



TEXAS TECH UNIVERSITY

**Edward E. Whitacre Jr.
College of Engineering™**

**Department of Industrial,
Manufacturing, & Systems Engineering™**

Graduate Handbook

**Master of Science in Industrial Engineering (MSIE)
Master of Science in Systems and Engineering Management (MSSYEM)
Master of Science in Manufacturing Engineering (MSMfgE)
Doctor of Philosophy in Industrial Engineering (PhD-IE)
Doctor of Philosophy in Systems & Engineering Management (PhD-SYEM)**

**A guide for general requirements specific to
the Department of Industrial, Manufacturing and Systems Engineering**

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Contents

PREFACE	4
1.0 APPLICATION AND ADMISSION	4
1.1 Full Admission to a Degree Program:	5
1.2 Conditional Admission to a Degree Program:	7
1.3 Temporary Non-degree Student:	7
2.0 FUNDAMENTAL KNOWLEDGE REQUIREMENTS	8
3.0 PROGRAMS AND SPECIALIZATIONS	9
3.1 Master of Science Programs:	9
3.1 Non-thesis Program (MS)	9
3.2 Thesis Program (MS)	10
3.3.1 Master of Science in Industrial Engineering (MSIE)	12
3.3.2 Master of Systems and Engineering Management (MSSYEM)	12
3.3.3 Master of Manufacturing Engineering (MfgE)	13
3.4 Areas of Specialization (and Other Courses)	13
3.5 Doctor of Philosophy:	14
3.5.1 Doctor of Philosophy in Industrial Engineering (PhDIE)	18
3.5.2 Doctor of Systems and Engineering Management (PhDSYEM)	19
4.0 CONTINUATION IN THE GRADUATE PROGRAM	19
5.0 ACADEMIC INTEGRITY	20
6.0 FINANCIAL SUPPORT	21
7.0 MINORS IN INDUSTRIAL ENGINEERING	22
8.0 FULL TIME STATUS IN THE GRADUATE PROGRAM	22
9.0 CURRICULAR PRACTICAL TRAINING	22
10.0 REGISTRATION IN ONLINE COURSES	24
MS Milestone Sequence	25
APPENDIX A	25
PhD Milestone Sequence	28
APPENDIX B	28
Master of Science of Industrial Engineering Course List	32

APPENDIX C	32
Master of Science Systems and Engineering Management Course List.....	33
APPENDIX D	33
Master of Science Manufacturing Engineering Course List.....	34
APPENDIX E	34
Doctor of Philosophy Industrial Engineering Course List.....	35
APPENDIX F.....	35
Doctor of Philosophy Systems and Engineering Management Course List	36
APPENDIX G.....	36
PhD Qualifying Exam Process.....	37
APPENDIX H.....	37

PREFACE

The Department of Industrial, Manufacturing and Systems Engineering (IMSE) at Texas Tech University (TTU) provides outstanding opportunities for students seeking the Master of Science in Industrial Engineering (MSIE), Master of Science in Systems & Engineering Management (MSSYEM), Master of Science in Manufacturing Engineering (MSMfgE), Doctor of Philosophy with an industrial engineering major (PhD-IE), or Doctor of Philosophy with a systems and engineering management major (PhD-SYEM). The Industrial, Manufacturing and Systems Engineering department dates back more than 75 years. Graduate studies in industrial engineering at Texas Tech have produced over 1,000 M.S. and over 200 Ph.D. graduates, who hold leadership positions in research, manufacturing, government, and consulting organizations.

The graduate faculty invites you to consider our program: faculty, instruction, research and facilities. The following material explains the general procedures, milestones, responsibilities and expectations regarding the M.S. and Ph.D. degrees.

AREAS OF SPECIALIZATION

The Department of Industrial, Manufacturing and Systems Engineering maintains five primary areas of specialization:

- I. Ergonomics and Human Factors Engineering,
- II. Manufacturing Systems,
- III. Operations Research,
- IV. Statistics and Quality Assurance,
- V. Systems and Engineering Management.

GRADUATE FACULTY

Graduate faculty with accompanying bios and research interests can be found on the IMSE website.

1.0 APPLICATION AND ADMISSION

Graduate application information and all necessary paperwork can be found from the Graduate School website at: <http://www.depts.ttu.edu/gradschool/>. Completed application forms should be submitted directly through Graduate Admissions. Applications should be completed online using the Graduate School's application system for both the master's and doctorate degrees for all students. The web site is located at: <https://texastechgrad.liaisoncas.com/>.

If an applicant is admitted, admission is granted in two steps: (1) by receiving the initial approval from Graduate Admissions that the application is ready for department review, pending receipt of all necessary application materials, and (2) by receiving the final approval from the Graduate Committee in the Department of Industrial, Manufacturing and Systems Engineering. Applicants for admission are notified of their admission decision by the Graduate Admissions Office using the online application system.

Two levels of admission exist: (1) full admission and (2) conditional admission. Full admission is necessary for ultimately becoming a degree candidate. Candidacy forms are held by the Graduate School until all conditions for full admission are met.

In addition to the two levels of admission, one level of graduate temporary non-degree student status (GTMP) is provided to allow people to enroll in graduate courses for one to two semesters prior to admission or to enable people to take graduate courses for credit without seeking a graduate degree. Therefore, GTMP students ultimately seeking a graduate degree must gain acceptance from the graduate degree program before the completion of 12 semester hours. Any exception to this rule is granted solely at the Graduate Dean's discretion. In addition, the Department of Industrial, Manufacturing and Systems Engineering only accepts 6 semester hours that were completed as a GTMP prior to the student's acceptance to an Industrial, Manufacturing and Systems Engineering graduate program (in-process courses at the time of acceptance do not count against this limit). Any exception to this rule is granted solely at the Industrial, Manufacturing and Systems Engineering Graduate Committee's discretion. Students who are seeking GTMP status should apply to the GTMP program (not an Industrial, Manufacturing and Systems Engineering graduate program) through the Graduate Admissions Office. The Graduate Admissions Office is the sole party that makes decisions on whether to accept or deny applicants to the GTMP program. Students who are accepted to the GTMP program and subsequently want to gain admission to an Industrial, Manufacturing and Systems Engineering graduate program must submit a change of program application to the Industrial, Manufacturing and Systems Engineering department for consideration. (GTMP students applying to change to an Industrial, Manufacturing and Systems Engineering graduate program must meet the same application requirements and standards as students who initially apply directly to the program).

In order to earn a graduate degree in industrial engineering or systems and engineering management from Texas Tech you must eventually gain full admission status. All applications for admission are processed by the

Graduate Admissions Office
P.O. Box 41030
Texas Tech University
Lubbock, TX 79409-1030
Telephone: (806) 742-2787

In general, graduate admission status remains in effect as long as a student is active in consecutive fall and spring semesters, with or without summer enrollment, and maintains academic performance that meets the current minimum requirements specified by the Graduate School and the Industrial, Manufacturing and Systems Engineering Department. Otherwise, the student must reapply each term he/she intends to be active in the graduate program and readmission is not guaranteed.

1.1 Full Admission to a Degree Program:

Persons who meet the admissions requirements of the Graduate School and the Department of Industrial, Manufacturing and Systems Engineering will receive full (unconditional) admission to the graduate program and are eligible to receive a graduate degree upon successful completion of an appropriate plan of study. Each and every application for graduate studies in the Department of Industrial, Manufacturing and Systems Engineering is carefully and holistically evaluated. Prior performance and potential performance for the degree sought are considered. As discussed further below, although it is not the only criterion considered, full admission status also requires that the applicant possess a certain minimum background in engineering, as evidenced by a recognized (accredited) bachelor's degree in an engineering discipline or having successfully completed a

leveling program specified by the Graduate Faculty of the Department of Industrial, Manufacturing and Systems Engineering. Only those completed applications received for fall or summer semester applicants by January 15 and for spring semester by June 15 are guaranteed consideration for admission and financial assistance. These deadlines will help to ensure that sufficient time will be available for necessary travel and visa arrangements (if necessary), and full consideration for financial aid. If time permits, the department will still review applications received after the deadlines. However, late applications are strongly discouraged as the department cannot guarantee that late applications will be processed in time for the desired admission term nor that these applications will be considered for financial assistance. If the department is unable to finish reviewing an application in time for the desired admission term, the decision will be an automatic rejection of the application.

To be considered for full admission status, a student's application must include:

- (1) an application form;
- (2) transcripts of all previous college work;
- (3) scores from the GRE (Graduate Record Exam);
- (4) one reference letter;
- (5) a non-refundable application fee;
- (6) a departmental questionnaire indicating the student's specific area of interest within industrial engineering

Further, the student must at minimum have completed the following courses in previous undergraduate or graduate coursework:

- (1) 3 hours of college level physics (with lab)
- (2) Calculus I, II, & III

Students without this background will not be admitted to graduate programs in the Department of Industrial, Manufacturing and Systems Engineering; instead, such applicants will be automatically rejected without further review. If a student who does not currently possess this background wishes to be considered for admission, the student must take any missing courses prior to applying and submit transcripts showing a grade of at least a 'C' in each course as part of their application.

In addition to these requirements, a statement of purpose is optional but is strongly encouraged, especially for PhD applicants. The student may also submit a CV/resume or a writing sample if desired.

Unless waived for all applicants for a certain term by the TTU graduate school (e.g., due to covid-19 considerations), the GRE is required for both the MS and PhD programs. Students must submit their GRE scores, but admission into the graduate program is not based on the GRE score criteria alone. As applicant evaluation is holistic, there is no cutoff applied for GRE scores, GPA or any other criterion. However, as a general guide, most successful past applicants for the MS programs have possessed at least a B average in their last 60 hours of undergraduate work. For work at the PhD level, a 3.5 grade point average in an MS program is typical. Academic performance as a non-degree student (GTMP) or Master of Engineering Student (Meng may be one factor considered in the admissions process. In addition, the PhD program applicant's credentials are examined to assess their potential for in-depth research work, and the fit of the student's credentials and research interests to faculty research interests and availability.

International students are subject to additional requirements as determined by the Graduate Admissions Office. In addition to financial and immigration requirements, international students are required to demonstrate English proficiency. Students should contact the Graduate Admissions Office or visit their website in order to understand the various methods for demonstrating English proficiency, including the minimum scores required on various English proficiency exams.

1.2 Conditional Admission to a Degree Program:

A student may be admitted conditionally to the Industrial Engineering, Systems and Engineering Management, or Manufacturing Engineering Graduate Program if: (1) their undergraduate degree lacks certain fundamental subject areas (see the 2.0 Fundamental Knowledge Requirements section below) and/or (2) if the student meets the requirements for admission except for proof of English proficiency. Students must contact their graduate advisors their first semester in the program to see whether conditions are attached to their degree programs. Students who are admitted conditionally due to a lack of background in subject areas, will be required to undertake additional study and/or testing to bring their background up to full admission standards. Additional work may take the form of "leveling" course requirements. Leveling work is described in Section 2 (Fundamental Knowledge Requirements).

1.3 Temporary Non-degree Student:

A student who has earned a bachelor's degree from a recognized U.S. institution and who was in good standing at the school last attended may be admitted as a "Graduate Temporary Non-degree Student" (GTMP) in non-degree studies. Students are allowed to take graduate courses for one or two semesters without being admitted to the Graduate Program in Industrial Engineering or Systems and Engineering Management. The Department of Industrial, Manufacturing and Systems Engineering may accept course work (up to 6 graduate credit hours) completed at Texas Tech under this classification prior to acceptance, which is consistent with a legitimate plan of study for either the MS or PhD, pending acceptance by the Graduate School and department.

1.4 Combined Bachelor's and Master's Programs (150hr Program)

The IMSE department offers two programs for outstanding students to complete both a Bachelor of Science (BS) degree and Master of Science (MS) degree in approximately five years (150 credit hours total). In one program, the student will earn both a BSIE and the Master of Science in Industrial Engineering (MSIE); Master of Science in Systems and Engineering Management (MSSYEM), or a Master of Science in Manufacturing Engineering (MSMfgE). This combined program allows dual counting of up to nine credits toward both the BS degree and the MS degree. BSIE students interested in either program should inform their academic advisor as soon as possible but no later than the beginning of the first semester of their junior year. Students should formally apply to the selected program during the semester before they are within 30 hours of completing their BSIE (for most students, this means the application should be submitted during the first or second semester of their junior year). Students must meet all university and departmental requirements for MS program admission before enrolling in graduate-level courses. Students will receive their BSIE degree upon completion of all BS requirements, which will typically occur prior to their completion of the MS requirements. Students interested in learning more about the programs and the application process should consult with their academic advisor, the IMSE departmental website and the IMSE graduate admissions coordinator.

Acceptance into the 150 hour program is based on the student's academic performance to date and the IMSE graduate admission committee's assessment of their suitability for graduate work. Achieving a certain GPA and/or GRE will not necessarily lead to acceptance into the program, as the assessment is holistic and competitive. However, the student must have a minimum GPA of 3.0 to apply, as well as a GRE score and a reference letter. The GRE requirement for this program may be waived if the student has a GPA of 3.5 or greater. Applications are submitted through the online application for graduate students (<https://ttugradschool.force.com/admissions/ApplicationLogin>)

Undergraduate students who have earned at least 90 hours toward graduation can be allowed to take up to 16 hours of graduate credit without formal admission to the 150 hour program. Although these courses do not count toward both the BS and the MS (as they do in the 150 hour program), they can count toward a MS if the student later applies and is admitted to the MS program. To take graduate courses as an undergraduate student (without acceptance to the 150 hour program), the student must have permission from the department, the undergraduate or graduate dean of the college and the graduate school. Students must also have at least a 3.0 cumulative GPA.

2.0 FUNDAMENTAL KNOWLEDGE REQUIREMENTS

Successful completion of the graduate program in the Department of Industrial, Manufacturing and Systems Engineering is based on the assumption that the applicant possesses the minimum background of either an accredited engineering undergraduate degree or the functional equivalent.

As discussed previously, graduate students in the Department of Industrial, Manufacturing and Systems Engineering are expected to possess a mathematical background up to and including Calculus III or the equivalent. This background includes differential calculus and integral calculus. In addition, all students are expected to possess a physical science background including at least 3 hours of college level physics (with lab). If an applicant's transcript indicates the applicant is missing all or part of this background, the applicant will not be admitted (will automatically be rejected without further review).

In addition to the Calculus and physics requirements, students are also expected to possess a basic, college-level knowledge in both probability and statistics. Applicant transcripts that do not reflect a course in probability and statistics at either the undergraduate or graduate level will have the admission condition of a leveling course in probability and statistics. Students are expected to complete this leveling early in their graduate programs. Specifically, leveling requirements should be completed in the first half of a graduate student's plan of study, in terms of graduate credit hours in industrial engineering. If sufficient progress in satisfying leveling requirements is not made, the graduate advisor may block enrollment in industrial engineering courses until the leveling requirements are completed. In general, a student may substitute a similar graduate course, if available, for the undergraduate leveling course with advance approval from the student's advisor and the course instructor. A grade of 'C' or better in each undergraduate leveling course or 'B' or better in each graduate leveling course, or their equivalents at another university, is expected. All leveling coursework must be taken for a grade and cannot be taken under the pass/fail option. If the course(s) are not taken at TTU, the burden of proof for content and completion rests on the student. The student must provide course outlines and other materials to satisfy the student's advisor of the equivalency of the proposed course(s). Students should consult with their graduate advisor to determine an appropriate leveling course. Appropriate grading leveling courses at TTU include (but are not necessarily limited to): STAT 5384, STAT 5385, or ISQS 5347.

3.0 PROGRAMS AND SPECIALIZATIONS

3.1 Master of Science Programs: Once admission has been gained, all Master of Science programs in the Industrial Engineering Department can be earned under one of two programs: (1) the 30-hour non-thesis program or (2) the 30-hour thesis program (see Appendices A,C,D,E for MS Milestone Sequences and MS Course Lists – Note, students that do not follow the milestone sequence or course list provided in this document can possibly delay their graduation at their own risk). All programs are offered both on-campus and through distance education (video/internet). In either case, the plan of study and application for candidacy (Program for the Master's Degree and Admission to Candidacy) must be signed by the student's advisor and filed before the submission deadlines published by the Graduate School (typically 6 months prior to graduation). If changes are to be made in the plan of study once it has been approved, the Form for Reporting Changes on Graduate Degree Programs is used and must also be signed by the student's advisor. In addition, an intent to graduate (Statement of Intention to Graduate) must be filed by the student early (usually within the first month) in the term of intended graduation. All necessary forms can be obtained from the Graduate School at: <http://www.depts.ttu.edu/gradschool/>.

Detailed Graduate School deadlines are also available from the Graduate School each term. It is the responsibility of each student to comply with the Graduate School deadlines and fees. Students are encouraged to contact the Graduate School early in their final term to verify that they are in compliance with all requirements.

3.1 Non-thesis Program (MS). The 30-hour program requires a minimum of 30 graduate credit hours, approved by the student's graduate advisor and the Graduate Dean, and successful completion of the MS final examination (see Appendix A). Students in the MS program must complete the core requirements for their degree (see below and Appendix C,D,E) and take at least 5 elective courses, of which at least 3 must be in IE:

The 30-hour program may include up to 6 semester hours of graduate level work transferred from another U.S. university. Transfer courses must be approved by the student's advisor and the Graduate Dean. Considerations include the course content, the strength of the other graduate program, and the grade earned (a grade of 'B' or better is required).

As indicated, typically, up to 6 credit hours can be taken in approved non-industrial engineering courses and serve as a minor. If a formal minor is pursued, the student must receive approval from the Minor Department.

The student's advisor is responsible for administering the 30-hour MS non-thesis degree option. Note – a maximum of two (2) independent study courses of IE 5332 or IE 5335 will be allowed on a student's MS non-thesis plan of study. As described in Section 9.0(CPT), only one IE 5335 earned through the department's internship course will be allowed on a student's plan of study, even if a student completes more than one IE 5335 credit through internship. Thus, a student earning one IE

5335 credit through internship may also take an IE 5332 independent study course with a professor and count both on their plan of study. However, even if a student completes two IE 5335 courses through internship, they cannot count both IE 5335 courses earned through internship toward their plan of study, but rather only one. The following additional policies also apply for all IE 5332 credit that is not earned through internship:

- A copy of the course syllabus, including a course title, course description, learning objectives, deliverables (assignments), grading criteria (e.g., points allocated to different assignments), textbook (if applicable) and a course schedule with tentative course deliverable dates, must be submitted to the graduate advisor before a permit for the course can be issued.
- A CR grade can be initially issued if the student does not complete the course within the enrollment semester. However, the student must complete the course within 12 calendar months of initial enrollment, else the course grade will be converted to an “F,” unless the instructor allows an extension.
- A student cannot enroll for additional IE 5332 while they still have a CR grade for a previous IE 5332.

As a requirement for graduation, students pursuing the MS non-thesis option must successfully pass a final comprehensive examination covering their graduate studies. The examination is intended to demonstrate to the faculty that the student has mastered the important concepts, techniques, and methodologies of industrial engineering and can apply them to real world engineering and management problems. The exact content and questions are determined by the examining faculty committee and may cover all such material that they consider relevant. Efforts are made to include faculty members who have instructed the student in class and/or are familiar with the student's work and area(s) of interest in industrial engineering. The student should request that the exam be scheduled in their last semester. Students must be enrolled during the term in which they take the final examination and complete all other graduation requirements.

If the examination is not passed on the first attempt, it may be repeated once. Under these circumstances, the student will be informed in writing of their deficiencies and of recommended steps to correct these deficiencies. It is the department's responsibility to notify the student and the Graduate School of test results.

3.2 Thesis Program (MS). The 30-hour thesis program requires a minimum of 24 graduate semester credit hours plus 6 hours of thesis research credit (IE 6000) approved by the student's MS committee. Students in a MS thesis program must complete all the core course requirements for their selected degree (see Sections 3.3.1-3.3.3). The 30-hour MS thesis program may include up to 6 semester hours of graduate level work transferred from another U.S. university. Considerations include the course content, the strength of the other graduate program, and the grade earned (a grade of ‘B’ or better is required). The student's plan of study must be approved by their committee, their graduate advisor, and the Graduate Dean. Note – a maximum of one independent study course of IE 5332 or

IE 5335 will be allowed on a student's MS thesis plan of study. The following additional policies also apply for all IE 5332 credit that is not earned through internship:

- A copy of the course syllabus, including a course title, course description, learning objectives, deliverables (assignments), grading criteria (e.g., points allocated to different assignments), textbook (if applicable) and a course schedule with tentative course deliverable dates, must be submitted to the graduate advisor before a permit for the course can be issued.
- A CR grade can be initially issued if the student does not complete the course within the enrollment semester. However, the student must complete the course within 12 calendar months of initial enrollment, else the course grade will be converted to an "F," unless the instructor allows an extension.
- A student cannot enroll for additional IE 5332 while they still have a CR grade for a previous IE 5332.

The master's thesis is expected to represent independent work by the student, conducted under the supervision of their thesis committee. It must be written clearly and concisely in English. The focus of the thesis may be an original contribution to the body of knowledge of an area relevant to industrial engineering or a significant application of existing knowledge to a real engineering or management problem. Students are encouraged to draw upon their work experience in defining a thesis topic.

As soon as the student's area for the thesis has been determined, the student is responsible for structuring their thesis committee. The thesis committee must consist of at least three members of the graduate faculty, at least two members (or a majority of the committee for larger committees) must be from the Department of Industrial, Manufacturing and Systems Engineering. A formal written plan of study and research proposal must be submitted to the committee, and an oral proposal successfully made, prior to enrollment in IE 6000. All members of the committee must approve the plan of study and proposed topic. The thesis committee is formally appointed by the Graduate Dean, upon the recommendation of the Department of Industrial, Manufacturing and Systems Engineering. Once enrolled in IE 6000, a student must maintain their enrollment each term until he/she defends their thesis and completes all other graduation requirements.

With the aid of their major professor (thesis advisor), the student must complete the research work and then schedule and successfully present and defend their thesis to their thesis committee. The final draft of the thesis document must be submitted to the thesis committee 2 weeks prior to the final defense to allow committee members adequate time to prepare for the defense. All theses must conform to the style and format set out by the Graduate School. It is the responsibility of the student to write the document and work with the Graduate School to meet all thesis style and format requirements and to deliver the proper number of copies to the Graduate School. The Graduate School issues a complete list of deadlines each term, relative to graduation requirements. In addition to the Graduate School requirements, the student is expected to furnish each committee member and the department with a bound copy of the thesis, if requested. The student's major professor (thesis advisor) is responsible for the administration of the MS thesis program, once a topic and major

professor are selected. At the time of the thesis defense, the student must be currently registered in at least 3 hours of IE 6000 under their major professor and must have taken at least 6 hours of IE 6000 under their major professor up to and including the semester in which the defense is scheduled. After the defense, the major professor will report the defense results to the Graduate School and also assign a letter grade to the last 3 hours of the IE 6000 credits taken, reflecting the student's grade on the thesis.

3.3.1 Master of Science in Industrial Engineering (MSIE). The Department of Industrial, Manufacturing and Systems Engineering at Texas Tech offers a master's degree in Industrial Engineering. This degree is offered both on-campus and through distance education (video/internet). This degree can be obtained with a thesis or non-thesis option, and, except for the difference in the core credits between degrees, all the degree requirements are the same across all MS degrees offered by the department.

Core credits for MSIE:

1. Operations Research – IE 5311. Optimization I or IE 5318. Operations Research Modeling with Spreadsheets
2. Systems and Engineering Management – IE 5320. Systems Theory or IE 5331 Systems Engineering Process
3. Manufacturing – IE 5351. Advanced Manufacturing Processes, IE 5352. Advanced Manufacturing systems, IE 5355. Computer Aided Manufacturing, or IE 5356. Biomedical Design and Manufacturing
4. Statistics – IE 5344. Statistical Data Analysis or IE 5342. Design of Experiments
5. Human Factors/Ergonomics – IE 5306. Advanced Systems Safety Engineering or IE 5301. Human Factors in Engineering and Design

In addition to the 15 hours of core credits, the degree requires 15 hours of elective credits.

3.3.2 Master of Systems and Engineering Management (MSSYEM). The Department of Industrial, Manufacturing and Systems Engineering at Texas Tech also offers a master's degree in Systems and Engineering Management. This degree is offered both on-campus and through distance education (video/internet). This degree can be obtained with a thesis or non-thesis option, and, except for the difference in the core credits between degrees, all the degree requirements are the same across all MS degrees offered by the department.

Core credits for MSSYEM:

1. IE 5320. Systems Theory
2. IE 5321. Decision Theory, IE 5322. Advanced Financial Systems for Engineers, IE 5324. Advanced Economics of Systems, or IE 5325. Productivity and Performance Improvement in Organizations
3. IE 5323. The Engineering Management Environment or IE 5329. Project Management
4. IE 5311. Optimization I or IE 5318. Operations Research Modeling with Spreadsheets
5. IE 5316. Simulation Models for Operations Analysis, IE 5319. Risk Modeling and Assessment, or IE 5346. Total Quality Systems

In addition to the 15 hours of core credits, the degree requires 15 hours of elective credits.

3.3.3 Master of Manufacturing Engineering (MfgE). The Department of Industrial, Manufacturing and Systems Engineering at Texas Tech also offers a master's degree in Manufacturing Engineering. This degree is offered both on-campus and through distance education (video/internet). This degree can be obtained with a thesis or non-thesis option, and, except for the difference in the core credits between degrees, all the degree requirements are the same across all MS degrees offered by the department.

Core credits for MfgE:

1. IE 5351 Advanced Manufacturing Processes
2. IE 5352 Advanced Manufacturing Engineering
3. IE 5353 Sustainable Manufacturing
4. IE 5356 Biomedical Design and Manufacturing
5. IE 5357 Manufacturing Facilities Planning and Design

In addition to the 15 hours of core credits, the degree requires 15 hours of elective credits.

3.4 Areas of Specialization (and Other Courses)

The Department of Industrial, Manufacturing and Systems Engineering maintains five primary areas of specialization, with a number of courses pertaining to each area:

I. Ergonomics and Human Factors (IE 530X)

- IE 5301. Advanced Industrial Ergonomics
- IE 5304. Biomechanics and Work Physiology
- IE 5305. Advanced Cognitive Engineering
- IE 5306. Advanced Systems Safety Engineering

II. Manufacturing Systems (IE 535X)

- IE 5351. Advanced Manufacturing Processes
- IE 5352. Advanced Manufacturing Engineering
- IE 5353. Sustainable Manufacturing
- IE 5355. Computer-Aided Manufacturing
- IE 5356. Biomedical Design and Manufacturing
- IE 5357. Manufacturing Facilities Planning and Design
- IE 5358. Nano-manufacturing

III. Operations Research (IE 531X)

- IE 5310 Stochastic Processes
- IE 5311. Optimization I
- IE 5312. Queueing Theory
- IE 5314. Optimization II
- IE 5315. Supply Chain System Management
- IE 5316. Simulation Models for Operations Analysis
- IE 5317. Statistical Analysis for Digital Simulation
- IE 5318. Operations Research Modeling with Spreadsheets
- IE 5319. Risk Modeling and Assessment

IV. Statistics and Quality Assurance (IE 534X)

- IE 5342. Design of Experiments
- IE 5344. Statistical Data Analysis
- IE 5345. Reliability Theory
- IE 5346. Total Quality Systems

V. Systems and Engineering Management (IE 532X)

- IE 5320. Systems Theory
- IE 5321. Decision Theory
- IE 5322. Advanced Financial Systems for Engineers
- IE 5323. The Engineering Management Environment
- IE 5324. Advanced Economics of Systems
- IE 5325. Productivity and Performance Improvement in Organizations
- IE 5329. Project Management
- IE 6320 Systems Dynamics
- IE 6323. Systems Management Global Environment
- IE 6325 Foundations of Engineering/Technology Management Knowledge
- IE 6329. Systems Management Seminar

In addition to the five primary areas of specialization, there are two additional (emerging or auxiliary) course areas:

VI. Quantum Computation

- IE 5371 Engineering Data Analytics
- IE 5372 Decision Making Under Uncertainty
- IE 5387 Quantum Algorithms

VII. Industrial Engineering Courses Independent of Area of Specialization

- IE 5331. Theoretical Studies in Industrial Engineering Topics
- IE 5332. Independent Study in Industrial Engineering Topics
- IE 5335 Practicum in Industrial Engineering
- IE 5000 Short Courses in Industrial Engineering
- IE 5100 Industrial Engineering Graduate Seminar
- IE 6000. Master's Thesis
- IE 6331. Theoretical Studies in Advanced Industrial Engineering Topics
- IE 6332. Independent Study in Advanced Industrial Engineering Topics
- IE 6399. Research Methods in Science and Technology
- IE 7000. Research
- IE 8000. Doctoral Dissertation

Catalog course descriptions are provided in the university course catalog.

3.5 Doctor of Philosophy: Once admission has been gained, the Doctor of Philosophy with a major in industrial engineering or systems and engineering management is earned by completing a minimum of 60 graduate level semester credit hours (beyond the B.S. level) – including 3-15 credit hours of IE 7000 – plus at least 12 credit hours of IE 8000 and the successful completion and defense of a dissertation (see Appendix B,F,G for PhD Milestone Sequence and PhD Course Lists – Note,

students who do not follow the milestone sequence or course list provided in this document can possibly delay their graduation at their own risk). At least 45 semester credit hours must be completed in industrial engineering or IE-equivalent courses at another university. The 60 credit hours must include at least 30 semester credit hours completed at Texas Tech University, with a maximum of 30 transfer credit hours allowed.

A minimum of 15 semester credit hours may be completed to serve as a minor (note: a minor is not required). If pursued, the minor area(s) should be chosen to support the PhD research work. If a formal minor is pursued, the student must receive approval from the Minor Department and a faculty member from the minor department must serve on the student's dissertation committee.

A total of up to 30 semester credit hours from a MS program or other previous graduate coursework (completed at TTU or other university) may be counted in either the major area or the minor area or a combination to the two areas. Transfer credit hours are evaluated by the student's advisor as to their applicability to the plan of study. Credits completed more than 7 years prior to entry in the PhD program must be justified, in writing, by the student as to their relevance towards the PhD plan of study. The acceptance of such credits is at the discretion of the student's advisor and the Graduate Dean.

The Graduate School requires a "residency" period of each PhD student. Residency normally constitutes full-time study, and to have completed 24 hours within a 12 month period, at Texas Tech. Specific details regarding current residency requirements are listed in the TTU Graduate Catalog. In some cases, a PhD student will be asked by their dissertation committee to satisfy tool requirements in order to complete the PhD program. Tool requirements consist of courses at either the graduate or undergraduate level and are not counted in either the major or minor course hours.

The PhD dissertation committee will consist of a minimum of four members of the Texas Tech University graduate faculty with Industrial, Manufacturing and Systems Engineering faculty always the majority. In addition, the committee must have at least one outside member who is either from another department at Texas Tech University or from another university (if from another university, the member may come from industrial engineering or a different discipline). It is acceptable to have two (or more) outside members as long as the majority of the members are current Industrial, Manufacturing and Systems Engineering graduate faculty. Outside university members require special approval from the Graduate School in order to serve on the student's committee. Dual degree programs will consist of four members with 2 Industrial, Manufacturing and Systems Engineering graduate faculty and 2 from the other participating university.

As previously indicated, once admission to the PhD program has been obtained, a number of specific requirements must be met (see Appendix B). The listing below provides a sequence of events that must take place in order to earn the Doctor of Philosophy with a major in industrial engineering or systems and engineering management:

1. **Admission to the Ph.D. Program.** This requirement is discussed in Section 1.
2. **Plan of Study and Committee.** A formal plan of study, detailing the major and minor courses and the dissertation committee, must be approved by the student's advisor and the Graduate Dean. As described above, a dissertation committee is typically made up of at least 3

Industrial, Manufacturing and Systems Engineering graduate faculty members and at least 1 graduate faculty member from outside Industrial, Manufacturing and Systems Engineering (for larger committees, a majority of faculty must always be from Industrial, Manufacturing and Systems Engineering). One of the Industrial, Manufacturing and Systems Engineering faculty members will serve (mandatory) as the committee chairperson or co-chairperson and the research advisor. The composition of the dissertation committee for PhD students (IE or SYEM) in dual degree programs, such as the Joint TTU-ITESM (Instituto Tecnológico de Estudios Superiores de Monterrey) program, will consist of a minimum of 4 faculty members – 2 members from TTU IMSE graduate faculty and 2 from ITESM, with 2 of the four professors (one from each institution) serving as co-chairs for the committee. Formulation of a plan of study is primarily the responsibility of the student and their major professor (dissertation advisor). The Doctoral Proposal and Report of Preliminary Examination form (see Graduate School for appropriate forms) is filed with the Graduate School by the student's major professor. Note – a maximum of 4 independent study courses of IE 5332, IE 5335 or IE 6332 will be allowed on a student's Ph.D. plan of study. The following additional policies also apply for all IE 5332 or IE 6332 credit that is not earned through internship:

- a. A copy of the course syllabus, including a course title, course description, learning objectives, deliverables (assignments), grading criteria (e.g., points allocated to different assignments), textbook (if applicable) and a course schedule with tentative course deliverable dates, must be submitted to the graduate advisor before a permit for the course can be issued.
- b. A CR grade can be initially issued if the student does not complete the course within the enrollment semester. However, the student must complete the course within 12 calendar months of initial enrollment, else the course grade will be converted to an "F," unless the instructor allows an extension.
- c. A student cannot enroll for additional IE 5332 while they still have a CR grade for a previous IE 5332.

3. **Qualifying Examination.** Successful completion of a qualifying examination must be accomplished before a PhD student can be admitted to candidacy. The examination is structured by the student's committee and occurs before, during, or in the next long semester after the semester in which the student completes 21 hours at TTU. The format is both verbal and written. Please see Appendix H for more details on the qualifying exam process. A report of the outcome is written by the major professor and submitted to the Graduate School using the Qualifying Exam Report Form. Once a student successfully completes both their Ph.D. qualifying exam and their proposal defense (see step 4), the student must register for IE 8000. IE 8000 registration must be maintained until all graduation requirements are completed. A full-time PhD student must take a minimum of 3 credit hours of IE 8000 per semester (including a minimum of 3 credits hours each summer) once they pass both their qualifying exam and proposal defense until completion of their doctoral program. A full-time student is allowed to take only one, 1 credit IE 8000 semester during the last semester in their doctoral program, if they have successfully defended and only need to turn in final document. Any exception to this policy must be approved by the department chair and the graduate committee. A part-time PhD student must take a minimum of 1 credit hour of IE 8000 per semester (including a minimum of 1 credit hour each summer) once they pass both their qualifying exam and proposal defense until completion of their doctoral program.

4. **Research Proposal.** Each PhD student is responsible for developing a research proposal in writing. This development should be done under the direction of the major professor and committee. Proposals may vary in length, but are expected to outline the research objective, relevant research questions, and a review of the literature, a proposed research procedure, and a summary of the contributions expected from the research. Research proposals must ultimately be presented to the student's dissertation committee and approved by that committee. The research proposal document must be submitted to the dissertation committee at least 2 weeks prior to the defense of the proposal to allow committee members adequate time to prepare for the defense. A PhD student working on their dissertation (or closely related research) with their major professor (i.e., dissertation advisor) should enroll in IE 7000 credit until they have passed both their qualifying exam and proposal defense; after that point, they must enroll in IE 8000 each semester until they complete their final dissertation defense and all other graduation requirements, as discussed above (see point 3). A student working on research unrelated to their dissertation topic with their major professor or another professor must take IE 5332 or IE 6332 rather than IE 7000; IE 5332 or IE 6332 can be taken at any point before or after the proposal defense. As with IE 8000, a grade will only be assigned to the last three hours of IE 7000, which is expected to correspond with the student's proposal defense. Any other IE 7000 taken will receive only a CR as the proposal defense is not yet complete. A student cannot switch from IE 7000 credit to IE 8000 credit during the semester.
5. **Dissertation and Defense.** Once the proposed research is completed, it must be formally reported in the form of a PhD dissertation. The dissertation must be defended by the PhD candidate in an open forum. All PhD students must have at least one refereed journal paper accepted for publication and one refereed journal paper submitted prior to their final defense. Please note: review papers are not counted. These papers do not have to be directly related to the student's dissertation, although it is expected that most papers will be related to the dissertation. However, they must represent work done at Texas Tech University in collaboration with the student's dissertation advisor, the student must be first author, and the advisor must be a co-author (additional co-authors are allowed). Further, the journal the paper is published in must be indexed in Web of Science or Scopus, and one paper must be accepted "As Is" (i.e., formally accepted with full consideration for publication, not accepted with changes) or already published at the time of the defense. At the start of the defense meeting, the candidate must provide evidence of paper acceptance to the committee (e.g., letter from journal editor, or doi information if the paper is already published) or the defense will be cancelled. The final draft of the dissertation document must be submitted to the committee at least 2 weeks prior to the final defense to allow committee members adequate time to prepare for the defense. In addition, at least 2 weeks prior to the final defense, the student must send a copy of their dissertation abstract, as well as a notice of the date, time, and location of their defense, to the department's Lead Academic Advisor for public distribution to departmental faculty and students as an invitation to attend the defense. All PhD defenses are public (excepting the portions devoted to dissertation committee discussions) and a typical defense will include the student, their dissertation committee and a representative of the Graduate Dean (required), as well as any other people wishing to hear or challenge the results. A positive vote by the dissertation committee as to the technical merit of the research constitutes a successful defense. This vote is reported to the Graduate School by both the Graduate Dean's representative and the major professor (dissertation advisor).

All dissertations must conform to the style and format set out by the Graduate School. It is the responsibility of the student to recruit a Graduate Dean's representative to serve at their defense, to write their dissertation document in English, to work with the Graduate School to meet all dissertation style and format requirements, and to deliver the proper number of copies and abstracts to the Graduate School (see Appendix B for details). In addition to the Graduate School requirements for the dissertation, the student is expected to furnish the department and each committee member with a bound copy of the dissertation, if requested. At the time of the dissertation defense, the student must be currently registered in at least 3 hours of IE 8000 under their major professor (dissertation advisor) and must have taken at least 12 hours of IE 8000 under their major professor (dissertation advisor) up to and including the semester in which the defense is scheduled. After the defense, the major professor (dissertation advisor) will also assign a letter grade to the last 3 hours of the IE 8000 credits taken, reflecting the student's grade on the dissertation.

The student's major professor (dissertation advisor) is responsible for the administration of the PhD program, once a topic and major professor are selected. A summarized sequence of major steps required for the PhD degree is shown in Appendix B. The Graduate School issues a complete list of deadlines each term, relative to graduate requirements.

Dissertation Format – the Department of Industrial, Manufacturing and Systems Engineering at Texas Tech University allows for multiple formats to be used in the composition of a student's doctoral dissertation. The PhD candidate must have prior approval from the dissertation committee chairperson (major professor) and the dissertation committee for the format to be used in the dissertation document. One of the formats that is acceptable to the department is the traditional dissertation composed of the following sections: introduction, literature review, research methodology, results and analysis, and research conclusion (with all appropriate bibliographic references and appendices required). Texas Tech University is a research university and expects all PhD students to provide their dissertation committee with at least two accepted journal papers prior to their final defense, as mentioned above. The Industrial, Manufacturing and Systems Engineering Department also allows, and students are strongly encouraged to consider, the use of a modified format that includes all the material presented in the traditional format sections, but constructed in a structure that incorporates three refereed journal publications within the text of the dissertation. The three refereed papers must be of scientific quality and must be at least submitted to approved journals by the time of final defense. (Note, if the student's required accepted papers are not directly related to the dissertation, they do not have to be included in the dissertation document, although the student must still provide evidence of paper acceptance to the dissertation committee as described above; if an accepted paper is related to the dissertation, it can likely constitute one of the three papers). At its discretion, the committee can waive the requirement that the papers actually be submitted for one or more papers, provided the student's advisor can verify that the student has provided the advisor with a "submission ready" version of the paper(s). The chairperson of the candidate's dissertation committee (major professor), in conjunction with the dissertation committee, determine which journals will constitute acceptable venues for submission for publication.

3.5.1 Doctor of Philosophy in Industrial Engineering (PhDIE). The Department of Industrial, Manufacturing and Systems Engineering at Texas Tech offers a doctoral degree in Industrial Engineering. This degree is offered on-campus only. Except for the difference in the core credits

between degrees, all the degree requirements are the same across all PhD degrees offered by the department.

Core credits for PhDIE:

Doctoral students with a major in industrial engineering must take at least 1 course in at least 4 of the 5 areas in the Department of Industrial, Manufacturing and Systems Engineering (see Section 3.4 above); transfer courses may be used with approval of the student's advisor. The student must also complete a minimum of 3 hours of IE 7000.

In addition to the 15 hours of core credits, the degree requires a minimum of 45 hours of elective credits and 12 hours of IE 8000.

3.5.2 Doctor of Systems and Engineering Management (PhDSYEM). The Department of Industrial, Manufacturing and Systems Engineering at Texas Tech offers a doctoral degree in Systems and Engineering Management. This degree is offered both on-campus and through distance education (video/internet). This degree is offered on-campus only. Except for the difference in the core credits between degrees, all the degree requirements are the same across all PhD degrees offered by the department.

Core credits for PhDSYEM:

1. IE 5320. Systems Theory
2. IE 5321. Decision Theory, IE 5322. Advanced Financial Systems for Engineers, IE 5324. Advanced Economics of Systems, or IE 5325. Productivity and Performance Improvement in Organizations
3. IE 5323. The Engineering Management Environment or IE 5329. Project Management
4. IE 5311. Optimization I or IE 5318. Operations Research Modeling with Spreadsheets
5. IE 5316. Simulation Models for Operations Analysis, IE 5319. Risk Modeling and Assessment, or IE 5346. Total Quality Systems
6. IE 6323. Systems Management Global Environment
7. IE 6325. Foundations of Engineering/Technology Management Knowledge
8. IE 6329. Systems Management Seminar
9. IE 6399. Research Methods in Science and Technology
10. IE 7000. Research (at least 3 hours)

In addition to the 30 hours of core credits, the degree requires a minimum of 30 hours of elective credits and 12 hours of IE 8000.

4.0 CONTINUATION IN THE GRADUATE PROGRAM

The Graduate School requires that a student earn at least a 3.0 grade point average (GPA) over the courses listed in their plan of study (filed with the Graduate School) to be eligible for graduation. Additionally, the GPA for each semester for all graduate courses taken must be at least 3.0 (regardless of the plan of study) for the student to remain "in good standing." An earned semester GPA of less than 3.0 will cause the student to be placed on academic probation. The condition for removal from probation is usually stated as a GPA of 3.0 or greater in the subsequent semester's work. Failure to merit removal from probation may result in suspension (dismissal) from the Graduate School. In addition to the general requirements of the Graduate School, the Department of Industrial, Manufacturing and Systems Engineering requires that its graduate students receive no

more than two (2) grades of 'C' or less in industrial engineering course work. Students who fail to meet this criterion will be dropped from the Graduate Program in Industrial, Manufacturing and Systems Engineering. In addition, all doctoral students will be reviewed by the department on an annual basis to determine whether satisfactory progress in the program is being made. The department may recommend dismissal for those students not making satisfactory progress. Students who are suspended or dropped may petition the Graduate School and department for re-admission.

Other Requirements:

An essential part of the graduate experience is to raise the awareness to professional standards of research ethics, integrity, and safety, and of challenges that student may face throughout their careers. Texas Tech University strives to maintain a standard of ethics and integrity in all its graduate students that reflects the motto “Strive for Honor”. All new graduate students must complete the Responsible Academic Conduct Training within their first year of attendance, and any returning Students must complete this training by November 16.

The application to graduate is mandatory for all students intending to graduate. Students can apply up to one year in advance. The application to graduate initiates the audit process at the graduate school, and the deadline is strict. Failure to apply by the given semester's deadline will result in extending your graduation to a different term. Students may apply to graduate here at <https://enrollment.grad.ttu.edu/graduate/>.

Students defending a thesis (either Doctoral or Masters) must complete the Defense Notification Form at least three weeks prior to defending. This document should be submitted by their advisor to the graduate school. Details on the process can be found here <https://www.depts.ttu.edu/gradschool/academic/DefendFormatSubmit.php>

5.0 ACADEMIC INTEGRITY

It is the policy of Texas Tech University and the Department of Industrial, Manufacturing and Systems Engineering to support and expect a high standard of honesty and academic integrity on the part of its students. The attempt of students to present as their own any work which they have not honestly performed is regarded by the faculty and administration as a most serious offense and renders the offenders liable to serious consequences, possibly suspension. This includes, but is not limited to:

1. Cheating or dishonesty on examinations, quizzes, written assignments, term projects, lab work or other activity. This includes obtaining information during an exam or assignment from an unauthorized source or another student, assisting others in cheating, alteration of grades or records, and unauthorized possession of examinations or other materials.
2. Plagiarism, offering the work of another as one's own without acknowledgment. Any quotation or expression of material taken from any source (e.g. books, journals, the internet, magazines, reports or writings of others) must be explicitly credited as such. Reference guides which have details on style and proper referencing procedures for writing assignments are available at the library and through various websites. All students are responsible for ensuring that written assignments adhere to these guidelines.

Any breach of academic integrity is subject to immediate disciplinary action, at the discretion of the professor and the Office of Student Conduct, which may range from a failing grade on the assignment or exam to a failing grade in the course. At the recommendation of the Office of Student Conduct, a student found guilty of academic dishonesty or plagiarism may be dismissed from the Graduate Program in Industrial, Manufacturing and Systems Engineering. The University's disciplinary policy and procedure is outlined in the Office of Student Conduct website: <http://www.depts.ttu.edu/studentconduct/>.

6.0 FINANCIAL SUPPORT

Financial support awarded on a competitive basis is available within the Department of Industrial, Manufacturing and Systems Engineering. Support consists of three primary forms: (1) scholarships, (2) research assistantships, and (3) teaching assistantships. All scholarships and assistantship appointments require that the recipient be a full-time student and be enrolled in a minimum number of credit hours during their appointment. The number of hours required is determined at the beginning of each term.

Scholarships. A limited number of scholarships are granted each year on a competitive basis. Scholarships applications are available through the Graduate School website at <https://www.depts.ttu.edu/gradschool/financial/FellowshipsScholarships.php>. The deadline for receiving applications each year is January 15. Scholarships are typically granted for the Fall term, cover a 12-month time period, and allow the recipient to pay tuition and fees at "resident" rates, which are roughly 50% of "out of state" rates. Scholarship awards may vary depending on the availability of funds. All scholarships are awarded for a maximum of one year. A student must reapply each year for future consideration.

The department also has a limited number of scholarships available that are granted each year on a competitive basis. New students who apply by the January 15 will automatically be considered for available scholarships on a competitive basis (no separate application is needed). Returning students should watch for notification of the scholarship deadline and application requirements (this notification is typically sent via TTU email by one of the department staff. Students who previously received a scholarship from the department are automatically considered for renewal for the next Fall semester. For the scholarship to be renewed, a student must have a 3.4 or higher in the previous year (two long terms) and have met any other requirements stipulate in the offer letter. A MS student is typically only eligible for one scholarship renewal during their MS degree.

Research Assistantships. Research assistantships are granted by individual faculty members, and are related to one of their research projects. Typically, research assistantships are granted on a 0.5 time basis, requiring approximately 20 hours of work per week. Research assistantship appointments are usually made on a term-by-term basis and allow the recipient to pay tuition and fees at "resident" rates for the term appointed, in addition to the assistantship payments.

Teaching Assistantships. Teaching assistantships are granted by the department chairperson, relative to departmental needs and budgets. Typically, teaching assistantships are granted on a 0.5 time basis, requiring the assistant to develop, deliver and/or grade instructional materials. Approximately 20 hours of work per week are expected. Teaching assistantship appointments are usually made on a

term-by-term basis and allow the recipient to pay tuition and fees at "resident" rates for the term appointed, in addition to the assistantship payments.

Other graduate scholarship and assistantship opportunities may exist outside the Industrial, Manufacturing and Systems Engineering department (e.g., at a College level or within another department on campus) but the student should contact the potential offering entities directly as the Industrial, Manufacturing and Systems Engineering department neither administers these awards nor maintains a list of such opportunities.

7.0 MINORS IN INDUSTRIAL ENGINEERING

Students who are not majoring in industrial engineering or systems and engineering management are allowed a minor in industrial engineering at both the MS and PhD levels.

7.1 Master of Science Minor: In order to earn an industrial engineering minor at the MS level, a thesis program student must successfully complete a minimum of 6 semester credit hours in approved industrial engineering courses. In addition, a member of the graduate faculty from the Department of Industrial, Manufacturing and Systems Engineering must be appointed to the student's thesis committee. Students in a non-thesis, 30-hour program, are required to complete 9 semester credit hours in approved industrial engineering courses for a minor.

7.2 Doctor of Philosophy Minor: In order to earn an industrial engineering minor at the PhD level, a student must successfully complete a minimum of 15 semester credit hours in approved industrial engineering courses. In addition, a member of the graduate faculty from the Department of Industrial, Manufacturing and Systems Engineering must be appointed to the student's dissertation committee.

Students who are interested in a minor should contact the Graduate Student Affairs Committee Chair for information on minor approval and advising.

8.0 FULL TIME STATUS IN THE GRADUATE PROGRAM

Enrollment in 9 or more hours in a long semester and 3 hours in a summer session is considered "full time" enrollment. However, in their last semester only, a student may be considered "full time" when taking fewer hours, to complete degree requirements. A student is allowed only one "last semester" with full time status for less than "full time" enrollment.

9.0 CURRICULAR PRACTICAL TRAINING

A student on an F-1 visa who wishes to complete an internship in industrial engineering while completing their graduate program is eligible to do so through Curricular Practical Training (CPT) if they meet certain requirements.

1. The student must have completed at least 2 long semesters at TTU, of at least 9 hours each as required by the graduate school, as part of their current graduate degree program. The student must also meet any other residency requirements determined by the Office of International Affairs (OIA).
2. The internship must be related to Industrial Engineering as determined through examination of the job description in the position offer letter and, if necessary, additional contact by the IMSE Department Chair with the offering company.

3. The duration of the CPT must be less than 12 months, regardless of whether the CPT work is completed full time or part time. No extensions to CPT will be permitted beyond 12 months.
4. The graduate student will present the position offer letter to the IMSE Lead Academic Advisor for the Graduate Program at least two weeks before a response to the company is due. In-order to determine whether the position relates to Industrial Engineering, the IMSE Department Chair may ask for additional information about the position from the student and/or the company. If CPT is approved, the student will be issued a CPT approval letter indicating the description of the work (e.g., position name), employer name and address, beginning date, ending date, and semester of registration in the department's internship course (IE 5335). Specific goals and deliverables of the CPT will be specified as part of the internship course. At the end of the CPT, the student will turn in to the internship course instructor a project report completed as part of the internship course, which must discuss the academic theories and models related to the student's internship experience, with appropriate citations, in addition to describing the applied outputs completed during the internship. The student must also give a presentation to the course instructor summarizing the information in the report. In-order to be eligible to take the department's internship course, a student cannot be a permanent employee of the company in which the internship is conducted during the semester of registration.
5. Course Registration – Students must generally be registered for credit in the department's internship course (IE 5335) for each semester in which CPT is taken (except in the circumstances described in point 6 below). Graduate students should contact the IMSE Graduate Academic Coordinator to register for the appropriate internship course. A student may only count a maximum of 3 credit hours of the internship course on their plan of study; internship/practicum beyond 3 hours may not be used as elective credits or credit toward degree. Students enrolled in CPT full time do not have to take other courses during their CPT semester(s), but may elect to. Students enrolled in CPT part time must take at least 6 hours of other course credit during their CPT semester(s). A full-time student can take a maximum of one additional online (distance) course during each semester of CPT.
6. If a student will have CPT beginning in the Summer semester that will continue through the end of the Fall semester, the student can elect to enroll in the internship course (IE 5335) for the Fall semester only. Likewise, if the student will have CPT beginning in the Spring that will continue through the end of the Summer term, then enrollment in the internship course would be required only in the Spring semester. **This total CPT duration must be stipulated in the original offer letter described in point 4 above.** This **will not apply** if a student has enrolled in CPT for the Summer and then receives a subsequent extension into the Fall semester; in this scenario, the student would be required to enroll in the internship course for both the Summer and the Fall semesters as students are required to enroll in CPT credit during each long semester (Fall or Spring) in which CPT is taken. Similarly, if a student has CPT that extends through two long semesters (Fall and Spring, or vice versa), the student will be required to enroll in the internship course during both long semesters (Fall and Spring), but would not be required to enroll in the internship course during any Summer terms covered by the original offer letter.
7. In general, students should aim to complete their CPT and the associated internship course (IE 5335) prior to their final semester. However, the OIA allows exceptions to this policy under certain circumstances, as described below:
 - *In order to abide by the regulatory language of CPT not impeding the “normal progress” of degree completion, the advisor will indicate if the course permitting CPT is a requirement to complete the degree. If it is an optional course the student is choosing to take before completing the degree, neither CPT nor an extension of an I-20 will be granted for CPT purposes only.*

- *If the course permitting CPT is not required for completion of the academic program, students will be advised to apply for OPT rather than CPT.*
- *An exception can be made to extensions and CPT during the final semester for students with extenuating circumstances described by the academic department. However, the student will be required to sign an exception form and agree to the requirements and risks detailed on the exception form. The exception to extensions and CPT during the final semester will still require the student to meet the “normal progress” standards outlined in this document.*
- *When an exception to the final semester rule is granted, CPT will only be issued until the date the student is eligible to apply for OPT. Once the student has applied for OPT, the CPT will be extended for the remainder of the semester. The OPT application will guarantee that the student does not request an additional semester of CPT beyond the “final” semester.*

If a student believes they are experiencing extenuating circumstances that justify completing CPT in their final semester, they should contact the IMSE Graduate Academic Coordinator and the IMSE Department Chair to discuss these circumstances as soon as possible and no later than two weeks before a response to the company is due. Ultimately, the decision on whether to approve the CPT, given the extenuating circumstances and the position characteristics (see point 2-4 above), is up to the IMSE Department Chair. If approved, the OIA will require the student to sign the exception form as described in bullet three above.

10.0 REGISTRATION IN ONLINE COURSES

In general, on campus students are not allowed to take online (distance) courses, but instead must take the on campus versions. If a student has a conflict that prevents them from taking the on campus version (e.g., conflict with another class or geographic conflict), the student may appeal to the course instructor for an exception. The student should contact their advisor to file the appeal and the advisor will then contact the course instructor. Work schedules will generally not be considered sufficient justification unless work schedules are inflexible (e.g., TA for a class that conflicts with the class time or full time CPT).

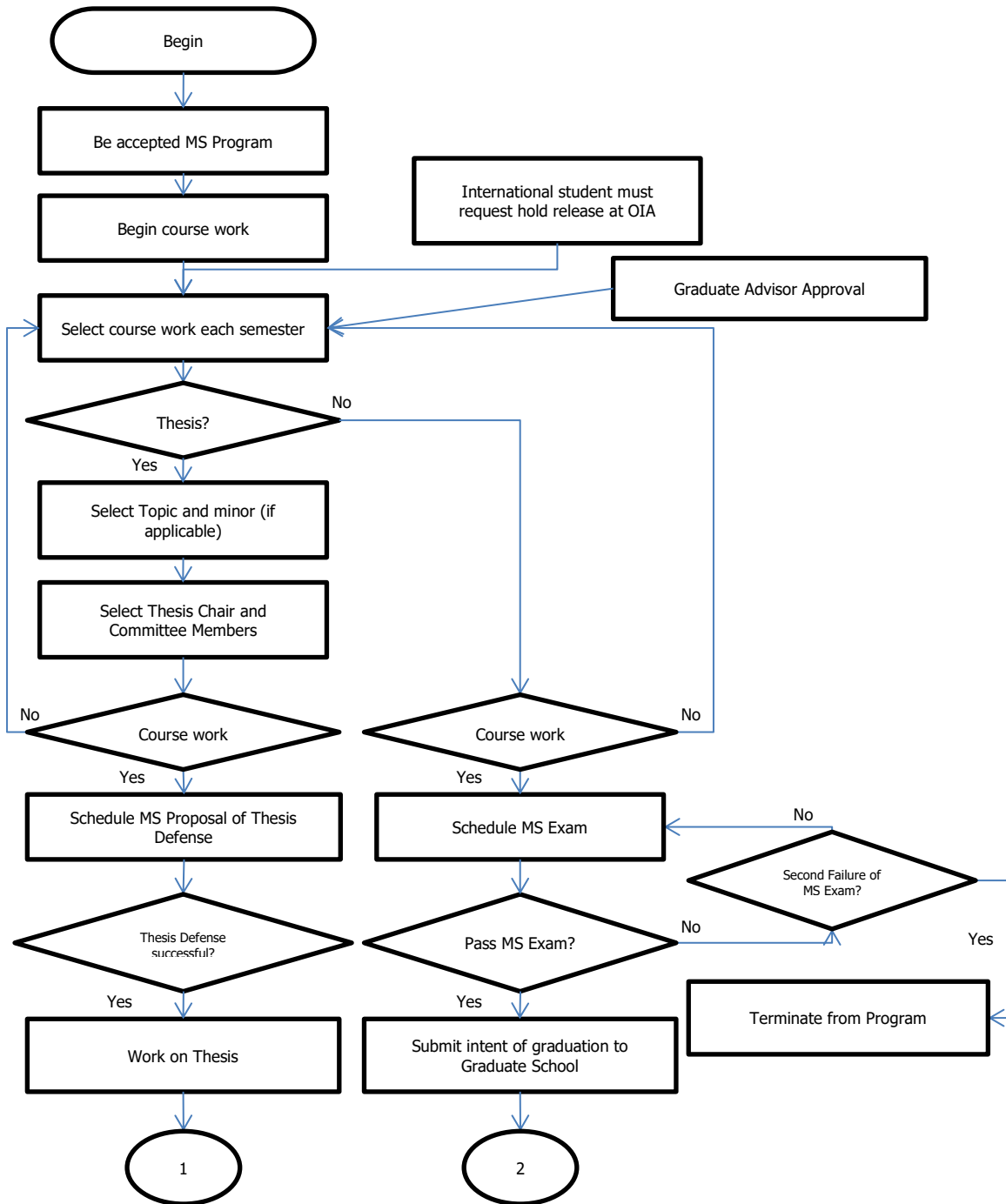
MS Milestone Sequence

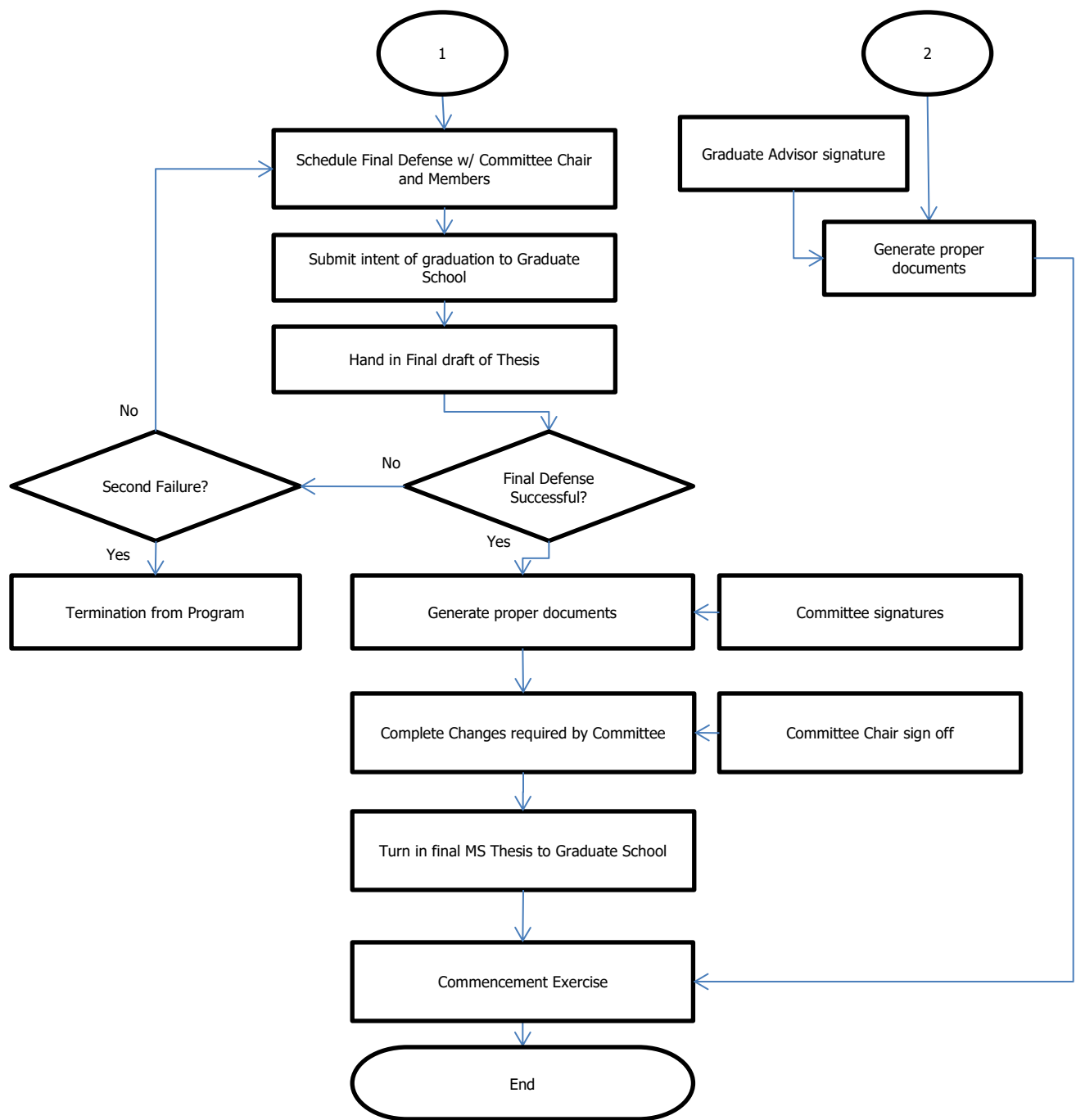
APPENDIX A

Sequential Process:

- ☐ Be accepted into MS Program (IE, SYEM, or MSMfgE)
- ☐ Begin graduate course work (international students must go to the Office of International Affairs (OIA) before the term begins to get important information about registration, University ID account, etc.)
- ☐ Select Thesis Topic and minor area (if applicable) for thesis major; non thesis majors do not need to complete this task.
- ☐ Select Thesis Chair (Major Professor) for thesis major; non thesis majors do not need to complete this task.
- ☐ Select course work for each semester (this must be approved by the Graduate Advisor)
- ☐ If an international student, must request the release of hold from Office of International Affairs
- ☐ Select Committee Members and get sign off by selected Committee Members on plan of study (Thesis option only)
- ☐ Submit plan of study to Graduate School (must have the graduate advisor signature + minor area advisor signature, if a formal minor is declared)
- ☐ Complete core course requirements
- ☐ Schedule Proposal Defense of MS thesis with Committee Chair and Members (Thesis option)
- ☐ Successfully defend Proposal defense (Thesis option)
- ☐ Work on Thesis (Thesis option)
- ☐ Schedule Final Defense of MS thesis with Committee (Thesis option)
- ☐ Submit intent to graduate to Graduate School in the final semester (term)
- ☐ Sign up for MS Comprehensive Exam in the final semester (Non Thesis option only)
- ☐ Successfully defend MS Comprehensive Exam (Non thesis option)
- ☐ Hand in final draft of Thesis to Committee Members 2 weeks prior to Final Defense (Thesis option)
- ☐ Successfully defend Final MS Thesis (Thesis option)
 - Get Committee members signatures
 - Generate proper documents for Graduate School
- ☐ Complete changes required by Committee to get the final document for MS Thesis (Thesis option)
- ☐ Obtain Committee Chair sign off on final corrections to Thesis (Thesis option)
- ☐ Turn in final MS Thesis document to Graduate School (Thesis option)
- ☐ Commencement Exercise (graduation)

MS Program Flowchart





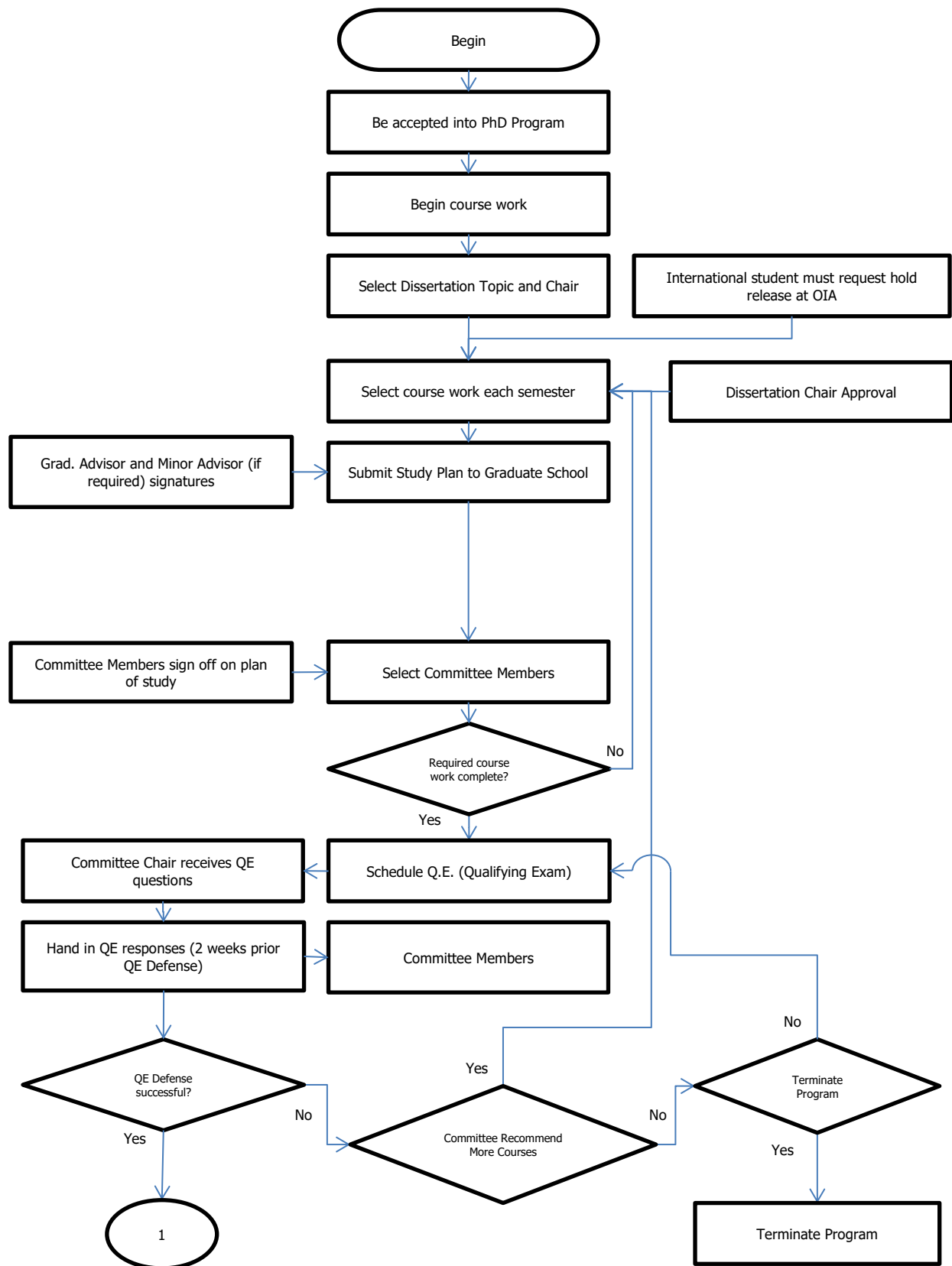
PhD Milestone Sequence

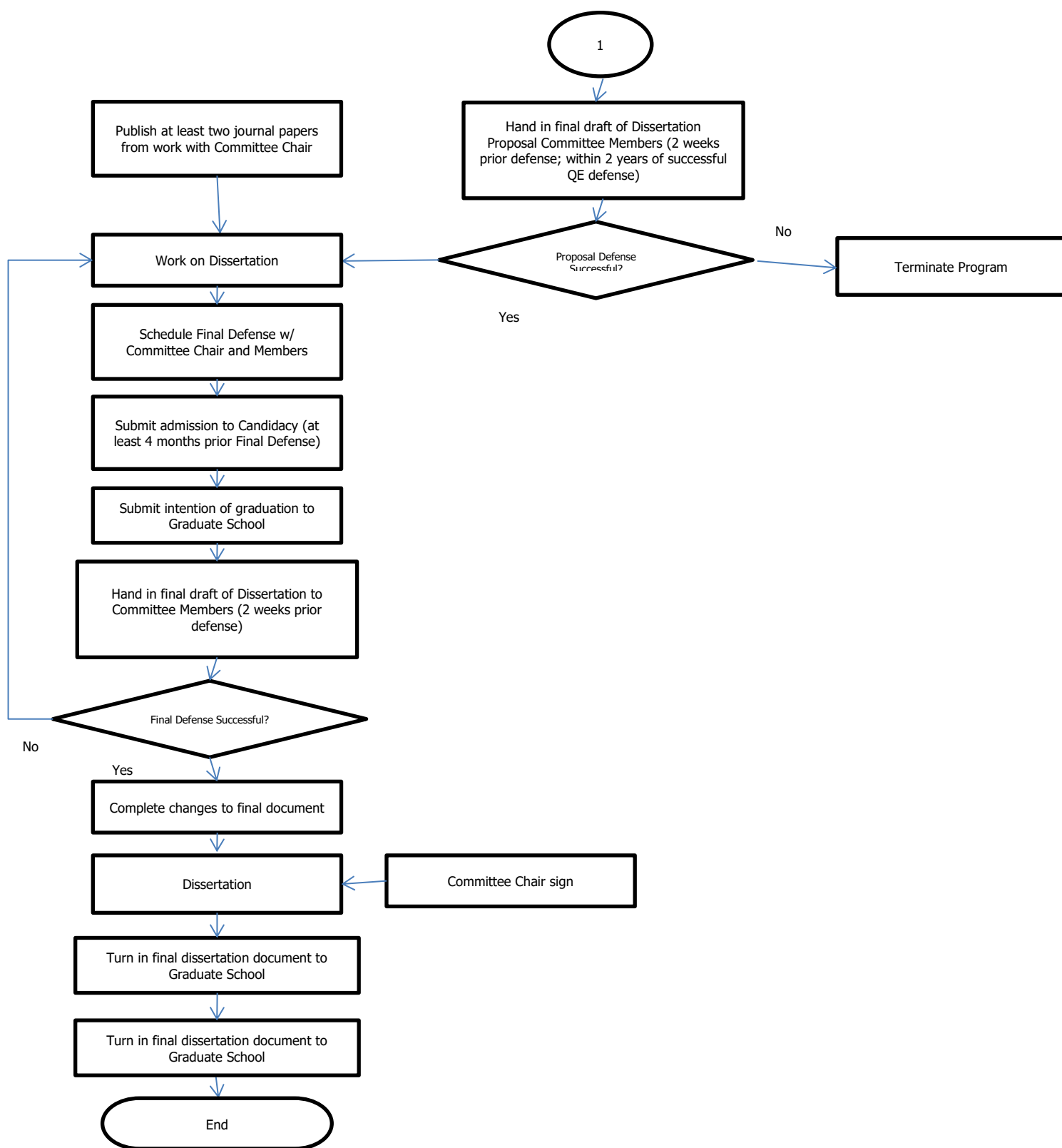
APPENDIX B

Sequential Process:

- ☐ Be accepted into PhD Program (IE or SYEM)
- ☐ Begin graduate course work (international students must go to the Office of International Affairs (OIA) before the term begins to get important information about registration, University ID account, etc.)
- ☐ Select Dissertation Topic and minor area (if applicable)
- ☐ Select Dissertation Chair (Major Professor)
- ☐ Select course work for each semester (this must be approved by the Dissertation Chair)
- ☐ If an international student, must request the release of hold from Office of International Affairs
- ☐ Select Committee Members and get sign off by selected Committee Members on plan of study
- ☐ Submit plan of study to Graduate School (must have the dissertation advisor signature + minor area advisor signature, if a formal minor is declared)
- ☐ Complete core course requirements
- ☐ Schedule Qualifying Exam with the Committee Chair and Committee Members and Submit Pre-Proposal to Committee Members at least 4 weeks prior to exam
- ☐ Committee Chair receives Qualifying Exam questions from Committee Members and submits to student
- ☐ Hand in written Qualifying Exam responses to Committee approximately 2 weeks prior Qualifying Exam Defense
- ☐ Successfully defend Qualifying Exam
 - Written responses to questions from Committee Members
 - Oral Defense of written responses to Committee Members
- ☐ Successfully defend Dissertation Proposal
- ☐ Work on Dissertation
- ☐ Publish at least two refereed journal papers from work with the Committee Chair
- ☐ Schedule Final Defense with Committee Chair and Members
- ☐ Submit admission to candidacy at least 4 months prior to Final Defense
- ☐ Submit intent to graduate to Graduate School in the final semester (term)
- ☐ Submit final draft of Dissertation to Committee Members at least 2 weeks prior to Final Defense
- ☐ Submit abstract and notice of defense to department at least 2 weeks prior to Final Defense
- ☐ Successfully defend Final Dissertation
 - Get Committee members signatures
 - Generate proper documents for Graduate School (requirements)

- ☐ Complete changes required by Committee to get the final document of Dissertation to Committee Chair
- ☐ Obtain Committee Chair sign off on final corrections for Dissertation
- ☐ Turn in final Dissertation document to Graduate School
- ☐ Commencement Exercise (graduation)





Master of Science of Industrial Engineering Course List

APPENDIX C

MASTER OF SCIENCE - INDUSTRIAL ENGINEERING GRADUATE COURSE OF STUDY

Name:	ID#:
Date Entered Program:	
Leveling Required:	YES NO COMPLETE
email:	Advisor:
Semester	Cumulative GPA

30 HOURS - THESIS/NON-THESIS OPTION

No more than 6 hours can be taken outside the department.

IE Core (15hrs, one from each core)			
Core	COURSE	SEM	GRADE
Core I	IE 5301		
Core I	IE 5306		
Core II	IE 5311		
Core II	IE 5318		
Core III	IE 5320		

Core	COURSE	SEM	GRADE
Core IV	IE 5342		
Core IV	IE 5344		
Core V	IE 5351		
Core V	IE 5352		
Core V	IE 5355		
Core V	IE 5356		

Electives (15hrs)			
Ergonomics and Human Factors		Statistics	
COURSE	SEM	GRADE	
IE 5304			
IE 5305			
Operations Research		Manufacturing	
COURSE	SEM	GRADE	
IE 5310			
IE 5312			
IE 5313			
IE 5314			
IE 5315			
IE 5316#			
IE 5317			
IE 5319			
Engineering Management		Quantum Computation	
COURSE	SEM	GRADE	
IE 5321			
IE 5322			
IE 5323			
IE 5324			
IE 5325			
IE 5328			
IE 5329			
Thesis Option - Must Complete 6 Hours		OTHER COURSES	
COURSE	SEM	GRADE	
IE 6000			
COURSE	SEM	GRADE	
IE 5331			
IE 5335			
IE 5000			
IE5100			

#Texas Tech IE Undergraduates may not take this course.

LEVELING REQUIREMENTS

COURSE	GRADE
IE 3341 - Engineering Statistics	does not apply to degree fulfillment
STAT 5384 Statistics 1 for Engineers and Scientist	counts a selective outside department

Master of Science Systems and Engineering Management Course List

APPENDIX D

MASTER OF SCIENCE - SYSTEMS AND ENGINEERING MANAGEMENT			
GRADUATE COURSE OF STUDY			
Name:	ID#:		
Date Entered Program:	150-HR Program		
Leveling Required:	YES	NO	COMPLETE
email:	Advisor:		
Semester	Cumulative GPA		
30 HOURS - THESIS/NON-THESIS OPTION			
No more than 6 hours can be taken outside the department.			
SYEM Core (15hrs, one from each core)			
Core	COURSE	SEM	GRADE
Core I	IE 5320		
Core II	IE 5321		
Core II	IE 5322		
Core II	IE 5324		
Core II	IE 5325		
Core III	IE 5323		
Core III	IE 5329		
Core	COURSE	SEM	GRADE
Core IV	IE 5311		
Core IV	IE 5318		
Core V	IE 5316#		
Core V	IE 5319		
Core V	IE 5346		
Electives (15hrs)			
Ergonomics and Human Factors		Statistics	
COURSE	SEM	GRADE	
IE 5301			
IE 5304			
IE 5305			
IE 5306			
Operations Research		Manufacturing	
COURSE	SEM	GRADE	
IE 5310			
IE 5312			
IE 5313			
IE 5314			
IE 5315			
IE 5317			
Engineering Management		Quantum Computation	
COURSE	SEM	GRADE	
IE 5328			
OTHER COURSES		Thesis Option - Must Complete 6 Hours	
COURSE	SEM	GRADE	
IE 5331			
IE 5335			
IE 5000			
IE 5100			
		COURSE	SEM
		IE 6000	

#Texas Tech IE Undergraduate students may not take this course.

LEVELING REQUIREMENTS

SEM

GRADE

IE 3341 - Engineering Statistics course does not apply to degree fulfillment

STAT 5384 Statistics 1 for Engineers and Scientist counts as a selective outside department

Master of Science Manufacturing Engineering Course List

APPENDIX E

MASTER OF SCIENCE - MANUFACTURING ENGINEERING GRADUATE COURSE OF STUDY

Name:	ID#:		
Date Entered Program:			
Leveling Required:	YES	NO	COMPLETE
email:	Advisor:		
Semester	Cumulative GPA		

30 HOURS - THESIS/NON-THESIS OPTION

No more than 6 hours can be taken outside the department.

MfgE Core (15hrs, one from each core)

Core	COURSE	SEM	GRADE	Core	COURSE	SEM	GRADE
Core I	IE 5351			Core IV	IE 5356		
Core II	IE 5352						
Core III	IE 5355						

Electives (15hrs)

Ergonomics and Human Factors

COURSE	SEM	GRADE
IE 5301		
IE 5304		
IE 5305		
IE 5306		

Statistics

COURSE	SEM	GRADE
IE 5342		
IE 5344		
IE 5345		
IE 5346		

Operations Research

COURSE	SEM	GRADE
IE 5310		
IE 5311		
IE 5312		
IE 5313		
IE 5314		
IE 5315		
IE 5316#		
IE 5317		
IE 5318		
IE 5319		

Manufacturing

COURSE	SEM	GRADE
IE 5355		
IE 5357		

Quantum Computation

COURSE	SEM	GRADE
IE 5381		
IE5382		
IE5383		

Thesis Option - Must Complete 6 Hours

COURSE	SEM	GRADE
IE 6000		

Engineering Management

COURSE	SEM	GRADE
IE 5320		
IE 5321		
IE 5322		
IE 5323		
IE 5324		
IE 5325		
IE 5328		
IE 5329		

OTHER COURSES

COURSE	SEM	GRADE
IE 5331		
IE 5335		
IE 5000		
IE5100		

#Texas Tech IE Undergraduates may not take this course.

LEVELING REQUIREMENTS

SEM

GRADE

IE 3341 - Engineering Statistics course does not apply to degree fulfillment

STAT 5384 Statistics 1 for Engineers and Scientist counts a selective outside department

Doctor of Philosophy Industrial Engineering Course List

APPENDIX F

DOCTOR OF PHILOSOPHY - INDUSTRIAL ENGINEERING GRADUATE COURSE OF STUDY

Name:	ID#:	
Date Entered Program:	150-HR Program	POS Filed
Leveling Required:	YES	NO
email:	Advisor:	
Semester	Cumulative GPA	

72 Hours Total -- Includes 57 hours coursework + 3 hours IE 7000 + 12 hours IE 8000

MAX 30 hours from MS degree or transfer; Minimum of 57 hours from IE

Must select courses from 4 out of the 5 areas.

Core	COURSE	SEM	GRADE
Core I	IE 5301		
Core I	IE 5306		
Core II	IE 5311		
Core II	IE 5318		
Core III	IE 5320		

Core	COURSE	SEM	GRADE
Core IV	IE 5342		
Core IV	IE 5344		
Core IV	IE 5346		
Core V	IE 5351		
Core V	IE 5352		
Core V	IE 5355		
Core V	IE 5356		

Electives (15hrs)

Ergonomics and Human Factors

COURSE	SEM	GRADE
IE 5304		
IE 5305		

Operations Research

COURSE	SEM	GRADE
IE 5310		
IE 5312		
IE 5313		
IE 5314		
IE 5315		
IE 5316#		
IE 5317		
IE 5319		

Engineering Management

COURSE	SEM	GRADE
IE 5321		
IE 5322		
IE 5323		
IE 5324		
IE 5325		
IE 5328		
IE 5329		
IE 6320		
IE 6323		
IE 6325		
IE 6329		
IE 6331		
IE 6399		

Statistics

COURSE	SEM	GRADE
IE 5345		

Manufacturing

COURSE	SEM	GRADE
IE 5353		
IE 5357		
IE 5358		

Quantum Computation

COURSE	SEM	GRADE
IE 5381		
IE5382		
IE5383		

Qual. Exam/Pro. Def. - Must Complete 3 hours

COURSE	SEM	GRADE
IE 7000		

Dissertation - Must Complete 12 Hours

COURSE	SEM	GRADE
IE 8000		

OTHER COURSES

COURSE	SEM	GRADE
IE 5331		
IE 5335		
IE 5000		
IE 5100		

#Texas Tech IE Undergraduates may not take this course.

LEVELING REQUIREMENTS

SEM	GRADE

Doctor of Philosophy Systems and Engineering Management Course List

APPENDIX G

DOCTOR OF PHILOSOPHY - SYSTEMS AND ENGINEERING MANAGEMENT GRADUATE COURSE OF STUDY

Name:	ID#:
Date Entered Program:	150-HR Program POS Filled
Leveling Required:	YES NO COMPLETE
email:	Advisor:
Semester	Cumulative GPA

72 HOURS TOTAL -- Includes 57 hours coursework + 3 hours IE 7000 + 12 hours IE 8000
 MAX 30 hours from MS degree or transfer
 Minimum of 57 hours from IE

SYEM Core (15hrs, one from each core)			
Core	COURSE	SEM	GRADE
Core I	IE 5320		
Core II	IE 5321		
Core II	IE 5322		
Core II	IE 5324		
Core II	IE 5325		
Core III	IE 5323		
Core III	IE 5329		
Core IV	IE 5311		
Core IV	IE 5318		

Core	COURSE	SEM	GRADE
Core V	IE 5316#		
Core V	IE 5319		
Core V	IE 5346		
Core VI	IE 6323		
Core VII	IE 6329		
Core VIII	IE 6325		
Core IX	IE 6399		

Electives

Ergonomics and Human Factors

COURSE	SEM	GRADE
IE 5301		
IE 5304		
IE 5305		
IE 5306		

Operations Research

COURSE	SEM	GRADE
IE 5310		
IE 5312		
IE 5313		
IE 5314		
IE 5315		
IE 5317		

Engineering Management

COURSE	SEM	GRADE
IE 5323		
IE 5328		
IE 5329		
IE 6320		

OTHER COURSES

COURSE	SEM	GRADE
IE 5331		
IE 5335		
IE 5000		
IE 5100		

Statistics

COURSE	SEM	GRADE
IE 5342		
IE 5344		
IE 5345		

Manufacturing

COURSE	SEM	GRADE
IE 5351		
IE 5352		
IE 5353		
IE 5355		
IE 5356		
IE 5357		
IE 5358		

Quantum Computation

COURSE	SEM	GRADE
IE 5381		
IE5382		
IE5383		

Qual. Exam/Pro. Def. - Must Complete 3 hours

COURSE	SEM	GRADE
IE 7000		

Dissertation - Must Complete 12 Hours

COURSE	SEM	GRADE
IE 8000		

#TTU IE undergrad students may not take this course.

LEVELING REQUIREMENTS

SEM	GRADE
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IE 3341 - Engineering Statistics course does not apply to degree fulfillment
 STAT 5384 Statistics 1 for Engineers and Scientists counts as a selective outside department

PhD Qualifying Exam Process

APPENDIX H

- Timing of the exam:
 - A student must complete their first attempt at the exam by the next long semester after the semester in which they complete 21 hours at TTU (i.e., transfer coursework does not count toward this total). E.g., suppose a student completes 9 hours in Fall 2019, 12 hours in Spring 2020, and 6 hours in Summer 2020; in this case, they crossed the 21 hour threshold in Spring 2020 and would be required to take the qualifying exam by the end of Fall 2020 (they could complete the exam before that, if they and their dissertation committee chair feel it is appropriate and if they meet the other requirements – see below).
 - In general, students must have completed at least 15 hours at TTU (again, not counting transfer coursework) in order to be eligible to take the exam. However, if a student wishes to take the exam prior to completing 15 hours at TTU, they can petition their dissertation committee chair and the IMSE graduate committee for an exception.
 - Prior to taking the exam, PhD IE students must have courses in at least 4 of the 5 IMSE areas (see IMSE graduate handbook) completed or in process, while PhD SYEM students must have at least 4 PhD SYEM core courses completed or in process. A maximum of one course can be transferred in to meet this requirement (i.e., at least 3 of the 4 courses required for the exam must be taken at TTU). Students must have also filed a PhD degree plan prior to the date of their exam.
- Exam format:
 - The exam will be administered by the student's dissertation committee (see the IMSE graduate handbook for the requirements for dissertation committees). Thus, a student must have both a dissertation committee chair (major professor) and dissertation committee in order to take the exam.
 - Two overall formats are allowed for the exam, as describe below.
 - **Option 1.** A minimum of 4 weeks prior to the qualifying exam date, the student must provide the committee with a pre-proposal which uses one of the following formats:
 - *Format 1:* A 10-20 page “white paper” which will contain: a) an introduction to the problem (the problem they intend to address, the motivation behind the problem, the general research questions and initial versions of the hypotheses); b) a brief literature review (to demonstrate the current state of knowledge related to the problem as well as the research “gap”); and c) a brief overview of the methodology (data collection and analysis procedures).
 - *Format 2:* An accepted or published refereed paper (journal or conference), written by the student on work done at TTU, and of no fewer

than 6 pages, plus a 1-5 page document describing how the student intends to extend the work in the paper for their dissertation research. In most cases, it is expected that the student would be the first author of the refereed paper and the student's dissertation committee chair would be a co-author. Note: the student must provide the committee with appropriate proof of acceptance/publication of the paper.

- The student should also recognize that many faculty may wish to see the pre-proposal prior to agreeing to serve on a student's committee; thus the student should anticipate that they may need to provide the pre-proposal to prospective committee members significantly earlier than 4 weeks before the qualifying exam.
- Within 5 business days of the student sending the pre-proposal to the committee, the student's dissertation committee chair should send a request for qualifying exam questions to the other committee members and set the official start date of the student's qualifying exam. The student is responsible for finding a date, time and location for the committee to meet for the oral portion of the qualifying exam, and must determine and communicate this to the committee no later than the official start date of the exam set by the student's dissertation committee chair. The oral portion of the qualifying exam must occur 4-6 weeks from the official start date of the exam set by the student's dissertation committee chair.
- After receiving the call for qualifying exam questions, each committee member will have 2 weeks to review the student's pre-proposal and to send at least one qualifying exam question to the student (and their dissertation committee chair).
 - The intent of the qualifying exam is to test the student's ability to do PhD-level research, not to primarily focus on re-testing the student on coursework completed at TTU (or a previous institution). However, the questions can, and often do, relate to concepts covered in courses at TTU or other institutions.
 - Thus, the exact format of the qualifying exam question(s) is up to each committee member, e.g., essay, problem-based, etc. However, the question(s) should typically relate to the general topic of the proposed dissertation research or a related topic (e.g., a student may propose to use a certain methodology, but the committee member might ask them a question about an alternate methodology).
 - Questions that test a student's general ability to conduct PhD-level research are also appropriate (e.g., ability to create a proposal for funded research, ability to review a journal paper).
- After the 2 week period for the receipt of questions concludes, the student will have 2 weeks to respond in writing to all of the qualifying exam

questions. The student must submit their answers to all of the qualifying exam questions to all of the committee members at the end of the 2 weeks via email or hard copy (depending on each committee member's preference as to format). Each committee member will receive the answers to all questions asked not just to their questions. While working on the qualifying exam questions, a student may ask a committee member for clarification of the meaning of their question, but not for instructions on how to complete it. Also, while a student should use outside published sources to answer the questions, they should not consult or work with any other outside parties on the exam questions.

- The oral portion of the qualifying exam will occur no more than 2 weeks after the submission of the written answers. During the oral portion, each committee member will ask the student questions related to the written qualifying exam questions and answers. (Note: a committee member can ask questions related to any of the written qualifying exam questions and answers, not just the ones they asked). Each committee member will consider both the student's written and oral responses in determining an overall grade of "Pass" or "Fail" for the exam. A student who receives no more than one "Fail" vote (each committee member will vote individually) will Pass the exam. The date and time for the oral portion of the qualifying exam must be determined no later than the official start date of the exam, and 90 minutes should be scheduled for the oral portion of the qualifying exam, to allow adequate time for committee discussion and voting (it is anticipated that the actual question and answer period with the student will typically take around one hour). Students must complete the oral portion of the qualifying exam either on campus or via videoconferencing software (e.g., Zoom, Teams). In addition to the Pass/Fail result, a Passing or Failing student may also have additional coursework requirements added to their plan of study based on committee feedback on the exam, e.g., if the committee believes the student is deficient in a certain area related to their research, the committee can require additional course(s) in that area be added to the student's plan of study, even if this causes the student to go above the minimum 60 hours of coursework. A student must satisfactorily complete any such deficiency coursework prior to their proposal defense.
- **Option 2.** A minimum of 2 weeks prior to the qualifying exam date, the student must provide the committee with a published refereed paper related to their dissertation research.
 - The student must have an **accepted or published** peer-reviewed, indexed (Scopus or Web of Science) journal paper in the same general research domain as their intended dissertation topic (e.g., human factors, manufacturing, operations research, or systems and engineering

management). The determination of whether the paper falls within the same general domain is ultimately up to the student's dissertation committee. The research in the paper must have been conducted at TTU during the student's PhD program, and the student **must** be the first author of this paper; additional co-authors are allowed. Upon petition from the student, the committee can consider a peer-reviewed indexed conference paper, which otherwise meets the requirements above (this requires unanimous approval of the committee).

- The student will distribute the paper to their committee at least two weeks prior to their scheduled oral exam date. The oral exam will typically be scheduled for 1.5 hours (90 minutes) to allow plenty of time for question & answer and committee discussion.
 - At least two weeks prior to their scheduled oral exam date, the student will also submit to their committee a brief "synopsis of future research direction" (1-2 pages) briefly describing the intended scope of the remainder of their dissertation research, including a summary of the research gap, research objectives (and/or hypotheses), and research methods.
 - At the oral exam, the student will present and defend the paper, and answer questions from the committee. Slides are required and must be distributed to the committee no later than the day before the oral exam.
 - Following the presentation and question & answer of the paper, the student will also present a few slides on their "synopsis of future research direction" and answer questions from the committee regarding their future research direction. (These slides must also be distributed to the committee no later than the day before the oral exam.)
 - After the entire question & answer period, the committee will take a vote "pass" or "fail" on the student's overall performance on the exam, which includes evaluation of the paper, presentation, and future research directions.
- If the student fails their first attempt at the qualifying exam, they will be allowed to retake the exam once no less than 4 months and no more than 6 months later, using either of the two options described above. (Note: students electing to use Option 2 for both attempts can utilize either the same paper or a different paper for the attempts). Each student is only allowed one retake on the exam. A student failing both attempts will be terminated from the PhD program. A student can also elect not to retake the exam and instead to leave the PhD program (applying to switch to the MS would usually be an option). A student who does not retake the exam within 6 months will be terminated from the PhD program.
 - After passing the qualifying exam, the student must successfully defend their proposal within 2 calendar years. A student who does not successfully defend

their proposal within 2 years from the qualifying exam will be terminated from the PhD program. As previously noted, a student must complete any deficiency coursework requirements set by the committee at the qualifying exam before their proposal defense. After passing both the qualifying exam and the proposal defense, the student must register for IE 8000 credit each subsequent semester until defending their final dissertation and completing all other graduation requirements (see Section 3.5 for more details).