

Department of Materials Science and Engineering

GRADUATE HANDBOOK

February 2019

(some policies outlined in this handbook will actually be implemented in August, 2019)

Tickle College of Engineering

Department of Materials Science and Engineering

The University of Tennessee - Knoxville

Welcome to Materials Science and Engineering.

Thank you for choosing the Department of Materials Science and Engineering at The University of Tennessee for your graduate education. We are dedicated to providing world class facilities with the most recent technological developments in our field. The quality of our faculty, many of which are international leaders in their fields of specialization, assures excellent opportunities for an outstanding graduate education. Our strong ties to Oak Ridge National Laboratories, as well as our involvement in many high-tech partner sites make the MSE department the premier choice for students wishing to develop skills that will ensure exciting careers available all over the world.

We encourage you to explore this handbook, which describes all degree requirements and procedures pertinent to the M.S. and Ph.D. degrees in Materials Science and Engineering. Please do not hesitate to see your advisor or contact me or the director of graduate studies if you have any questions about our programs.

Sincerely,

A handwritten signature in blue ink, appearing to read 'Veerle Keppens', with a long horizontal flourish extending to the right.

Prof. Veerle Keppens

Department Head

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1. Introduction to the Materials Science & Engineering Graduate Programs at the University of Tennessee - Knoxville

1.1. Background

In order to serve the mission and vision of the Graduate School and preserve the integrity of Graduate Programs at the University of Tennessee, Knoxville (UTK), information related to the process of graduate education in each department is to be provided for all graduate students. Based on *best practices* offered by the Graduate Council of the Graduate School, it is important that detailed articulation of the information specific to the graduate degrees offered in each department/program be disseminated. This Graduate Handbook does not deviate from established Graduate School Policies noted in the Graduate Catalog, but rather provides the specific ways in which these policies are carried out. For Graduate School policies, please refer to the *Academic Policies and Requirements for Graduate Students*:

http://catalog.utk.edu/content.php?catoid=25&navoid=3185#doc_degree_require

The department of Materials Science and Engineering (MSE) offers graduate programs that lead to the degrees of Master of Science (M.S.) and Doctor of Philosophy (Ph.D.). These graduate programs are flexible and interdisciplinary in nature. Students may be admitted from a wide range of disciplines, including physics, chemistry, chemical engineering, mechanical engineering, electrical engineering, materials engineering, nuclear engineering and engineering science programs. The purpose of this handbook is to describe all degree requirements and procedures pertinent to the M.S. and Ph.D. degree programs in MSE.

For general campus policies and procedures, standards of conduct, academic policies and procedures, and information about student support, services, and organizations, please consult the Hilltopics Student Handbook, the student handbook of UTK (<https://hilltopics.utk.edu/>). As a graduate student, you are bound by the Graduate School policies, which are listed in the Graduate Catalog (<http://catalog.utk.edu/index.php> - at this link, select 2018-2019 Graduate Catalog under “Please select a catalog”) and can also be found on the Graduate School website (<https://gradschool.utk.edu/>), together with UTK Graduate Council appeals procedures (<https://gradschool.utk.edu/documents/2016/02/student-appeals-procedures.pdf/>).

The MSE Graduate Affairs committee oversees all issues relevant to these programs. The committee consists of the following faculty members: K. Sickafus (chair), G. Duscher, Y. Gao, B. Hu, P. Liaw, D. Mandrus, T.G. Nieh, P. Rack, W. Weber, and H. Xu. Dr. Sickafus serves as the Director of Graduate Studies for the MSE department.

All faculty and graduate students in the MSE department are expected to be fully-committed to the MSE graduate programs. All graduate students are expected to be aware of and satisfy all regulations governing their work and study at the university.

1.2. Admission Requirements and Application Procedures

All students who wish to pursue a graduate degree in the MSE department must first be admitted to UTK through the Graduate School. Candidates must have earned a bachelor's degree with a grade point average of at least 2.7 out of 4.0 (or a 3.0 during the senior year of undergraduate study), from a college or university accredited by the appropriate regional accrediting agency or a foreign equivalent (this is a Graduate Council minimum requirement). The Tickle College of Engineering (TCE) also requires that all applicants take the Graduate Record Examination (GRE) before applying for admittance. Additionally, students whose native language is not English must submit results of the Test of English as a Foreign Language (TOEFL) or other tests specified by the Graduate Admission Office.

Students wishing to apply to the MSE graduate programs must submit the UTK Graduate Application for Admission to the Graduate School (with on-line application available at <https://gradschool.utk.edu/admissions/applying-to-graduate-school/new-applicants/> and <https://www.applyweb.com/utg/index.ftl>).

The MSE Graduate Handbook (i.e., this document) includes information about the MSE Department, including summaries of research programs and facilities. Additional information may be obtained by visiting the MSE Web pages (<https://mse.utk.edu/>).

1.3. Financial Support, Residence Requirements and Vacation

Many graduate students in the MSE department receive financial assistance through a Graduate Research Assistantship (GRA) or a Graduate Teaching Assistantship (GTA). All assistantships are governed by the Policy for the Administration of Graduate Assistantships: (http://catalog.utk.edu/content.php?catoid=25&navoid=3185#poli_admi_grad_assi). MSE GRA appointments are typically twelve-month, one-half time (50% full-time equivalent, FTE) appointments. GRAs perform duties in support of university research, which typically relate directly to thesis/dissertation studies. A student appointed as a GRA works under the direct supervision of his/her faculty advisor, i.e., major professor.[§] Research assistantships may be financed through funds from gifts, grants, contracts, state appropriations designated for research, or UTK internally sponsored programs. Students who receive financial support are expected to be in residence throughout the calendar year pursuing full-time research and study. Typical annual vacation time is two weeks plus university holidays.

1.4. Major Professor for Graduate Students

All GRA students are assigned a major professor. The major professor is, in most instances, the professor providing a particular student with financial support. Students admitted without financial support should report to the Director of Graduate Studies. In this case, the Director of Graduate

[§] The Graduate School refers to the faculty advisor as the “major professor.” This said, we will refer to the faculty advisor as the major professor throughout this document.

Studies will review the student's background experience and advise the student on a program of coursework appropriate to the first year of study. A permanent advisor (i.e., a major professor who will direct the thesis or dissertation) should be chosen before the end of the first semester (the Director of Graduate Studies serving as the interim advisor). Students should arrange appointments with potential faculty advisors during the first semester, in order to learn about research projects that may be available. When an major professor and a research project have been agreed upon, the student should inform the Director of Graduate Studies of the decision. The Director will then confirm that the proposed major professor is willing and a formal transfer will occur. At this point, a copy of the student's file will be provided to the major professor, who will then assume all advising responsibilities.

For the M.S. program, any faculty member may serve as a faculty advisor for a student. For the Ph.D. program, only faculty approved by the Graduate School for directing doctoral dissertations are automatically acceptable. However, other faculty may apply to the Dean of the Graduate School for permission to direct the dissertation research of individual students. A list of potential MSE advisors (major professors) is provided in Appendix 1 of this document.

1.5. Continuous Enrollment, Credit Hours, and Course Loads

All degree-seeking students are expected to make a full commitment to their graduate study in order to ensure that they can complete all degree requirements without unnecessary delay. Graduate students are therefore required to maintain an active status through continuous enrollment from the time of first enrollment until graduation.

Continuous enrollment is maintained by registering for a minimum of one graduate *credit hour*[§] (CH) per semester (excluding the summer). However, Ph.D. students who have started taking dissertation hours (course 600 Dissertation) must maintain a minimum of 3 CHs per semester during all semesters, including the summer, in order to comply with the Continuous Enrollment requirement.

MSE 502 – Registration for Use of Facilities. This course (graded Satisfactory/No Credit) may be used to maintain continuous enrollment, in circumstances in which a student is not otherwise registered for coursework during a semester. Students are required to register for MSE 502 if they are not registered for any other coursework during a semester, but are using university facilities and/or faculty time. This course may be repeated up to a total of 15 CHs, but these CHs may NOT be used toward degree requirements.

Special Note for International Students. The minimum enrollment for international students may be different, and international students need to check with the Center for International Education (CIE – <https://cie.utk.edu/>) in order to determine what minimum enrollment they need to maintain in order to satisfy all enrollment requirements attached to their specific visa.

[§] The unit of credit is the semester credit hour. Normally, each credit hour represents an amount of instruction that is equivalent to 700 minutes of classroom-based direct instruction. Credit hours earned in courses such as internships, research, theses, dissertation, etc. are based on outcome expectations established by the academic program.

The maximum course load for a graduate student is 15 credit hours (CHs) during fall and spring semesters. Students holding a one-half (50 percent full-time equivalent, FTE) time assistantship normally should enroll in at least 6 CHs during the semesters of the assistantship. **However, a student must be enrolled in at least 9 CHs to be considered full-time for federal financial aid purposes, even if the student has an assistantship.** For the summer semester, graduate students may register for a maximum of 12 CHs in an entire summer semester or for a maximum of 6 CHs in a five-week summer session. Students may enroll in only one course during a mini-term session.

Registration for more than 15 CHs during any semester, or for more than 12 CHs in the summer semester, is not permissible without prior approval. The major professor may request registration of up to 18 CHs during a semester if the student has achieved a cumulative grade point average of 3.60 or better in at least 9 CHs of graduate work with no outstanding incompletes. The Graduate Course Overload form can be found on the Graduate School Forms Central page on the Graduate School website (<https://gradschool.utk.edu/>).

1.6. Programs and Concentrations

MSE offers both M.S. and Ph.D. graduate degree programs. The M.S. degree is offered through two sub-programs: (1) the *thesis* M.S. degree; and (2) the *non-thesis* M.S. degree. MSE also offers three technical *areas of concentration*: (1) *nanomaterials* (M.S. and Ph.D.); (2) *automotive materials* (M.S. and Ph.D.); and (3) *energy science & engineering* (Ph.D. only). Detailed requirements for the M.S. and Ph.D. programs are summarized below. MSE also offers a 5-year B.S.-M.S. program and a Dual M.S.-M.B.A. program. Information regarding these special programs can be found in the UTK Graduate Catalog (<http://catalog.utk.edu/index.php>).

2. MSE M.S. Degree Programs

The MSE M.S. degree is offered through two sub-programs: (1) the *thesis* M.S. degree; and (2) the *non-thesis* M.S. degree. These programs are described separately below.

2.1. MSE Thesis M.S. Degree Program

2.1.1. Major professor and thesis committee

The MSE department requires that each M.S. student be assigned a major professor prior to the end of the first semester of study. The major professor directs the student's thesis research and chairs the thesis committee. The major professor is not required to be an MSE professor, though this is usually the case. The student and the major professor must establish an M.S. thesis committee based on the following two guidelines:

1. The committee must consist of a minimum of 3 faculty members, all of whom must have a minimum rank of Assistant Professor in the UTK system (Assistant Professor can be a Research Assistant Professor or tenured / tenure-track Assistant Professor or an ORNL-based joint faculty member).
2. Of the 3 primary committee members, a minimum of 2 members must be MSE professors. These members may have joint appointments with other UTK departments (or with ORNL), but their primary academic unit appointment should be in MSE. [Exceptions to this guideline are possible via a written petition to the Director of Graduate Affairs and subsequent approval by the MSE Graduate Affairs Committee.]

The responsibility of the M.S. thesis committee is to assist the student in planning a program of study and carrying out research, and to assure fulfillment of the degree requirements. The MSE department requires that the thesis committee be appointed prior to the end of the second semester of study.

2.1.2. Thesis M.S. coursework requirements

30 CHs are required to earn a thesis M.S. degree in MSE.

Additional requirements include:

1. 9 graduate *core* course CHs of MSE 511, MSE 512, MSE 513, or MSE 514 are required (choose 3 of 4).
2. 15 additional graduate course CHs in either MSE or related technical fields are required (students seeking an M.S. degree *with a concentration* should refer to Section 2.1.3. for additional guidance).[§]
3. 6 CHs (minimum) of MSE 500 (Thesis) are required. MSE 500 is P/NP (Pass/No Pass).^{§§}

[§] There is no limit to the number of CHs of MSE 576 (Special Topics in MSE) or MSE 676 (Advanced Topics in MSE) that may be applied toward graduate course CHs. Note also that any 400 level courses must be listed in the Graduate Catalog in order to receive credit.

^{§§} The Graduate School will accept up to 12 CHs of MSE 500, but only 6 of these 12 CHs will be counted towards graduation.

4. 3 CHs of MSE 503 (Graduate Seminar) may be counted toward M.S. degree requirements. MSE 503 is S/NC (Satisfactory/No Credit).
5. Graduate students must obtain a cumulative overall 3.0 GPA by the end of the semester in which they will graduate (Graduate School requirement).
6. Satisfactory performance on a comprehensive oral examination administered by the faculty committee is required.

2.1.3. Concentration coursework requirements for M.S. candidates

As mentioned in Section 1.6, students may opt to enroll in a *concentration* while pursuing their M.S. degree in MSE. The following requirements apply to the three concentrations offered in MSE:

1. *nanomaterials*: two courses (6 CHs) from the nanomaterials concentration course list are required. Faculty points-of-contact: Professors Gerd Duscher and Haixuan Xu.
2. *automotive materials*: two courses (6 CHs) from the automotive materials concentration course list are required. Faculty points-of-contact: Professors Yanfei Gao and T.G. Nieh.

The concentration course lists mentioned above are provided in Appendix 2 of this document.

2.1.4. Thesis registration and thesis

A thesis M.S. student must be registered for course MSE 500 (Thesis) each semester during work on the M.S. thesis, including a minimum of 3 CHs during the semester in which the thesis is accepted by The Graduate School. Six CHs of MSE 500 are required for the thesis option. After receiving the M.S. degree, a student is no longer permitted to register for MSE 500.

The thesis represents the culmination of an original research project completed by the student. It must be prepared according to the UTK Guide to the Preparation of Theses and Dissertations (<http://web.utk.edu/~thesis/thesisresources.shtml>). Two copies of the thesis must be approved and accepted by The Graduate School on or before the deadline specified each semester (<https://gradschool.utk.edu/graduation/graduation-deadlines/>). Each copy must include an approval sheet, signed by the M.S. committee members, certifying that they have examined the final copy of the thesis and judged it to be satisfactory. Two additional copies are required by the department for use as future reference documents.

An M.S. candidate presenting a thesis must pass a final oral (or oral and written) examination on all work offered for the degree. The examination, which is concerned with coursework and the thesis, measures the candidate's ability to integrate material in the major and related fields, including the work presented in the thesis (this verbiage comes directly from the Graduate School). This examination, scheduled through the major professor, the committee and the MSE department, must be held at least two weeks before the final date for approval and acceptance of thesis by the Graduate School. Final examinations not properly scheduled must be repeated. The final draft of the thesis must be distributed to all committee members at least two weeks prior to the date of the

final examination. In case of failure, the candidate may not apply for re-examination until the following semester. The result of the second examination is final.

Candidates have six calendar years from the time of enrollment in the Graduate School to complete the M.S. degree. Students who change degree programs during this six-year period may be granted an extension after review and approval by the Graduate School. In any event, courses used toward the M.S. degree must have been taken within six calendar years of graduation.

2.2. MSE Non-Thesis M.S. Degree Program

Any candidate may apply for a *non-thesis* M.S. option. Upon acceptance, a supervisory committee of three will be appointed. At least two members of the committee will be from the faculty in the major area (i.e., MSE). The faculty committee must approve the candidate's degree program.

2.2.1. Non-thesis M.S. coursework requirements

30 CHs are required to earn a non-thesis M.S. degree in MSE.

Additional requirements include:

1. 9 graduate *core* course CHs of MSE 511, MSE 512, MSE 513, or MSE 514 are required (choose 3 of 4).
2. Satisfactory completion of MSE 580 (Critical Review). MSE 580 (3 CHs) may be counted toward the 30 CH M.S. requirement. This course must include a final presentation by the M.S. candidate to the faculty committee. The committee may also request a written report. In MSE, a comprehensive exam is NOT required. MSE 580 should be taken during the semester in which the degree is to be awarded. MSE 580 is graded A-F.
3. 3 CHs of MSE 503 (Graduate Seminar) may be counted toward M.S. degree requirements. MSE 503 is S/NC (Satisfactory/No Credit).
4. Of the 30 CHs required for the M.S. degree, a minimum of 18 CHs must be in MSE (e.g., 9 CHs MSE 511,512,513,514 plus 3 CHs MSE 580 plus 3 CHs MSE 503 plus one more MSE 3 CH graduate course).[§]
5. Graduate students must obtain a cumulative overall 3.0 GPA by the end of the semester in which they will graduate (Graduate School requirement).
6. Students seeking an M.S. degree with a *concentration* need to refer to Section 2.1.3. for additional guidance.

[§] There is no limit to the number of CHs of MSE 576 (Special Topics in MSE) or MSE 676 (Advanced Topics in MSE) that may be applied toward graduate course CHs. Note also that any 400 level courses must be listed in the Graduate Catalog in order to receive credit.

3. MSE Ph.D. Degree Program

3.1. Ph.D. Faculty Advisor (Major Professor)

The MSE department requires that each Ph.D. student be assigned a faculty advisor (*major professor*) prior to the end of the first semester of study. The major (advising) professor directs the student's dissertation research and serves as the *Chair* of the Ph.D. dissertation committee. The major professor is not required to be an MSE professor, though this is usually the case. In 2018, The Graduate School published the following requirements for *Ph.D. Committee Chairs*:[§]

1. Committee chairs must hold a doctoral degree.
2. UTK tenured, tenure-track, and joint faculty holding a doctoral degree may chair Ph.D. committees.
3. The chair is typically from the student's department/interdisciplinary program, but department heads may make exceptions.
4. UTK employees holding a non-tenure track assistant professor, associate professor or professor title may *co-chair* committees, if their appointment is within the student's major (the other co-chair must be a UTK tenured, tenure-track or joint faculty member)
5. Emeritus faculty can chair committees on which they are serving in that capacity at the time of retirement.

The MSE department has no additional requirements for major professors (Ph.D. committee chairs), other than requirements 1-5 enumerated above. If a *co-chair* arrangement for a particular student is agreed upon, then the co-chairs must (together) meet all five of the requirements enumerated above (with one exception, namely that in MSE, one of the co-chairs can be a UTK employee holding the title, *Research Professor*).

3.2. Ph.D. Dissertation Committee

The student and the major professor are tasked with establishing a Ph.D. dissertation committee. In 2018, The Graduate School ceded Ph.D. committee requirements to the departments within the university. Details of the Graduate School guidelines for Ph.D. committee service are provided at <https://gradschool.utk.edu/forms-central/phd-committee-form/>. This link also provides guidelines for Ph.D. committee service. This said, there are a few principal Graduate School rules regarding *Ph.D. committee* make-up that are summarized as follows:[§]

1. The committee must have at least 4 members.
2. At least 2 committee members must be UTK tenured or tenure-track faculty members.
3. At least one committee member must be from outside of the student's department/interdisciplinary program. This external member can be from outside UTK.

[§] The Graduate School policy provides for exceptions to the above, and in the case that exceptions are needed, the MSE Department Head must petition the Dean of the Graduate School.

4. UTK tenured or tenure-track faculty without a doctoral degree and other experts in the field may serve on Ph.D. committees with department head approval.
5. Emeritus faculty can serve on committees on which they are serving in that capacity at the time of retirement.

The MSE department *Ph.D. committee* make-up requirements are listed below:

1. The committee must consist of a minimum of 4 members.
2. Of the 4 primary committee members, a minimum of 3 members must be approved by the UTK Graduate Council to direct doctoral research (<http://gradschool.utk.edu/faculty-staff/graduate-council/>).
3. Of the 4 primary committee members, a minimum of 2 members must be MSE professors. These members may have joint appointments with other UTK departments (or with ORNL), but their primary academic unit appointment must be in MSE.
4. Of the 4 primary committee members, a minimum of 1 member must be from outside the MSE department. This external member may have a joint appointment with MSE (or an adjunct appointment with MSE). Alternatively, this external member can be from outside UTK.

[NOTE: Students are encouraged where appropriate to seek a 5th member in the field of specialization from outside the university to serve on their Ph.D. committee.]

This Ph.D. committee is nominated by the MSE department head or TCE dean and approved by the Graduate School.

The responsibility of the Ph.D. committee is to assist the student in planning a program of study and carrying out research, and to assure fulfillment of the degree requirements. The MSE department requires that the Ph.D. committee be appointed prior to the Ph.D. “dissertation defense.”

3.3. Ph.D. Qualifying Examination

The MSE department requires all Ph.D. candidates to pass a *Ph.D. qualifying examination*. This examination consists of four written exam sections (based on the four core courses in MSE; see Section 3.4.1.). Each Ph.D. candidate is required to attempt and **pass a minimum of three** of the four written exam sections. All four exam sections are offered in January of each year. Ph.D. candidates may take each exam section twice (over a two-year period), in their effort to pass the minimum three exam sections. Failing to pass three exam sections disqualifies a candidate from continuing to pursue a Ph.D. in MSE.[§] In this circumstance, a student may consider an option to finish their MSE graduate experience by completing an M.S. degree (this must be arranged with the student’s major professor). All Ph.D. candidates must attempt the Ph.D. qualifier examination

[§] A major professor may petition the Head of the MSE department for an exception to this policy.

within 1.5 years following admission into the MSE Ph.D. program. Finally, students taking the Ph.D. qualifying examinations must be in the Ph.D. program (M.S. students must enroll and be accepted into the Ph.D. program prior to attempting the qualifiers).[§]

3.4. Ph.D. Course Requirements

Course requirements differ depending on whether a student proceeds directly to the MSE Ph.D. degree program from their baccalaureate degree (B.S. or B.A) or join the Ph.D. program after earning an M.S. degree. These cases are considered individually below.

3.4.1. Graduate course credit hour requirements for students WITHOUT a prior M.S. degree

For Ph.D. candidates proceeding directly to the Ph.D. from a baccalaureate degree (B.S. or B.A), the Graduate School requires **completion of a minimum of 72 CHs of study prior to graduation**. The MSE department requires that a minimum of 36 CHs (of the required 72 CHs) be graduate *course* credit hours. The remaining 36 CHs may be satisfied through doctoral research and dissertation credit. Additional requirements are as follows:

1. Four graduate MSE *core* courses, MSE 511 (crystallography), MSE 512 (mechanical properties), MSE 513 (thermodynamics), and MSE 514 (electronic, magnetic, optical properties), are required. These courses account for 12 CHs toward the required 72 CH total (3 CHs per class).
2. A minimum of 24 additional CHs of coursework in MSE and related fields is required for graduation. Of these 24 CHs, 12 CHs must be in MSE. A maximum of 6 CHs may be in MSE seminar - MSE 503. MSE 503 is 1 CH per semester. MSE 503 is S/NC (Satisfactory/No Credit). The 24 CHs of additional coursework may consist of any combination of 400,^{§§} 500, or 600 level courses (MSE or non-MSE).^{§§§} Two 600-level graduate courses are required (this is a Graduate School requirement). These two courses must be in MSE (this is a department requirement).^{§§§§}
3. A minimum of 24 CHs is required in MSE 600: Doctoral Research & Dissertation (this is a Graduate School requirement). **The MSE department allows students to take up to 36 CHs of MSE 600** (i.e., up to half of the requisite 72 CH minimum required for graduation). MSE 600 is P/NP (Pass/No Pass).

[§] A student enrolled in the MSE M.S. degree program may transfer to the MSE Ph.D. degree program at any time (i.e., without obtaining an M.S. degree) by submitting a Change of Program form (access this form via the reapplication link, <https://gradschool.utk.edu/admissions/applying-to-graduate-school/readmission/>; the reapplication fee is ½ the normal application fee).

^{§§} Any 400-level courses must be listed in the Graduate Catalog in order to be available for graduate credit. The MSE department must submit a formal curriculum change request in order to add a 400-level course to the catalog that is not listed in the Graduate Catalog (<http://catalog.utk.edu/index.php?catoid=21>). The approval and implementation process for such a request requires approximately one academic year to complete.

^{§§§} There is no limit to the number of CHs of MSE 576 (Special Topics in MSE) or MSE 676 (Advanced Topics in MSE) that may be applied toward graduate course CHs.

^{§§§§} Non-MSE 600-level courses may be permitted upon petition to the Director of Graduate Affairs.

4. A minimum of 30 CHs of graduate coursework at UTK (beyond the baccalaureate degree) must be graded A-F (Graduate School requirement).
5. Graduate students must obtain a cumulative overall 3.0 GPA by the end of the semester in which they will graduate (Graduate School requirement).

Appendix 3 shows a sample course template for a four-year Ph.D. program.

3.4.2. Concentration course requirements (Ph.D. Candidates)

The following guidelines are additional requirements for students whose Ph.D. work includes an area of concentration:

1. Nanomaterials. Four courses (12 CHs) from the nanomaterials concentration course list are required. Faculty points-of-contact: Professors Gerd Duscher and Haixuan Xu.
2. Automotive Materials. Four courses (12 CHs) from the automotive materials concentration course list are required. Faculty points-of-contact: Professors Yanfei Gao and T.G. Nieh.
3. Energy Science & Engineering. Six courses (18 CHs) must be from the curriculum jointly approved by the Bredesen Center for Interdisciplinary Research and Graduate Education and the MSE graduate affairs committee. Faculty points-of-contact: Professors David Mandrus and Bill Weber.

The concentration course lists mentioned above are provided in Appendix 2 of this document.

3.4.3. Graduate course credit hour requirements for students WITH a prior M.S. degree

For students who have earned an M.S. degree in MSE or a *related technical discipline*, from either UTK or another university, the MSE department allows up to 30 CHs of prior M.S. *technical* graduate coursework to be used toward the Graduate School Ph.D. requirement of 72 CHs of graduate study.[§] Authority to approve this prior graduate coursework *waiver* rests first with the Head of the MSE department, then with the Dean of the Graduate School (via recommendation from the MSE Director of Graduate Affairs). Although these prior graduate courses are used as part of the requirements toward the UTK Ph.D. degree and are listed on the UTK Ph.D. admission to candidacy form, these courses are not officially transfer courses and are not placed on the student's university transcript. Official transcripts must be sent directly to the Graduate School from all institutions previously attended before any credit (i.e., credit waiver) will be considered.

Additional requirements for the remaining 42 CHs of graduate study include:

1. MSE graduate core courses (MSE 511, 512, 513, 514) are required (12 CHs total).

[§] Current Graduate catalog verbiage indicates that a student with a *thesis* M.S. degree may only transfer 24 CHs of prior MS technical graduate coursework. This is a department (not Graduate School) requirement and this requirement presupposes that a thesis M.S. student has a transcript containing at least 6 hours of thesis (research) coursework. These thesis CHs are not transferable (thus, the additional course requirements for *thesis* M.S. students described above). However, if the thesis M.S. student *does* have additional CHs of technical graduate coursework (beyond the 24 CHs described above), these CHs will be accepted by the department, up to the maximum Graduate School transferable limit of 30 CHs.

2. Two 600-level graduate courses are required (6 CHs total).
3. Ph.D. candidates with a *concentration* (nanomaterials, automotive materials, or energy science & engineering), must satisfy the concentration requirements outlined in Section 3.4.2.
4. 6 CHs of MSE 503 (seminar) may be applied to the remaining 42 CHs of graduate study. MSE 503 is S/NC (Satisfactory/No Credit).
5. A minimum of 24 CHs of MSE 600 (doctoral research & dissertation) are required. MSE 600 is P/NP (Pass/No Pass).
6. A minimum of 12 CHs of graduate coursework at UTK (beyond the master's degree) must be graded A-F (Graduate School requirement).

3.5. Graduate School Requirement for “Continuous Enrollment” in *Dissertation*

The Graduate School requires that once a Ph.D. candidate enrolls in MSE 600 (Doctoral Research & Dissertation), the candidate must register continuously for MSE 600 (minimum 3 CHs per semester) for the entire time that the candidate pursues his/her Ph.D. degree (this includes summer semesters and the semester in which the dissertation is accepted by the Graduate School). Initial registration for MSE 600 should be determined through consultation with the major professor. Registration for MSE 600 usually begins when a Ph.D. candidate begins to work actively on dissertation research. Under certain circumstances, a leave of absence from continuous registration of MSE 600 can be granted (refer to the forms on <https://gradschool.utk.edu/forms-central/>).

3.6. Concurrent M.S. Degree Program

The Graduate School permits Ph.D. students to earn a concurrent M.S. degree, on their way to the Ph.D. degree. The student who is interested in obtaining this degree will remain active in the Ph.D. degree program and complete the M.S. degree in MSE along the way to the Ph.D. Over the course of the program, the concurrent M.S. degree program requires three forms (available at <http://gradschool.utk.edu/forms-central/>): (1) Request for Concurrent Masters Degree; (2) Admission to Candidacy – Masters or Specialist Degree; and (3) Report of Final Examination/ Defense of Thesis/ Project/ Capstone (Master's, Specialist in Education, DSW Degrees). The CH and course requirements for the concurrent M.S. degree in MSE are the same as for the non-thesis M.S. degree (see Section 2.2.1.). In particular, concurrent M.S. students are required to take MSE 580 (Critical Review). MSE 580 (3 CHs) is graded A-F and may be counted toward the 72 CH Ph.D. requirement. Note that doctoral students earning a concurrent M.S. degree on the way to the Ph.D. must still satisfy a Graduate School requirement that 30 CHs of their graduate coursework is graded A-F.

3.7. Dissertation Written Proposal and Dissertation Proposal Oral Examination

3.7.1. Dissertation written proposal

Within two years after passing the Qualifying Examination, and at least one year before defending the dissertation, each Ph.D. candidate in MSE is required to submit a *written* proposal describing

their proposed dissertation research. This proposal is submitted to the candidate's Ph.D. dissertation committee. The proposal should contain sufficient detail, by way of literature search and preliminary experimental and/or theoretical development, to demonstrate understanding of the methodology to be used and allow the examining committee to assess the likelihood of success.

3.7.2. Dissertation proposal oral examination

An oral examination of the proposal material should be conducted by the doctoral committee within one month of submission of the dissertation proposal. If the committee is satisfied with the dissertation proposal, the candidate proceeds to "Admission to Candidacy" (see Section 3.8). If the committee decides that the proposal *does not* demonstrate a clear path towards a successful Ph.D., the dissertation proposal can be rewritten and the oral examination can be repeated.

3.8. Admission to Candidacy

Admission to Ph.D. candidacy reflects consensus among the student, the doctoral committee, and The Graduate School, that the student has demonstrated the ability to do acceptable graduate work and that normal progress has been made toward earning the Ph.D. degree. This action usually connotes that all prerequisites to admission have been completed and a program of study has been approved.

The Graduate School approves admission to candidacy for the Ph.D. degree upon passage of the Comprehensive Examination.[§] In MSE, this comprehensive examination consists of three parts:

1. The Qualifying Examination (Section 3.3).
2. The Dissertation Proposal (Section 3.7.1.). This proposal satisfies the Graduate School written requirement for the comprehensive examination.
3. The Dissertation Proposal Oral Examination (Section 3.7.2.). This oral portion of the comprehensive examination is encouraged by the Graduate School.

Admission to candidacy must be applied for and approved at least one full semester prior to the date the Ph.D. degree is to be conferred. Each student is responsible for filing the Admission to Candidacy form, listing all courses to be used for the degree, signed by the doctoral committee and approved by The Graduate School. Ordinarily, this form is signed by the doctoral committee upon satisfactory completion of the oral dissertation proposal.

[§] NOTE: The Graduate School also requires that the student maintain at least a B average in all graduate coursework. Falling below B (or cumulative GPA < 3.0) will automatically place the student under probation. Refer to the Graduate Catalog for policies on probation and termination. Also note that the Graduate School will not accept any "D" grade on the Admission to Candidacy form.

3.9. Dissertation and Defense of Dissertation Examination

3.9.1. Dissertation

The Ph.D. dissertation represents the culmination of an original major research project completed by the student. The organization, method of presentation, and subject matter of the dissertation are important in conveying to others the results of such research.

The dissertation should be prepared according to the requirements outlined in the Guide to the Preparation of Theses and Dissertations (<https://gradschool.utk.edu/thesesdissertations/>) An electronic copy of the dissertation must be submitted to and accepted by The Graduate School, on behalf of the Graduate Council. Each dissertation must be accompanied by one approval sheet, signed by all members of the doctoral committee. The approval sheet certifies to The Graduate School that the committee members have examined the final dissertation and found that its form and content demonstrate scholarly excellence. The Doctoral Dissertation Agreement form, Survey of Earned Doctorates form, and the Abstract form, are also submitted at this time. Two additional copies of the dissertation are required by the MSE department for use as future reference documents.

3.9.2. Defense of dissertation examination (the final oral defense)

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

3.10. Ph.D. Time Limit

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

4. Appeals Procedures

Grievances against any policy or action by the University or its personnel may be presented according to the procedures specified in the Graduate Council Appeal Procedure (<https://gradschool.utk.edu/documents/2016/02/student-appeals-procedures.pdf/>).

In addition, complaints or disputes involving the MSE department or its personnel may be addressed within the department. When appropriate, the student should request a meeting with his/her advisor, or his/her committee. If a resolution of an issue cannot be achieved with either the advisor or the student's committee, or if the dispute involves them, then the student should request a meeting with the Department Head and any departmental personnel involved in the dispute. If a resolution satisfactory to the student cannot be achieved within the MSE department, then the student may request a meeting with the Dean of Engineering or may follow procedures described in the Graduate Council Appeal Procedure.

APPENDICES

APPENDIX 1: MSE Faculty and Their Research Interests

Mahshid Ahmadi, Ph.D., Nanyang Technological University, Singapore: *synthesis and development of hybrid organic-inorganic perovskites, high radiation energy sensors, electronic and ionic charge transport*

Sudarsanam “Suresh” Babu, Ph.D., University of Cambridge (UK): *advanced manufacturing, non-equilibrium phase transformation computational materials science*

Hahn Choo, Ph.D., Illinois Institute of Technology: *powder metallurgy, physical/mechanical metallurgy, neutron scattering*

Gerd J. Duscher, Ph.D., Sci., University of Stuttgart (Germany): *interface science, analytic (scanning) transmission electron microscopy*

Takeshi Egami, Ph.D., University of Pennsylvania: *amorphous and nanocrystalline solids, neutron and x-ray scattering, electronic oxides*

Jason D. Fowlkes, Ph.D., University of Tennessee: *laser-induced nanostructures in silicon*

Yanfei Gao, Ph.D., Princeton University: *computational materials science, mechanics of materials, friction and adhesion*

Easo P. George, Ph.D., University of Pennsylvania: *high-entropy alloys, mechanical behavior in extremes conditions*

Dustin A. Gilbert, Ph.D., University of California at Davis: *properties of nanostructured materials & nanoscale phenomena, interactions & reversal behavior in hysteric systems*

Bin Hu, Ph.D., Chinese Academy of Sciences (China): *electronic and optical polymeric materials and devices*

Ramakrishnan “Ramki” Kalyanaraman, Ph.D., North Carolina State University: *thin films, laser processing, electronic properties, nanocomposites*

David J. Keffer, Ph.D., University of Minnesota: *multiscale materials modeling with applications in fuel cells, nanoporous materials, polymers, explosive sensors, etc.*

Veerle Keppens, Ph.D., Katholieke Universiteit Leuven (Belgium): *physical acoustics, synthesis and characterization of novel materials*

Kevin M. Kit, Ph.D., University of Delaware: *polymer blends, agricultural materials*

Peter K. Liaw, Ph.D., Northwestern: *mechanical behavior, composite materials, life prediction and extension*

Carl D. Lundin, Ph.D., Rensselaer: *welding, joining, non-equilibrium metallurgy*

David G. Mandrus, Ph.D., SUNY Stony Brook: *synthesis and characterization of novel materials*

Charles L. Melcher, Ph.D., Washington University: *crystal growth and characterization of novel scintillation materials*

James R. Morris, Ph.D., Cornell University: *computational materials science*

T. G. Nieh, Ph. D., Stanford University: *metallic glasses, nanostructured materials, composites, lightweight alloys, intermetallics, refractory metals, thin films, bioceramics, superplasticity, high temperature mechanical properties*

Philip D. Rack, Ph.D., University of Florida: *electronic and optoelectronic materials, thin film processing and characterization, and selective nanoscopic processing*

Claudia J. Rawn, Ph.D., University of Arizona: *ceramics processing, X-ray diffraction, neutron scattering*

Kurt E. Sickafus, Ph.D., Cornell University: *crystallography, radiation damage effects, microstructure of materials*

Michael L. Simpson, Ph.D., University of Tennessee: *electronic materials, nanostructured materials, nanofabrication, biomaterials*

William J. Weber, Ph.D., University of Wisconsin: *radiation effects, ion-beam modification of materials, nuclear materials, defect properties in ceramics*

Haixuan Xu, Ph.D., University of Florida: *electronic structure of point defects to physical properties of complex materials using atomistic simulations*

Yanwen Zhang, Ph.D., Lund Institute of Technology (Sweden): *ions and electrons interactions with solids, radiation effects and radiation detector physics, ion beam analysis*

Mariya Zhuravleva, Ph.D., Tohoku University (Japan): *crystal growth, scintillation materials*

Steven J. Zinkle, Ph.D., University of Wisconsin: *physical metallurgy of structural materials, ion and neutron irradiation effects, fusion and fission reactor materials, deformation and fracture mechanisms*

APPENDIX 2: Course Lists for MSE Concentrations

1. Nanomaterials Concentration Course List

MSE 515 – Diffusion, Phase Transformations, and Microstructure of Materials

MSE 522 – Defects in Crystals

MSE 540 – Basic Polymer Chemistry

MSE 544 – Polymer Solution Thermodynamics and Characterization

MSE 551 – Solar Photovoltaics

MSE 556 – Materials for Energy

MSE 567 – Magnetism and Magnetic Materials

MSE 578 – Advanced Biomaterials: Biological Applications of Nanomaterials

MSE 611 – Fundamentals of Thermodynamics, Phase Transformations, and Material Simulations at Small Length Scales

MSE 612 – Computational Plasticity and Micromechanics

MSE 630 – Thin Film Materials Processing

MSE 644 – Optoelectronic Processes in Semiconducting Materials and Devices

MSE 652 – High Performance Fibers

MSE 666 – Nanoindentation and Small-Scale Contact Mechanics

2. Automotive Concentration Course List

MSE 484: Introduction to Maintainability Engineering

MSE 510: Mathematical and Numerical Problem-Solving Skills for Materials Scientists and Engineers

MSE 516: Fundamentals of Plastic Deformation

ME 517: Finite Elements for Engineering Applications

MSE 525: Welding Metallurgy

MSE 527: Welding Metallurgy II

MSE 532: Metallurgy of Deformation and Fracture

MSE 552: Laboratory Methods in Polymer Engineering

ME 565: Structural Dynamics

ME 567: Smart Structures/Materials
ME 588: Intro/Hybrid Electric Vehicles
ME 589: Hybrid Electric Vehicle Control Systems Design and Analysis
ME 591: Advanced Engineering Analysis
MSE 611: Fundamentals of Thermodynamics, Phase....
MSE 612: Computational Plasticity and Micromechanics
MSE 639: Polymer Engineering Principles II
MSE 650: Mechanical Behavior of Solids at Elevated Temperatures
MSE 652: High Performance Fibers
MSE 675: Advanced Structural Analysis

3. Energy Science and Engineering (ESE) Course List

ESE 511: Introduction to Energy Science and Technology I

Core ESE requirement. Topics include: energy basics, history of energy and society, current and future supply and demand, political and environmental aspects of energy production, energy technologies (fossil fuels, biomass, nuclear fission, nuclear fusion, solar, wind, geothermal), energy conversion, storage, transportation, and distribution, energy efficiency, and innovation.

ESE 512: Introduction to Energy Science and Technology II

Core ESE requirement. Topics include: energy basics, history of energy and society, current and future supply and demand, political and environmental aspects of energy production, energy technologies (fossil fuels, biomass, nuclear fission, nuclear fusion, solar, wind, geothermal), energy conversion, storage, transportation, and distribution, energy efficiency, and innovation.

ESE students in MSE are also required to take MSE 511, 512, 513, and 514, in order to satisfy requirements for the ESE concentration. The combination of MSE 511-14 and ESE 511-12 constitute the 18 CHs required to graduate with a concentration in ESE.

APPENDIX 3: Course Template for Ph.D. Candidate Entering MSE Directly from B.S. Degree

**Ph.D. Candidate – Credit Hour (CH) Requirements
(direct from Bachelor’s Degree)**

Required MSE 500-LEVEL COURSE CREDIT HOURS	Required 600-LEVEL COURSE CREDIT HOURS (MSE)	Additional MSE or NON-MSE COURSE CREDIT HOURS (400, 500, 600 level)	TOTAL COURSE CREDIT HOURS	TOTAL THESIS CREDIT HOURS (MSE 600 Doctoral Research & Dissertation)	TOTAL CREDIT HOURS
12* (minimum)	6 (minimum)	18** (minimum)	36 (min)	36 (max)	72 (minimum)
			48 (max)	24 (min)	

* Required: MSE 511 (3 CH), 512 (3 CH), 513 (3 CH), 514 (3 CH). Total: 12 CH

** Of these additional course CHs, 6 CHs (maximum) may be MSE 503 (seminar)

Ph.D. Candidate – Year 1 (Total Accumulated CH = 20)

Fall – Year 1	CH / course	Accumulated Total CH
MSE 511, 512, 513, 514 (choose 3 of 4)	3	9
MSE 503 (Seminar)	1	10

Spring – Year 1	CH / course	Accumulated Total CH
MSE Elective (e.g., MSE 572, X-ray diffraction)	3	13
MSE Elective (e.g., MSE 522, Defects in Crystals)	3	16
600-level MSE Elective (e.g., MSE 630, Thin Film Materials Processing)	3	19
MSE 503 (Seminar)	1	20*

Summer – Year 1	CH / course	Accumulated Total CH
Registration requirements in summer depend on a student's financial aid circumstances	-	20

* 20 CHs - ALL MSE course credit hours

Ph.D. Candidate – Year 2 (Total Accumulated CH = 43)

Fall – Year 2	CH / course	Accumulated Total CH
MSE 511, 512, 513, 514 (remaining 1 of 4)	3	23
600-level MSE Elective (e.g., MSE 674, Materials Physics)	3	26*
MSE 600 (Doctoral Research & Dissertation)	3	29
MSE 503 (Seminar)	1	30

Spring – Year 2	CH / course	Accumulated Total CH
Elective (e.g., PHYS 671, Advanced Solid State Physics)	3	33
Elective (e.g., CHEM 572, Thermodynamics and Statistical Mechanics)	3	36
MSE 600 (Doctoral Research & Dissertation)	3	39
MSE 503 (Seminar)	1	40

Summer – Year 2	CH / course	Accumulated Total CH
MSE 600 (Doctoral Research & Dissertation)	3	43

* 6 CH of MSE **600-level course credit hours** requirement now COMPLETE

Ph.D. Candidate – Year 3 (Total Accumulated CH = 60)

Fall – Year 3		
	CH / course	Accumulated Total CH
MSE 600 (Doctoral Research & Dissertation)	6	49
MSE 503 (Seminar)	1	50
Spring – Year 3		
	CH / course	Accumulated Total CH
MSE 600 (Doctoral Research & Dissertation)	6	56
MSE 503 (Seminar)	1	57*
Summer – Year 3		
	CH / course	Accumulated Total CH
MSE 600 (Doctoral Research & Dissertation)	3	60

* Minimum 36 **course credit hour** requirement now COMPLETE.

Ph.D. Candidate – Year 4 (Total Accumulated CH = 72)

Fall – Year 4	CH / course	Accumulated Total CH
MSE 600 (Doctoral Research & Dissertation)	6	66

Spring – Year 4	CH / course	Accumulated Total CH
MSE 600 (Doctoral Research & Dissertation)	6	72*

* This course template uses the maximum allowed 36 CHs of MSE 600. Also, the 72 total CHs requirement is now COMPLETE.

NOTE: Signing up for 6 CH per semester in Year 4 and paying a \$100 fee to use the Health Clinic ends up being cheaper than paying for 9 CH per semester.