	Thesis Option	Non-Thesis Option
IE Core	9	9
IE Electives	9	12
Technical Electives	6	6
Thesis	6	0
Project	0	3
Seminar	2	2
Total	32	32

Industrial Engineering Core Courses

- IE 516 Statistical Methods in Industrial Engineering
- IE 518 Advanced Engineering Economic Analysis
- IE 522 Optimization Methods in Industrial Engineering

Seminar

- IE 550 Graduate Seminar (2 credit hours)

Industrial Engineering Elective Courses

- IE 504 Product Development Process
- IE 506 Product Selection and Evaluation
- IE 508 Integrated Manufacturing Systems
- IE 509 Multidisciplinary Project
- IE 513 Facilities Planning and Design
- IE 514 Advanced Information Systems Analysis and Design
- IE 515 Advanced Production and Inventory Systems
- IE 517 Reliability Engineering

IE 519 Human Factors Engineering and Ergonomics
 IE 521 Human Factors Engineering Methods
 IE 526 Advanced Applications of Systems Modeling and Simulation.
 IE 527 Lean Production Systems
 IE 552 Advanced Linear Programming
 IE 556 Data Mining in Engineering & Manufacturing
 IE 561 Multivariate Statistics
 Other IE Graduate Courses (e.g. 600 level courses) selected with major professor

Technical Electives

The 6 credit hours of technical electives must be selected in consultation with the Major Professor (chair of Committee). Areas for these electives typically include computer science, mathematics and statistics, but other relevant areas are acceptable.

Thesis: IE 500

An M.S. student who chooses the thesis option must be registered for IE 500 each semester, during the time work on the thesis is in progress, with a minimum of 3 hours the semester in which the thesis is accepted by the Graduate School. A total of six hours of IE 500 is required for the thesis option. After receiving the master's degree, a student is no longer permitted to register for IE 500.

Industrial Engineering Design (Capstone) Project: IE 501

This is a three-credit hour project that emphasizes the integration of theory, concepts, and procedures in several areas of industrial engineering, including, but not limited to, engineering economy, inventory and production control, operations research, and manufacturing processes. The student's creativity and ability to apply this material will be of fundamental importance to succeed in this course. Details regarding the IE Design (Capstone) Project are listed in the appendix of Section 5.1.

3.1.2 Engineering Management Concentration

The engineering management (EM) concentration has the same basic admission requirements for the Master of Science program plus an additional admission requirement of two years of industrial experience as a practicing engineer or scientist in a company in the United States, or current being a full-time employment in an appropriate engineering or applied science position. The prerequisite requirements for this concentration are the same as previously indicated in the opening of Section 5.1. As indicated therein, this concentration does not require IE 301 as a prerequisite course.

This concentration is fully supported off-campus utilizing electronic media for videotaping and interactive distance teaching methods, and is made available through the cooperative efforts of the Department of Industrial and Systems Engineering at The University of Tennessee main campus in Knoxville and The University of Tennessee Space Institute (UTSI) in Tullahoma.

Competency with contemporary information technologies (including PC, productivity software tools, and web usage) is assumed.

The semester graduate course hour requirements for the thesis and non-thesis options for the Engineering Management concentration are summarized below.

	Thesis Option	Non-Thesis Option
IE Core	9	9
EM Concentration	9	9
IE electives	3	6
EM electives	3	3
Thesis	6	0
Project	0	3
Seminar	2	2
Total	32	32

Engineering Management Core Courses

IE 516 Statistical Methods in Industrial Engineering

IE 518 Advanced Engineering Economic Analysis

ENMG 537 Analytical Methods for Engineering Managers (for those students with an undergraduate degree in Industrial Engineering, IE 522 Optimization Methods in Industrial Engineering is required instead of ENMG 537)

Seminar

IE 550 Graduate Seminar (2 credit hours)

Engineering Management Concentration Courses (required)

ENMG 533 Theory and Practice of Engineering Management

ENMG 534 Financial Management for Engineering Managers

ENMG 536 Project Management

IE Technical Electives

Select 6 hours for non-thesis option and 3 hours for thesis option in consultation with major professor.

IE 514 Advanced Information Systems

IE 515 Advanced Production and Inventory Systems

IE 517 Reliability Engineering

IE 519 Human Factors Engineering and Ergonomics

IE 522 Optimization Methods in Industrial Engineering

IE 526 Systems Modeling and Simulation

IE 527 Lean Production Systems

- * Students with an undergraduate industrial engineering degree may substitute 3 hours of graduate coursework in another engineering discipline, if approved by the major professor.

Engineering Management Electives

Select 3 credit hours for non-thesis option and thesis option in consultation with major professor.

ENMG 532 Productivity and Quality Engineering

ENMG 535 Management of Technology

ENMG 538 New Venture Formation

ENMG 539 Strategic Management in Technical Organizations

ENMG 541 Managing Change and Improvement in Technical Organizations

ENMG 542 Design of Experiments for Engineering Managers

ENMG 543 Legal and Ethical Aspects of Engineering Management

Thesis: ENMG 500 or IE 500

Same requirements as for the thesis for the industrial engineering area study.

Engineering Management Capstone Project: ENMG 501

The details of the IE Design (Capstone) Project are listed in the appendix of Section 5.1.

3.1.3 Reliability and Maintainability Engineering

The Industrial and Systems Engineering department participates in an inter-departmental MS degree program in reliability and maintainability engineering. The Reliability and Maintainability Engineering (RME) program is designed to support part-time students with all courses offered through distance education (see <http://www.engr.utk.edu/rme/>). The College of Engineering also offers a graduate certificate in reliability and maintainability engineering.

Applicants for admission to the RME program are expected to have a bachelor's degree from an accredited undergraduate program in engineering or physics. Students from other appropriate disciplines (e.g. chemistry, mathematics, etc.) can be admitted with additional engineering courses being possibly required. Entering students must have competency in mathematics through ordinary differential equations. The maintenance and reliability engineering Program Coordinator is the contact for students interested in this major.

A student may choose between a thesis option and a non-thesis project option. Similarly all coursework must be approved by the graduate student's major professor and committee. The committee will include the student's major professor in Industrial and Systems Engineering department, the reliability and maintainability engineering program coordinator (or his/her appointee), and another faculty member at the rank of assistant professor or above. After the completion of the coursework and research, the student must pass an oral examination conducted by the graduate committee. Degree requirements for the thesis and non-thesis options are summarized below.

	Thesis Option	Non-thesis Option
RME Core	12	12
Statistics Sequence	6	6
RME Electives	3	6
Statistics Electives	3	3
Thesis	6	0
RME Project	0	3
Total	30	30

RME Core Courses

IE 483	Introduction to Reliability Engineering
IE 484	Introduction to Maintainability Engineering
CBE/NE 585	Process System Reliability and Safety
IE 517	Reliability of Lean systems

Statistics Sequence

STAT 560	Introduction to Mathematical Statistics
STAT 567	Survival Analysis

RME Electives

IE 529	Applications of Linear Algebra in Engineering Systems
CBE/IE 562	Applications of Multivariate Statistics & Process Modeling & Data Analysis
ECE 504	Random Process Theory for Engineers
IE 516	Statistical Methods in Industrial Engineering
ME/BME/ES 534	Mechanical Vibrations
NE 575	Equipment and System Prognostics
NE 579	Advanced Monitoring and Diagnostic Techniques

Statistics Electives

STAT 474	Data Mining and Business Analytics
STAT 537	Statistics for Research I
STAT 538	Statistics for Research II
STAT 566	Statistical Techniques in Industrial Processes
STAT 575	Applied Time Series
STAT 579	Applied Multivariate Methods
ENGMG 542	Design of Experimenters for Engineering Managers

Thesis: IE 500

Same requirements as for the thesis for the industrial engineering area study.

Project: IE 501

The details of IE Design (Capstone) Project are listed in the appendix of Section 5.1.

3.2 Five-Year BS-MS Program

The department offers a 5-year BS-MS program with a major in industrial engineering for qualified students. These students may take up to 9 hours of approved graduate courses as part of their senior undergraduate courses and have them count toward both the bachelor's and master's degrees at the University of Tennessee. This program is designed only for students attending the University of Tennessee for their Master of Science degree, since other universities may not accept these courses for graduate credit after being used to satisfy Bachelor of Science degree requirements. Students may also take an additional 9 credit hours that will count only for the master's degree. Students interested in this program must satisfy the following **departmental requirements**.

- An overall GPA of at least 3.4 to be admitted to the program.
- Conditional admission may be granted after completing 60 hours of required undergraduate course work, while full admission is granted after completing 90 hours of required course work with a minimum overall GPA of 3.4 for this work.
- Admission of students into this program must be approved by the department and the Graduate School and the admission form is available at <http://ise.utk.edu/undergraduate/five-year-bsms-program/>.
- Students must have conditional or full admission before taking graduate courses for both their bachelor's and master's degrees.
- All courses taken for graduate credit must be approved by the departmental chair of the program. Students admitted to the program must request permission from the Graduate School to take approved courses for graduate credit. Students admitted to the program must also follow the normal procedure for admission to Graduate School.

3.3 Dual MBA-MS Program

The College of Business Administration and the College of Engineering offer an integrated program leading to the conferral of the Master of Business Administration degree with a major in business administration (concentration in operations management preferred) and the Master of Science with a major in computer science or one of the following engineering majors: aerospace, biomedical, civil, chemical, computer, electrical, engineering science, environmental, industrial, materials science, mechanical and nuclear engineering. The objective of the dual degree program is to prepare graduates to take a leading management role in companies that must react quickly to

a dynamic market where forces of competition require rapid changes via short cycles in design, manufacturing and product development.

All students enrolled in the program must complete coursework designed to provide them with an integrated, multidisciplinary experience. The MBA-MS curriculum consists of 36 hours of coursework in the College of Business Administration and 24 hours of coursework in the College of Engineering, for a total of 60 hours.

Fall – First Year	Credit hours
Session 1: <u>7½ Weeks</u>	
ACCT 505 - Financial Accounting I	1.5
MGT 506 – Competitive Strategy	1.5
STAT 505 – Quantitative Methods	1.5
MKTG 505 - Demand Management I	1.5
BA 515 - Business Skills Development I	1.5
Session 2: <u>7½ Weeks</u>	
ACCT 506 - Managerial Accounting I	1.5
FIN 505 – Financial Management I	1.5
MKTG 506 – Demand Management II	1.5
ECON 505 – Economics of Strategy	1.5
BA 516 - Business Skills Development II	1.5
Spring – First Year	
Session 1: <u>7½ Weeks</u>	
MGT 505 - Leading Complex Organizations	1.5
SCM 505 – Supply Chain Management I	1.5
MGSC 505 – Descriptive Modeling	1.5
OMS 505 – Operations Management	1.5
BUAD 517 – Business Skills Development III	1.5
Session 2: <u>7½ Weeks</u>	
SCM 506 – Supply Chain Management II	1.5
FINC 506 - Financial Management II	1.5
BULW 505 - Foundations of Bus. Law and Ethics	1.5
ECON 506 - Market Forces in the Global Environment	1.5
BUAD 518 - Innovation in Practice	1.5
*Industrial Engineering Major course	3.0
Summer – First Year	
Industrial Engineering Major Course / Statistics course	6.0
Fall – Second Year	
*IE 516 Statistic Method in Industrial Engineering	3.0
Industrial Engineering elective	3.0
MBA Electives (Entrepreneurship & Innovation preferred)	6.0

Spring – Second Year

*IE 518 Advanced Engineering Economic Analysis	3.0
*IE 522 Optimization Methods in Industrial Engineering	3.0
Industrial Engineering elective	<u>3.0</u>

Total hours required for dual program **60**

*Industrial Engineering Core Courses: IE 516, IE 518, and IE 522

3.4 Transfer Credits

Courses taken at another institution may be considered for transfer into a master's program as determined by the advisory committee and approved by the Dean of The Graduate School. Official transcripts must be sent directly to the Graduate School from all institutions previously attended before any credit will be considered. To be transferred into a master's program at the University of Tennessee, Knoxville, a course must be taken for graduate credit, carry a grade of 3.0 or better, be a part of a graduate program in which the student had at least a 3.0 average, not have been used for a previous degree, and be approved by the student's graduate committee and the Dean of the Graduate School on the Admission to Candidacy form. For more details see http://catalog.utk.edu/content.php?catoid=12&navoid=1061#Masters_Degree.

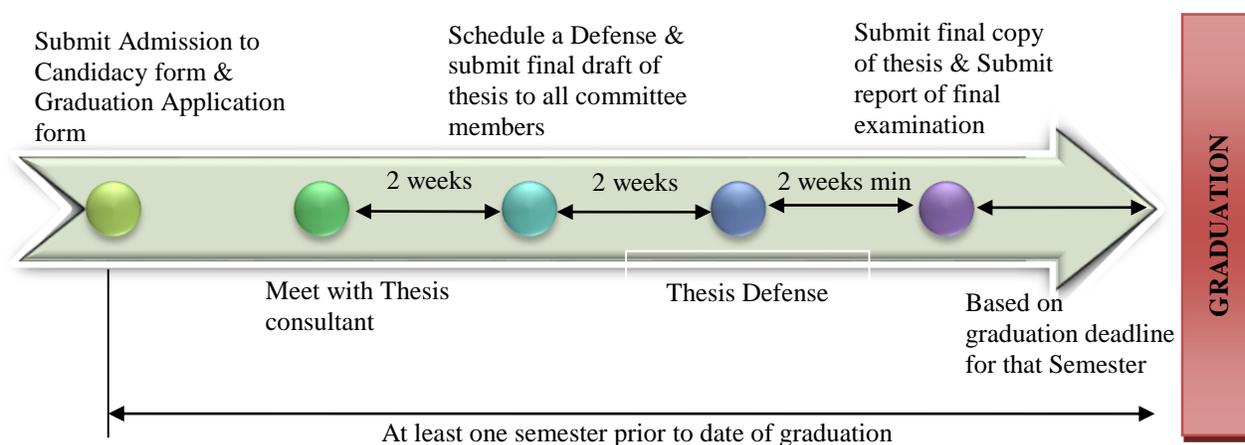
Courses transferred to any graduate program will not affect the minimum residence requirements for the program, nor will they be counted in determining the student's grade point average. Credits transferred from universities outside The University of Tennessee System cannot be used to meet the thesis requirements. Credit for extension courses taken from other institutions and credit for any course taken at an unaccredited institution are not transferable. A majority of the total hours required for a master's degree must be taken at the University of Tennessee, Knoxville. Transferred courses must have been completed within the six-year period prior to receipt of the degree. The courses must be listed on the Admission to Candidacy form and are placed on the student's university transcript only after admission to candidacy.

3.5 Master's Degree Advisory Committee

An Advisory Committee composed of the major professor (chairperson) and at least two other faculty members (at least one of the two must be from Industrial and Systems Engineering), all at the rank of assistant professor or above, should be formed early in a student's program. The committee assists the student with his or her thesis or project work and conducts the final examination. If the minor in statistics is part of the student's program, one member of the committee must be from the Statistics Program of the University. The major professor and the student are responsible for forming the committee. This is required for the completion of the Application for Admission to Candidacy form.

3.6 Admission to Candidacy

Admission to candidacy indicates that the student has demonstrated the necessary ability to do acceptable graduate work and that satisfactory progress has been made toward a degree. Admission to candidacy can be applied as soon as the student has completed any prerequisite courses and 9 hours of graduate coursework, excluding the transferred credits, with a GPA of 3.0 or higher in all graduate work. The form must include all coursework being used for the degree, including transfer coursework, must be signed by the student's committee, and must be submitted to the Office of the University Registrar no later than the last day of classes of the semester preceding the one in which he/she plans to graduate, as indicated in the flowchart below. The form required to document admission to candidacy is available at <http://gradschool.utk.edu/gradforms.shtml>.



3.7 Master's Degree Final Examination

A student presenting a thesis or project must pass a comprehensive oral examination. In the case of a project, this is supplemented by a written exam, which is determined by the student's graduate committee. The examination, which is concerned with coursework and the thesis or project work, is to determine the ability of the candidate to integrate material in the major and related fields. The final draft of the thesis or project document, approved by the major professor, must be distributed to all committee members at least two weeks prior to the date of the final examination.

Except with prior approval from The Graduate School, the examination must be given in university-approved facilities. It must be scheduled through the Industrial and Systems Engineering department at least two weeks prior to the exam and at least two weeks before the final date for acceptance and approval of their thesis by The Graduate School. The major professor must submit the results of the defense by the deadline. In case of failure, the candidate may not apply for reexamination until the following semester. The result of the second examination is

final. Students in the engineering management concentration, however, may schedule their exam through the Engineering Management Office in Tullahoma. This office will then contact the Office of Graduate Admissions and Records to complete the scheduling process.

Final Examination for Non-Thesis Students

Each non-thesis student must pass a final comprehensive written examination. The ISE Department also requires an additional oral examination. The examination is not merely a test over course work, but a measure of the student's ability to integrate material in the major and related fields. Except with prior approval from the Dean of the Graduate School, the examination must be given in university-approved facilities. It should be scheduled through the academic department at least two weeks prior to the examination. Students taking the final examination but not otherwise using university facilities may pay a fee equal to one hour of graduate credit instead of registering. The results of the comprehensive exam (Pass/Fail form with original signatures) must be submitted to the Graduate School by the deadline date indicated on the Graduate Student Deadline Dates. In case of failure, the candidate may not apply for reexamination until the following semester. The result of the second examination is final.

Final Examination for Thesis Students

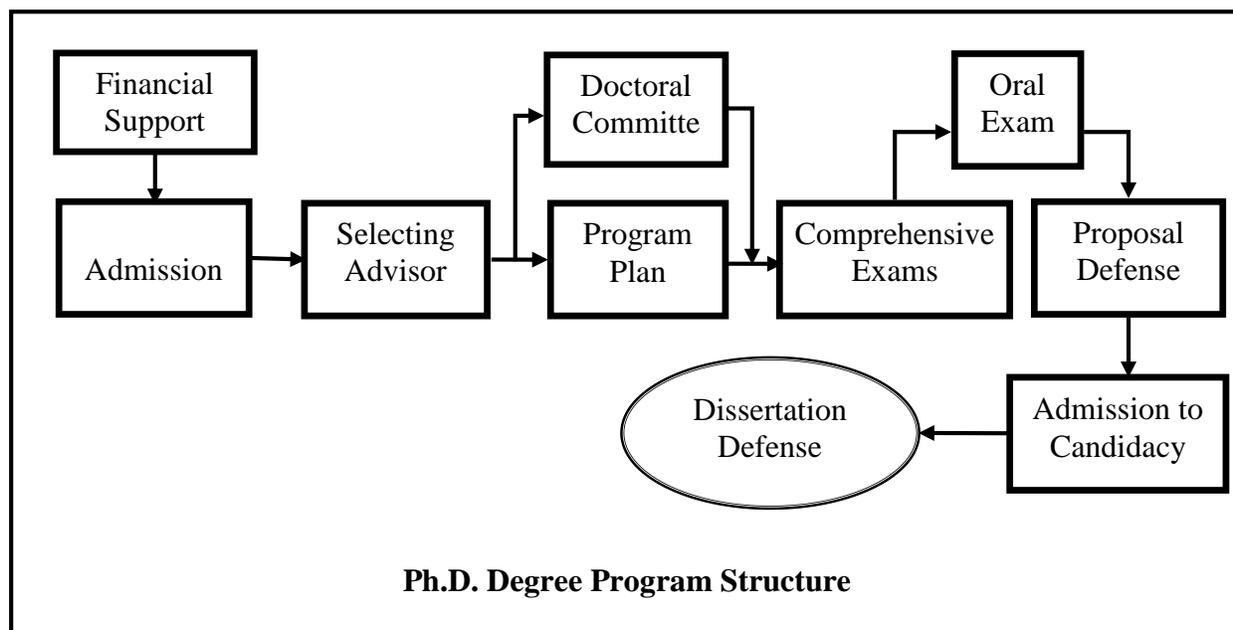
A candidate presenting a thesis or problems in lieu of thesis must pass a final comprehensive oral (or oral and written) examination on all work offered for the degree. The examination, which is concerned with course work and the thesis or problems, measures the candidate's ability to integrate material in the major and related fields, including the work presented in the thesis or problems. The final draft of the thesis must be distributed to all committee members at least two weeks prior to the date of the final examination. Except with prior approval from the Dean of the Graduate School, the examination must be given in university-approved facilities. This examination should be scheduled through the academic department at least two weeks prior to the examination. This examination must be held at least two weeks before the final date for acceptance and approval of thesis by the Graduate School on behalf of the Graduate Council. The major professor must submit the results of the defense by the thesis deadline. In case of failure, the candidate may not apply for reexamination until the following semester. The result of the second examination is final.

3.8 Time Limit for MS Degree

Candidates have six calendar years to complete the degree, starting at the beginning of the semester of the first course counted toward the degree. Students who change degree programs during this six-year period may be granted an extension after review and approval by the Dean of the Graduate School. In any event, courses used toward a master's degree must have been taken within six calendar years of graduation.

4. Ph.D. DEGREE

The following diagram summarizes the overall structure of the entire process to accomplish the Ph.D. degree. This process starts with the application step and ends with the dissertation defense step.



4.1 Doctoral Degree Program Requirements

4.1.1 Credit Hour Requirements

A minimum of 72 graduate credit hours (coursework plus research and dissertation) is required beyond the B.S. degree. For students who have already earned graduate credit hours for relevant coursework at UT or at other university, some of the credits may be transferable. Details on transferring credits are given in Section 5.2. The Degree Plan form provided in Section 5.2 is used to assist the student and the committee to document the course work and dissertation credit hour requirements of the Ph.D. degree. This form must be submitted to the department Graduate Program Director.

Entrance Requirement

ENMG 537 Analytical Methods for Engineering Managers (or equivalent) is required for students who do not have an MS degree in Industrial Engineering. It may be counted as part of the 72 graduate credit hours.

Industrial and Systems Engineering (a minimum of 24 graduate credit hours)

500-level or higher (at least 15 credit hours):

The following three courses, or their equivalent as appropriate, are required:

- IE 516 Statistical Methods in Industrial Engineering (3 credit hours)
- IE 522 Optimization Methods in Industrial Engineering (3 credit hours)
- IE 550 Graduate Seminar (3 credit hours)

Two additional IE 500-level courses (6 credit hours) with approval of major professor

600-level (at least 9 semester hours, as required by Graduate School):

- Select 3 IE 600-level courses (at most 3 credit hours from IE 691, 692, and 693) with approval of major professor.
- Taking more than 3 credit hours of IE 691, 692, and 693 requires the approval of the Graduate Committee.

Other (12 graduate credit hours)

- Mathematics courses 400 level or higher
- Statistics courses 500 level or higher
- Additional courses designated as Math/Statistics not used to meet other requirements (e.g., IE 529 and ENMG 542)

Dissertation

IE 600 Doctoral Research and Dissertation (a minimum of 24 credit hours)

4.1.2 Residency Requirement

Residence is defined as full-time registration (9-12 credit hours) for a given semester on the campus where the program is located. The summer term is included in this period. During residency, it is expected that the student will be engaged in full-time on-campus study towards a graduate degree. For the doctoral degree, a minimum of two consecutive semesters of residency is required. A statement as to how and during what period of time the residency requirement should be met is presented on the Admission to Candidacy form ([Admission to Candidacy Application form](#)).

4.2 Transfer Credits

At the doctoral level, courses are not officially transferred although they may be used to meet degree requirements. This has to be determined by the committee and approved by the Dean of the Graduate School. Where a requirement has been met through course work in another program, the student may petition the academic unit for a waiver of the requirement at the doctoral level. Official

transcripts must be sent directly to the Graduate School from all institutions previously attended before any credit will be considered.

Courses transferred to any graduate program will not affect the minimum residence requirements for the program nor will they be counted in determining the student's grade point average. Credits transferred from universities outside the University of Tennessee system cannot be used to meet the dissertation requirements or 600-level course work requirements. Credit for extension courses taken from other institutions is not transferable, nor is credit for any course taken at an unaccredited institution.

Course work taken prior to admission to a doctoral program may be used toward the degree, as determined by the student's doctoral committee. Although the courses are used as part of the requirements toward the degree and are listed on the admission to candidacy, they are not officially transfer courses and are not placed on the student's university transcript.

4.3 Ph.D. Advisory Committee

The major professor directs the students' dissertation and research and chairs the students' doctoral committee. The student and the major professor select a doctoral committee composed of at least four faculty members holding the rank of assistant professor or above, three of whom, including the chair, must be approved by the Graduate Council to direct doctoral research. At least three members must be affiliated with ISE, two of whom must be tenured or tenure-track faculty. At least one member must be from an academic unit from outside the student's major field. This committee must be approved by the Department Head and the Dean of Graduate Studies. Each committee must have a chair or two co-chairs, as deemed appropriate.

The committee should be formed during the student's first year of doctoral study, or by the time the student completes the first 18 credit hours. Subject to Graduate Council policies and individual program requirements, the committee must approve all coursework applied towards the degree, certify the student's mastery of the major field and any cognate fields, assist the student in conducting research, and recommend the dissertation for approval and acceptance by the Graduate School.

4.4 Comprehensive Examination

The comprehensive examination must be taken within five years, and all requirements must be completed within eight years, from the time of the student's first enrollment in a doctoral degree program. The comprehensive examination must be taken after finishing the 500 level course requirements.

The comprehensive exam content will be determined and administered by the student's doctoral committee. This examination must be passed prior to admission to candidacy with the requirement of both a written and an oral component.

The comprehensive exam consists of two parts. The first part is a written examination. The second part is an oral examination. The specific format of comprehensive exams will be determined by the student's doctoral committee and may vary from student to student.

The current department policy allows to successfully pass the comprehensive exams. A failure to clear the exam within 2 attempts will result in the student being terminated from the Ph.D. program. Termination process and communication with student includes process of appeal within the department and route of appeal following department's decision.

The completed Comprehensive Exam Checklist and Report of Comprehensive Exam forms provided in Section 5.2 must be submitted to department Graduate Program Director.

4.5 Proposal Defense

After successful completion of the comprehensive exam, the student prepares a dissertation proposal. This proposal should be submitted not later than one semester after the Comprehensive Examination has been passed. When approved by the major professor, the student will provide the written research proposal to each member of the doctoral committee, schedule a committee meeting, and make an oral presentation of the proposal. The admission to candidacy for the doctoral degree is approved after the proposal of dissertation research is successfully accomplished.

The proposal examination focuses on the relevance of the research problem, soundness of proposed methodology and specific contributions of the research. As such, the document outlining the proposed work should include at least the following items: (a) problem definition; (2) relevant literature survey; (3) proposed methodology (outlining both conceptual and specific approaches to solve the problem being considered); (4) research contributions; (5) significant references.

The completed Proposal Approval Record form provided in Section 5.2 must be submitted to the departmental Graduate Program Director.

4.6 Admission to Candidacy

Admission to candidacy reflects agreement among the student, the doctoral committee and the Graduate School that the student has demonstrated the ability to do acceptable graduate work and that satisfactory progress has been made toward a degree. A student is eligible for admission to candidacy after passing the comprehensive examination, successful defending the dissertation proposal, and maintaining at least a 3.0 grade point average in all graduate coursework. The student and the major professor are responsible for filing the [Admission to Candidacy Application form](#), which lists all courses to be used for the degree, including courses taken at UT Knoxville or at another institution prior to admission to the doctoral program. It is signed by the doctoral committee and by an authorized representative of the ISE department. Admission to candidacy

must be approved by the Graduate School at least one full semester prior to the date the degree is to be conferred.

All forms provided in Section 5.2 must be submitted to the Graduate Program Director prior to applying for admission to candidacy.

4.7 Doctoral Research and Dissertation

At least 24 credit hours of IE 600 (Doctoral Research and Dissertation) must be satisfactorily completed. Once registration for IE 600 begins, students are required to register continuously for at least 3 credit hours of IE 600 each semester, including summer terms (see the graduate catalog for additional information on continuous registration).

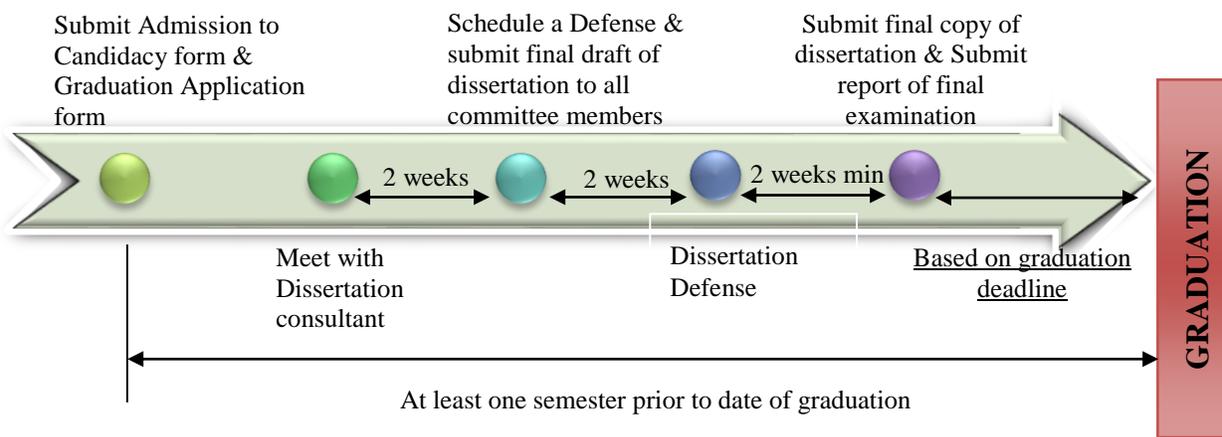
4.7.1 Dissertation

The dissertation represents the culmination of an original major research project completed by the student. The organization, method of presentation, and subject matter of the dissertation are important in conveying to others the results of such research. A student should be registered for the number of dissertation hours representing the fraction of effort devoted to research and dissertation.

4.7.2 Defense of Dissertation

A doctoral candidate must pass an oral examination on the dissertation. The dissertation, in the form approved by the major professor, must be distributed to the committee at least two weeks before the examination. The examination must be scheduled through the Office of the University registrar at least one week prior to the examination and must be conducted in university-approved facilities. The examination is announced publicly and is open to all faculty members. The defense of dissertation will be administered by all members of the doctoral committee after the completion of the dissertation and all course requirements. This examination must be passed at least two weeks before the date of submission and acceptance of the dissertation by Graduate Student services. The major professor must submit results of the defense by the dissertation deadline.

Two copies of the dissertation (prepared according to the current edition of instructions in the [UT Knoxville Guide to the Preparation of Thesis and Dissertations](#)) must be submitted to and accepted by The Graduate School. Each copy must include an approval sheet, signed by all members of the doctoral committee, which certifies to the Graduate School that they have examined the final copy and found that its form and content demonstrate scholarly excellence. Microfilm Agreement form, Survey of Earned Doctorates, and Abstract form are also submitted at this time. The student should check concerning additional required copies of the dissertation.



4.8 Time Limit for Ph.D. Degree

Comprehensive examinations must be taken within five years, and all requirements must be completed within eight years, from the time of a student's first enrollment in a doctoral degree program.

5. APPENDICES

5.1 Design or Capstone Project Requirements and Guidelines

The purpose of the design (capstone) project is to provide a culminating experience in the student's master's program that requires the integration and application of knowledge attained in the coursework. The analysis of a problem in industry or another application area is the normal type of project pursued. The required project work, in general, is modeled after the thesis but is reduced in scope and has a different focus; that is, the project is three graduate credit hours of work instead of six and does not have the same research emphasis as a thesis.

The selected project area must require the integration of a reasonable scope of IE/EM knowledge, including emphasis on the application of one or more methodologies. The project will be done individually by the student with the support of the major professor and other members of his or her master's committee. The project must be original work by the student. For example, the description of a previous or current project in industry or another application area in which the student was or is involved as part of the effort is not acceptable. Some important attributes of a well-selected project area, and the subsequent effort by the student, are as follows:

1. The scope and focus of the problem or application area are properly defined and consistent with three credit hours of semester work. The project integrates IE/EM knowledge with

emphasis on one or more methodologies, and addresses an area of interest in industrial engineering / engineering management.

2. The goals of the project are clearly defined and achievable.
3. Normally, a process including development, analysis, and comparison of alternative courses of action is required.
4. A relevant literature search, related to the project area and methodologies used is included, and the results of the search are accounted for in the project work.
5. A professional final project report, using the outline given in this appendix, is prepared.

The preparation (writing) of a professional final report is an important part of the student's project effort. The report is the primary academic product and also serves as the basis of the required oral presentation by the student to his or her master's committee (and to meet other communication needs related to the project). The final report logically discusses the problem or application area, related information and data, the analysis process and results, and the conclusions and recommendations. The basic contents of the project report are as follows:

1. Initial material
 - a. Title page
 - b. Table of contents
 - c. List of Tables
 - d. List of figures
 - e. Executive summary (not to exceed 1 ½ pages)
2. Body of the report
 - a. Introduction
 - b. Description of the problem or application area
 - c. Planned goals and objectives
 - d. Literature search (and interpretation of results)
 - e. Development (and description) of the alternative courses of action or methodology
 - f. The analysis process and results
 - g. Conclusions
 - h. Recommendations
3. Supporting (back) material
 - a. List of references from the literature search
 - b. Appendices
 - c. Student's resume

The student's oral presentation to his or her master's committee will be primarily based on Section 2 (body of the report). After the presentation, the committee will complete the oral part of the final examination on the project and other selected coursework subjects.

An academic type project may be used as an alternative to an industry or other application based problem. An academic project usually addresses a methodology question (which may be in the context of a hypothetical situation) or a set of technical topics, and requires a more in-depth literature search and emphasis on the technical considerations being addressed.

The contents of the final report for an academic project will be basically the same as discussed above with modifications to the body of the report as necessary. However, the major professor may approve in place of the report the preparation of a technical article ready for submission to a refereed journal for publication. The contents and format of the article will be determined by the requirements of the selected journal and accepted professional practice. The oral presentation by the student to the committee and the completion of the oral part of the final examination by the committee are the same as for the problem type project.

5.2 Departmental Documentation Forms

These forms are internal departmental documents that will be used to monitor the progress made by the students toward fulfilling degree requirements: Degree Program Plan, Comprehensive Exam Checklist, Record of Comprehensive Exam Results, and Record of Proposal Defense. **These forms must be completed before seeking departmental approval for degree candidacy.**

COMPREHENSIVE EXAM CHECKLIST

The student is responsible for completing this checklist before the comprehensive exam is scheduled. This checklist must accompany the Report of Comprehensive Exam form. The student should initial each appropriate blank indicating that the specified criterion has been satisfied, or where appropriate, been waived.

Student Name _____ Student ID: _____

Please check compliance with each requirement.

1. Registered for semester term during which the exam occurs. (If the entire exam is between semesters, then the student must have been registered for the preceding term). _____
2. Student has a degree plan approved by the committee. _____
3. GPR over all eligible courses since beginning graduate work at UT is greater than or equal to 3.000 (Includes 300 and 400 level courses taken while in a graduate program but does not include transfer courses.) _____
4. GPR over all courses on the degree plan (excluding transfer courses) is greater than or equal to 3.000 as indicated in the degree evaluation.) _____
5. All committee members have scheduled or waived the written portion and agreed to attend the oral portion of the exam or found a substitute. Only one substitute is allowed; there may not be a substitute for the chair. _____
6. At the end of the semester in which the exam is given, there are no more than 6 hours of course work remaining on degree plan. (Does not include IE 600s). _____
7. Comprehensive examinations must be taken within five years from the time of a student's first enrollment in a doctoral degree program. _____

Student Signature _____

Date _____

The University of Tennessee

Department of Industrial and Systems Engineering

REPORT OF COMPREHENSIVE EXAM

Student's Name: _____ Student ID: _____

The Written Portion of the Exam must be considered satisfactory by all committee members. The Oral Exam is taken only when all written components are satisfactory.

Are All Written Components Satisfactory? Yes _____ No _____

We have examined the student over the material covered by courses listed in the degree plan. After the examination the number of votes casted by the committee members are as follows:

Members Voting Yes _____

Members Voting No _____

Approval Recommended:

Chair: _____ Department _____

Member: _____ Department _____

Member: _____ Department _____

Member: _____ Department _____

Date of Oral Examination _____

The University of Tennessee
Department of Industrial and Systems Engineering

PROPOSAL APPROVAL RECORD

Student's Name: _____ Student ID: _____

Date of Examination: _____

Note: The proposal should be approved no later than one semester after the comprehensive examination has been passed.

The comprehensive (oral) exam was passed on _____

TENTATIVE TITLE OF PROPOSAL FOR Ph.D. DISSERTATION

RECCOMENDATIONS BASED ON EXAM

APPROVAL RECOMMENDED

Chair: _____ Department _____

Member: _____ Department _____

Member: _____ Department _____

Member: _____ Department _____

Date of Approval _____