

August 18, 2016

Dear Friend:

I am glad that you chose to join our program. I know that you probably had several schools recruiting you to study with them. We have an outstanding faculty and staff at KSU and I believe that you will be glad that you chose to come here. We will do everything in our power to insure that your efforts will be productive and that your hard work will lead to a successful career.

On behalf of the faculty and staff of the Department of Industrial & Manufacturing Systems Engineering, I welcome you to Kansas State University. You are joining a department with a proud tradition of excellence in graduate education. Our graduates are working successfully in industry and academia around the world. At times, it may seem like you will be in school forever, but I know that after graduation you will look back on your time at KSU with pride and wonder how you accomplished so much in so little time.

I want to challenge you to make the most of your opportunity to study with us. You should realize that the quality of your education is dependent on your investment of time and effort. A graduate education is more than just the courses that you take. Your teachers and your fellow students will be a great source of information and inspiration. Take advantage of every opportunity to participate in discussions, extracurricular activities, professional society organizations, intramurals, conferences and seminars. Attend the thesis defense presentations of your fellow students, make friends with people from different cultures and academic homes. Do not be content with doing the minimum possible, push yourself to higher levels - Strive to Excel.

This letter precedes our graduate handbook which contains information about our graduate programs. Please take time to read your copy carefully. If you have any questions, please know that my door is open to you. Simply make an appointment with our office staff.

Sincerely,

A handwritten signature in black ink that reads "Bradley A. Kramer". The signature is written in a cursive, flowing style.

Bradley A. Kramer, Ph.D.
Associate Professor and Head

**INDUSTRIAL & MANUFACTURING SYSTEMS ENGINEERING
KANSAS STATE UNIVERSITY**

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WHY GRADUATE STUDY?

This text is quoted (with permission of the author) from remarks made by the Kansas State University Teaching Scholar, Clifton Meloan, at the December 1995 Graduate Commencement Exercises.

"Members of the platform party, faculty, graduates and members of the audience. My remarks today are primarily directed to the audience. The parents among you have paid most of the bills and have wondered many times why it takes so long. What do they do that takes so long? The faculty and the graduates all know what I will be talking about.

What I will try to do in a few minutes is to describe the difference between a technician, a Master's candidate and a Ph.D. Let me use an item of apparatus to help illustrate these differences. This [shows object] is a buret and is one [of] our tools of the trade. Each field represented here today also has their own tools of the trade.

It looks simple, but unless it is operated correctly the results produced will be horrible. Students will be shown how to test for cleanliness, how to clean the buret, how to fill it without making air bubbles, how to read it to plus or minus 0.01 mL, what is meant by parallax, how to use a black line to improve the accuracy of the reading, how to see through a dark solution, how to calibrate it to make sure it is reading, correctly, and how to hold and turn the stopcock. If you see someone do it with two hands then they have been poorly educated. They should use one hand. Place the smallest two fingers on one side along the tip and reach through with the thumb and forefinger to turn the stopcock. This applied pressure on the stopcock is to prevent it from coming loose when it is turned. They will be shown how to remove the small air bubble under the stopcock and they will be shown how to unplug a clogged stopcock. What's the big deal about that? Just push a small wire up the end? If you do that you have created an even bigger problem. They will be shown how to use a wash bottle to split a drop. They will be shown how to swirl the flask to control the reaction rate rather than slosh the solution back and forth and they will be shown how to use a light colored background to improve the clarity of the endpoint.

This is technique and if done properly it saves time, improves accuracy and is money in the bank. This is what technicians must know. This is also what M.S. and Ph.D. students must know because they will be hiring technicians and they need to show them how to do it properly.

There is more to the story. When this buret is used, a measured volume of a solution of known strength is added to a sample of unknown strength. The strength of the unknown can be determined by an equation. This relationship is known as a Principle. This is just one of many principles students must learn.

At the M.S. level, the students must learn how to recognize this principle in other situations so they can explain what is happening. For example: right now this same principle is taking place in your body hundreds of times each minute. They are called duct glands. Tiny sacks of chemicals, like a buret, only thousands of times smaller, are opening and closing to react with selected chemicals in your body. They very same equation used with the buret can be used, only the volume is much smaller.

The next step in a graduate education is to learn to apply existing principles to new situations. Let me illustrate this by one of my own experiences that involved my graduate students. Many years ago K-State had a swimming team and one day coach Fedowski came to me nearly in tears. The chlorinator on the swimming pools had broken and there was so much chlorine in the water that his swimmers had to take a shower after swimming just one length because their skin burned so bad. There was a Big-8 swimming meet the next day and the swimmers would be arriving this afternoon to practice. There was not enough time to drain the pool and refill it and they couldn't contact the teams on the road to cancel the meet. Could we help? I used the same principle as with the buret and the same equation. We didn't have a small flask of liquid, but 120,000 gallons. I didn't have a huge buret, but we found some gallon jugs and filled each with a chemical to destroy the excess chlorine. We couldn't swirl the pool like the flask, but we got some boat oars and stirred. By 2 p.m., when the first school's team arrived, they never knew that we had had a problem. We try to teach this type of independent problem solving by classroom discussions, problem sets and by having students work on these problems when they occur, just like the swimming pool. We expect Master's candidates to be able to do this with a wide variety of principles without fear.

There is more to the story. What about new principles, ones that have not yet been discovered? This involves research. It begins with the Master's degree and is continued much more extensively for the Ph.D. degree. This is also where the major professor becomes important. It is the job of the major professors to be aware of the problem areas in their field and where

profitable research might be done. A Master's candidate is usually given several small projects to select from. These usually only require existing apparatus and at least the major professor believes there is a high probability for success. This when the students begin to learn how to look into the unknown and to get a real feeling for their field. This is also where they begin to learn how to handle failure. No one likes to fail, but in research it is most assuredly going to happen. It is the job of the major professor to teach the student how to handle this fear and to overcome it.

The Ph.D. requires the investigation of a much more difficult problem. The problem must be both original and significant. As I tell my students, you can count the stones in this building. That is original, because no one has done it before, but it isn't significant. It is this venture into the unknown that separates the Ph.D.'s from the M.D.'s and the Lawyers. They too work hard, very hard in fact, but they are following a prescribed course and they know almost to the day when they will graduate. This is not so for the Ph.D. and it is looking into the unknown that is why the Ph.D. is considered to be the highest academic degree. When they begin a project they have no idea when it will be finished. They are entering into an area where no one has been before so many mistakes are likely to be made. New apparatus may have to be built. New compounds may have to be prepared. The candidate and the major professor work closely together on the project. The student becomes almost like a member of the family and most major professors will take on the world to defend their students. The student learns how to plan a project, how to make accurate measurements and how to interpret the data. Many students can take data, but unless they learn how to interpret it they will not become a Ph.D. After what seems like an eternity, the project is finished. Do we have a Ph.D.? Perhaps, but maybe not yet.

All during this process there has to be the development of a proper mental attitude. Major professors can tell immediately if a student is a Ph.D. No one wants to write it down on paper, but a major professor can tell. It has to do with how the student answers questions, the type of questions asked, the way the research is organized and finally, does the student take the project away from the major professor? Does the student come in with suggestions on the direction the project should take and have a rational reason for doing it? It's almost as if the student has become a child again. The student will start asking questions as freely as was done in kindergarten and first grade. The candidate may even act like a teenager again when they knew the answer to everything.

These candidates before you know the techniques of their profession. They know how to handle problems and they know how to look for new principles. They are ready.

Now on behalf of the faculty I will take one last parting shot at the candidates. It is now time to stand back and put things in proper perspective. I will do this with a short story I heard several years ago and I have modified it to fit this occasion.

A Ph.D. candidate was waiting for the ceremonies to progress and he began to think back on what he had done during the past seven years. He thought about all of the books he had read and how much he had really learned from them. He thought about the reports, the problem sets, and how much he had learned studying for all of those exams. He now began to realize just how smart he had become from the seminars, meetings and just bull sessions with other students. He knew how much he had learned from doing the research. He was really feeling smart and by the time he got his hood on he felt very smart. After he shook the president's hand he was bursting with wisdom. As he walked across the stage all of a sudden he threw open his arms, looked upward, and exclaimed, "Here I am world. I have a Ph.D. degree." The world looked down at this young man and said, "Sit down and I'll teach you the rest of the alphabet."

INTRODUCTION

This manual is designed to acquaint graduate students in Industrial & Manufacturing Systems Engineering (IMSE) with the policies and procedures dealing with graduate study in our department. Some parts of this manual have been summarized from information presented in the KSU Graduate Handbook and the KSU Graduate Catalog. This document, however, is not an attempt to reproduce the KSU Graduate Handbook. All KSU graduate students are bound to follow the rules published therein. You should be aware that rules concerning graduate study are dynamic and that the University requirements supersede departmental requirements. You may find a current version of the Graduate handbook at: <http://www.ksu.edu/grad/>.

GRADUATE PROGRAMS AND EXPECTED OUTCOMES

The IMSE department currently offers Master of Science degrees in Industrial Engineering (MSIE), Engineering Management (MEM) and Operations Research (MSOR). All three Masters of Science degrees offer a course work only option and MSIE and MSOR also have a thesis option. Additionally, a person can receive a Ph.D. in Industrial Engineering.

A student that completes one of these degrees should be able to

1. solve advanced engineering problems using discipline appropriate math, science, computation and analysis skills.
2. synthesize and evaluate information.
3. demonstrate advanced knowledge in the area of specialization.
4. (a) recognize and apply the state of the art techniques in the field (M.S. coursework option).
(b) plan and conduct scholarly activities (M.S. thesis option).
(c) plan and conduct scholarly activities that make original contributions to the knowledge base in the field of study (Ph.D. degree).
5. communicate effectively both in written and oral forms.
6. recognize of the need for and ability to engage in life-long learning and professional service.
7. be effective in leadership and collaboration (MEM only).

BASIC TERMS & REQUIREMENTS

Each graduate degree is uniquely tailored to the student's needs. As an undergraduate, you followed a specific curriculum that all the students in your major followed to earn the baccalaureate degree. As a graduate student, the set of courses that you will take will be a combination of courses that you needed to broaden and deepen your background in the field and courses that help you to develop new skills and acquire information to conduct your research. This set of courses is called the ***Program of Study***. It is determined by the student during their first semester as a graduate student with the advice of a ***Major Professor*** and the concurrence of a ***Supervisory Committee***. The program of study must meet all graduate school rules and follow one of the department's approved graduate programs detailed later in this document.

Your ***Major Professor*** is an IMSE graduate faculty member who consents to supervise and examine your work. All graduate students must choose a major professor during their first semester at KSU. This professor will supervise your research work and advise you in developing a program of study. He or she is the one who determines when your work is complete and ready to be taken to the supervisory committee for ***Final Examination***.

The *Supervisory Committee* is formed in consultation with the major professor. It is formed during the development of the Program of Study. Its purpose is to supervise the student's academic work and to conduct the final examination of the student.

Every graduate student is required to pass a *Final Examination*. The purpose of the final examination is to assess the quality of the student's work to determine whether the student should graduate. The student's supervisory committee conducts the final examination. All students, who complete a thesis, will defend their work before their supervisory committee. This examination may include questions related to their mastery of their field and/or program of study. The final examination for students who take a course-work only option will consist of at least a 5-page single spaced report on the knowledge gained through their course work efforts. This report should be comprehensive in the treatment of the courses and include how knowledge from different courses interacts to improve the efficiency of systems.

Registration - Each on-campus graduate student must meet with his advisor prior to enrolling. If the student does not have an advisor yet, he or she must meet with the Graduate Committee Chairperson or the Department Head.

Each on-campus graduate student must enroll for **IMSE 892 - Graduate Seminar (0)** during every semester that they attend KSU. Seminar attendance requirements will be clearly detailed each semester during the first scheduled seminar by the faculty member in charge of the seminar. Part-time students are required to complete the same percentage of seminar meetings as the percentage of time in which they are enrolled. We define a full-time load to be nine (9) hours for every student. Therefore, a graduate student enrolled in 6 hours is responsible for 67% of the seminar meetings, etc. The seminar leader, however, has the right to make some of the seminars mandatory and every graduate student is expected to attend these seminars regardless of their enrollment status. Unexcused absences from seminar or failure to complete all seminar requirements must be made up by work assigned by the faculty member responsible for the seminar. Graduate students are required to make one technical presentation to the seminar group during their time at KSU.

Outside coursework* - In order to obtain a master's degree or a Ph.D. degree in the IMSE Department, no more than 6 credits can be taken outside the IMSE Department. Prior approval by the IMSE Department Head or the Graduate Committee Chairperson must be obtained if extra course-work outside the IMSE Department is needed for the student's research.

Annual Progress Review - All IMSE graduate students are required to complete an annual progress review, as per the KSU Graduate Handbook Chapter 1.E (<http://www.k-state.edu/grad/graduate-handbook/>). The review's purpose is to support timely degree completion and professional development. In the case of funded students, the review also is submitted to the Department Head to support decisions about GRA and GTA positions for the upcoming year. Reviews will be maintained by the IMSE Department as part of the student's academic record.
Review content:

All Ph.D. students, MS students who received any funding (from the IMSE Department or on an IMSE faculty member's project) in the previous academic year, and MS students who wish to be considered for funding in the upcoming academic year should complete the review form *Annual Progress Report for Doctoral Students and Funded Master Students*.

MEM, MSOR, and MSIE students who received no funding from the IMSE Department or an IMSE faculty member's project in the previous year and who do not wish to be considered for funding in the upcoming year should complete the review form *Annual Progress Report for Non-Funded Master Students*.

Review process:

1. First week of April: IMSE Department notifies each graduate student by email that annual reviews are due and provides a link to the review forms.
2. On or before May 1: Student completes and submits the self-evaluation portion of the form.
 - a. Annual Progress Report for Doctoral Students and Funded Master Students is submitted to the student's major professor.
 - b. Annual Progress Report for Non-Funded Master Students is submitted to IMSE_GradProgress@ksu.edu.
3. On or before May 30: Major professor reviews the form, provides comments to the student, completes the major professor evaluation portions of the form, and files the completed form with the IMSE Department.
4. A student who does not complete the annual review in a timely manner will have an enrollment hold placed on his/her account, and the major professor will report that the student has failed to make satisfactory progress toward the degree. A completed report and consultation with the major professor are required to remove the hold.

Responsible Conduct of Research Training (RCR) – All graduate students working on research (at the MS and PhD level) are required to take the RCR training course during their first semester. Once completed, each student should submit the certificate of completion to the research advisor.

The course can be found at: <http://www.k-state.edu/comply/rcr/training/>

MASTER'S DEGREE

The master's degree is awarded to one who has developed a mastery of basic principles and concepts. The graduate understands these theories to the point of being able to apply them to new situations and different application areas. A typical master's program will require a combination of course work in advanced subjects and research into current topics and fields.

There are two different routes to obtain a Master's degree:

- 1) Course work + Thesis
- 2) Course work Only

Those students who work on an assistantship in the department will be expected to complete a thesis. Also, those students who think they may eventually want to work toward a Ph.D. should plan to do the thesis option. The thesis is an original work. It builds on what has already been done in the field and presents something original and valuable. It must be technically and scientifically sound. A hypothesis is posed, experiments planned, data obtained and analyzed, and results and conclusions reported. The course work only option is useful to gain a mastery of current information in the field without developing independent research capability.

Required Graduate IE Coursework – Each of the three masters' degrees has core courses. A student may receive at most one C in any of the core courses. This may require some students to repeat courses.

ENTRANCE REQUIREMENTS

To be considered for admission, the applicant must satisfy the following requirements. Any exception must be approved by the Graduate Committee.

- (1) A baccalaureate degree in engineering, math, statistics, computer science or science.
- (2) An undergraduate/graduate grade point average of 3.0/4.0 or better (or equivalent).

The applicant must supply:

- (1) A completed graduate application form
- (2) Three letters of reference
- (3) Official transcripts from all institutions at which the applicant studied
- (4) A statement of objectives for graduate study
- (5) An official GRE exam report directly from ETS (except for the MEM program)
- (6) Foreign students who have not obtained a baccalaureate or graduate degree from a U.S. institution and whose primary language is not English must have a TOEFL score that satisfies the Graduate School requirements.
- (7) All foreign student applicants must also provide a completed Affidavit of Financial Support with documentation.

MAKE-UP COURSES

- (1) Entering IE graduate students are expected to have a mastery of linear programming (at the level of IMSE 560) and statistics (at the level of Stat 510/511) as these classes are prerequisites for two of MSIE's core courses. Individuals, who have not taken these courses, may take a proficiency test in either or both subjects prior to the first semester and if the student passes the test, then the corresponding prerequisite is waived. Any makeup or prerequisite courses should be taken for undergraduate credit and will not affect the student's graduate GPA.
- (2) Any additional makeup courses will be decided by the Department Head with policy recommendations from the graduate committee.
- (3) Make-up courses must be passed during the first year of study. The student must earn a B or better for each make-up course. Failure to earn a B or complete a prerequisite course may result in the student being dismissed from the graduate program.

THESIS OR COURSE WORK OPTIONS

The Program of Study for each student must meet IMSE program guidelines and graduate school policies. Students must earn 60% or more of their credit hours in courses numbered 700 or higher. No more than three hours in problems or other individualized courses may be applied to the master's degree.

The IMSE Department has two options for the M.S. degree

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|-------------------------------|---|
| (1) <i>Thesis option</i> | As part of the degree program, the student will complete a thesis for a minimum of 6 credit hours. The thesis option requires a total of at least 30 graduate credit hours. |
| (2) <i>Course-work option</i> | The student's degree program will consist of course work only, but it will include evidence of advanced work, such as term papers or designs, as determined by the committee. The course-work option requires a total of at least 30 graduate credit hours. |

For coursework only students.

The students pursuing a coursework only MSOR degree should have a supervisory committee of Dr. Easton, Dr. Heier Stamm and Dr. Wu. Dr. Easton is typically the major professor.

The students pursuing a coursework only MSIE degree should have a supervisory committee of Dr. Chang, Dr. Lei, and Dr. Rys. Any of these faculty members is typically the major professor.

The students pursuing a coursework only MEM degree should have a supervisory committee of Dr. Kramer, Dr. Ben-Arieh and Dr. Lin, Dr. Zhang, or Dr. Cassone. Dr. Kramer is typically the major professor.

Final Culminating Experience

For students taking the course work option the students must present a culminating experience to the student's supervisory committee. The purpose of this experience is to determine that the student can integrate materials from various classes to solve real-world problems. At least two members of the student's supervisory committee must be present at this presentation. Any supervisory committee not present will evaluate the work based upon the slides from the presentation.

Students in the MEM program should prepare a presentation on a real-world problem where they have applied the knowledge gained from their courses. This 15-30 minute presentation should describe the problem, why it is important to solve and the avenues the student pursued to solve these problems. A successful presentation should integrate knowledge from at least 3 classes on the student's program of study. This presentation should also show that the student has mastery of both the material and the application of the material from these courses.

Students in the MSOR and MSIE programs should prepare a presentation on a real-world problem where they can apply the knowledge gained from their courses. This 15-30 minute presentation should describe the problem, why it is important to solve and the avenues the student would pursue to solve it. A successful presentation should integrate knowledge from at least 3 classes on the student's program of study. This presentation should also show that the student has mastery of both the material and the application of the material from these courses.

All students that reside within 250 miles of Kansas State University must take their final exam on campus.

FINAL EXAMINATION

A final examination is required for the M.S. degree. The examination will be administered after the student has completed the program of study and other requirements or in the term in which the candidate intends to complete them.

If the student takes the thesis option, an oral examination will be conducted on his or her thesis. Some of the guidelines for this oral examination are listed in the following:

- (a) The ideal presentation time is 20 to 30 minutes and certainly should not be more than 40 minutes. The primary purpose of the examination is to present the research value and defend its value.
- (b) The examination is divided into three parts:
 - (1) The first part is an oral presentation by the graduate student. This portion of the exam is open to the public. Questions from the general audience are allowed.
 - (2) During the second part, only the committee members and the candidate should be present. The public audience is excused. The committee will examine the candidate in more depth.
 - (3) The third part of the exam is the deliberation by the committee members to render judgment on the quality of the work. Only the committee members should be present.
- (c) The committee may decide to pass, pass with qualification, or fail the student. Negative votes by half or more of the members of a supervisory committee constitute failure. A candidate who fails a master's examination may take a second examination no sooner than two months or later than 15 months after the failure, unless an extension is granted by the Dean of the Graduate School. No third trial is allowed.

For students taking the course work option, the students must present a culminating experience to the student's supervisory committee. The purpose of this experience is to determine that the student can integrate materials from various classes to solve real-world problems.

Students in the MEM program should prepare a presentation on a real-world problem where they have applied the knowledge gained from their courses. This 15-30 minute presentation should describe the problem, why it is important to solve and the avenues the student pursued to solve the problem. A successful presentation should integrate knowledge from at least 3 classes on the student's program of study. This presentation should also show that the student has mastery of both the material and the application of the material from these courses.

Students in the MSOR and MSIE programs should prepare a presentation on a real-world problem where they can apply the knowledge gained from their courses. This 15-30 minute presentation should describe the problem, why it is important to solve and the avenues the student would pursue to solve it. A successful presentation should integrate knowledge from at least 3 classes on the student's program of study. This presentation should also show that the student has mastery of both the material and the application of the material from these courses.

All students that reside within 250 miles of Kansas State University must take their final exam on campus.

OTHER REQUIREMENTS AND PROCEDURES FOR A MASTER'S DEGREE

- (1) Upon arriving at the university, report to the Graduate Committee Chairperson. Then, with the advice of the Department Head or the Graduate Committee Chairperson, register for appropriate courses.
- (2) The student should discuss his or her areas of interest with members of the faculty and with mutual agreement choose a major advisor before enrolling for the second semester.
- (3) The student's registration form, which lists all the courses to be taken during the semester, must be signed by his/her advisor. If the student does not have an advisor yet, then the form must be signed by the Department Head or the Graduate Committee Chairperson. If enrolling by KATS, the student meets with his advisor prior to enrolling.
- (4) A supervisory committee will be formed for each student. The student should work with his or her major advisor to form this committee before being allowed to enroll for the second semester. This supervisory committee must be composed of the major advisor and at least two other graduate faculty members. A student pursuing a thesis must have at least one committee member from outside the department.
- (5) Every M.S. supervisory committee must have at least one tenured faculty member for the IMSE Department.
- (6) The student must file a program of study before enrolling for the third semester.
- (7) Students may change their advisor, but the change must be approved in writing by both the current and the new advisors. (Program/Committee Change Form)
- (8) All M.S. students must pass a final oral examination and must have a 3.0 average or better in their course work.
- (9) Students obtaining a thesis option must present a poster to summarize their research before the final oral examination. This poster must be approved by the major professor and used to advertise the student's defense. After the student successfully passes the final oral examination, he or she must turn in an M.S. thesis to the graduate school within three months of the examination.
- (10) A letter of recommendation for practical training will NOT be written for foreign students before the student's oral defense has been scheduled.
- (11) Enrollment in IMSE 892 - Graduate Seminar (0) is required each semester for all graduate students. M.S. students obtaining a thesis are required to make at least one technical presentation during their

program. Unexcused absences from the seminar course must be made up by work to be assigned by the instructor.

- (12) To obtain an M.S. degree, at least 60% of the graduate courses on the Program of Study must be at or above 700 level and no more than 6 credits may be at the 500 level. All 500 level courses must be in the student's minor fields and approved by the supervisory committee.
- (13) One working paper submitted to the Department's file system is required for all master students completing a thesis before graduation.

GRADUATE SCHOOL REQUIREMENTS

In addition to the requirements listed here, the student must also satisfy all the requirements of the graduate school to obtain an M.S. degree.

KANSAS STATE UNIVERSITY
DEPARTMENT OF INDUSTRIAL & MANUFACTURING SYSTEMS ENGINEERING
Master of Science - INDUSTRIAL ENGINEERING
 Program Format and Minimum Requirements*

To pursue the Industrial Engineering M.S. through the Industrial and Manufacturing Systems Engineering graduate program, students must meet the KSU Graduate School admissions requirements, hold a B.S. degree in engineering, mathematics, or physical science and be versed in several of the basic areas of industrial engineering. Non-industrial engineering undergraduates may require 6 semester credit hours of prerequisite courses. GRE scores are required for all students who apply unless they will have completed an undergraduate degree from an ABET-accredited program.

An entering M.S.I.E. student is expected to have proficiency in computer programming, linear programming and statistics. Students failing to meet these expectations may be required to take some prerequisite courses.

The formats for this program are as follows. *

	<u>Thesis</u>	<u>Course Work</u>
Core Courses	9	9
Other IMSE Courses and Electives	15	18
Thesis	6	0
IE Seminar **	0	0
TOTAL GRADUATE CREDITS	30	30

Core Courses and Policies

IMSE 641 - Statistical Process Control in Manufacturing
 IMSE 811 – Advanced Production & Inventory Control
 IMSE 780 - Methods of Operations Research I **or** two of the following classes

- IMSE 881 – Linear Programming
- IMSE 882 – Network Flows and Graph Theory
- IMSE 884 – Integer Programming and Combinatorial Optimization
- IMSE 982 – Nonlinear Programming
- IMSE 866 – Applied Stochastic Processes and Theoretical Simulation
- IMSE 751 – Normative Theory of Decisions and Games
- IMSE 760 – Stochastic Calculus Financial Engineering
- IMSE 810 – Industrial Logistics Engineering
- IMSE 830 – Applied Fuzzy Set Theory
- IMSE 842 – Reliability Theory
- IMSE 865 – Simulation of Industrial Management Systems
- IMSE 971 – Industrial Queuing Processes
- IMSE 976 – Scheduling Theory
- IMSE 991 – Multiple Criteria Decision Making

To graduate, a student may receive at most one C in all of the core courses (no D's or F's are allowed). This may require some students to retake core courses.

- * Actual degree requirements will be summarized on an approved plan of study. Some general guidelines include:
 - At least 60 percent of classes must be above the 700 level.
 - No more than 6 hours can be taken from an outside department without prior permission.
 - Courses in the IMSE department must be above the 600 level.
 - Courses outside the department must be above the 500 level.
 - No more than 6 hours can be taken at the 500 level.
- ** All full-time students are required to enroll in the graduate seminar (IMSE 892) each semester.

KANSAS STATE UNIVERSITY
DEPARTMENT OF INDUSTRIAL & MANUFACTURING SYSTEMS ENGINEERING
Master of ENGINEERING MANAGEMENT
 Program Format and Minimum Requirements*

This program is designed to be a part-time program and typically requires 2 to 4 years to complete.

To pursue the MEM degree, the student must meet the KSU Graduate School admissions requirements, have a B.S. degree in engineering, mathematics, or physical science and have taken at least one course each in calculus and statistics.

Master of Engineering Management is an online program only. This program is designed to be a part-time program and typically requires 2 to 4 years to complete.

Students not meeting the above requirements may be considered if they can demonstrate equivalent evidence of an appropriate background. Contact the Department of Industrial and Manufacturing Systems Engineering to discuss.

The format for this program is as follows: *

	<u>Course Work</u>
Core Courses (any 5 of the 6 core courses)	15
Electives *	15
TOTAL GRADUATE CREDITS	30

Core Courses (each offered once every three years):

- IMSE 605 - Advanced Industrial Management
- IMSE 680 - Quantitative Problem Solving Methods
- IMSE 806 - Engineering Project Management
- IMSE 810 - Industrial Logistics Engineering
- IMSE 811 - Advanced Production and Inventory Control
- IMSE 822 - Advanced Engineering Economy

Besides the above academic requirements, a graduating student must have at least 3 years full-time work experience.

Elective Courses

Electives are any course not utilized as a core course on your program of study.

- * Actual degree requirements will be summarized on an approved plan of study. Some general guidelines include:

- At least 60 percent of classes must be above the 700 level
- At most 6 hours can be transferred from another school without prior permission.
- No more than 6 hours can be taken from an outside department without prior permission.
- Courses in the IMSE department must be above the 600 level.
- Courses outside the department must be above the 500 level.
- No more than 6 hours can be taken at the 500 level.
- Students may take courses in Psychology, Business, and other Engineering disciplines to broaden and enhance their engineering management skills.

KANSAS STATE UNIVERSITY
DEPARTMENT OF INDUSTRIAL & MANUFACTURING SYSTEMS ENGINEERING
Master of Science in OPERATIONS RESEARCH
 Program Format and Minimum Requirements*

To pursue the Operations Research M.S. through the Industrial and Manufacturing Systems Engineering graduate program, the student must meet the KSU Graduate School admissions requirements, have a baccalaureate degree, and have strong background in applied mathematics including calculus and linear algebra. The student must also have completed 3 semester credits each in introductory statistics (equivalent to K-State's STAT 510) and introductory operations research and (equivalent to K-State's IMSE 560 or IMSE 680)*, and have knowledge of computer programming (equivalent to K-State's CIS 200 or CIS 209). Otherwise, appropriate remedial courses will be required. GRE scores are required for all students who apply unless they will have completed an undergraduate degree from an ABET-accredited program.

**If an entering student has not taken an introductory operations research course, the student should enroll in IMSE 680 - Quantitative Problem Solving Techniques, to gain this knowledge.*

The formats for this program are as follows:*

	<u>Thesis</u>	<u>Course Work</u>
Operations Research Core Courses	9	9
Additional Operations Research Courses	3	9
Electives	12	12
Thesis	6	0
IE Seminar **	<u>0</u>	<u>0</u>
TOTAL GRADUATE CREDITS	30	30

One core course must be taken in each of the three areas:

Continuous Optimization:

- IMSE 881 – Linear Programming
- IMSE 982 – Nonlinear Programming

Discrete Optimization:

- IMSE 882 – Network Flows and Graph Theory
- IMSE 884 – Integer Programming and Combinatorial Optimization

Stochastic Processes:

- IMSE 842 – Reliability Theory
- IMSE 866 – Applied Stochastic Processes and Theoretical Simulation
- IMSE 971 – Industrial Queuing Processes

Additional Operations Research courses include the following courses and any core courses:

- IMSE 643 – Industrial Simulation
- IMSE 780 – Methods of Operations Research
- IMSE 830 – Applied Fuzzy Set Theory
- IMSE 751 – Normative Theory of Decisions and Games
- IMSE 865 – Simulation of Industrial Management Systems
- IMSE 976 – Scheduling Theory
- IMSE 983 – Dynamic Programming
- IMSE 990 – Adv Topics in Operations Research

- * Actual degree requirements will be summarized on an approved plan of study. Some guidelines include:
 - At least 60 percent of classes must be above 700 level.
 - No more than 6 hours can be taken from outside the department without prior permission.
 - Courses in IMSE the department must be above the 600 level.
 - Courses outside the department must be above the 500 level.
 - No more than 6 hours can be taken at the 500 level.
 - No course can count as both a core course and an additional operations research course.
- ** All full-time students are required to enroll in the graduate seminar (IMSE 892) each semester.

THE DOCTORAL DEGREE

The doctoral degree is awarded to those individuals who go beyond mastery of current industrial engineering principles and applications to being able to identify valuable research areas, determine a plan to accomplish the research, and can direct others to accomplish these research projects. The Ph.D. is the highest degree awarded in this field and is only granted to those with an exceptional understanding of industrial engineering and an ability to envision needed changes to the profession and direct efforts to develop new tools and applications, to teach others the field, and to validate the use of these tools and applications.

ADMISSION

To gain admission to the graduate school, the student must be approved for admission both by the graduate school and the IMSE department. All complete applications for admission to our Ph.D. program will be reviewed first by the graduate coordinator then routed to all IMSE graduate faculty members. Most of the IMSE graduate faculty members must approve the application for admission. Furthermore, admission to graduate school does not imply admission to candidacy for a Ph.D. degree. Candidacy is confirmed only upon the successful completion of the preliminary examination.

ENTRANCE REQUIREMENTS

Students who majored in engineering, computer science, natural sciences and mathematics may be considered for admission. Any exceptions must be approved by the Graduate Committee. The basic requirements for being considered for admission are:

- (1) A Bachelor of Science degree in engineering, math, statistics, computer science or science.
- (2) Adequate preparation in the proposed major area of study.
- (3) A graduate grade point average of 3.5 or better out of possible 4.0.
- (4) Students who do not have at least one degree in industrial or manufacturing engineering may be required to take some additional courses in order to pass the preliminary examination.

To document that these requirements have been met, the applicant must supply:

- (1) A completed application form for admission to graduate school
- (2) Three letters of references
- (3) Transcripts from all institutions at which the applicant studied
- (4) A statement of purpose for pursuing a Ph.D. degree.
- (5) An official GRE exam report directly from ETS.
- (6) Foreign students who have not obtained a degree from a U.S. institution and whose native language is not English must have a TOEFL score that satisfies the graduate school requirements (a paper-based score of 550 or computer-based score of 213) for direct admission into the program

- (7) All foreign student applicants must also provide a completed Affidavit of Financial Support with documentation.

Ph.D. MAKEUP AND CORE COURSES

If the Ph.D. applicant did not major in industrial engineering for either the baccalaureate degree or master's degree or whose major field does not include the required undergraduate courses, he or she may be required to take some make-up courses based upon either the recommendations of the major professor, the Graduate Committee Chairperson, or the Department Head. A grade of "B" or better must be obtained for these make-up courses. If student does not successfully complete a prerequisite course, the student must enroll in the same course the next semester. If on the second try the student does not receive a "B" or better, he or she is dismissed from the program.

The field of industrial engineering is broad. To assure that each student obtains a broad understanding of industrial engineering, each student must take at least one class in five of the six core areas. In each of the student's core courses, the student must receive a grade of "B" or better. This may require taking courses more than one time.

Optimization IMSE 780, IMSE 881 or IMSE882
Stochastic Processes IMSE 865, IMSE 866, IMSE 971
Statistics: IMSE 841, Stat 713, Stat 720 or Stat 722
Production and Inventory Control: IMSE 811
Ergonomics and Decision Theory: IMSE 751, IMSE 822 or IMSE 850
Manufacturing: IMSE 825 or IMSE 868

A student may satisfy a core course requirement by passing an examination of the material. Students desiring this must discuss this intention with the Department Head, who will assign a faculty member to prepare an exam. Only one exam may be taken for each core area and failure to pass the exam requires the student to take a class. Furthermore, a student cannot take an exam for an area if he or she has already received a "C" for a course in that area. If the student passes the exam, then the student may substitute 3 hours of graded courses.

PROGRAM OF STUDY ISSUES

The Ph.D. degree requires at least three years of full-time study beyond the bachelor's degree, equivalent to at least 90 semester hours, including a dissertation equivalent to 30 hours of research credits. An earned M.S. degree in an appropriate field from an approved institution can be used in lieu of thirty hours of credit in the program of study.

- (1) Each student must choose a major professor before beginning his or her second semester at KSU. However, it is in the student's best interest to decide as early as possible. The major professor must be both a member of the KSU Graduate Faculty and Certified to Direct Doctoral Students.
- (2) Each student must file the Graduate School Program of Study before the end of his or her second semester at KSU.
- (3) Until the student chooses a major professor, the Graduate Committee Chairperson will serve as the student's advisor
- (4) The student must meet with his or her advisor prior to enrolling. The student's advisor must lift the student's flags to register for classes and sign any forms related to course changes later in the semester. If the student does not have an advisor yet, then the flags must be lifted and the forms signed by the Department Head or the Graduate Committee Chairperson.
- (5) The student with the advice of his or her advisor will choose at least 2 additional members (not including the major professor) for the Supervisory Committee. At least one member must be from outside the IMSE department. The Department Head will select one IMSE faculty member to be on the student's Supervisory Committee. All Supervisory Committees must include at least one tenured IMSE faculty member.

- (6) The Supervisory Committee should be actively engaged in the student's research. Each year the student must present a written report to each committee member detailing the year's research achievements. Alternately, a published paper can be given to the research committee in place of this report.
- (7) A student may change his or his major advisor, provided he or she obtains the agreement of both the current and the new advisors in writing (Program/Committee Change Form).
- (8) Enrollment in IMSE 892 - Graduate Seminar (0) is required each semester for all graduate students. Ph.D. students are required to make at least one technical presentation during their program. Unexcused absences from the seminar course must be made-up by work assigned by the course instructor.
- (9) A Ph.D. candidate may choose a related field in another department as his or her minor field outside the IMSE Department.
- (10) Doctoral students must include at least 15 graduate graded credit hours in courses numbered 800 or higher on their Program of Study.
- (11) No more than 6 hours of 500 level courses are permitted and then only with written justification from the supervisory committee. No 500 level courses from the student's major field of study are allowed.

PRELIMINARY EXAMINATION

It is recommended that the preliminary examination be taken about 2 years after enrollment in the IMSE department. This time should allow the student to have taken all necessary courses and have a fundamental understanding of how to perform successful research. Additionally, the preliminary examination must be completed at least seven months before the final examination.

It is highly recommended that the student decide at least one semester in advance to take the preliminary exam. This decision must have the concurrence of the student's major professor and the student must fill out the proper Graduate School forms. The student should notify the department secretary of his or her intention to take the preliminary examination at least eight weeks prior to the test date. The preliminary exam will begin about one month after fall or spring classes begin.

The preliminary examination's purpose is to verify that a student is capable of performing quality research in his/her chosen field. The preliminary exam has two parts. The first part is an exam to test the student's ability to perform research in his or her chosen field. The second part is a proposal of the student's Ph.D. dissertation topic, which includes a plan on how the student will complete the research.

Preliminary Exam Part 1

The first portion of the Preliminary Exam is to test that the student can perform research in his or her chosen area. The student selects one of the six core areas. The Supervisory Committee prepares two or three research questions that relate to this area. These questions cannot be directly related to the student's Ph.D. research topic. The student selects one of these questions and has between two and five weeks to prepare a written response. This response should include a review of the existing literature and a description of how to solve the research problem. The student should anticipate preparing a solution to the problems in a proper research format (either a journal article style or an NSF research grant style). Two weeks after submitting the written report to the Supervisory Committee, the student will present an oral defense of his or her work.

Upon conclusion of the oral defense, the committee will decide whether or not the student passed the first part. A failure of the first part is considered a failure of the Preliminary Exam. The student, with approval from the Supervisory Committee, may take the exam a second time. This retake must be completed during the next fall or spring semester. A third retake is not allowed. If the student passes this first part, then he or she continues to the second part.

Preliminary Exam Part 2 Dissertation Proposal

Within six weeks of the student completing the first part of the preliminary exam, the student must complete the second part of the Preliminary Exam. This second part consists of the student presenting and defending his or her proposed Ph.D. dissertation research to the Supervisory Committee. The student outlines his or her research topic in writing; the NSF proposal format is recommended. This document must be submitted to the Supervisory Committee at least one week before the oral defense. During the oral defense, committee members can examine the hypothesis, feasibility, depth, methods, and other details based on the presentation and the written proposal.

If the proposal does not satisfy the Supervisory Committee, then the student fails the Preliminary Exam. The student, with approval from the Supervisory Committee, may take the exam a second time. This retake must be completed during the next fall or spring semester. In performing this retake, the student would not need to retake the first part of the Preliminary Exam. There is no opportunity for a third retake.

If the student passes, then the student has passed his or her Preliminary Exam and is considered a candidate for a Ph.D. in Industrial Engineering. To help the candidate achieve his/her research goals, the committee members may suggest additional courses or avenues of research for the student to pursue.

DISSERTATION

A doctoral candidate must complete a dissertation. A critical aspect of a Ph.D. degree is publication. Every student must have submitted **at least two papers** related to the student's Ph.D. research to journals prior to scheduling the final defense.

Each student must summarize his or her research on a poster that will be used to advertise their defense. This poster must be approved by the major professor and be completed at least 24 hours prior to the student's final examination.

FINAL EXAMINATION

A final examination (dissertation defense) is required for the Ph.D. degree. The examination will be administered after the student has completed the program of study and other requirements or in the term in which the candidate intends to complete them. The oral examination will be conducted on his or her thesis. Its purpose is to test the student's research work. An outside chairperson, appointed by the graduate school, will supervise the examination. Students must turn in their dissertation within three months of their final examination date.

Some of the guidelines for this oral examination are listed in the following:

- (1) The ideal presentation time is 20 to 30 minutes and certainly should not be more than 40 minutes. The primary purpose of the examination is to present the research contribution and defend its value.
- (2) The examination is divided into three parts:
 - (a) The first part is an oral presentation by the graduate student. This portion of the exam is open to the public. Questions from the general audience are allowed.
 - (b) During the second part, the public audience is excused. Only the committee members and the candidate should be present. The committee will examine the candidate in more depth.
 - (c) The third part of the exam is the deliberation by the committee members to render judgment on the quality of the work. Only the committee members should be present.
- (3) The committee may decide to pass, pass with qualification, or fail the student. Negative votes by half or more of the members of a supervisory committee constitute failure. A candidate who fails a Ph.D.'s examination may take a second examination no sooner than two months or later than 15 months after the failure, unless an extension is granted by the Dean of the Graduate School. No third trial is allowed.

- (4) **Two working papers** submitted to the Department's file system is required for Ph.D student before the graduation.
- (5) The Chairperson and Supervisory Committee may decide to pass, pass with qualification, or fail the student. Negative votes by half or more of these individuals constitute failure. A candidate who fails a Ph.D.'s examination may take a second examination no sooner than two months or later than 15 months after the failure, unless an extension is granted by the Dean of the Graduate School. No third trial is allowed.

GRADUATE SCHOOL REQUIREMENTS

In addition to the requirements listed here, the student must also satisfy all the requirements of the graduate school to obtain a Ph.D. degree.

Ph.D. IN INDUSTRIAL ENGINEERING

The requirements and program format for the Ph.D. degree is summarized on the following page.

KANSAS STATE UNIVERSITY
DEPARTMENT OF INDUSTRIAL & MANUFACTURING SYSTEMS ENGINEERING
Doctor of Philosophy
 Program Format and Minimum Requirements[♦]

Admission to the Ph.D. program in the Department of Industrial Engineering is based on a vote of the departmental graduate faculty. Decisions concerning financial assistance are the responsibility of the Department Head.

<u>With an MS degree</u>	<u>Hours</u>	<u>Without an MS degree</u>	<u>Hours</u>
One class from 5 of 6 core areas	15**	One class from 5 of 6 core areas	15**
Optimization IMSE 780, 881 or 882		Optimization IMSE 780, 881 or 882	
Stoch. Proc. IMSE 865, 866 or 971		Stoch. Proc. IMSE 865, 866 or 971	
Statistics IMSE 841, STAT 713, 720 or 722		Statistics IMSE 841, STAT 713, 720 or 722	
Prod. and Inv. IMSE 811		Prod. and Inv.: IMSE 811	
Ergo. and Dec. The. IMSE 751, 822 or 850		Ergo. and Dec. The. IMSE 751, 822 or 850	
Manufacturing IMSE 825 or 868		Manufacturing IMSE 825 or 868	
Maximum credit for MS	30	Additional graded courses	24
Additional credit hours	15	Additional credit hours	21
Ph.D. research hours	<u>30</u>	Ph.D. research hours	<u>30</u>
Total graduate credit hours	90*	Total graduate credit hours	90*

Additional graded courses must be courses that are awarded a letter grade.

Additional credit hours can be graded courses or taken for credit/no credit such as Ph.D. research.

If the Graduate School approves less than 30 hours of credit for an MS degree, then the remainder of the 30 hours (up to a maximum of 24 hours) must be taken as additional graded courses. These additional hours must be graded courses.

* Students are required to enroll in the graduate seminar (IMSE 892) each semester.

** A student may satisfy a core course requirement by passing an examination. In such a situation, the student may take an additional 3 hours of graduate graded courses in place of a core course.

FINANCIAL AID

To facilitate research work, the IMSE Department provides financial aid to selected graduate students in the form of teaching and research assistantships. Financial aid decisions are made separately from the admission decisions.

Assistantships are not grants. Students who are awarded an assistantship must do their work. Failure to perform will result in a loss of the assistantship. To maintain an assistantship requires that the student make significant academic progress toward graduation each semester and that the student satisfies the work requirements specified by their supervisor.

Graduate assistants are employees of the university. In addition to your assistantship, out-of-state students receive tuition reductions of approximately \$2200 per semester, which averages out to about \$550 per month. Normally graduate assistants on a 4-tenths appointment are responsible for 16 hours work per week; graduate assistants on a 5-tenths appointment are responsible for 20 hours per week. This time should be spent helping your supervisor with any chores he or she may want done (library work, lab supervision, grading papers, running experiments, etc.)

Graduate Teaching Assistants (GTAs) and Graduate Research Assistants (GRAs) are eligible for health insurance benefits. The GTA or GRA must be on a 5-tenths appointment. Brochures are available through the departmental office.

Your assistantship is contingent on both good work performance and good grades. Your work performance will be evaluated each semester by your supervisor (not necessarily your advisor). Based on the supervisor's evaluation, your rate of pay may be adjusted upward or downward. Your assistantship may be discontinued if:

- (a) The student's supervisor gives the student a poor evaluation
- (b) The student makes C or lower grades in any class
- (c) The student withdraws from classes
- (d) The student does not accomplish research to the satisfaction of their advisor

Failure to comply with these requirements will result in a reduction in your assistantship. If you work at some other job on campus to earn extra money (e.g., at the Union) it must be limited to five hours per week.

Assistantships may be funded by either the department or a sponsored project. The Department Head determines which students will be put on departmental support and makes out the work assignments each semester. Each student on departmental support will be assigned to a faculty member to support our educational programs. This assignment will be for 4-10 hours/week. You will be expected to assist your supervisor in teaching their course(s) in areas such as: monitoring a laboratory, grading, running experiments, gathering resource materials, serving as a teaching assistant, etc. The balance of your assignment will be spent working to support our research mission by assisting your assigned faculty member with their research needs. These assignments could include helping with instruction as noted before or include library work, running experiments, critiquing papers, analyzing data, programming, writing research proposals, or summarizing research results.

When a faculty member successfully earns a grant from a funding agency to support graduate students, they are free to decide which graduate students they would like to support on the grant. A decision to support a student for one semester is not a guarantee of support throughout the student's educational program. The faculty member who earned a grant is responsible for accomplishing the research specified in the proposal. If the work is not accomplished for whatever reason or the funds are pulled from the project, the student may lose their assistantship. The student must realize that significant work must be accomplished every semester in order for the project to be successful. The department cannot commit to support every student who is dropped from a sponsored project.

Loss of assistantship: Students may lose their assistantship if they fail to accomplish their assigned work or if they fail to make significant progress. Those students on departmental support will be evaluated at the end of each semester to determine whether the assistantship will be continued. Students on a funded project will be

continually evaluated by the supervisor. If a student is not working well or progressing academically, they will be warned in writing that they are in danger of losing their assistantship. If the situation does not improve immediately, they will lose their assistantship.

Vacation Leave: Graduate students appointed as Research Assistants (GRA) or Teaching Assistants (GTA) do not have a paid leave. Students are paid for their work on campus and are not paid during vacation, travel home, or any other leave not related to their work. Other arrangements must be made with the research advisor for GRAs. Each individual on a GRA or GTA appointment who will not be on campus during periods when the university is open must notify the IMSE office and his/her faculty supervisor.

ASSISTANTSHIP RULES

The following rules apply to graduate students on support.

- (1) All graduate students on an assistantship must complete a thesis or dissertation.
- (2) Students on assistantships are normally required to work 16 hours work per week (.4 appointment) or 20 hours work per week (.5 appointment). This time will be spent helping the student's supervisor (not necessarily the student's advisor). Tasks may include research, library work, lab supervision, grading papers, etc.
- (3) The maximum number of graduate credit hours a student can take while on a .4 appointment is 12 graduate credit hours and on a .5 appointment is 10 graduate credit hours. Exceptions to this policy must obtain written permission from the department and the graduate school.
- (4) All students, who receive financial aid, must take at least 6 graduate credit hours during each fall and spring semester.
- (5) The assistantship is contingent upon both good work performance and good academic performance. Work performance will be evaluated each semester by the student's supervisor. The student's rate of pay may be adjusted upward or downward based on their evaluation. The assistantship will be discontinued if any of the following conditions occur:
 - (a) The student's supervisor gives the student a poor evaluation
 - (b) The student makes C or lower grades in any class
 - (c) The student withdraws from classes
 - (d) The student does not accomplish research to the satisfaction of their advisor
- (6) Non-assistantship related work (outside or somewhere else in the university) must be limited to no more than five hours per week.
- (7) Failure to file a program of study by the end of the first semester of study will result in suspension of the assistantship

The following rules apply only to those Master's students on *departmentally funded* support:

- (1) Master's students are not supported by the department during the summers
- (2) Students will be funded at most for four semesters. Any exception must be approved by the IMSE Graduate Committee
- (3) Students will be assigned to support both our educational and research missions. They will typically have two different supervisors for this work

The following rules apply only to those Ph.D. students on *departmentally funded* support:

- (1) Ph.D. students on support will be normally funded for up to three years including summers.
- (2) Students will be assigned to support both our educational and research missions. They will typically have two different supervisors for this work.

GRADUATE STUDENT PRIVILEGES

Mail Boxes: Each graduate student is assigned a mailbox in the department. These boxes are in the central office. These boxes should be used primarily for business correspondence and for internal communication purposes (including telephone messages). Students should be quiet and considerate of the business being conducted in the office while checking for or retrieving their mail. Graduate students should have their personal correspondence sent to their residential address. Your address here is as follows:

Name
Department of Industrial & Manufacturing Systems Engineering
Kansas State University
2061 Rathbone Hall
Manhattan, Kansas 66506-5101

Computer Accounts: Each student may apply for a computer account on the department's network. The department's network is used for class information (e.g., homework assignments, rescheduling, etc.) and department information. Here, students will have access to PC and workstation computing and through these to the University's computing resources. Access to the university computing facilities may be obtained by applying to the KSU Computing and Networking Services for an account.

Computing facilities in Durland 130 and 134 are available for use by IMSE graduate and undergraduate students. These labs are only for IMSE students. DO NOT allow colleagues from outside the department to use these facilities without explicit permission from the Department Head.

Offices: There is a lack of office space for graduate students. Requests for office space must be made by a student's major professor, rather than the student. IMSE faculty and staff review office assignments each semester. The status of each graduate student is (re-)evaluated and adjustments to the student's priority in getting/keeping an office are made; office space may be taken from one student and given to another. Generally, offices are given in the following order: Ph.D. students on a support, Ph.D. students, visiting scholars, Master's students on a GRA/GTA, and Master's students pursuing a thesis. If someone has any concerns over offices, they may take their concerns to a member of the Graduate Committee.

Once assigned an office, students could be asked to leave if:

- They have not made sufficient progress toward their degree in the last semester.
- Their student status has changed, i.e., dropped from assistantship, put on academic probation, changed to a coursework only degree, etc.
- They have been irresponsible with department space or equipment, i.e., damaged their office space, broken furniture or equipment, posted inappropriate material, etc.
- They were not good neighbors in their office, i.e., there were complaints from others assigned to the office that they were interfering with their work in some way.

Students may post things inside their office under the following restrictions:

- (1) Items may be posted only with thumbtacks - no adhesive materials are to be used - on the special bulletin board panels. If in doubt, ask a member of the department staff.
- (2) No items may be attached to the painted walls - either by tack or by using adhesives.

Computer Labs: A student can access the computer labs 24 hours a day. However, **priority on the computers must be given to those students who are enrolled in Simulation, IMSE 643.** No food or drink is allowed in the labs. Periodically and without warning, excess information is erased from the hard drives. So, please save all important files to either your h: drive or on disk. These computers are designed to assist you with courses and research, (**No game playing**).

Keys: The following rules apply to IMSE Departmental keys assigned to you during your enrollment with the department.

- (1) You are required to report ALL lost keys AS SOON AS they are discovered missing. You will be responsible for all costs incurred for the loss of your keys. This cost may include the rekeying of the lock if it is deemed necessary to protect the room and equipment for which the key was lost.
- (2) During the semester that you graduate and PRIOR TO YOUR LEAVING CAMPUS, you are required to return ALL keys assigned to you and which you have not previously reported missing, to Ms. Vicky Geyer (Durland 205). This must be done NO LATER THAN the last day of final examinations for that semester. Ms. Geyer will mark her records indicating your return of these keys and will return the keys to Dykstra Hall for you. This should simplify the process of returning keys for you.
- (3) Students who do not satisfy these requirements:
 - will be placed on DELINQUENT STATUS with the university
 - will not be able to receive copies of their transcript, and
 - will not be allowed to enroll in the University again until the DELINQUENCY is resolved.

Additionally, such students can expect to receive recommendations from departmental faculty that reflect their irresponsible handling of departmental keys. Graduate assistants who are delinquent will not receive their last paycheck from the University.

Lockers: There are a few lockers on the ground floor of Durland that may be used by IMSE students by asking for permission in the departmental office.

- (1) You must put your name, address, and phone number on a card taped to the outside of the locker door. It should be taped to the locker so it will not fall off or be brushed off easily.
- (2) You must supply your own combination lock and the combination must be on file with Ms. Vicky Geyer (Durland 205).
- (3) When you leave the department you must remove your lock and empty out the locker. Unlabeled lockers will have their locks cut off and the contents discarded. This has been done on a number of occasions in the past.
- (4) Please follow the rules and do not select a locker unless you will really use it. With a locker for the storage of your coats and books, you will be able to study in one of the study carrels or in the library on the second floor of Durland.

Laboratory Usage: Keys to laboratories are available only to those who need to use the laboratory. They may be acquired by asking your major professor to request a key for the specific lab to which you need access. The major professor will request a key for you through the Department Head. Rules for office keys apply to laboratory and building keys as well. Any graduate student who plans to work in one of the departmental laboratories when the main office is not open should have permission to do so

Production Processes Use: No one should ever work alone with the manufacturing processes equipment. Another graduate student or professor must be present in case an emergency situation occurs. Any graduate student who plans to work in the manufacturing laboratories when the main office is not open should have permission to do so. To acquire this permission, they must pass a safety test and demonstrate that they have sufficient knowledge to safely operate the equipment that they plan to use. The major professor must request permission from the Department Head for each graduate student that wants to use the manufacturing labs outside of normal working hours.

Copier: The department has a copy machine in its main office complex. This copier is to be used for official business only. The rule about copying is: **IF IT IS NOT DEPARTMENT BUSINESS FOR PROFESSOR RESEARCH, COPYING IS NOT ALLOWED!** The only time you may use the copier is when your professor/supervisor gives you work to copy. Please let the office staff know whom you are making copies for. Your professor/supervisor is assigned a code number on the copy machine and he/she will give you that code in order for you to copy. The office staff will not supply you with the code.

You may not make copies and pay cash for them. Both the Engineering Copy Center in the Fiedler Library and the Union Copy Center do good work for six cents per copy.

You CANNOT use the department's copy machine or printing facilities to make copies of your thesis, or other school documents. You are only allowed to print the original document using our print facilities. You should make all necessary copies using personal or commercial resources.

Coffee Room: The key to your office opens the break room (DU 208). The room contains a microwave, a refrigerator, a coffee maker and a phone (local calls only). Our students in the past have used this break room in a thoughtful and considerate way, which is why we continue to invite them to do so. Please clean up after yourself and under no circumstances should coffee grounds be dumped into the sink!

Occasionally, snacks are brought into the coffee room to be shared by the faculty and staff. Unless you are specially invited to have some of this food, you should assume that it is intended for faculty and staff. When sufficient quantity is available, you will be invited to partake.

Practical Training: The IMSE Department will not approve practical training for students admitted and enrolled to work toward the Ph.D. degree but decided not to complete the Ph.D. degree requirements. All practical training recommendation letter will be given to student only **after student has submitted a draft of his/her thesis to the thesis committee and scheduled the date of the final defense.**

Conference Travel Support: PhD students and MS thesis students are encouraged to present their research at professional conferences. Each PhD student will be granted a maximum of \$2000 and each MS thesis student will be granted a maximum of \$1000 in travel funds from the IMSE Department during the course of his/her studies. If a student completes an MS and begins a PhD, any amount granted during the MS does not count toward the total for the PhD.

To be eligible for funds, a student must submit a request according to the IMSE Graduate Student Travel Funding Request Process outlined here. This information and the relevant forms are also available at: <http://www.imse.ksu.edu/grad/travel/>.

1. Student prepares [IMSE Graduate Student Travel Request form \(pdf\)](#), including budget and supporting documentation for expense estimates.
2. Student prepares and submits [Graduate Student Council Travel Award application](#) (note that the deadline for this is typically more than 2 months in advance of travel date).
3. Upon notification about GSC funds, student enters this information on the IMSE Graduate Student Travel Request form.
4. Student submits IMSE Graduate Student Travel Request form to faculty supervisor, who enters amount committed. Student and supervisor agree on amount to request from department and college and enter these requests on the form. Note that to be eligible to receive college funds, the faculty supervisor and the department must commit an amount that is at least what is requested from the college (1:1:1 match).
5. Student submits IMSE Graduate Student Travel Request form to IMSE department office. Department head approves/rejects department request.
6. Student submits scanned pdf copy of updated IMSE Graduate Student Travel Request form, completed [ERGP Travel Request Form \(Excel\)](#), notification from Graduate Student Council, and confirmation of conference presentation acceptance by email to faculty advisor, department head, and College of Engineering Research and Graduate Programs Office (ergp@ksu.edu). ([See ERGP policy](#)).
7. Within two weeks of completion of travel, student submits a trip report (as detailed in the IMSE Graduate Student Travel Request form) to the faculty supervisor. This report must be approved by the faculty supervisor and then subsequently submitted to the IMSE department head.

8. Within two weeks of completion of travel, student submits necessary documentation of expenses for reimbursement to department and university offices. The IMSE department will not process reimbursement until the trip report has been approved by both the faculty supervisor and the IMSE department head.

Poster funds: PhD students and MS students completing a thesis are encouraged to give poster presentations for their research at a campus research forum or a technical conference. Students interested in poster presentation should obtain permission from their major professor to do so. The IMSE department will cover the printing cost of one poster per year (not to exceed \$150) for each student.

APPENDIX A: IMSE FACULTY AND THEIR RESEARCH INTERESTS

KANSAS STATE UNIVERSITY INDUSTRIAL AND MANUFACTURING SYSTEMS ENGINEERING

David Ben-Arieh – Ph.D. Purdue University, 1985, Robotics, Computer Aided Manufacturing, Expert Systems

Shing I. Chang – Ph.D. Ohio State University, 1991, Quality Control, Statistical Process Control, Quality Engineering

Todd W. Easton – Ph.D. Georgia Institute of Technology, 1999, Operations Research, Graph Theory, Integer Programming

Jessica Heier Stamm – Ph.D. Georgia Institute of Technology, 2010, Operations Research and Industrial Engineering applications to humanitarian relief and public health efforts

Bradley A. Kramer – Ph.D. Kansas State University, 1985, Production Planning and Control, Manufacturing Systems Engineering, Computer Aided Manufacturing

E. Stanley Lee – Ph.D. Princeton University, 1962, Operations Research, Queuing Theory, Stochastic Systems, Uncertainty Reasoning

Shuting Lei - Ph.D. Purdue University, 1999, Manufacturing Processes, Manufacturing Engineering

Margaret Rys – Ph.D. Kansas State University, 1989, Ergonomics, Occupational Safety Engineering

John Chih-Hang Wu – Ph.D. Penn State University, 1993, Operations Research

Meng (Peter) Zhang – Ph.D. Kansas State University, 2014, Advanced Manufacturing

Rev: December 14, 2016

APPENDIX B: IMSE COURSE LISTING

S'03

KANSAS STATE UNIVERSITY DEPARTMENT OF INDUSTRIAL AND MANUFACTURING SYSTEMS ENGINEERING

Courses for Undergraduate Credit

- IMSE 015 **Engineering Assembly.** (0) I,II. Assemblies are held once a month for practicing industrial engineers to make presentations to the students. Students are given an opportunity to interact with the visitors. The purpose is to provide an opportunity to learn about various companies and their products and operation. Required every semester.
- IMSE 050 **Industrial Plant Studies.** (0) II. Trip to industrial centers for study of facilities of special interest to industrial engineering students. Pr.: Junior standing in industrial engineering.
- IMSE 201 **Introduction to Industrial Engineering.** (3) I. Introduction to the major functions of industrial engineers with emphasis on the analysis, design and control of production systems. Two hours lec. and two hours lab a week.
- IMSE 250 **Introduction to Manufacturing Processes & Systems.** (2) I, II. This course provides an introduction to manufacturing processes and systems. The history and impact of manufacturing on society will be explored. A review of manufacturing processes and the products to which they are best suited will be emphasized. The impact of product design on manufacturability will be introduced. The role of engineers in designing good manufacturing processes and systems will be discussed. Two hours lec. a week. Pr.: sophomore standing.
- IMSE 251 **Manufacturing Processes Laboratory.** (1), I, II. General introduction to foundry, welding, and machining. Includes safe manufacturing practices, metrology, and hands-on experience in foundry, welding, and machining operations. Three hours lab/week. Pr. or Conc.: IMSE 250, ME 212.
- IMSE 252 **Welding Laboratory.** (1) I. Introduction to welding. Includes safe welding practices and lab experiments in gas, spot, and arc welding. Three hours lab/week. Pr. or Conc.: IMSE 250, ME 212.
- IMSE 253 **Net Shape Manufacturing Laboratory.** (1) I. Includes safe manufacturing practices and experiments in casting and injection molding. Three hours lab/week. Pr. or Conc.: IMSE 250, ME 212.
- IMSE 254 **Machining Laboratory.** (1) I, II. Production of machined parts. Includes metrology, safe machining practices, reading shop drawings, and good machining practices. Three hours lab/week. Pr. or Conc.: IMSE 250, ME 212.
- IMSE 255 **Computer Numerical Control Laboratory.** (1) II. Introduction to Computer Numerical Control. Part Programming for CNC lathes and mills will be accomplished. Three hours lab/week. Pr.: IMSE 253 or 254.
- IMSE 499 **Honors Research in Industrial Engineering.** (Var.) I,II. Individual research problem selected with approval of faculty advisor. Open to students in the College of Engineering honors program. A report is presented orally and in writing during the last semester.

Courses for Undergraduate Credit and Graduate Credit in Minor Field

- IMSE 501 **Industrial Management.** (3) I,II. Basic functions in an industrial organization and their interrelationships; management considerations involving product, process, plant, and personnel. Three hours rec. a week.
- IMSE 530 **Industrial Project Evaluation.** (3) I, II. The evaluation of the economic aspects of industrial projects. Focus on decision making among competing alternatives. Concepts of time-value of money, effects of taxation, depreciation, and inflation. Methods of comparing alternatives are developed, including: equivalent worth, rate of return, payback period, and benefit-cost ratio. Risk/uncertainty, sensitivity, break-even and replacement analysis as well as estimating methods and cost concepts. Three hours rec. per week. Pr.: MATH 222.
- IMSE 541 **Statistical Quality Control.** (3) I, II. Normal, binomial, and frequency distributions. Seven process improvement tools. Control charts on means and variances for variables and attributes. Design of experiment for process and product design. Acceptance sampling plans. Two hours rec. and two hours lab a week. Pr: CIS 209, PR.: or conc.: STAT 511.
- IMSE 555 **Industrial Facilities Layout and Design.** (3) I, II. Design of industrial facilities with emphasis on manufacturing engineering and material handling. Two hours rec. and two hours lab a week. Pr.: IMSE 250 and IMSE 251.
- IMSE 560 **Introduction to Operations Research I.** (3) I, II. A study of the methods of operations research including model formulation and optimization. Topics include: assignment/transportation problems, linear programming, network flows. Three hours lec. a week. Pr.: CIS 209 and Math 222.
- IMSE 563 **Manufacturing Processes Engineering.** (4) II. A study of the effects of operating variables on manufacturing processes such as machining, metal forming, casting, welding, plastics, etc. Emphases are on manufacturing process theory, process variables measurement, and the technical inferences of collected data. Strength of materials, manufacturing process theory, instrumentation, computer data acquisition, and data analysis concepts are included. Laboratory testing of manufacturing processes and the engineering design of experiments for process variable measurements are used to develop efficient manufacturing processes. Three hours rec. and three hours lab a week. Pr: IMSE 240 and IMSE 251, CHE 352, CE 530 or Statics equivalent.
- IMSE 564 **Product and Process Engineering.** (3) I. A study of the interrelationships between product design and production process selection. Emphasis is on the development of economic production systems for discrete products in a

competitive manufacturing environment. Concepts of design for manufacture and assembly, tool engineering, and manufacturing systems design are included. Two hours lec. and three hours lab per week. Pr.: IMSE 250 and IMSE 251.

S'01

**KANSAS STATE UNIVERSITY
DEPARTMENT OF INDUSTRIAL AND MANUFACTURING SYSTEMS ENGINEERING**

Courses for Undergraduate and Graduate Credit

- IMSE 580 **Manufacturing Systems Design and Analysis.** (4) II. Comprehensive design and analysis of a manufacturing system; integration of the undergraduate industrial engineering and manufacturing engineering option courses. Two hours rec. and four hours lab a week. Pr.: Senior standing within 35 credit hours of graduation.
- IMSE 591 **Senior Design Project.** I. (2) I, II. Students organize themselves in teams, not exceeding 5 students in each team. The teams select a general subject, formulate a specific design project and gather data and resources needed to support the project. Two hours rec. a week. Pr.: Senior standing within 35 credit hours of graduation.
- IMSE 592 **Senior Design Project.** II. (2) I, II. Continuation of IMSE 591 in which student teams complete engineering design projects formulated and approved in IMSE 591. Two hours rec. a week. Pr. or Conc.: IMSE 591.
- IMSE 602 **Topics in Industrial Engineering.** (Var.) I,II, S. Lectures on recent topics in industrial engineering.
- IMSE 604 **Independent Study of Industrial Engineering.** (Var.) I,II,S. This course involves independent study at the introductory graduate level.
- IMSE 605 **Advanced Industrial Management.** (3) I. Managing groups of employees in engineering settings; theory of organization design; designing engineering and technological organizations; professionalism and ethical considerations in engineering. Three hours lec. a week. Pr.: IMSE 501.
- IMSE 610 **Occupational Safety Engineering.** (3) II. An overview of factors affecting safety in organizations, emphasizing analysis techniques and design strategies. Topics include occupational safety, accidents, fire protection, industrial hygiene, hazardous waste, toxicology, radiation safety, product liability and federal standards. A project involving a hazard analysis and the design of a solution for a field location is required. Three hours lec. a week. Pr.: IMSE 250 and IMSE 251.
- IMSE 612 **Hazardous Materials Management.** (2) I. All aspects from generation to final disposal will be studied, including: identifying hazardous materials, chemical safety, storing and shipping chemicals, and treatment and disposal of hazardous wastes. Two hours lec. a week. Pr.: CHM 230.
- IMSE 623 **Industrial Ergonomics.** (3) I, II. Process analysis and charting; principles of motion economy and ergonomics; work stations and environments; micromotion analysis and an introduction to standard data systems. Two hours rec. and three hours lab a week. Pr. or conc.: STAT 510.
- IMSE 625 **Work Environments.** (3) II. Basic structure and performance of the human, viewed as a component in information processing and control systems. Effect of visual, auditory, toxic, and thermal environments. Two hours rec. and two hours lab a week. Pr.: IMSE 250 and IMSE 251.
- IMSE 633 **Production Planning and Inventory Control.** (3) I, II. Principles, techniques, and applications of production planning and inventory control. Design of control systems. Three hours rec. Pr.:IMSE 250 and IMSE 251. Pr. or conc.: IMSE 560.
- IMSE 641 **Statistical Process Control in Manufacturing.** (3) II. An introduction to the modern practice of quality engineering concepts, systems, strategies, and tools. Topics include advanced techniques related to statistical process control, international quality standards, quality data management, and automatic inspection. Three hours lec. a week. Pr.: STAT 511.
- IMSE 643 **Industrial Simulation.** (3) I, II. Basic concepts of computer simulation modeling of manufacturing, production, service and other systems. Use of a commercial simulation software environment to build, analyze, verify and validate models. Use of models as a system design tool. Three hours rec. per week. Pr.: IMSE 560. Pr. or conc.: STAT 511.
- IMSE 660 **Introduction to Operations Research II.** (3) I, II. Continuation of IMSE 560. Topics are decision theory, nonlinear programming, dynamic programming, Markovian decision processes, and queuing theory. Three hours lec. a week. Pr.: IMSE 530, IMSE 560, STAT 510.
- IMSE 662 **Computer Aided Manufacturing.** (3) I. Concepts in CAM, integrated control of machine tools and transport devices with production control. Concepts of CAM and automated assembly in small lot production environment. Two hours lec. and three hours lab a week. Pr.: IMSE 250 and IMSE 251 and CIS 209 or equiv.
- IMSE 671 **Topics in Automated Factory Concepts.** (3) I. Introduction to concepts of automation, automatic transfer lines and CAD/CAM. Emphasis on robots and their role in automated factories. Concepts of group technology, computer-aided process planning, automated material handling equipment for automated factories. Three hours lec. a week. Pr.: IMSE 662 and IMSE 633.
- IMSE 672 **Robotic Applications.** (3) II. History, development of the work environment for robots, their application and implementation. Concepts of control and sensory feedback in robots are covered. Three hours lec. a week. Pr.: IMSE 250 and IMSE 251 and CIS 209.

- IMSE 680 **Quantative Problem Solving Techniques** (3) Summer. Survey of decision making techniques. Topics covered include: Linear, Integer and Nonlinear Programming, Network Flows and Stochastic Processes. A focus of the course will include modeling and the use of software to solve these problems. Three hours lecture a week. Pr. Math 205.
- IMSE 685 **Principles of Manufacturing Information Systems.** (3) II. Introduction to the theory and concepts of information for manufacturing. Design of manufacturing systems such as MRP, SFRS, CAD/CAM, etc. Concerns of integration and man-machine interface in manufacturing systems. Three hours lec. a week. Pr. or conc.: IMSE 633.
- IMSE 751 **Normative Decision Theory and Games.** (3) I, in odd years. Baye 's theorem, Bayesian estimators, utility, loss function and risk, minimax strategies, elementary game theory. Three hours rec. a week. Pr.: STAT 511 or equiv.
- IMSE 780 **Methods of Operations Research.** (3) II. An overview of O.R. at the graduate level. After this course, the student will have the general basic knowledge in O.R. and a better idea about the usefulness and interrelationships of the various subjects in O.R. Topics to be covered include the various optimization techniques, stochastic processes and optimization, and the various approaches in the treatment of uncertainty. Three hours recitation per week. Pr.: MATH 222 and STAT 510.

Courses for Graduate Credit

- IMSE 802 **Advanced Topics in Industrial Engineering.** (Var.) I,II, S. Lectures on recent advanced topics in industrial engineering.
- IMSE 804 **Advanced Independent Study in Industrial Engineering.** (Var.) I,II,S. This course involves independent study of recent advanced topics in industrial engineering.
- IMSE 805 **Engineering Administration.** (3) I. Engineering administration; organization factors in decision-making. Three hours rec. a week. Pr.: IMSE 501.
- IMSE 806 **Engineering Project Management.** (3) II. Planning, scheduling, and controlling engineering projects. Includes determination of appropriate project team, cost/benefit analysis, PERT and CPM scheduling techniques, reporting, and use of computerized project management tools. Three hours lec. a week. Pr.: IMSE 501 and IMSE 530.
- IMSE 810 **Industrial Logistics Engineering.** (3). On sufficient demand. Models for developing a logistics strategy and making logistical decisions. Three hours recitation per week. Pr. Math 240.
- IMSE 811 **Advanced Production and Inventory Control.** (3) II. Analytical and mathematical methods of making decisions on production, inventories, human resources, and shipping in modern industrial plants. Three hours rec. a week. Pr.: IMSE 633.
- IMSE 820 **Intelligent Manufacturing Systems.** (3) II. Concepts and applications of machine intelligence to manufacturing process and systems. Each student will develop a prototype system which demonstrates the appropriate application of machine intelligence to solve a practical integrated manufacturing systems problem. Two hours rec. and three hours lab a week. Pr.: IMSE 671 or equivalent.
- IMSE 822 **Advanced Engineering Economy** (3) (alternate years). This course expands on the principles of the fundamental engineering economic analysis. Emphasis is placed on quantification and evaluation of risk and uncertainty factors, capital allocation and budgeting concerns, the effects of inflation, economic consequence estimating models, engineering capital equipment replacement analyses and decision-tree and multi-attribute decision models in the context of engineering economic analysis of engineering problems. Lecture style with mini-projects, spreadsheet applications and group discussions to enhance learning. Three hour lec. a week. Pr.: IMSE 530, or ME 560, or CE 680, or equivalent.
- IMSE 825 **Tribology in Manufacturing.** (3) Taught on sufficient demand. An introduction to system approach to Tribology; Surface Topography; Physical, Chemical, and Geometric Nature of Surfaces; and the Mechanics of contact between surfaces. This course also investigates various theories of friction and wear; hydrodynamic; elastohydrodynamic, and boundary lubrication; frictional instabilities; rolling contact problems; and application of system methodology to tribological problems in engineering design and manufacturing. Pr.: PHYS 214 and IMSE 563.
- IMSE 830 **Applied Fuzzy Set Theory.** (3) I. The emphasis will be on applicational aspects. Topics covered are elementary fuzzy set theory, fuzzy measure, possibility theory, fuzzy linear programming and other fuzzy optimization techniques, fuzzy linguistics and expert systems, fuzzy production and inventory control, and fuzzy operations research models. Three hours rec. a week. Pr.: STAT 510.
- IMSE 841 **Advanced Topics in Quality Engineering.** (3) I. A survey of current advances in quality engineering. Includes both off-line and on-line quality engineering. Three hours lec. a week. Pr.: STAT 704, 705 and IMSE 641 and knowledge of Lotus 123 and (Fortran, Pascal or C.)
- IMSE 842 **Reliability Theory I.** (3) I. The mathematics of reliability theory. The hazard function. Calculation of failure density and mean life for series, parallel systems, and various types of standby systems. Hypotheses tests on mean life. Left testing with censoring. Three hours rec. a week. Pr.: STAT 511 or equiv.
- IMSE 843 **Reliability Theory II.** (3) II (alternate years). Maintenance and repair models, availability, using Laplace transforms and Markovian analysis. Basics of Bayesian decision theory with applications to reliability theory. Three hours rec. a week. Pr.: IMSE 842.
- IMSE 850 **Ergonomics (Human Factors) Engineering I.** (3) I. The design and analysis of applied experimental research on human behavior as applied to engineering systems. An experimental project. Two hours rec. and three hours lab a week. Pr.: STAT 702 or 703.

- IMSE 865 **Simulation of Industrial Management Systems.** (3) II. Simulating industrial management systems on computers utilizing Monte Carlo techniques and simulation languages. Numerical methods related to simulation. Three hours rec. a week. Pr.: IMSE 643.
- IMSE 866 **Applied Stochastic Processes and Theoretical Simulation.** (3) I in even years. Survey of stochastic processes and simulation. Topics covered include: discrete and continuous markov chains, random walks, queuing theory, renewal theory, random number generation, random variates and simulation modeling and analysis. Three hours lecture a week. Pr. Statistics 510.
- IMSE 867 **Modeling of Manufacturing Systems.** (3) II. Discussion and application of various techniques used in modeling manufacturing systems. Techniques included are discrete event computer simulation, queuing models, network models and neural network models. Three hours lecture a week. Pr.: IMSE 643.
- IMSE 871 **Advanced Topics in Computer Integrated Manufacturing.** (3) II. Modern issues of computerized manufacturing considering both hardware and software approaches and methods. Advanced concepts in intelligent machine programming and applications, group technology, computer aided process planning, and scheduling will be discussed. Research issues will be presented. Three hours lec. a week. Pr.: IMSE 633, IMSE 662 or equivalents.
- IMSE 872 **Industrial Forecasting Techniques and Applications.** (3) I. The problems of model construction for industrial forecasting. The application of least squares, regression, exponential smoothing, and adaptive fitting will be studied in solving industrial engineering problems. Three hours rec. a week. Pr.: STAT 511 or 705.
- IMSE 881 **Linear Programming.** (3) II (alternate years). Development of the theory of linear programming and related topics including simplex methods, duality theory, integer programming, transportation methods, and stochastic linear programming. Application to industrial problems and the use of computer solutions are emphasized. Three hours rec. a week. Pr.: IMSE 560.
- IMSE 882 **Network Flows and Graph Theory.** (3) I (every other year). Survey of topics from Network Flows and Graph Theory with an emphasis on algorithmic analysis. The topics covered include: Complexity Analysis, Shortest Paths, Maximum Flows, Network Simplex, Minimum Spanning Trees, Matchings, Planar Graphs, Colorings, Perfect Graphs and Heuristics. Three hours lecture a week. Pr: consent of instructor.
- IMSE 883 **Discrete Optimization.** (3) (on sufficient demand) Optimization problems involving discrete variables. Solution methods include single- and multiple-branch implicit enumeration and cutting methods. Focus is on problem formulations and solution tractability. Three hours lec. a week. Pr.: IMSE 560.
- IMSE 884 **Integer Programming and Combinatorial Optimization** (3) II (every other year). Solution techniques to optimization problems involving integer variables. The topics covered include: single-and multiple-branching, implicit enumeration, polyhedral theory and cutting planes, mixed integer programs, unimodular matrices and matroids. Three hours lecture a week. Pr.: IMSE 560.
- IMSE 885 **Advanced Manufacturing Information Systems.** (3) I. Survey of topics in Computer Integrated Manufacturing. Issues such as the Manufacturing Automation Protocol (MAP), representation of solids in CAD, storage and retrieval of such information are considered. Three hours lecture a week. Pr.: IMSE 685 or equivalent.
- IMSE 888 **Research Methods in Industrial Engineering** (3) II. This course will provide students with effective methods to perform literature reviews, survey current solution methodologies, develop and evaluate research and present research results. Pr. or concurrent at least one of IMSE 780, IMSE 641 or IMSE 811.
- IMSE 889 **Applied Methods in Industrial Engineering** (1) (upon demand). Zero hours lecture a week. This class requires the student to have at least 6 weeks of full-time work experience in a job related to Industrial Engineering. Pr: consent of Department Head.
- IMSE 892 **Graduate Seminar in Industrial Engineering.** (0) I,II. Presentation and discussion of topics of contemporary interest in industrial or manufacturing engineering. M.S. and Ph.D. candidates make one presentation. One one-hour seminar meeting a week.
- IMSE 899 **Master's Thesis.** (Var.) I, II, S. Topics selected with approval of major professor and Department Head.
- IMSE 971 **Industrial Queuing Processes.** (3) I,II. Introduction to the queuing process and theory of queues; analysis of single and multistation queues; application to production, materials handling, inventory and maintenance systems. Three hours rec. a week. Pr.: STAT 510.
- IMSE 976 **Scheduling Theory.** (3) I,II. Project scheduling, assembly line balancing, shop scheduling, basic structure, measures of performance, combinatorial and statistical aspects. Various approaches to the analysis of shop scheduling. Three hours rec. a week. Pr.: consent of instructor.
- IMSE 982 **Nonlinear Programming.** (3) I,II. Study of nonlinear models and their solution. Topics covered are nonlinear programming including Kuhn-Tucker theory, quadratic programming, separable programming, geometric programming, gradient and search methods, quasilinearization, and invariant imbedding. Three hours rec. a week. Pr.: STAT 510.
- IMSE 990 **Advanced Topics in Operations Research.** (Var.) I, II, S. (6 hrs. maximum). Study of topics related to operations research not covered in other courses. Selected according to the interests and needs of graduate students. May be repeated. Pr.: consent of instructor.
- IMSE 991 **Multiple Criteria Decision Making.** (3) I,II. Decision processes for problems involving multiple conflicting criteria; multiple attribute decision making; multiple objective decision making, and group decision making under multiple

criteria. Various methods/approaches for different problems are discussed. Three hours rec. a week. Pr.: IMSE 560 and IMSE 874.

IMSE 999

Dissertation Research (Var.) I, II, S. Topics selected with approval of major professor and Department Head.

You Know You're a Graduate Student If ...

- ...you can analyze the significance of appliances you cannot operate.
- ...your carrel is better decorated than your apartment.
- ...you have ever, as a folklore project, attempted to track the progress of your own joke across the Internet.
- ...you are startled to meet people who neither need nor want to read.
- ...you have ever brought a scholarly article to a bar.
- ...you rate coffee shops by the availability of outlets to your laptop.
- ...everything reminds you of something in your discipline.
- ...you have ever discussed academic matters at a sporting event.
- ...you have ever spent more than \$50 on photocopying while researching a single paper.
- ...there is a microfilm reader in the library that you consider "yours."
- ...you actually have a preference between microfilm and microfiche.
- ...you can time the time of day by looking at the traffic flow at the library.
- ...you look forward to summers because you're more productive without the distraction of classes.
- ...you regard ibuprofen as a vitamin.
- ...you consider all papers to be works in progress.
- ...professors don't really care when you turn in work anymore.
- ...you find the bibliographies of books more interesting than the actual text.
- ...you have given up trying to keep your books organized and are now just trying to keep them all in the same general area.
- ...you have accepted guilt as an inherent feature of relaxation.
- ...you automatically start analyzing those Greek letters before you realize that it's a sorority sweatshirt, not an equation.
- ...you find yourself explaining to children that you are in the "20th grade."
- ...you start referring to stories like "Snow White et al."
- ...you frequently wonder how long you can live on pasta without getting scurvy.
- ...you look forward to taking some time off to do laundry.
- ...you have more photocopy cards than credit cards.
- ...you wonder if APA style allows you to cite talking to yourself as "personal communication."

Courtesy of

James Beale
Dept. of Psychology
Cornell University
Ithaca, NY 14853

APPENDIX C: CHOOSING A THESIS TOPIC

The Rabbit, the Fox, and the Wolf: A Graduate Student Fable

One sunny day a rabbit came out of her hole in the ground to enjoy the weather. The day was so nice that the rabbit became careless, so a fox sneaked up to her and caught her.

"I am going to eat you for lunch!" said the fox.

"Wait!" replied the rabbit, "you should at least wait a few days."

"Oh, yeah? Why should I wait?"

"I am almost finished writing my Ph.D. thesis."

"Hah! That's a stupid excuse. What is the title of your thesis anyway?"

"I am writing a thesis on 'The Superiority of Rabbits over Foxes and Wolves.'"

"Are you crazy? I should eat you up right now! Everybody knows that a fox will always win over a rabbit."

"Not really; not according to my research. If you'd like, you can come to my hole and read it for yourself. If you are not convinced you can go ahead and have me for lunch."

"You are really crazy." But since the fox was curious and had nothing to lose, it went with the rabbit into its hole. The fox never came back out.

A few days later the rabbit was again taking a break from writing, and, sure enough, a wolf came out of the bushes and was ready to eat her.

"Wait!" yelled the rabbit, "You cannot eat me right now." "And why might that be, you fuzzy appetizer?"

"I am almost finished writing my Ph.D. thesis on 'The Superiority of Rabbits over Foxes and Wolves.'"

The wolf laughed so hard it almost lost hold on the rabbit. "Maybe I shouldn't eat you, you're really sick in the head, you might have something contagious," the wolf opined.

"Come read for yourself. You can eat me after that if you disagree with my conclusions." So the wolf went into the rabbit's hole and never came out.

The rabbit finished writing her thesis and was out celebrating in the lettuce fields. Another rabbit came by and asked, "What's up? You seem to be very happy."

"Yup, I just finished writing by dissertation."

"Congratulations! What is it about?"

"It is titled 'The Superiority of Rabbits over Foxes and Wolves.'"

"Are you sure? That doesn't sound right."

"Oh, yes, you should come over and read for yourself."

So they went together to the rabbit's hole. As they went in, the friend saw the typical graduate student abode, albeit a rather messy one after writing a thesis. The computer with the controversial dissertation was in one corner. On the right there was a pile of fox bones and on the left was a pile of wolf bones, and in the middle was a lion.

MORAL: The title of your dissertation doesn't matter - all that matters is your thesis advisor.