GRADUATE HANDBOOK

M.S. and PhD Programs

in

Mechanical Engineering
and
Engineering Mechanics

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Program Overview

1 INTRODUCTION AND OVERVIEW

Masters (MS) and Doctoral (PhD) degrees in *Mechanical Engineering* and in *Engineering Mechanics* are awarded by the Michigan State University Department of Mechanical Engineering. Students in the MS degree programs must complete 30 credits of graduate work. The MS programs *can* be completed in four semesters. Students with an MS degree in Mechanical Engineering, Engineering Mechanics, or a related area may be admitted directly into the PhD program. The PhD Degree is a research-based degree with no specific course requirements.

Most of our graduate students receive financial aid, the majority in the form of research or teaching assistantships and fellowships. Graduate students appointed as Research Assistants (RAs) work on funded research projects sponsored by various industrial and federal agencies. This work is typically the basis for the student's MS or PhD thesis. In addition to RAs, some students have appointments as Teaching Assistants (TAs). Teaching Assistantships enable many of our students to obtain both laboratory and classroom teaching experience. Many of our graduate students start in their program as TAs, but move to RA positions.

Nearly all of our graduate students are involved in a research project. Most research activity in the department is organized around one of several research laboratories, which support a variety of experimental, computational, and analytical activities. Primary focal areas of research in the department include:

- ***Thermal-Fluids:***
  Computational Fluid Dynamics, Experimental Fluid Mechanics, Combustion, Heat Transfer, Turbomachinery
- ***Manufacturing Processes:***
  Computational Fluid Dynamics, Experimental Fluid Mechanics, Combustion, Heat Transfer, Turbomachinery
- ***Mechanics:***
  Experimental Mechanics, Biomechanics, Computational Mechanics
- ***Dynamics and Systems:***
  Nonlinear Dynamics, Vibration, Control Systems, Acoustics, System Modeling

1.1 Welcome!

This handbook will make your graduate student life easier. If you have questions, consult first this handbook, then come to the department office: if you find errors or believe additional topics should be discussed, please inform the ME Graduate Program Office.

1.2 Mechanical Engineering (ME) Graduate Program

The Department of ME offers graduate programs leading to the **MS** and **PhD** degrees. There are ***three groups*** within ME:

- Systems/Controls
- Thermo-Fluids/Fluids
- Mechanics/Biomechanics

Within these **groups** are **subgroups**; within the **subgroups** are **individual faculty members**; each faculty member has **several research projects** spanning numerous subjects. Interdepartmental and cross-College collaborations are common. Intellectual diversity is promoted, fostered, encouraged, and applauded.

1.3 ME Students and Student Participation

All of our graduate students shall participate actively in the ME department. Participation consists of the following:

- Taking the required number of courses and maintaining a satisfactory performance level
- Carrying out research with your research advisor/mentor
- Attending departmental seminars

There are other forms of participation, which are encouraged but are not mandatory:

- Membership on standing ME department committees
- Membership on College-level committees
- Membership on University-level
- Assisting with on-going ME department projects

1.3.1 Two Primary Responsibilities:

Your ***first*** responsibility is to meet with your major professor (advisor) assigned to you by the department (i.e., by the graduate advisor). This temporary advisor will act as your advisor until you find a research project with a professor in ME who is willing to act as your advisor. The faculty members listed above may serve as advisors in the ME department.

Your second and most important responsibility derives from the first: Preferably in your first semester but no later than the end of your second semester you should find your permanent advisor, with whom you will carry out your MS thesis or PhD dissertation research at MSU. Your permanent advisor is your career mentor.

1.3.2 Maintain Good Status:

In order to be considered full-time, you must carry the following minimum number of credits per semester.

- MS Level:……...9 credits
- PhD Level……..6 credits
- Graduate/Professional Level……12 credits

Academic standards comprise:

- **Grades:** You must earn a 2.0 or higher in each course in the approved program of study (which is assembled with your advisor).
- **Cumulative Grade-Point Average (GPA):** You must maintain a GPA > 3.00 in the courses in the approved program of study.
- **Seminars:** All ME graduate students shall participate in the departmental seminars.
- **Probational Status:** This occurs when GPA < 3.00. You are then prevented from carrying more than 9 credits per semester or to enroll in Independent Study courses until GPA > 3.00.
- **Retention/Dismissal from ME:**
  1. **Academic Progress:** Your academic progress is evaluated each year on March 15. Satisfactory progress in the assessment of your advisor means you may continue to enroll in the program. Not making satisfactory progress will be cause for dismissal from the program.
  2. **Cumulative GPA:** If your GPA < 3.00 after completing 16 credits in the approved program of study, you will be put on *probation*. If at the end of the following semester GPA > 3.00 you may continue. If not, you shall be dismissed.

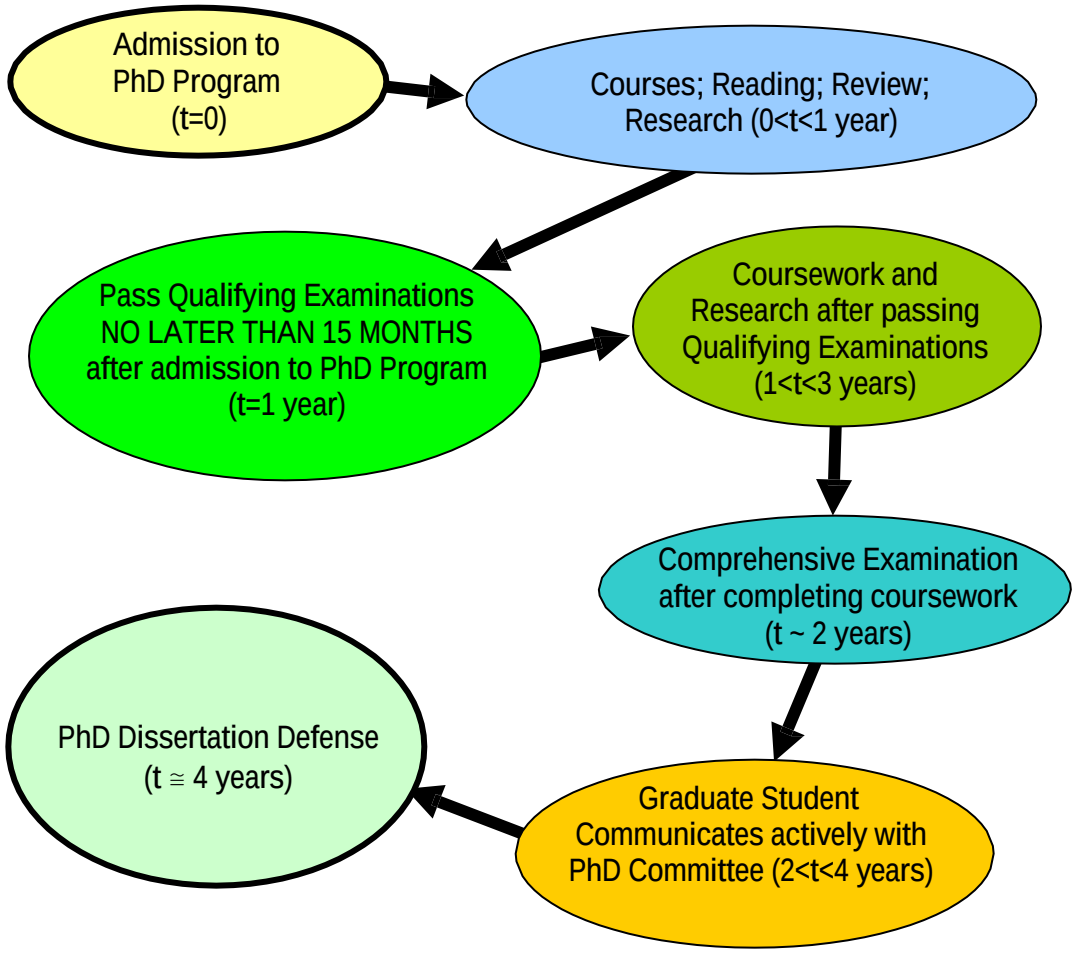
1.3.3 Typical Student Progress through the ME Program:

Although each student is different, the pattern for graduate students is generally the following:

- **MS Students:** Most MS students begin in the *Fall term* and all have financial support either as a TA, an RA, or some combination of fellowships and assistantships. Typical students register for **9 credits** per term (a considerable load): this ensures good progress to the MS. In the first summer, MS research is begun in earnest and by the *second Fall term* the student is making progress on thesis research and in the classroom. In this term the student typically registers for only one course while going full-bore on research while writing (conference) papers. A similar pattern is seen for the second Spring term. The student may attend a professional meeting or two. By the end of the second summer (before the beginning of the *third* Fall term), the typical MS thesis student is finished and gainfully employed.
- **PhD Students:** The first hurdle for a Ph.D. student is to find a research advisor. The second formal hurdle in the PhD program is the qualifying exams. Ph.D.

students must complete the requirements within 15 months of the time of their first enrollment in the Ph.D. Program. Ph.D. programs require a minimum of 42 credits of course work beyond a B.S. in Mechanical Engineering or Engineering Mechanics and a minimum of 18 credits beyond a M.S. in Mechanical Engineering or Engineering Mechanics. The Ph.D. degree requires completion of research that provides a significant, original, contribution to the state-of-the-art in Mechanical Engineering or Engineering Mechanics. The PhD is normally completed ~ 4 years from the MS. In rare cases, the PhD is completed sooner.

Graphic showing the timeline for a PhD. Note that ***t*** = time.



1.4 Additional Information

In addition to this handbook, the following web sites and addresses provide potentially useful information:

Michigan State University Academic Programs

http://www.reg.msu.edu/ucc/ucc.asp

Michigan State University Description of Courses Catalog

http://ntweb1.ais.msu.edu/j4100/scripts/CatalogSearch.asp

- Graduate School (http://www.msu.edu/user/gradschl/)
- Academic Programs (http://www.reg.msu.edu/ucc/ucc.asp)
- Vice President for Research (http://www.msu.edu/unit/vprgs/)
- College of Engineering (http://www.egr.msu.edu/egr/programs/doctoral/)
- Guidelines for Integrity in Research and Creative Activities (http://grad.msu.edu/staff/mentoreport.pdf)
- Commencement information: (http://www.commencement.msu.edu)
- Dissertation Formatting (http://grad.msu.edu/current/formatting.htm)
- Guide to Preparation of Master's Theses and Doctoral Dissertations (http://grad.msu.edu/format.htm)

Theses/Dissertation Submission Packet forms (http://grad.msu.edu/current/packet.htm)

- Application for Graduation (https://www.reg.msu.edu/StuForms/GradApp/GradApp.asp)
- Quick Guide to Enrollment and Registration Booklet (http://www.reg.msu.edu/readPDF/Enrollment_QuickGuide.pdf)
- Spartan Life: Student Handbook and Resource Guide, (http://www.vps.msu.edu/SpLife/default.pdf)
- Ombudsman's Office (http://www.msu.edu/unit/ombud/)
- Academic Freedom for Students at Michigan State University (http://www.vps.msu.edu/SPLife/acfree.htm)
- Council of Graduate Students = COGS (http://www.msu.edu/user/cogs)
- Office for International Students and Scholars (http://www.isp.msu.edu/oiss)

2 Admission

In this chapter all of the details of the MS and PhD degree requirements are described. These include conditions and requirements for admission, course requirements in the degree programs, the structure of the MS and PhD committees, and the organization and order of the qualifying exam, the comprehensive exam and the final dissertation defense.

2.1 General Admission Information

Deadlines: For full consideration for admission and financial aid:

- **December 15** for Fall enrollment. Most common semester to start a graduate program. Most of our financial aid offers are made for Fall semester.
- **September 15** for Spring enrollment. A smaller number of financial aid offers are available to Spring applicants.

Required Application Materials:

- Completed on-line application form, available on-line from MSU Graduate Admissions (http://www.msu.edu/user/gradschl/) along with an application fee of $50.00 US. See also http://grad.msu.edu/apply.htm. On-line applications are required unless impossible (non-existing internet access, etc.), in which case a mail-in application is accepted. The on-line application goes directly to the MSU Graduate School and is subsequently forwarded to the ME department.
- **Three letters of recommendation**, completed by instructors or supervisors familiar with the applicant's work. Letters of recommendation must be submitted on official stationery.
- A written **Statement of Purpose** explaining your reasons for seeking a graduate program degree. This statement of purpose is contained in the on-line application. **The following statement must be included:** *"My intended area of specialization in the graduate program in Mechanical Engineering at Michigan State University will be in _____."* Current research areas are: Automotive Engines, Bioengineering, Computational Fluid Dynamics, Computational Solid Mechanics, Manufacturing, Fluid Mechanics, Heat Transfer & Thermodynamics, Mechanics, Systems & Controls, Turbo-Machinery, and Dynamics & Vibrations.

IN ADDITION TO THE ON-LINE SUBMISSIONS DESCRIBED ABOVE, YOU MUST SUBMIT THE FOLLOWING ITEMS TO THE ADDRESS BELOW:

Department of Mechanical Engineering
Attn: ME Graduate Application Processing
Michigan State University
2555 Engineering Building
East Lansing, MI 48824-1226

- One official copy of **transcripts** from all previous universities attended.
- An official copy of your **Graduate Record Examination** (GRE).
- An official copy of **TOEFL** Scores is required from all applicants from countries where the *official language is not English*.
- A Statement of Financial Proof. This statement must originate from your source of support and must be a certified statement with an original signature. We cannot accept photocopies unless notarized, signed and sealed.
  http://www.grad.msu.edu/prospect/gradappintl.pdf

2.2 Admission Requirements: M.S. Programs

2.2.1 Admission with regular status:

Admission is granted subject to overcoming two hurdles: (1) Student qualification; (2) Departmental support availability.

- Domestic Students: Undergraduate GPA $\geq$ 3.0 or highly ranked in the BS Engineering class (i.e., high Engineering GPA).
- International Students: Upper 10% of class. Demonstrated technical through an excellent academic record and Graduate Record Exam scores. Demonstrated excellent English language through TOEFL and, if available, MSU SPEAK examination scores.

Regular admission to the MS program requires a 4-year bachelor's degree in Mechanical Engineering, Engineering Mechanics or a closely related field (e.g., Physics, Chemistry, etc.).

2.2.2 Admission with provisional status:

Collateral work is required from the student to conform their level of education with Department's requirements. These requirements indicate the skills needed to satisfactorily complete ME graduate courses and conduct research. When collateral work is required the minimum acceptable grades received by the student will be stated in the admission letter. Provisional status is removed when these conditions of admission have been met. Approval of the Mechanical Engineering Department and the Engineering Dean's Office is required.

Proficiency requirement: Students whose undergraduate degree is not in Mechanical Engineering or Engineering Mechanics must, during their course of study, demonstrate proficiency in three (3) out of the four (4) undergraduate courses below:

ME 332: Fluid Mechanics
ME 410: Heat Transfer
ME 451: Controls
ME 461: Vibrations

2.2.3 Transfer to ME from another MSU program

Transfer from another graduate program:

The transfer qualifications are similar to those for applicants in general. Proficiency requirements, support requirements, application deadlines also apply. The application process is slightly different because the student is already at MSU.

Transfer from another MSU graduate program:

Get the "Application for Admission to Graduate Study" form, write "Transfer" on top, and include items outlined below (do not need the application fee): (1) MSU application (paper); (2) All official non-MSU transcripts; (3) GRE and TOEFL scores for international students; (4) The letters of recommendation with email address of recommender; (5) Statement of purpose; (6) Completed on-line "Graduate Admissions, Recruitment, and Financial Aid Information Sheet" at the web site

https://www.egr.msu.edu/apps/gts/apply/

Make an appointment with the ME graduate coordinator and provide all of these items. Your application will then be evaluated by the ME Graduate Studies Committee and the graduate coordinator.

Degree Requirements for Transfer Students:

At least 12 of the ME credits must include courses for which a grade has NOT been received prior to admission to ME.

An ME advisor must be assigned and a second MS program filed BEFORE half the required 22 credits of ME course materials are completed.

Proficiency requirement: Students whose undergraduate degree is not in Mechanical Engineering or Engineering Mechanics must, during their course of study, demonstrate proficiency in three (3) out of the four (4) undergraduate courses below:

ME 332: Fluid Mechanics	ME 410: Heat Transfer
ME 451: Controls	ME 461: Vibrations

Applying for a second, joint, or dual master's degree from MSU

The dual degree request form is available from the Mechanical Engineering Graduate Program office. It requires approval from your current advisor along with the department advisor, chairperson and the Dean's office.

2.3 Admission Requirements: Ph.D. Programs

2.3.1 Regular Status

Admission to a doctoral degree program with regular status may be granted by the department, subject to the availability of resources and to the approval of the dean, upon consideration of the likelihood that the applicant will be able to pursue a doctoral program successfully without taking collateral courses. As evidence of eligibility for admission, the student may offer any of the following:

a. The possession of a master's degree in engineering or a related field.

b. The completion of the equivalent of a master's degree program in the major field.

c. Evidence of ability and resolution to complete a doctoral program, as attested by the department upon review of the applicant's academic record, test scores, experience, reference statements, professional qualifications, proposed studies, and other relevant information.

Admission to the doctoral program without a master's degree, or the equivalent thereof, will require special consideration by the department and the dean.

2.3.2 Accelerated Ph.D. Program Entry

M.S.M.E. and M.S. E.M. students in the Department of Mechanical Engineering at Michigan State University may apply for provisional admission to the Ph.D. program before they complete their M.S. degree program. Provisional admission through this program requires completion of

a) eighteen (18) credits of M.S. program coursework* at a GPA of 3.5 or above,
b) passing the Mechanical Engineering Department Qualifying Exam requirements and
c) an application submitted to the Mechanical Engineering Graduate Program.

To advance to regular Ph.D. student status, provisionally admitted students must complete either option 1 or option 2 below.

1. Complete all requirements of an M.S. Thesis program in the Department of Mechanical Engineering at Michigan State University.

2. i) Completion of a minimum of 22 credits of coursework* at a GPA of 3.5 or above and

   ii) Written evidence that the student has an externally reviewed paper** accepted that is based on work done in the Department of Mechanical Engineering at Michigan State University.

To remain a student making satisfactory progress towards completion of a degree, the student has one year from date of admission into the accelerated Ph.D. program to complete one of the two options above. While both options will allow regular admission

into the Ph.D. program, option 1) will generate a M.S. degree from Michigan State University while option 2) will not. The selection of either option for completion is the student's choice.

* M.S. degree program coursework includes courses at the 400 level or above with a maximum of 9 credits at the 400 level, and a maximum of nine (9) credits outside Mechanical Engineering. (Sect 3.1.1, ME Graduate Handbook) Coursework in this context does not include ME898, ME899, ME891, ME990 and ME999 (Project, Independent study and Research credits)

** An externally reviewed full paper in this context must be accepted for publication in i) an ISI abstracted journal or ii) a conference proceedings/technical transactions for a national or international engineering professional society (ISBN, ISSN numbered publications).

2.3.3 Provisional Status.

Admission to a doctoral degree program with provisional status may be granted by the department, subject to the approval of the dean:

a. To an applicant qualified for regular admission except that collateral courses are deemed necessary, or

b. To an applicant for the Accelerated Ph.D. Entry program, or

c. To an applicant whose record is incomplete.

If collateral courses or other work are required, the minimum acceptable grades and the semesters by which those courses must be completed will be specified on the admission form. The provisional status will be changed to regular status when the conditions specified on the admission form have been met, as determined by the department and approved by the dean.

2.4 Department admission selection process

Step 1: Review of applicant file. Answers the question: Is the applicant a viable candidate for graduate study at MSU?

Step 2: Make offer of admission: Examine availability of TAs, RA and fellowships that will completely support the applicant for a minimum of three consecutive semesters from the time of admission.

NOTE: Not all qualified students can gain admission because of Step 2. We cannot always offer support to all deserving applicants.

3 Graduate Degree Requirements

3.1 Master of Science (M.S.) Degree Requirements

3.1.1 Credit Requirements:

The M.S. Degree from the Department of Mechanical Engineering at Michigan State University requires a minimum of 30 credits at the 400 level or above with a maximum of 9 credits at the 400 level, a minimum of 21 credits at the 800 level or above and a maximum of nine (9) credits outside Mechanical Engineering

3.1.2 M.S. Program Form:

Before the end of the first semester in the graduate program the student must file a **MS Degree Program** form approved by the Department and College. These forms are available on the Department website and from the Mechanical Engineering program Office

3.1.3 Seminar Requirement:

First year graduate students are required to attend 7 seminars from the graduate seminar series.

3.1.4 Breadth Requirements:

The M.S. breadth requirements provide breadth at the graduate level in the student's coursework program across a majority of the technical disciplines in the major. Area requirement courses increase the technical breadth of MS students by requiring all students to complete a limited number of credits outside their primary technical discipline area. The area courses required for each degree program are distributed across Fall and Spring semesters to allow students to complete the area requirement within 1 year of enrollment

For an M.S. in Mechanical Engineering, a student must complete at least one course in three of the following four areas.

1. Thermal Sciences: ME80x or ME81x courses, or ME 822
2. Solid and Structural Mechanics: ME82x courses, except ME 822
3. Fluid Mechanics: ME83x and ME84x courses
4. Dynamical Systems: ME85x or ME86x courses

For an M.S. in Engineering Mechanics, a student must complete the following four Subject (Area) requirements:

1. ME 820 (Continuum Mechanics);
2. ME 821 (Linear Elasticity);

3. At least one of ME 861 (Advanced Dynamics) or ME 825 (Experimental Mechanics);
4. ME 800 or at least one course (approved by the student's academic advisor) at the 400 level or above in mathematics or statistics.

3.1.3.1 Plan A (Thesis)

The Plan A MS degree consists of course work, research, thesis and the final thesis defense. Because of the academic value of the research experience, almost all of our M.S. students historically choose this option.

Major Professor:

Before the end of the second semester of study the student must identify a major professor to serve as research supervisor/advisor and notify the Mechanical Engineering Graduate Program Office.

Thesis Proposal Requirement:

Early in the program the student is required to submit to the major professor and Department Chairperson a short written proposal on the thesis research.

Certifying Examination:

Michigan State University requires a Certifying Examination of all M.S. thesis program students. If the thesis defense is not successful the candidate will have one additional opportunity to defend the thesis. The timing and specific requirements to be met before the second attempt will be specified in writing by the examining committee.

Master's Thesis:

The student's M.S. Thesis must be submitted to the graduate school according to Michigan State University regulations upon approval of the student's major professor.

NOTE: The maximum of 8 thesis credits requires at least 22 credits of coursework. This can be achieved by taking eight courses (24 credits) or seven courses (21 credits) plus an independent study unrelated to thesis research (1 or more credits).

3.1.3.2 Plan B (Course Work)

Plan B consists only of 30 credits of course work. *Few ME graduate students have historically chosen this option.*

Program Advisor and Program:

During the first semester in the graduate program the student must identify a academic advisor and file a master's degree program plan.

3.1.3.3 Plan B1 (Project)

Credit Requirements:

A total of 30 credits required of which a minimum of 21 credits is at the 800 level or above including 3-6 project credits from ME 898 (Master's Project Research).

Project Proposal Requirement: Early in the program the student is required to submit to the major professor and Department Chairperson a short written proposal on the project research.

Certifying Examination: Same as Plan A.

Project Report: Submitted to the Department according to its regulations upon approval of the student's major professor.

3.2 Doctor of Philosophy (Ph.D.) Requirements

The Department of Mechanical Engineering offers two (2) Ph.D. programs: Engineering Mechanics and Mechanical Engineering. The recipients for both degrees must satisfy University, College and Department requirements. The requirements for the two degrees differ primarily in the coursework plan and qualifying examinations. The requirements of the Ph.D. Program and their deadlines are given below. The details of these requirements along with strategies to meet them are discussed in the "Graduate Degree Components" section of this handbook.

3.2.1 Advisor and Guidance Committee

An advisor must be selected and a guidance committee formed within 1 year of beginning Ph.D. study at Michigan State University.

3.2.2 Doctoral Program of Study

A Ph.D. Program form signed by each student's guidance committee must be submitted for approval to the Mechanical Engineering Graduate Program office and the College of Engineering Research and Graduate Program Office. An approved program must be filed within 1 year of beginning Ph.D. study at Michigan State University.

3.2.3 Ph.D. Qualifying Examinations

The Qualifying Examination tests the breadth of a graduate student's knowledge across the technical disciplines of the Department of Mechanical Engineering. The examination covers course material required for the B.S. degree in mechanical engineering at Michigan State University. Each part of the examination is written at the level of mastery of that material required for all mechanical engineering graduate students.

Each Ph.D. student must pass the Ph.D. Qualifying Examinations within 15 months of beginning Ph.D. study. Any graduate student (M.S. or Ph.D.) has up to three trials before this deadline.

3.2.4 Comprehensive Exam

The Comprehensive Examination tests the depth of a graduate student's knowledge in the student's individual technical discipline of the Department of Mechanical Engineering and the student's technical preparation to conduct Ph.D. level research. The examination includes course material specified on the student's Doctoral Program of Study as well as other areas the student's Advisor and Guidance Committee may specify. Each part of the examination is conducted at the level of mastery of that material required for Ph.D. graduate students in their technical discipline. Upon passing the Ph.D. Comprehensive Examination, a Ph.D. student achieves the rank of Ph.D. Candidate.

3.2.5 Doctoral Degree Time Limits

Michigan State University requires passing the Comprehensive Examination within five years of the student's first enrollment as a Ph.D. student. The Comprehensive

Examination may be repeated no more than twice. The Comprehensive Examination must be successfully completed no later than six months prior to the final oral examination in defense of the thesis. All remaining requirements for the degree must be completed within eight years of the student's first enrollment as a Ph.D. student. Applications for extension of these time limits may be submitted by a Ph.D. student to the ME Graduate Program for approval by the Dean of Engineering and the Dean of the Graduate School.

3.2.6 Ph.D. Research

Successful Ph.D. research must be conducted that is "a significant, original contribution to the state-of-the-art" in Mechanical Engineering. This research must be documented in a Ph.D. dissertation approved by the student's Ph.D. research advisor.

3.2.7 GPA for Graduation

The Engineering College requires a minimum GPA of 3.00 for courses on the approved doctoral degree program. MSU also requires a minimum total GPA of 3.00.

3.2.8 Ph.D. Dissertation Defense

The Ph.D. Dissertation Defense tests the Ph.D. Candidate's ability to present and defend the significance and originality of the Ph.D. Candidate's research results. Each Ph.D. student must successfully pass an oral Dissertation Defense to complete the requirements for the Ph.D. degree. To schedule this examination, the Notice of Final Oral Exam forms must be completed and turned in to the Mechanical Engineering Graduate Program Office at least two (2) weeks prior to your final oral examination. You need to notify the Graduate Program Office and supply a copy of your abstract.

3.2.9 Thesis Copies Ph.D. dissertation preparation and submission shall be made in accordance to the requirements set forth by the Graduate School. A hard bound copy of the PhD dissertation shall be provided to the major professor.

4 DEGREE PROGRAM COMPONENTS

The Department of Mechanical Engineering has Master of Science (M.S.) and Doctoral of Philosophy (Ph.D.) degree programs. An M.S. or Ph.D. can be obtained in either ***Mechanical Engineering*** or ***Engineering Mechanics***. The components of these degree programs are described in detail in this section.

4.1 SELECTION of THESIS/DISSERTATION ADVISOR

Initiation and successful completion of independent research requires early and continued advice and oversight by a faculty advisor. Faculty advisors must be members of the Mechanical Engineering regular faculty members. For students in the Ph.D. program, the faculty advisor is the guidance committee chairperson and dissertation/academic advisor. For students in the M.S. program, the faculty advisor is the thesis/project/academic advisor. Advisor selection is a joint decision by every graduate student and member of the faculty. Normally students meet and discuss program objectives with all the faculty members in their area of technical interest. Based on that interaction, a faculty member agrees to advise each student. The student and faculty member propose and form a research guidance committee.

4.1.1 Time line for selection of a faculty advisor

All students in the graduate program must have a faculty advisor. Students in the M.S. program must select an advisor prior to the completion of their first semester while those in the Ph.D. program must select an advisor prior to the completion of their first year in the program.

4.1.2 Advisor selection process

Students who are admitted to the graduate program with a research assistantship that is provided by a particular faculty member will have that faculty member as their academic advisor and thesis/dissertation advisor. Other students may be admitted with a graduate assistantship or fellowship that is from general funds or third-party funds and not explicitly tied to a particular faculty member. In those cases, the selection of an advisor is based on mutual research interests. When more than one faculty member has expressed interest in serving as academic advisor to a student who was admitted with an assistantship or fellowship from general funds or third parties, the student should select an advisor within the time frame described in the previous section.

4.1.3 Roles and responsibilities of the thesis/dissertation advisor

The role of the advisor includes the following.

1. Ensuring that graduate students receive information about requirements and policies of the graduate program.

2. Advising graduate students on developing a program plan, including appropriate course work, research or project activity, and on available resources.
3. Advising graduate students on the selection of a thesis or dissertation topic and on the formation of a guidance committee.
4. Providing training and oversight in creative activities, research rigor, theoretical and technical aspects of the thesis or dissertation research, and in professional integrity.
5. Encouraging graduate students to stay abreast of the literature and cutting-edge ideas in the field.
6. Helping graduate students to develop professional skills in writing reports, papers, and grant proposals, making professional presentations, establishing professional networks, interviewing, and evaluating manuscripts and papers.
7. Providing regular feedback on the progress of graduate students toward degree completion, including feedback on research or creative activities, course work, and teaching, and constructive criticism if the progress does not meet expectations.
8. Helping graduate students develop into successful professionals and colleagues, including encouraging students to participate and disseminate results of research or creative activities in the appropriate scholarly or public forums.
9. Facilitating career development, including advising graduate students on appropriate job and career options, as well as on the preparation of application materials for appropriate fellowship, scholarship, and other relevant opportunities.
10. Writing letters of reference for appropriate fellowship, scholarship, award, and job opportunities.
11. Providing for supervision and advising of graduate students when the faculty advisor is on leave or extended absence.

4.1.4 Roles and responsibilities of the student

The student has responsibilities in the advisor/student relationship. These include the following.

1. Learning and adhering to university and academic unit rules, procedures, and policies applicable to graduate study and research or creative activities, including those outlined in the publications *Academic Programs, Graduate Student Rights and Responsibilities*, and *Academic Freedom for Students at MSU*.
2. Meeting university and academic unit requirements for degree completion.
3. Forming a guidance committee that meets university requirements as well as requirements that are outlined in the *Graduate Handbook* of the academic unit.
4. Following disciplinary and scholarly codes of ethics in course work, thesis or dissertation research, and in creative activities.
5. Practicing uncompromising honesty and integrity according to university and federal guidelines in collecting and maintaining data.

6. Seeking regulatory approval for research in the early stages of thesis or dissertation work where applicable.
7. Keeping the faculty advisor and guidance committee apprised on a regular basis of the progress toward completion of the thesis or dissertation.

4.1.5 Change of advisors

Once a thesis/dissertation advisor is selected, it is unusual to change advisors. However, if a situation arises where a change seems imperative, the student should consult with the graduate coordinator who will facilitate changes of faculty advisor.

4.1.6 Final Defense Examination regulations and format

The graduate student will present the results of the thesis/dissertation in a seminar open to the community. The student should arrange a suitable examination date after consulting with the thesis advisor and members of the examination committee. The student should also arrange for a suitable room in which to hold the seminar by consulting with the office staff of the Mechanical Engineering Department. This should be done in communication with the Department graduate secretary, who will arrange for announcement of the upcoming defense.

For both the master's degree candidate and doctoral candidate, the following regulations apply.

1. The final oral examination must be scheduled for a date not earlier than two weeks after the dissertation and abstract have been submitted to the chairperson of the guidance committee, other guidance committee members, and any appointed examiner.
2. The student must be registered during the semester in which the final oral examination is taken.
3. The dissertation and the student's performance on the final oral examinations must be approved by a positive vote of at least three-fourths of the voting examiners and with not more than one dissenting vote from among the Michigan State University regular faculty members of the guidance committee.

For both the master's degree candidate and doctoral candidate, the following format is typical. The examining committee members may or may not choose to meet before the exam to discuss the procedure. The candidate presents the results in seminar fashion and responds to questions and comments from those in attendance. After the general audience has had opportunity to raise questions and comments, they are excused from the room and the defense continues with only the examining committee. At the end of the examination, the student is asked to step out of the room, and the examining committee members each indicate in writing a pass or fail grade. The student is then asked to enter the room to receive the result of the final examination. A summary report of the examination result is submitted to the Dean of Engineering and the Chairperson of the Department.

Master of Science Defense Examining Committee

The Mechanical Engineering Department's certifying examination is an oral defense of the student's MS thesis to an examining committee consisting of the major professor and two other faculty members. At least two of the three members of the examining committee must be regular faculty members in the Department of Mechanical Engineering at MSU. The major professor and the student will nominate, to the Department Chairperson or a designated individual, for approval, the two other faculty members of the examining committee.

Doctor of Philosophy Defense Examining Committee

The doctoral final oral examination committee consists of the student's guidance committee. According to University policy, at the discretion of the Dean of Engineering, the guidance committee may be augmented by one appointed faculty member. Other interested faculty members may attend the examination without vote.

4.2 Master of Science (M.S.) Program Components

4.2.1 Master's Plan A

There is a Master's plan A for degrees in either *Engineering Mechanics* or *Mechanical Engineering*. Master's plan A has these components: (1) prescribed course work, (2) research, (3) a master's thesis, and (4) the oral defense of the master's thesis.

M.S. Degree Examination Committee

The M.S. Degree Examination Committee consists of at least three Michigan State University regular faculty members, at least two of whom must be on the faculty of the Department of Mechanical Engineering. The committee is selected by the thesis advisor and student with the approval of the Department's graduate coordinator. One member of the committee must be the thesis advisor. Other interested faculty members may attend the examination without vote.

4.2.2 Master's Plan B

There is a Master's plan B for degrees in either *Engineering Mechanics* or *Mechanical Engineering*. The Master's plan B has two components: (1) prescribed course work, and (2) a final evaluation by the academic advisor and graduate advisor.

4.3 Doctor of Philosophy (Ph.D.) Degree Components

The components of the doctoral programs in Engineering Mechanics and Mechanical Engineering are very similar. In each case, the student first finds an advisor and forms a committee. Subsequently, the components of the doctoral degree programs consist of a qualifying exam, a comprehensive exam, prescribed course work, research, the dissertation, and a final oral defense and examination, each of which is discussed in detail

in this section. Differences in the degree components for Engineering Mechanics and Mechanical Engineering will be specified as they arise below.

4.3.1 FORMATION OF THE Ph.D. GUIDANCE COMMITTEE

Ph.D. students must form a guidance committee no later than the end of their second semester of attendance. The guidance committee will consist of at least four Michigan State University regular faculty members, including the committee chairperson. At least three members of the guidance committee shall be from the Mechanical Engineering Department and at least one member shall be from a different academic department at Michigan State University. The outside member may be from another department within the College of Engineering or from a department outside the College. You must complete the necessary forms (see the Graduate Program Office) and have them approved and signed by your major professor and your committee. These forms must be on file by the 2nd semester. Further registration will not be permitted until an approved program is filed.

The responsibilities of the guidance committee include the following.

1. Advising graduate students on course work, research, or creative activities.
2. Providing at least feedback and guidance concerning progress toward the degree.
3. Administering the comprehensive exams and the final oral exam.
4. Reviewing the thesis or dissertation.

4.3.2 Ph.D. Program of Study

The guidance committee shall meet collectively with the student to produce the Doctoral Program of Study. This program shall be submitted for approval to the ME department and to the dean. Registration will not be permitted for the second semester until this requirement has been met. Courses (in addition to those numbered ME 999) will be prescribed by the guidance committee to insure that the student will have a comprehensive knowledge of a major field and related subjects. The courses that a student is required to complete will depend upon prior academic background in relation to the selected graduate program. Any changes in the program must be approved by your committee and shall likewise be submitted for approval to the department (Graduate Advisor, Department Chair) and to the dean. The Ph.D. program requires 39 credits of coursework beyond the B.S. degree and 18 credits of coursework beyond the M.S. degree. A maximum of nine (9) of the post MS credits can be outside of ME and a maximum of nine (9) of the post MS credits can be from the 400 level. Course work does not include ME898, ME899, ME990 and ME999 (Project, Independent study and Research credits). The course plan is directed toward (1) passing the qualifiers and (2) acquiring the necessary skills - in the judgment of the student's advisor and committee - in his/her chosen field of research.

4.3.2 Ph.D. Research

Each student working toward a Doctor of Philosophy (Ph.D.) degree must conduct original research, culminating in a dissertation that makes a significant, original, contribution to the state-of-the-art in engineering mechanics or mechanical engineering. The research is carried out under the direction of, and in accordance with the advice of, the guidance committee consisting of the student's advisor and at least three other committee members.

4.3.3 Ph.D. Qualifying Examinations

Students must pass the Qualifying Exam within 15 months of beginning Ph.D. study. Any graduate student (M.S. or Ph.D.) has up to three trials before this deadline.

Each Qualifying Examination includes four areas. In exceptional circumstances, an extra attempt (oral or written) may be requested by petition to the Department Chairperson by the advisor of a graduate student who has failed to satisfy the qualifying examination requirements in a single area.

The Mechanical Engineering Ph.D. Qualifying Examination is offered in seven sub areas (1-7) in three groups (I-III):

(I) Mathematics (1)
(II) Solid and structural mechanics (2), systems and control (3), dynamics and vibrations (4)
(III) Fluid mechanics (5), heat and mass transfer (6), thermodynamics (7)

To pass the examination, a student must pass examinations in *four* of the seven areas, which must include *at least one pass in each of the three different groups (I-III).*

The Engineering Mechanics Ph.D. Qualifying Examination is offered in four areas (I-IV) as defined below.

(I) Mathematics
(II) Solid and Structural Mechanics
(III) Intermediate Mechanics
(IV) Vibrations and Dynamics

To pass the examination, a student must achieve a passing grade in all four areas.

4.3.4 The Qualifying Examination

The Ph.D. Qualifying Examination is a four-part examination which prospective Ph.D. students must pass as a condition of formal admission to the ME Ph.D. program. The purpose of the Ph.D. Qualifying Examination is to ensure that, early in their programs of study, Ph.D. students have attained a broad and significant command of the professional disciplines that comprise mechanical engineering. The four-part examination is therefore intended to provide an assessment of whether students have the mature grasp of undergraduate material that is considered essential for successful Ph.D. studies. The

examination is offered in January and August each year, and is administered by the ME faculty.

The Ph.D. Qualifying Examination required in Engineering Mechanics is offered in four areas as defined below.

1. Mathematics
2. Solid and structural mechanics
3. Intermediate mechanics
4. Dynamics and vibrations

To pass the examination, a student must achieve a passing grade in all four of these areas

The Ph.D. Qualifying Examination required in Mechanical Engineering is offered in seven areas in the three groups as defined below.

1. Mathematics
2. Solid and Structural mechanics, Systems and Control, Dynamics and Vibrations
3. Fluid Mechanics, Heat Transfer, Thermodynamics

To pass the *Mechanical Engineering* examination, a student must achieve passes in at least four areas comprising mathematics; an area from group 2); an area from group 3); and a fourth area from either of groups 2) or 3).

Examinations in each area are administered by two faculty members, appointed by the ME Graduate Program. It is typical to retain one examiner in each area from the previous occasion on which the examination was offered, to help assure consistency in examination standards. The examination topics and content are detailed in the Appendix of this document.

If a student has not passed all parts of the examination within 15 months, his/her Ph.D. study program will be terminated. The student and his/her Guidance Committee Chairperson may appeal the termination-of-study status to the Graduate Studies Committee (GSC). However, only in highly exceptional circumstances will this appeal be accepted and forwarded to the Department Chairperson for final consideration.

The ME Graduate Program Office notifies all eligible Masters and Ph.D. students of the forthcoming exams one to two months in advance. Students wishing to attempt the examination must then inform the Graduate Secretary by a specified date. An examination schedule is then posted by Graduate Program Office and candidates are notified of their individual schedules.

4.3.5 Doctoral Comprehensive Examination & Dissertation Proposal

The comprehensive examination must be successfully completed no later than six months prior to the final oral examination in defense of the thesis. When approximately 80% of

the student's coursework is completed the student must apply to take the comprehensive examination. The comprehensive examination may be repeated no more than twice.

4.3.6 Doctoral Research

Each student working toward a Doctor of Philosophy degree must conduct original research, culminating in a dissertation that makes a significant, original, contribution to his or her field of research. The research is carried out under the direction of, and in accordance with, the advice of, the guidance committee consisting of the student's advisor and at least three other committee members.

4.3.7 Dissertation, Final Oral Examination and Thesis Defense

The final master's or doctoral examination is the culmination of a student's graduate education and training and reflects not only the accomplishments of the graduate student but also on the quality of the graduate program. An approved thesis/dissertation that is accepted by the graduate school becomes a single-author publication and contributes to the body of knowledge of mechanical engineering. The Department keeps a library of all master's and doctoral theses accepted by the Department. Those from recent years are stored in the Departmental conference room. Please see the graduate secretary if you wish to check out a copy for short-term borrowing.

Final Oral Examination forms must be completed and turned in to the Mechanical Engineering Graduate Program Office at least two (2) weeks prior to your final oral examination. You need to notify the Graduate Program Office and supply a copy of your abstract. See below for details. Once you complete your program and you are ready to give your final oral exam, you must do the following:

- Set up a time between you and your committee members when you can take your final oral exam (defense).
- Reserve a room for the defense.
- See the ME Graduate Program Secretary. Provide a copy of your Abstract and information about when and where the dissertation defense will take place.
- The ME Graduate Program Secretary will send out a Seminar Notice from the information you provided her. She will need to do this at least two weeks prior to the defense.
- Take Form D with you to your final defense for signatures.
- Return the completed forms to the Graduate Program Secretary for your file. These will be needed so that your graduation papers can be completed.

Final Oral Exam Results (Form D): Your major professor and your committee approve your Final Oral Exam (dissertation defense).

The doctoral student will present results of the thesis research in a seminar open to the community, and with a written dissertation. The guidance committee evaluates the written dissertation and the oral defense of the thesis. The approved dissertation is a

single-authored university publication that contributes to the body of knowledge of of the degree program, i.e. Engineering Mechanics or Mechanical Engineering. See Chapter 6 for details.

5 ADADEMIC PERFORMANCE POLICIES

5.1 Academic Standards for the Master of Science Program

Grades: The student must earn a grade of 2.0 or higher in each course in the approved program of study. The student must repeat any course for which the grade earned was below 2.0.

Cumulative Grade–Point Average: The student must maintain a cumulative grade–point average of at least 3.00 in the courses in the approved program of study.

Probational Status: A student is placed on probational status if the student's cumulative grade–point average for the courses in the approved program of study is below 3.00. A student in probational status is not allowed to carry more than 7 credits per semester or to enroll in any course the primary focus of which is independent study.

5.2 Retention In and Dismissal from the Master's Program

Should a student's cumulative grade–point average fall below 3.00 after having completed 16 or more credits in courses in the approved program of study, the student may be enrolled in probational status in the master's degree program for one additional semester. If at the end of the additional semester the student's cumulative grade–point average is 3.00 or higher, the student may continue to enroll in the master's degree program. If at the end of the additional semester the student's cumulative grade–point average is still below 3.00, the student will be dismissed from the program.

Each student's academic progress and professional potential are evaluated by March 15 of each year. A student who in the judgment of the faculty is making satisfactory academic progress and has professional potential may continue to enroll in the master's degree program, provided the grade point average is within the acceptable range as previously described. A student who in the judgment of the faculty is not making satisfactory academic progress or lacks professional potential will be dismissed from the program.

5.3 Academic standards for the Doctor of Philosophy program

Grades: The student must earn a grade of 2.0 or higher in each course in the approved guidance committee report, including collateral courses as well as courses accepted in transfer or used as part of the minimal number of doctoral credits. The student must repeat any course for which the grade earned was below 2.0.

Cumulative Grade–Point Average: The student must maintain a cumulative grade–point average of at least 3.00 in the courses in the program plan approved by the guidance committee. Students must make continuous progress towards completion of those courses.

Probational Status: A student is placed on probational status if the student's cumulative grade–point average for the courses in the approved program of study is below 3.00. A student in probational status is not allowed to carry more than 7 credits per semester or to enroll in any course the primary focus of which is independent study.

5.4 Retention and Dismissal from the Doctoral Program

Should a student's cumulative grade–point average fall below 3.00 after having completed half of the courses in the approved guidance committee report, the student may be enrolled in probational status in the doctoral degree program for one additional semester. If at the end of the additional semester the student's cumulative grade–point average is 3.00 or higher, the student may continue to enroll in the doctoral degree program. If at the end of the additional semester the student's cumulative grade–point average is still below 3.00, the student will be dismissed from the program.

Should a student accumulate more than 3 deferred grades in courses other than those courses the primary focus of which is independent study, the student may be enrolled on probational status in the doctoral program for one additional semester. If at the end of the additional semester the student has no more than 3 deferred grades, the student may continue to enroll in the doctoral degree program. If at the end of the additional semester, the student still has more than 3 deferred grades, the student will be dismissed from the program.

Each student's academic progress and professional potential are evaluated by March 15 of each year. A student who in the judgment of the faculty is making satisfactory academic progress and has professional potential may continue to enroll in the doctoral degree program, provided the grade point average and number of courses with deferred grades is within the acceptable range as previously described. A student who in the judgment of the faculty is not making satisfactory academic progress or lacks professional potential will be dismissed from the program.

5.5 Student Records

The Department maintains an academic record for each graduate student that is kept on file until 5 years after graduation. Graduate students have the right to inspect any of their own educational records, barring confidential letters of recommendation, including their official transcript. Students also shall have the right to inspect reports and evaluations of his or her academic performance.

A typical inventory of the Department record is as follows.

- College of Engineering Master's Plans and Doctoral Plans.

- Guidance Committee reports.
- Results of qualifying examinations, comprehensive examinations, and final oral examinations.
- Grade reports from the Office of the Registrar.
- Annual evaluation forms.
- Other forms filed by the student or on behalf of the student.
- Items from the student's application for admission, including transcripts, test scores, and reference letters.

The Department maintains a separate personnel file for teaching assistants, as prescribed by the GEU/MSU contract. The Department also maintains a separate personnel file for research assistants.

6 DEPARTMENT POLICIES:

6.1 The MSU perspective

Each graduate student should obtain access to the document 'Guidelines for Integrity in Research and Creative Ideas'. Section 1.5 describes how access can be obtained. The conduct of research and creative activities by faculty, staff, and students is central to the mission of Michigan State University and is an institutional priority. Faculty, staff, and students work in a rich and competitive environment for the common purpose of learning, creating new knowledge, and disseminating information and ideas for the benefit of their peers and the general public. The stature and reputation of MSU as a research university are based on the commitment of its faculty, staff, and students to excellence in scholarly and creative activities and to the highest standards of professional integrity.

As a partner in scholarly endeavors, MSU is committed to creating an environment that promotes ethical conduct and integrity in research and creative activities. Innovative ideas and advances in research and creative activities have the potential to generate professional and public recognition and, in some instances, commercial interest and financial gain. In rare cases, such benefits may become motivating factors to violate professional ethics. Pressures to publish, to obtain research grants, or to complete academic requirements may also lead to an erosion of professional integrity.

Breaches in professional ethics range from questionable research practices to misconduct. The primary responsibility for adhering to professional standards lies with the individual scholar. It is, however, also the responsibility of advisors and of the disciplinary community at large. Passive acceptance of improper practices lowers inhibitions to violate professional ethics.

Integrity in research and creative activities is based not only on sound disciplinary practice but also on a commitment to basic personal values such as fairness, equity,

honesty, and respect. These guidelines are intended to promote high professional standards by everyone — faculty, staff, and students alike.

6.2 Key Principles

Integrity in research and creative activities embodies a range of practices that include:

- Honesty in proposing, performing, and reporting research
- Recognition of prior work
- Confidentiality in peer review
- Disclosure of potential conflicts of interest
- Compliance with institutional and sponsor requirements
- Protection of human subjects and humane care of animals in the conduct of research
- Collegiality in scholarly interactions and sharing
- Adherence to fair and open relationships between senior scholars and their coworkers

6.2.1 Honesty in Proposing, Performing, and Reporting Research.

The foundation underlying all research is uncompromising honesty in presenting one's own ideas in research proposals, in performing one's research, and in reporting one's data. Detailed and accurate records of primary data must be kept as unalterable documentation of one's research and must be available for scrutiny and critique. It is expected that researchers will always be truthful and explicit in disclosing what was done, how it was done, and what results were obtained. To this end, research aims, methods, and outcomes must be described in sufficient detail such that others can judge the quality of what is reported and can reproduce the data. Results from valid observations and tests that run counter to expectations must be reported along with supportive data.

6.2.2 Recognition of Prior Work.

Research proposals, original research, and creative endeavors often build on one's own work and also on the work of others. Both published and unpublished work must always be properly credited. Reporting the work of others as if it were one's own is plagiarism. Graduate advisors and members of guidance committees have a unique role in guiding the independent research and creative activities of students. Information learned through private discussions or committee meetings should be respected as proprietary and accorded the same protection granted to information obtained in any peer review process.

6.2.3 Confidentiality in Peer Review.

Critical and impartial review by respected disciplinary peers is the foundation for important decisions in the evaluation of internal and external funding requests, allocation of resources, publication of research results, granting of awards, and in other scholarly decisions. The peer-review process involves the sharing of information for scholarly assessment on behalf of the larger disciplinary community. The integrity of this process depends on confidentiality until the information is released to the public. Therefore, the contents of research proposals, of manuscripts submitted for publication, and of other scholarly documents under review should be considered privileged information not to be shared with others, including students and staff, without explicit permission by the authority requesting the review. Ideas and results learned through the peer-review process should not be made use of prior to their presentation in a public forum or their release through publication.

6.2.4 Disclosure of Potential Conflicts of Interest.

There is real or perceived conflict of interest when a researcher has material or personal interest that could compromise the integrity of the scholarship. It is, therefore, imperative that potential conflicts of interest be considered and acted upon appropriately by the researcher. Some federal sponsors require the University to implement formal conflict of interest policies. It is the responsibility of all researchers to be aware of and comply with such requirements.

6.2.5 Compliance with Institutional and Sponsor Requirements.

Investigators are granted broad freedoms in making decisions concerning their research. However, these decisions are still guided, and in some cases limited, by the laws, regulations, and procedures that have been established by the University and sponsors of research to protect the integrity of the research process and the uses of the information developed for the common good. Although the legal agreement underlying the funding of a sponsored project is a matter between the sponsor and the University, the primary responsibility for management of a sponsored project rests with the principal investigator and his or her academic unit.

6.2.6 Protection of Human Subjects and Humane Care of Animals.

Research techniques should not violate established professional ethics or federal and state requirements pertaining to the health, safety, privacy, and protection of human beings, or to the welfare of animal subjects. Whereas it is the responsibility of faculty to assist students and staff in complying with such requirements, it is the responsibility of all researchers to be aware of and to comply with such requirements.

The University Committee on Research Involving Human Subjects (UCRIHS) is an Institutional Review Board (IRB). Federal regulations and University policy require that all research projects involving human subjects and materials of human origin be reviewed and approved by an IRB before initiation. Research is defined as “a systematic

investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge". The "generalizable knowledge" criteria may include developing publications/papers, theses/dissertations, making public presentations, etc. A human subject of research is a) a living individual from whom an investigator obtains data by interaction or intervention or b) identifiable private information.

All research involving human subjects and/or data collected from living human subjects (including preexisting data) is subject to UCRIHS review. Instructions for applying for approval are available at the following web site.

(http://www.humanresearch.msu.edu/applications/Initial_Application_Instructions.pdf).

The use of vertebrate animals in research, teaching, and outreach activities is subject to state and federal laws and guidelines. University policy specifies that: all vertebrate animals under University care (that is, involved in projects under the aegis or sponsorship of the University) will be treated humanely; prior to their inception, all vertebrate animal projects receive approval by the All University Committee on Animal Use and Care (AUCAUC); Michigan State University (MSU) will comply with state and federal regulations regarding vertebrate animal use and care.

Responsibility for assuring compliance with state and federal regulations belongs to the Vice President for Research and Graduate Studies. The Vice President has designated the Assistant Vice President for Research and Graduate Studies to be the "Institutional Official" as defined in federal regulations.

The AUCAUC works closely with the Institutional Official, and has responsibility and authority under federal law for specific actions.

University Laboratory Animal Resources (ULAR), which reports to the Vice President for Research and Graduate Studies, provides a comprehensive program of animal care for all laboratory animal colonies, as well as training for researchers. ULAR also participates in developing institutional policies designed to insure humane treatment of vertebrate animals and to assist investigators in maintaining high quality care of animals used in MSU projects.

An animal use form (AUF) must be submitted to the AUCAUC for review prior to the start of the project, regardless of the source of funding for the project. The AUF can be obtained from the AUCAUC office; the completed form will include descriptions of experimental protocols, plans for animal care, available facilities, and any other matters relevant to the project. Some granting agencies require review and approval of the AUF before a grant application will be processed. An agency-approved grant will not be accepted by the Board of Trustees, nor will an account number be assigned, unless the AUF has been approved by the AUCAUC. For an animal use application form contact: Candy Flynn at 432-4151, email flynnc@msu.edu

6.2.7 Collegiality in Scholarly Interactions and Sharing of Resources.

Collegiality in scholarly interactions, including open communications and sharing of resources, facilitates progress in research and creative activities for the good of the community. At the same time, it has to be understood that scholars who first report important findings are both recognized for their discovery and afforded intellectual property rights that permit discretion in the use and sharing of their discoveries and inventions. Balancing openness and protecting the intellectual property rights of individuals and the institution will always be a challenge for the community. Once the results of research or creative activities have been published or otherwise communicated to the public, scholars are expected to share materials and information on methodologies with their colleagues according to the tradition of their discipline.

Faculty advisors have a particular responsibility to respect and protect the intellectual property rights of their advisees. A clear understanding must be reached during the course of the project on who will be entitled to continue what part of the overall research program after the advisee leaves for an independent position. Faculty advisors should also strive to protect junior scholars from abuses by others who have gained knowledge of the junior scholar's results during the mentoring process, for example, as members of guidance committees.

6.2.8 Fair and Open Relationships between Scholars and Coworkers.

The relationship between senior scholars and their coworkers should be based on mutual respect, trust, honesty, fairness in the assignment of effort and credit, open communications, and accountability. The principles that will be used to establish authorship and ordering of authors on presentations of results must be communicated early and clearly to all coworkers. These principles should be determined objectively according to the standards of the discipline, with the understanding that such standards may not be the same as those used to assign credit for contributions to intellectual property. It is the responsibility of the faculty to protect the freedom to publish results of research and creative activities. The University has affirmed the right of its scholars for first publication except for "exigencies of national defense". It is also the responsibility of the faculty to recognize and balance their dual roles as investigators and advisors in interacting with graduate students of their group, especially when a student's efforts do not contribute directly to the completion of his or her degree requirements.

6.3 Misconduct in Research and Creative Activities

Federal and University policies define misconduct to include fabrication (making up data and recording or reporting them), falsification (manipulating research materials, equipment or processes, or changing or omitting data such that the research is not accurately represented in the record), and plagiarism (appropriation of another person's ideas, processes, results, or words without giving appropriate credit). Serious or continuing non-compliance with government regulations pertaining to research may constitute misconduct as well. University policy also defines retaliation against whistle

blowers as misconduct. Misconduct does not include honest errors or honest differences of opinion in the interpretation or judgment of data.

The University views misconduct to be the most egregious violation of standards of integrity and as grounds for disciplinary action, including the termination of employment of faculty and staff, dismissal of students, and revocation of degrees. It is the responsibility of faculty, staff, and students alike to understand the University's policy on misconduct in research and creative activities, to report perceived acts of misconduct of which they have direct knowledge to the University Intellectual Integrity Officer, and to protect the rights and privacy of individuals making such reports in good faith.

6.4 Office of Radiation Chemical & Biological Safety (ORCBS)

The use of hazardous materials in research, teaching, and outreach activities is subject to state and federal laws and guidelines. The Vice President for Research and Graduate Studies has been assigned responsibility to see that appropriate practices are followed where hazardous materials are involved, to maintain a safe environment for campus personnel, to protect the surrounding community, and to assure that MSU meets its obligations under the law.

Oversight of activities involving hazardous substances is provided by the ORCBS. ORCBS is assisted by faculty committees in the areas of radiation safety, chemical safety, and biological safety. The Radiation Safety Committee has responsibility and authority under federal law for specific actions.

It is University policy that faculty members and principal investigators (PIs) are responsible for the day-to-day safety and well-being of all personnel engaged in activities under their aegis. Administrative officers, and ORCBS, are responsible for making available to faculty information needed to maintain a safe working environment, for providing safety training, for keeping project directors informed about changes in regulations, and for assaying laboratories and work areas for radiation, chemical, or biological hazards.

All individuals who work with hazardous substances must accept shared responsibility for operating in a safe manner once they have been informed (a) about the extent of risk and (b) about safe procedures that should be followed.

The ORCBS provides live and on-line training classes throughout the year to educate the employees and students of Michigan State University on safe work practices. Completion of these courses by MSU personnel ensures that the university is fulfilling local, state and federal requirements in radiation, chemical, biological, hazardous waste, and environmental safety.

Your training requirements will depend on your specific job duties. Some general guidelines are listed below:

- • Required for all laboratory employees engaging in the use of hazardous chemicals (and supervisors of the employees): Chemical Hygiene and Laboratory Safety;

Hazardous Waste Refresher (required annually after completion of Chemical Hygiene & Laboratory Safety course) and Security Awareness.

- • Required for all employees working with radiation: Radiation Safety Initial; Radiation Safety Refresher (required annually following completion of the Radiation Safety Initial course).
- • Required for all employees with a reasonable anticipated risk of exposure to blood-borne pathogens/human blood/bodily fluids: Blood-borne Pathogen Initial; Blood-borne Pathogen Refresher; (required annually following completion of the Blood-borne Pathogen Initial course)

If you would like assistance determining which courses you should complete, please contact the ORCBS at 355-0153.

7 STUDENT CONDUCT AND CONFLICT RESOLUTION

7.1 Student Conduct

The University expects student conduct and behavior to reflect qualities of good citizenship. The out-of-classroom activities of Michigan State University students should reflect favorably upon the institution and should indicate the personal integrity of the individual. See Spartan Life: Student Handbook and Resource Guide for specific policies, ordinances and regulations that define some of the relevant University expectations.

7.2 Conflict Resolution

Conflicts involving a graduate student may be handled informally or, at the request of a party or parties, formally. Student's rights and responsibilities, including grievance procedures, are detailed in the document: Academic Freedom for Students a Michigan State University. Procedures more specifically designed for graduate students are to be found in the publication Graduate Student Rights and Responsibilities. Grievance procedures outlined in these documents shall be followed and the Engineering College Advisory Council is responsible for the interpretation and execution of these procedures in the College.

APPENDICES

A-1 ME Faculty

The following is a list of the faculty in the ME department who serve as research advisors/mentors:

Averill, Ronald **Associate Professor**
Computational mechanics, composite structures, laminated plate theory, crashworthiness, design optimization, finite element method.
[(517) 353-7188, averillr@egr.msu.edu]

Baek, Seungik **Assistant Professor**
Patient-specific modeling of cardiovascular diseases and clinical treatments, cardiovascular mechanics, biomaterials, intracranial aneurysms, thermal therapies
[(517) 432-3161, sbaek@egr.msu.edu]

Benard, Andre **Associate Professor and Associate Chair – Graduate Programs**
Transport phenomena in materials processing, heat transfer, polymers and composites microstructures, multiphase problems, finite elements.
[(517) 432-1522, benard@egr.msu.edu]

Brereton, Giles **Associate Professor**
Turbulence and its prediction; unsteady fluid mechanics; IC engine Flows; cardiovascular flows; nucleation and non-equilibrium thermodynamics; Nonlinear acoustics.
[(517) 432-3340, brereton@egr.msu.edu]

Choi, Jongeun **Assistant Professor**
Adaptive, learning, distributed and robust control, with applications to unsupervised competitive learning algorithms, self-organizing systems, distributed coordination algorithms for autonomous vehicles, multiple robust controllers and micro-electromechanical systems (MEMS).
[(517) 432-3164, jchoi@egr.msu.edu]

Cloud, Gary **Professor**
Experimental mechanics, optical methods of measurement, composites, Fasteners, geomechanics, biomechanics, nondestructive evaluation.
[(517) 355-9574, cloud@egr.msu.edu]

Diaz, Alejandro **Professor and Chairperson**
Optimal design, finite-element methods.
[(517) 353-0825, diaz@egr.msu.edu]

Engeda, Abraham **Professor**
Applied thermofluids, internal and unsteady flow in turbomachines, design and performance prediction of turbomachines.
[(517) 432-1834, engeda@me.msu.edu]

Feeny, Brian **Associate Professor**
Nonlinear dynamical systems and haos, nonsmooth systems.
[(517) 353-9451, feeny@egr.msu.edu]

Foss, John **Professor**
Analytical Experimentation (determination of governing phenomena using flow field measurements). Turbulent shear flows Vorticity measurements, and automotive applications
[(517) 355-3337, foss@egr.msu.edu]

Goodman, Erik **Professor**
Genetic algorithms, design optimization, manufacturing optimization, environmentally conscious manufacturing.
[(517) 355-6453, goodman@egr.msu.edu]

Haut, Roger **Professor**
Impact-trauma biomechanics, orthopedic biomechanics, experimental mechanics.
[(517) 355-0320, haut@egr.msu.edu]

Jaberi, Farhad **Associate Professor**
Advanced computational fluid dynamics, turbulent mixing and reaction, large eddy and direct numerical simulations, combustion and propulsion, and complex fluids and multiphase transport.
[(517) 432-4678, jaberi@egr.msu.edu]

Koochesfahani, Manoochehr **Professor**
Turbulent mixing, unsteady aerodynamics, turbulent shear flow control, optical diagnostics.
[(517) 353-5311, koochesf@egr.msu.edu]

Kwon, Patrick **Associate Professor**
Materials issues in design and manufacturing, manufacturing processes, mechanics and mechanical behavior of materials, advanced materials, materials by design. Machining and tribology.
[(517) 355-0173, pkwon@egr.msu.edu]

Lee, Tonghun **Assistant Professor**
Laser imaging of advanced propulsion, combustion and alternative energy conversion systems.
[(517) 290-8005, tonghun@msu.edu]

Liu, Dahsin **Professor**
Impact dynamics of materials and structures, mechanics of composite Materials, photomechanics, nonlinear computational structures.
[(517) 353-6716, liu@egr.msu.edu]

Loos, Alfred **Professor**
Heat Transfer and flow phenomena in materials processing; mathematical Modeling of manufacturing processes; mechanics of materials; finite Element analysis; materials characterization and testing; composite manufacturing; mechanics of composite materials.
[(517) 432-0844, aloos@egr.msu.edu]

Mueller, Norbert **Assistant Professor**
Turbomachinery and centrifugal compressor design, HVAC with natural Refrigerants, micro-fabricated energy systems, environmentally friendly Energy systems.
[(517) 432-9139, mueller@egr.msu.edu]

Mukherjee, Ranjan **Professor**
Robotics, Computer Assisted Surgical Procedures, Motion Planning and Feedback Stabilization of Nonholonomic Systems, Active Magnetic Bearings.
[(517) 355-1834, mukherji@egr.msu.edu]

Naguib, Ahmed **Associate Professor**
Turbulent shear flows' physics and control, experimental techniques, Application of MEMS to flow control and diagnostics, and digital data processing.
[(517) 432-1616, naguib@egr.msu.edu]

Pence, Thomas **Professor**
Continuum mechanics, nonlinear elasticity, wave propagation in solids, Mechanics of composite materials, buckling and postbuckling, modeling of phase transitions, mechanics of thing films.
[(517) 353-3889, pence@egr.msu.edu]

Pourboghrat, Farhang **Associate Professor**
Computational Mechanics, Plasticity, Constitutive Modeling of Engineering Materials, Sheet Metal Forming and Manufacturing Process Design.
[(517) 432-0189, pourbogh@egr.msu.edu]

Priezjev, Nikolai **Assistant Professor**
Molecular simulations of complex fluids, interfacial phenomena, microfluidics, hybrid multiscale methods, liquid crystals, and statistical mechanics.
[(517) 432-9132, priezjev@egr.msu.edu]

Radcliffe, Clark **Professor**
System dynamics, instrumentation design, control, acoustics.
[(517) 355-5198, radcliff@egr.msu.edu]

Rosenberg, Ronald **Associate Dean for Research & Graduate Studies**
Dynamic system modeling and simulation, multiport system theory, computer aided engineering design.
[(517) 432-2464, rosenber@egr.msu.edu]

Schock, Harold **Director & Professor**
Thermodynamics, combustion, optical diagnostics, turbulence, internal combustion engines.
[(517) 353-9328, schock@egr.msu.edu]

Shaw, Steven **Professor**
Dynamics, bivrations, nonlinear dynamical systems.
[(517) 432-3920, shawsw@egr.msu.edu]

Somerton, Craig **Associate Professor**
Heat and mass transfer in porous media, CAD of thermal systems.
[(517) 353-6733, somerton@egr.msu.edu]

Thompson, Brian **Professor**
High speed machinery, composite materials, smart materials, design Methodologies. [(517) 355-2179, thompson@egr.msu.edu]

Wang, C.Y. **Adjunct Professor**
Laminar fluid mechanics, heat conduction and convection, vibration and stability of membranes, beams and plates, and physiological modeling.
[(517) 353-3837, cywang@mth.msu.edu]

Wichman, Indrek **Professor**
Combustion theory, fire research, ignition, extinction and quenching, triple flames, sprays.
[(517) 353-9180, wichman@egr.msu.edu]

Wright, Neil **Associate Chair-Undergraduate Program and Associate Professor**
Measuring multi-axial thermophysical properties of elastomers and biological Soft tissues that are subjected to finite multi-axial deformation. Thermomechanically-induced damage to proteins, cells and tissues.
[(517) 432-4917, ntwright@egr.msu.edu]

NOTE: Additional information about the ME faculty can be found on the department website at www.egr.msu.edu. Click on *Departments* and proceed to the listing for the ME faculty. See the individual websites.

A-2 Qualifying Examination Process and Topics:

Preparation for the Qualifying Exam

A directory containing of questions used in the examination in preceding years is made available for reference in the Graduate Program website. It is strongly recommended that prospective Ph.D. students review these files, to familiarize themselves with the expected standards. Many students also find it helpful to prepare for the components of this examination in groups, posing, answering, and discussing questions of the expected level of difficulty. The Graduate Program Secretary can put interested students in contact with others who wish to form groups in common areas of interest. It is important to point out that, in preparation for this examination, students should emphasize achieving a thorough understanding of the relevant undergraduate material, with a masters' level of maturity. Therefore graduate-level courses in these areas may not necessarily be helpful as preparation. Furthermore, the level of proficiency required to merely pass the equivalent undergraduate course is also unlikely to be sufficient for this examination.

Examination Format and Grading

This section provides a detailed description of the examination and is intended to serve as a reference for both student candidates and faculty examiners.

Each part of the examination will be written and may be open-book or closed-book according to examiners' instructions. Each part is reviewed by the Graduate Studies Committee in advance of the examination, as a check for possible errors and ambiguities, and to ensure that the content is appropriate and that the level of difficulty is consistent from year to year.

As a means of ensuring fairness in the grading of this examination, prior to the examination period, each candidate is assigned a code number which he or she writes on the solution sheets as the sole means of its author's identification. To preserve this impartiality, each part of the examination is prepared and checked by the Graduate Studies Committee so that there should be no need for examiners to be present in examination rooms. Thus examiners grade impartially and report results to the Graduate Program Office without knowing the names of the candidates or the implications of their passing/failing any part of an examination. The results of the examination and its individual parts should be available from the Graduate Program Office approximately two weeks after the completion of the last part of the examination. In borderline cases, when examiners cannot assess from written papers whether a student has passed part of the examination, they may schedule an oral examination to help them reach a decision.

Examination Subjects

The descriptions of material covered are provisional insofar as, prior to each examination, the Graduate Advisor will ask the appropriate examining faculty to notify him/her of any changes and revise this section of the document accordingly.

Mathematics

Material typically covered in: ME 391. The following topics may be covered:

- Partial Differential Equations --- Separation of Variables Methods
- Ordinary Differential Equations --- Coupled Systems of ODEs, Laplace Transform ODE methods
- Linear Algebra --- Operations and Solutions of Coupled Systems of Linear Algebraic Equations
- Eigenvalue Problems and their association with the above topics
- Least Squares Solution Procedures
- Numerical Analysis and Approximation
- Series --- Taylor, Fourier, convergence
- Differential Geometry, Equations of Curves and Surfaces, Gradients, Surface and Volume Integrals
- Complex Variables

Typical textbooks at the level and coverage expected include

Barnett & Wiley, Advanced Engineering Mathematics

Kreyszig, Advanced Engineering Mathematics

Potter & Goldberg, Mathematical Methods

Solid and Structural Mechanics

Material typically covered in: MSM 211, ME 471. The following topics may be covered:

- Deflections
- Resultant force and force equilibrium, moments, couples
- Free body diagrams
- Elementary structures and friction
- Stress, strain, stress-strain relations, Hooke's law
- Material behavior
- Axial load, torsion, bending, shear, combined loadings
- Deflection of beams, buckling of columns
- Machine elements --- springs, shafts, beams
- Compound stresses

- Failure criteria
- Fatigue

Typical textbooks at the level and coverage expected include:

Norton, *Machine Design*, Prentice Hall

Shigley & Mischke, *Mechanical Engineering Design*, McGraw Hill

Beer & Johnston, *Mechanics of Materials*, McGraw-Hill

Crandall, Dahl & Lardner, An Introduction to the Mechanics of Solids, McGraw-Hill

Systems and Controls

Material typically covered in: ME 451. The following topics may be covered:

- Time response solutions for linear, time- invariant, sets of ordinary differential equations --- associated eigenvalue problems --- interpretations of eigenvalues and eigenvectors
- Mechanical, electrical, thermal, and fluid system and subsystem modeling
- Linearization of non-linear differential equations about a non-zero operating point
- Transfer function analysis from block diagrams, and/or differential equations
- Control system design methods --- root locus, Bode diagrams, Routh-Hurwitz criterion --- to develop stability, character and speed-of-response estimates
- Proportional-Integral-Derivative (PID), PI and PD controller designs

Typical textbooks at the level and coverage expected include

Phillips and Harbor, *Feedback Control Systems*, Prentice Hall, Chap 1-9

Ogata, System Dynamics

Dynamics and Vibrations

Material typically covered in ME 461 and ME 361. The following topics may be covered:

- Equations of motion, Newton's and Euler's laws; linearization about equilibrium
- Use of rectilinear, cylindrical and path coordinates; planar rotating coordinate frames
- Work/energy and impulse/momentum principles for rectilinear and rotational motion

- Kinematics and kinetics of particles, systems of particles, and planar motions of rigid bodies
- Single-degree-of-freedom systems, solution of second order ODEs, and their interpretation
- Multi-degree-of-freedom systems, matrix/vector formulation, natural frequencies and normal modes, modal analysis, proportional damping
- Vibration applications, including: logarithmic decrement, rotating imbalance, support motion, quality of resonance, vibration isolation, accelerometers, seismometers, tuned absorbers

Typical textbooks at the level and coverage expected include

W.T. Thomson and M.D. Dahleh, *Theory of Vibration with Applications*, Prentice-Hall

L. Meirovitch, Elements of Vibration Analysis, McGraw-Hill

F.P. Beer and E.R. Johnston, Jr., Vector Mechanics for Engineers–Statics and Dynamics, McGraw-Hill

R.W. Soutas-Little and D.J. Inman, *Engineering Mechanics–Dynamics,* Prentice-Hall

Fluid Mechanics

Material typically covered in: ME 332, ME 432. The following topics may be covered:

- Control Volume Analysis
- Continuity
- Linear and Angular Momentum
- Energy Equations
- Dimensional Analysis
- Hydrostatics
- Inviscid Flow
- Steady 1-D Compressible Flow
- Lift and Drag
- Simple Viscous Incompressible Flow

Typical textbooks at the level and coverage expected include:

White, Fluid Mechanics, McGraw-Hill
Fox & McDonald, *Introduction to Fluid Mechanics*, McGraw-Hill
Munson, Young & Okiishi, *Fundamentals of Fluid Mechanics*, Wiley

Heat Transfer

Material typically covered in: ME 410. The following topics may be covered:

- Conservation principles and control volume analysis
- Steady-state and transient conduction
- Internal, external, laminar, and turbulent convection
- Radiation heat transfer, radiation properties and radiation in enclosur es
- Heat transfer by combined modes
- Heat exchangers

Typical textbooks at the level and coverage expected include:

Incropera & DeWitt, *Introduction to Heat Transfer*, Wiley
Bejan, *Heat Transfer*, Wiley
Arpaci, *Conduction Heat Transfer*
Burmeister, *Convection Heat Transfer*

Thermodynamics

Material typically covered in ME 201. The following topics may be covered:

- First and second laws
- System and control volume analyses
- Properties and behavior of pure substances
- Ideal gases and mixtures
- Thermodynamic availability
- Power and refrigeration cycles

Typical textbooks at the level and coverage expected include:

Sonntag & Van Wylen, *Introduction to Thermodynamics*, Wiley
Cengel & Boles, *Thermodynamics -- An Engineering Approach*, McGraw-Hill
Wark, *Thermodynamics*, McGraw-Hill

A-3 Document Revisions and Dates

February 14, 2008	Made changes to Sections 3.2.4, 3.2.5 and 3.2.8
February 12, 2009	Made changes to Section 3.1.4, 4.3.5
October 14, 2010	Made changes to Section 3.1.4, 4.3.2
May 11, 2011	Made changes to Section 3.1.3.3