# GUIDELINES FOR GRADUATE STUDENTS

# IN THE MATERIALS SCIENCE PH.D. PROGRAM

# THE UNIVERSITY OF ALABAMA - TUSCALOOSA CAMPUS

2014

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# 1 Welcome to the Materials Science Ph.D. Program

The Materials Science Ph.D. Program is an interdisciplinary, interdepartmental, and intercampus doctoral program linking the three universities that comprise the University of Alabama System – The University of Alabama (UA), in Tuscaloosa, The University of Alabama at Birmingham (UAB), and The University of Alabama in Huntsville (UAH).

Through this interdisciplinary graduate education approach, students tailor their course work across department, college, and university campus boundaries. In doing so, students have greater options to maximize their academic, research, and professional interest. Students typically have undergraduate degrees in physics, chemistry, or materials-related engineering disciplines.

Since Materials Science is a graduate program, and not a department, nominally students select a "home department" where their advisor resides. With their advisor and graduate committee, students develop a plan of study that satisfies each campus's Ph.D. requirements. Students who successfully complete the program receive a Ph.D. degree in Materials Science from the University of Alabama System.

The following information is designed to guide you (the student) in procedures used by the program in completing your graduate degree. This should be regarded as a supplement to, but not a replacement for, the material in the UA campus (located in Tuscaloosa) Graduate Catalog. Any possible errors in these guidelines do not supersede or can replace those outlined in the Graduate Catalog. Students enrolled at the other UA campuses follow the specific guidelines of their particular Graduate School campus. If students have questions concerning the guidelines, they are encouraged to discuss their concerns with their graduate advisor and/or the campus director of the Materials Science Ph.D. program. This will ensure all the requirements are being meet and each student is making adequate progress towards graduation.

Admission to the Graduate School and the Materials Science Ph.D. program does not imply admission of a student to candidacy for a degree. Admission to candidacy is contingent upon the recommendation of the student's committee and the approval of the graduate dean, after the student has met the formal requirements for candidacy listed below and demonstrated sufficient preparation to pursue the graduate study and research required for the degree sought.

## *1.1 Graduate Committee*

During the first year, a Materials Science student composes his/her doctoral dissertation committee under the guidance of the primary advisor, who serves as the committee chair. The committee is charged to help design a set of Materials Science courses that address the basics of Materials Science, the general themed areas of Examination I (described below) and Examination II, commonly referred to as a proposal defense, which serves to prepare the student for his/her research emphasis. These courses should be science and/or engineering related and meet the Ph.D. course and research hour requirements for the Ph.D. degree as outlined by the respective campus's Graduate School.

The form for **Appointment/Change of a Doctoral Dissertation Committee** is completed by the student and submitted to the graduate school once all the members are identified under the guidance of the primary advisor. The committee must comprise a majority of Material Science faculty and at least one should be off-campus (UAB or UAH) Materials Science faculty. Please consult each campus's faculty directory in identifying such members in the relevant academic/research fields. Note that all members of a dissertation committee must be members of the UA Graduate Faculty as described in the Catalog's section on **Qualifications of the Graduate Faculty**. If an outside member is not a full or associate member of the UA Graduate Faculty (e.g., a highly qualified person from another university, a business or industry), the graduate dean needs to appoint that member by approving Temporary Graduate Faculty status for the specific purpose of serving on the student's dissertation committee. Unless there are extraordinary circumstances meriting approval by the graduate dean before the final oral defense of the dissertation, all members of the dissertation committee must attend the defense of the dissertation. Gaining Temporary Graduate Faculty status for this member is done by submitting a letter from the primary advisor and approved by the Director of the Materials Science program to the Graduate Dean outlining the attributes and needs to include this person. This packet should also include a curriculum vita of the proposed committee member.

If the student does not have an advisor at their time of arrival at UA Tuscaloosa, the campus Director of the Materials Science Ph.D. program serves in that role until an academic course advisor until a permanent advisor is secured.

# 2 Requirements for the Ph.D. Degree

The doctor of philosophy degree is granted on the basis of scholarly proficiency, distinctive achievement in a special field, and capacity for independent, original investigation. The first two criteria are tested in coursework and a comprehensive examination (parts I and II), the last in a dissertation in which the student must present clearly and effectively the results of substantial research. A combination of these accomplishments, rather than the mere accumulation of residence and course credits, is the essential consideration in awarding the Ph.D. degree. Admission to any doctoral program is limited to students whose scholastic records show distinct promise of success in doctoral study. Admission to the Ph.D. program does not guarantee acceptance into a doctoral candidacy program.

## *2.1 Ph.D. degree course work requirements:*

As outlined in the UA guidelines, a defined field of specialization is required of all candidates for the doctor of philosophy degree, which for this program is the Materials Science Ph.D. A minimum of **48 semester hours** of non-dissertation course credit is required. Ph.D. track students should consult their primary advisor and supervisory committee (described above) on courses that are suited to fulfilling the course of study.

A listing of relevant (but not required) courses is given in Appendix A; this is not a comprehensive listing of materials courses and students are strongly encouraged to continually review the Registrar's Schedule of Classes for courses and consult his/her advisor and graduate committee

for courses throughout their tenure at the university. Students interested in courses offered at other UA campuses (UAB or UAH) should consult that university's course listings and instructors about enrollment and accommodations (such as video connections). If an off-campus course has been identified, the UA campus student typically enrolls in the 'special topics' dissertation hours of their 'home department' with the primary advisor listed as the instructor. The instructor of the off-campus course then assigns the grade at the end of the term, which the primary advisor gives as the special topics grade. This avoids the added complexity of enrollment and acceptance of students between different UA campuses while providing students in this program the opportunity to access the system-wide academic options for the degree.

In addition, a student must complete a minimum of **24 hours of dissertation research (699)** under their primary advisor. This course is listed in the primary advisor's home department's course catalog.

Per the UA- Graduate School Guidelines, entering Materials Science Ph.D. students that have earned a M.S. degree elsewhere can apply for up to and no more than 24 hours of course work to be credited towards the 48 semester hours of course work listed above and must have been earned within the time line before their enrollment at UA. For these hours to be credited, students must show equivalent standing of the former courses to ones offered at UA. The petition form can be found at the Graduate School website under 'Forms.' Students who seek approval for these equivalent credit hours should discuss these courses with their primary advisor and/or committee after which formal approval is done by the Director of the Materials Science Ph.D. program.

Other requirements:

- **500- and 600-Level Courses.** At least 48 hours of semester course hours must be at the 500 and/or 600 levels to count for the Ph.D. The courses should be closely related to the materials science and research field of the student.
- **Time Limits.** All requirements for the doctoral degree must be completed within seven (7) years (21 total semesters) following admission to the doctoral program. Please consult the UA graduate catalog for extension requests.
- **Residency requirements**. The intent of the residency requirement is to ensure that doctoral students contribute to and benefit from the complete spectrum of educational, professional, and enrichment opportunities provided at The University of Alabama. Please consult the UA graduate catalog for the several ways to meet the residency requirement.
- **Application for Graduation.** Each candidate for a doctoral degree must apply for the degree through myBama no later than the "last day to register or add a course" of the semester or the first term of the summer session in which requirements for the degree are to be completed. That day is published for each semester at the website of the **University Registrar**.
- **Clearing the Academic Record for Commencement.** At least one week before commencement, the candidate's record must have been cleared for graduation.
- **Attendance at Commencement.** A candidate for a doctoral degree must be present at a scheduled commencement to receive the diploma and hood, unless excused by the graduate dean.

- **Withholding or Withdrawing an Advanced Degree.** The University of Alabama reserves the right to withhold or withdraw an advanced degree on the recommendation of the graduate faculty.

Please consult the UA- graduate catalog for other university requirements.

## *2.2 Plan of Study*

Early in the graduate program, each Ph.D program student must confer with their advisor and committee in the development of a plan of study and research direction. After which a Plan of Study is prepared and submitted to the Graduate School. The **PhD Plan of Study** can be found at the Graduate School website. *All doctoral students **must** have a completed Plan of Study approved by the Graduate School no later than the semester during which the student will complete 30 semester hours of UA and/or transfer credit toward the doctoral degree*. Otherwise, a "hold" may be placed on future registrations. An amended Plan of Study (if needed) must be submitted to the Graduate School when the student submits the form for **Admission to Candidacy for Doctoral Degree**.

## *2.3 Competency Examinations*

The competency examination is required of all candidates for the Doctor of Philosophy Degree. The Materials Science examination includes two parts: Examination I and Examination II. Advisors and students are strongly encouraged to be aware of the time frames of these exams and ensure that they are met. As the examination is handled by the committee, see below, it can be given at a variety of dates depending on the student and committee schedule. **Hence, it is essential that the advisor monitor the student progress in the Materials Science program and ensure these necessary metrics are meet at the appropriate timeframes.**

### 2.3.1 Examination I:

Examination I composes questions requiring substantive knowledge of experimental and theoretical topics in Materials Science. The exam has three general themed sections:

- Section I – Structure and Properties of Materials
- Section II – Characterization and Testing
- Section III – Thermodynamics and Processing.

The total examination cannot be more than 6 hours in length (or up to 2 hours per section). The examination questions and format is determined by the assembled graduate committee. Since Materials Science is a broad field, with students from a range of backgrounds, this examination format provides the student and committee flexibility of determining core competency in the material-focused area based on the student's research and course of study. The primary advisor and student should be cognizant of assembling committee members that can address each of these areas as they relate to the student's research. Committee members are encouraged to contact faculty instructors that provided course work in the student's plan of study. These instructors can

provide necessary questions and solutions to grade from in each of the themed areas, if they are not provided by the committee members themselves. The examinations should be designed to assess the breadth and depth of the student's knowledge, encourage organization and integration of knowledge, and inform the faculty concerning the student's academic competence.

Once the examination and solutions are assembled and agreed upon by a simple majority vote of the committee, the exam is then forwarded to the campus Director of the Materials Science Ph.D. program for approval that each themed area has been addressed. The exam should be given to the Director no later than three (3) weeks before the determined date of the examination. If any concerns are raised, the Materials Science Ph.D. campus director will meet with the committee to resolve these issues. Once approved, Examination I can be administered.

Students should be informed at least six (6) weeks prior to the determined date of the Examination I by the committee before its administration.

Once completed, each written exam section is graded by at least two members of entire committee using an agreed upon key and point value system where an average score for each section is given.

Students that achieve 70% or higher receive a pass; student scores between 50-69% are eligible for an oral examination by the committee in the deficient areas. Approval of passing after the oral is done by a simple majority vote of the committee. Students written scores under 50% or do not receive a majority pass vote in the oral exam, are not passed. Students have up to two (2) opportunities to take the examination. Failure of any one section after two attempts excludes the student from receiving a PhD in Materials Science.

The examination should be taken at least once during the first two years of a student’s enrollment in the Materials Science program. A second, and final attempt, must be completed no later than a student’s third year in the program. Formal petitions, with documented extenuating circumstances, may be petition to the on-campus Director of the Materials Science program if these deadlines are not meet and must compile with UA Graduate School guidelines.

### 2.3.2 Examination II:

Once a student successfully completes and passes Examination I, the student will present a research proposal that integrates the graduate course work and demonstrates scholarly proficiency and capacity for independent, original investigation in their specialized field of research. The research proposal should include no more than an one-page abstract summary, fifteen (15) pages of technical content and integration of prior (and appropriately referenced) proposed research in the materials field of specialty. The proposal should demonstrate adequate understanding of doctoral level research as determined by the committee. This proposal should provide the basis for the dissertation research. The proposal should be given to your supervisory committee no later than two (2) weeks before a commonly agreed date where the student will provide an oral defense of the proposal. This committee will evaluate the merit of the research proposal and oral presentation and provide constructive input for the research.

The Examination II should be completed within two academic terms of passing Examination I and at least one academic term before the Ph.D. dissertation defense. Passing Examination II is done

by a simple majority vote of the committee. If a student fails Examination II, the student can re-take the exam one more time. Failure to pass Examination II after two attempts results in termination of the student from the Materials Science Ph.D. program.

Students are strongly encouraged to recognize that Examination II is a proposal and not a 'practice defense' of the research completed. Though having results collected by the student can be useful, the examination is a proposal where sufficient laboratory results are not required. This provides an opportunity for the committee to have adequate input before the student has completed a majority of the laboratory research.

See the UA graduate catalog for further details and required forms.

### 2.3.3 Grievance

If a student is concerned about the grading and/or decision of the examination or other relevant academic matters, the student can file a grievance for resolution. The details of the process can be located in the UA Graduate Catalog (http://graduate.ua.edu/catalog/13950.html).

## *2.4 Admission to Candidacy*

Successful completion and passing of the Ph.D. competency examination I and II transfers a Ph.D. student to a Ph.D. candidate and the student is admitted to candidacy for the doctoral degree. The **Admission to Candidacy for the Doctoral Degree** form is submitted to the Graduate School and should be done the semester when Examination II has been passed.

Once a student has met the requirements for admission to candidacy, the student must pursue completion of the dissertation without interruption by enrolling each fall and spring semester of the academic year for at least 3 hours of dissertation research. Summer enrollment for Dissertation Research is *required* for dissertation research (3 hours minimum) when a doctoral student is graduating in August or defending the dissertation during the summer semester. This is true whether or not the student has submitted an **Application for Admission to Candidacy**.

Each Ph.D. student must have completed a minimum of 24 hours of Dissertation Research work upon completion of the degree. The amount of dissertation research for which a student enrolls in any given semester should be commensurate with the progress a student is expected to make on the dissertation, as well as reflective of the extent to which University facilities and faculty time are invested in the proposed activities.

## *2.5 Dissertation*

A dissertation showing the ability to conduct independent research and skill in organization, writing and presentation must be prepared on a topic in the major field. It must constitute an original contribution to knowledge. The subject of the dissertation must be approved by the dissertation committee of the Materials Science Ph.D. program and by the dean of the Graduate School. The dissertation committee must be approved by the Graduate Dean, and any later changes to the committee also require Graduate School approval. See the "Forms" section of the Graduate School's website for the Application for Admission to Candidacy

(http://www.graduate.ua.edu/academics/forms/candidacy_doc.pdf). The dissertation should be given to the committee with at least two (2) weeks before the mutually agreed defense date.

## *2.6 Ph.D. dissertation format*

The dissertation must comply with the regulations in **A Student Guide to Preparing Electronic Theses and Dissertations**. Graduate School deadlines, including each semester's **dissertation deadline**, are available at the **Graduate School's homepage**. Consult the **ETD website** for details of ETD submission, including information on what needs to be submitted to the Graduate School. The graduate dean must approve the dissertation before the student can be cleared for graduation. The Catalog section on Continuous Dissertation Registration for Doctoral Students states that once a student qualifies for doctoral candidacy, the student must enroll each semester for at least 3 hours of dissertation (699) research. If certain conditions are met for the student's final semester, however, the student may qualify to enroll for fewer than 3 hours of 699 dissertation research, but only in that final semester and within the time frame of submitting the required paperwork for graduation that semester. See the UA graduate catalog for details.

**Article Style vs. Journal Format**
The decision of the dissertation style is determined by the student's graduate advisor. Please see the Graduate Catalog for further details.

**Article Style**.
At the doctoral level, "article-style dissertations" are unified works that include several distinct but related studies of research or creative activity, each of which is of publishable quality. This approach is intended for a doctoral student whose dissertation will consist of a number of related manuscripts or articles, representing independent research or creative activity. Article-style dissertations must be based upon research completed while the student is enrolled at The University of Alabama. For each article used, the student must be the first author, or equivalent, as defined by the discipline.

As with traditional dissertations, the article-style dissertation must be the student's original idea. It must be a unified work and include a sequence of articles of publishable quality around a cohesive theme, with a comprehensive review of literature demonstrating an in-depth understanding of the unifying framework.

- In article-style dissertations there will be introductory material to describe the studies, show how they are related, and explain their significance;
- connecting language to bridge each study to the next; and
- a summary making clear the importance of the studies, integrating the major findings, and discussing the implications for the overall topic.

These components do not have to be separate sections or chapters. They may be parts of the manuscripts or may be accomplished in an abstract.

All parts of both traditional and article-style dissertations must conform to the provisions set forth in **A Student Guide to Preparing Electronic Theses and Dissertations**, except when the circumstances of a specific project or discipline's style manual require deviation. Students

considering the article-style approach should contact the Graduate School before beginning their work if they have questions concerning specific problems or deviations from traditional procedure.

All doctoral candidates must give members of the dissertation committee a minimum of two (2) weeks to read the dissertation before the date of the required final oral examination.

***Electronic submission of dissertations:*** August 15, 2009, is the date when electronic submission began to be required and paper submission no longer was accepted. Consult the **ETD website** for details of ETD submission, including information on what needs to be submitted to the Graduate School. The graduate dean must approve the dissertation before the student can be cleared for graduation.

**Journal Format**.
A "journal-format dissertation" is acceptable. Such a thesis follows the format of a particular journal in which the student and advisor want the thesis to be published. To prepare a journal-format thesis, the student uses the journal's "information for authors" or similarly titled guidelines in conjunction with the Graduate School's **Student Guide to Preparing Electronic Theses and Dissertations**.

# 3 Academic eligibility during graduate school

Students should consult the UA graduate catalogue on academic eligibility requirements. Students are required to maintain an average of a 3.00 GPA during their progressive to their graduate degree. If a student receives a cumulative GPA below this minimum, they are placed on academic probation for one academic semester. If a student does not achieve a 3.00 GPA the following academic term, the student is dismissed from the department and graduate school, per the guidelines of the UA graduate catalog. Graduate course grades are “A”, “B”, “C”, “D”,”F”. No plus or minus grade scale is used in UA graduate school programs.

## *3.1 Conditional admission upon entering graduate school*

Some entering graduate students may have conditional admission, which normally refers that their prior GPA to graduate school is below 3.00. These students are eligible for the M.S. program, and if successful in completing a M.S. degree, can apply for enrollment in the Ph.D. program of the department. Student admitted under conditional admission must secure a minimum 3.00 GPA within their first 12 hours of graduate education. Failure to do so results in dismal from the department and the graduate school, per the guidelines of the UA graduate catalog.

# *4* Academic Misconduct

The UA Graduate Catalog defines academic misconduct as “all acts of dishonesty in any work constitute academic misconduct. This includes, but is not limited to, cheating, plagiarism, fabrication of information, misrepresentation, and abetting any of the above. The following definitions of cheating, plagiarism, fabrication of information, and misrepresentation are taken from the UA undergraduate catalog:

*cheating* - using or attempting to use unauthorized materials, information, study aids, etc.

*plagiarism* - representing the words, data, works, ideas, computer program or output, or anything not generated in an authorized fashion, as one's own.
*fabrication* - presenting as genuine any invented or falsified citation or material.
*misrepresentation* - falsifying, altering, or misstating the contents of documents or other materials related to academic matters, including schedules, prerequisites, and transcripts.

Penalties for academic misconduct can range from a reprimand to a penalty as severe as suspension for a definite time or even expulsion. In the event that academic misconduct occurs, The Academic Misconduct Disciplinary Policy will be followed. It is fully outlined in the online Student Handbook linked from the Dean of Students Internet site (http://www.sa.ua.edu/DoS/).

# 5 Protection of Human Subjects for Research

Scientific research involving human subjects has produced substantial benefits for society, but it also can pose troubling ethical questions. The mission of the University's **Institutional Review Board (IRB)** for Protection of Human Subjects is to ensure that research involving human subjects is conducted ethically. University and federal policies require that review and approval to use human subjects in research precede the research. In the case of thesis research that involves the use of human subjects in any way, the principal investigator is responsible for contacting the college Human Research Review Committee to obtain approval for the planned research. If you are using human subjects in your research, please consult your graduate advisor for specific training and compliance to human subject research.

# 6 Safety training

Safety is our utmost concern during your graduate education and research in your individual laboratories. Every individual who works in a lab should complete the basic lab safety course through SkillSoft Academy. To sign up for this course, please ask your advisor to request it, if not done so, or you can request it by visiting UA's Environmental and Health Safety website http://bama.ua.edu/~ehs/.

Each laboratory you are assigned to work in should have signage posted outside the door identifying the possible health hazards, including chemical and flammability dangers in the lab. A Materials Safety and Data Sheet (MSDS) of every chemical in the laboratory should also be provided for each lab. This book will give you the protocols of handling any and all chemicals. Please be informed of this information. If your laboratory does not have these items, please see your advisor, the laboratory contact person and/or UA's Environmental and Health Safety (http://bama.ua.edu/~ehs/).

You should consult with your graduate advisor and/or supervising committee on other protocols and safety needs for your research. In some of your research, you may be required to complete and pass safety examinations to demonstrate competency in the laboratory. This could include Radiation Safety (for example, if you use X-ray diffraction), laser safety, etc. Please consult UA's Environmental and Health Safety (http://bama.ua.edu/~ehs/) for more information and how to take the mandatory exams for such areas.

If you have any questions concerning safety, please contact your advisor, supervisory committee and UA's Environmental and Health Safety.

# 7 Other resources

## *7.1 Writing Center:*

To assist you in your writing of technical papers, thesis, and/or dissertations, students can use free-of-charge UA's writing center. This center will be able to help you with grammatical editing, while your advisor and/or supervisory committee can assist you in the technical content editing. Please see UA's writing center website (http://writingcenter.ua.edu/) for hours of operation.

## *7.2 Fellowships:*

Most entering graduate students are either on a Graduate Research Assistantship (GRA). In some cases, students will be given a Graduate Teaching Assistance (GTA) by the home department of the advisor. Please note that students who receive a GTA must qualify for this position by completing and passing the following:

For your information, there are several fellowships you may be eligible for during your graduate education. These are listed below and students are encouraged to talk with their advisor and/or supervisory committee for details. Many of these have specific deadlines for applying and eligibility requirements.

- UA Graduate Council Fellowships - http://graduate.ua.edu/council/
- UA McNair Graduate Fellowships - http://graduate.ua.edu/financial/mcnair.html
- National Science Foundation Graduate Fellowships – www.nsf.gov
- NASA Graduate Fellowships - https://fellowships.nasaprs.com/gsrp/nav/
- National Defense Science & Engineering Graduate Fellowship - http://ndseg.asee.org/
- Department of Energy Graduate Fellowships - http://scgf.orau.gov/
- Stewardship Science Graduate Fellowship - http://www.krellinst.org/ssgf/sitemap

## *7.3 Conference travel grants:*

Each academic semester, UA graduate school offers some travel support to offset graduate students cost to present research at a professional meeting or participate in a training meeting. Please consult your graduate advisor for details and eligibility requirements. Please see the following for more details: http://graduate.ua.edu/financial/researchtravelfund.html

## *7.4 Graduate Teaching Assistantships:*

Though the Materials Science Program does not offer Graduate Teaching Assistantships (GTAs), sometimes Materials Science students are supported on home departmental GTAs. For a student to be eligible for a GTA funding, the following instruction is required and must be completed and passed.

Graduate Teaching Assistants workshop. This is held prior to the official start of courses in the fall (only). All graduate students (domestic and international) are required to complete this training

to be eligible for a GTA funding line. Registration for the Workshop for New GTAs o the workshop is handled by the department's registering each new GTA registering through the Graduate School website (http://graduate.ua.edu/gs.thml). Clerical staff at the home department must register each new GTA; new GTAs do not register themselves.

- International Teaching Assistant Program (ITAP). This workshop is held each year just prior to the start of the fall academic term. **It is required for all international graduate students who will hold a teaching or lab assistantship** (involving any type of instructional contact with students). ITAP includes the following:
    - those with lab, tutorial, or classroom responsibilities involving any type of instruction, tutoring, or other types of contact with students
    - those with instructional contact on a one-to-one, small group, or large group basis;
    - those with instructional contact when a senior instructor or professor is present, or
    - those with instructional contact when they are teaching or providing help to students in any type of course or lab when a senior instructor or professor is not present.

  International graduate students must hold regular or conditional admission to the Graduate School and must have satisfied the minimum TOEFL requirement of iBT 79/pBT 550 or IELTS of 6.5. The ITAP also monitors the progress of ITAP participants after they begin teaching and assists department and graduate assistants with planning teaching assignments. More details can be found at http://www.eli.ua.edu/statichome/international-teaching-assistant-program/

**It is the home department's responsibility (not the Materials Science Program) to notify each student of the requirement to attend the ITAP and provide them with a copy of the information sheets as the Materials Science program does not have teaching requirements for graduate students**. Advisors and students who foresee Materials Science students who will have need of GTA support, are strongly encouraged to complete this training; without it, these students will not be eligible for this type of assistantship.

More information can be found at http://www.eli.ua.edu/statichome/international-teaching-assistant-program/

*The Materials Science Ph.D. Program wishes you the best in your research and graduate career. Roll Tide!*

## Appendix A – Selected List of Materials Science Related Courses at The University of Alabama

This is not intended to be a complete or required course listing. It serves as a guide to possible courses. Offerings of each course should be determined by consulting the register catalog for each academic term. Similarly, courses at the other UA campuses can be found by consulting their registry of courses

### *Aerospace and Mechanics:*

- AEM 552 Composite Materials: Mechanisms and influence of heterogeneity/anisotropy on thermomechanical behavior. The behavior, manufacturing, and test methods of continuous fiber reinforced polymeric composites are emphasized.
- AEM 637 Theory of Elasticity: Equations of linear elasticity, principal stresses and strains, stress and displacement potentials, energy principles, and numerical methods. Boundary value problems of elasticity.
- AEM 644 Fracture Mechanics: Linear elastic and elastic-plastic fracture mechanics. Fracture analysis using Griffith 's criterion, stress intensity factors, CTOD methods, and the J-Integral.
- AEM 648 Theory of Plasticity: Fundamentals of inelastic behavior of solids. Basic stress-strain relations for plastic action, yield criteria of metals, plastic instability, and slip-line field theory. Applications to axial, flexural, torsional, and cylindrically symmetric loads.
- AEM 649 Fatigue Analysis: Presentation of the strain life and fracture mechanics approaches to fatigue analysis. Review of damage parameters, mean stress effects, and cycle counting methods for uniaxial and multiaxial loading.
- AEM 655 Advanced Composite Materials: Advanced topics in composite materials, including theories of linear orthotropic elasticity, micro-mechanics of composites, nano-composites, and sandwich structures.

### *Civil, Construction and Environmental Engineering*

- CE 534 - Advanced Structural Mechanics - Introduction to advances structural mechanics topics, including elementary elasticity, elementary beam theories, beams on elastic foundations, energy methods, buckling and free vibration of beams, and elementary thin-plate theory. (Fall semester, Annually)
- CE 535 - Concrete Materials - Portland cement and supplementary cementitious materials, aggregates, properties of fresh and hardened concrete, concrete durability issues, mixture proportioning, concrete construction methods, special concrete materials, test methods. (Spring semester, Annually)
- CE 635 - Analytical Methods in Cement and Concrete - Experimental methods used to characterize cementitious materials and conduct forensic or in-service investigations of concrete structures in the field (i.e. SEM, EDS, XRD, XRF, electron microprobe, calorimetry, and nondestructive testing / data acquisition & processing). Capabilities and limitations of these methods. Topics to rotate as needed to support current research. (Offered as needed)
- CE 636 - Advanced Infrastructure Materials - Introduction to advanced and innovative materials used in civil infrastructure systems. An introduction to research methodology in materials is also included. (Spring semester, even years)

## *Chemical and Biological Engineering:*

- CHE 512 Polymer Materials Engineering: Introduction to the manufacture, processing, and applications of organic polymeric materials. This course covers the chemistry of polymer manufacture, the molecular structures of polymers, and the structure-property relationship for thermoplastic and thermosetting polymers.
- CHE 518 Tissue Engineering: Tissue engineering is an emerging dynamic, experimental science in which engineering and biological science principles are used to develop techniques for improving or restoring the structure and function of tissue
- CHE 651Statistical Mechanics and Multi-Scale Simulation Methods:This course will begin by briefly covering the underlying quantum mechanical principles relevant to chemical bonding, intermolecular interactions, and reactivity. Statistical mechanics will be discussed in-depth, including the underlying theories behind Monte Carlo and molecular dynamics simulations. Various methods will be presented for modeling larger systems, such as dissipative particle dynamics and lattice-Boltzmann. These simulation techniques will be applied to model liquids, polymers, and adsorption on surfaces and within porous materials.

## *Electrical and Computer Engineering*

- ECE 530 Solid-State Devices: The study of solid-state devices based on the principles of solid-state physics. Devices for study include PN junction, Schottky diodes, BJTs, MOSFETs, and organic thin-film devices (thin-film transistors, light-emitting diodes, solar cells) and their applications for flexible displays. The objective of this course is to gain an in-depth understanding of solid-state devices, in particular their non-ideal behaviors.
- ECE 563 Magnetic Materials and Devices**.** Three hours. Prerequisites: ECE 340 or consent of instructor. Diamagnetism and paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism, magnetic anisotropy, domains and the magnetization process, fine particles and thin films, magnetization dynamics.
- ECE 663 Spin Electronics. Three hours. Prerequisites: ECE 463 or ECE 563 or consent of instructor. Electron spin. Giant magnetoresistance theory. Spin-tunneling phenomena in magnetic tunneling junctions. Spin structure to spin electronics. Image of magnetization configuration. Magnetic materials for spin electronics devices. Spin transport to design of magnetic nanodevices.

## *Metallurgical & Materials Engineering:*

- MTE 549 Powder Metallurgy: Describing the various types of powder processing and how these affect properties of the components made. Current issues in the subject area from high-production to nanomaterials will be discussed.
- MTE 556 Advanced Mechanical Behavior: Topics include elementary elasticity, plasticity, and dislocation theory; strengthening by dislocation substructure, and solid solution strengthening; precipitation and dispersion strengthening; fiber reinforcement; martensitic strengthening; grain-size strengthening; order hardening; dual phase microstructures, etc.
- MTE 562 Metallurgical Thermodynamics: Laws of thermodynamics, equilibria, chemical potentials and equilibria in heterogeneous systems, activity functions, chemical reactions,

phase diagrams, and electrochemical equilibria; thermodynamic models and computations; and application to metallurgical processes.

- MTE 579 Advanced Physical Metallurgy: Graduate-level treatments of the fundamentals of symmetry, crystallography, crystal structures, defects in crystals (including dislocation theory), and atomic diffusion.
- MTE 585 Materials at Elevated Temperatures: Influence of temperatures on behavior and properties of materials.
- MTE 587 Corrosion Science and Engineering: Fundamental causes of corrosion problems and failures. Emphasis is placed on tools and knowledge necessary for predicting corrosion, measuring corrosion rates, and combining this with prevention and materials selection.
- MTE 622 Solidification Processes and Microstructures: This course will cover the fundamentals of microstructure formation and microstructure control during the solidification of alloys and composites.
- MTE 655 Electron Microscopy of Materials: Topics include basic principles of operation of the transmission electron microscope, principles of electron diffraction, image interpretation, and various analytical electron-microscopy techniques as they apply to crystalline materials.
- MTE 670 Scanning Electron Microscopy: Theory, construction, and operation of the scanning electron microscope. Both imaging and X-ray spectroscopy are covered. Emphases is placed on application and uses in metallurgical engineering and materials-related fields.
- MTE 680 Advanced Phase Diagrams: Advanced phase studies of binary, ternary, and more complex systems; experimental methods of construction and interpretation.
- MTE 684 Fundamentals of Solid State Engineering: Fundamentals of solid state physics and quantum mechanics are covered to explain the physical principles underlying the design and operation of semiconductor devices. The second part covers applications to semiconductor microdevices and nanodevices such as diodes, transistors, lasers, and photodetectors incorporating quantum structures.

## *Physics and Astronomy*

- PH 511 Biophysics*: Physics of biological systems: proteins, lipids, nucleic acids, supramolecular structures, and molecular motors; structure, function, energetics, thermodynamics, bionanotechnology. Emphasis on systems that are best understood in physical and molecular detail.
- PH 534 Digital Electronics and Computer Interfacing: Theory and practical application of digital integrated circuits, including gates, flip flops, counters, latches, and displays. Computer data acquisition and control using LabView, A/D and D/A fundamentals. Digital communications.
- PH 571 Statistical Physics: Ensembles, partition function, quantum statistics, Bose and Fermi systems, phase transitions and critical phenomena, and applications.
- PH 581 Solid-State Physics: Structure of simple crystals; thermal, electrical, and magnetic properties of solids; the free-electron model and the band approximation; and semiconductors.

- PH 582 Laser Physics I/II */**: May deal with any physics or astronomy topic not covered by existing courses. The course title is added at the time the course is taught. Repeat credit is allowed for different course titles.
- PH 585 Magnetism: Phenomenological properties of magnetic materials including anisotropies, magnetostriction, domain walls, coercivity, reversal mechanisms, superparamagnetism, and dynamics.
- PH 586 Advanced Solid-State Physics: Computational methods in solid-state physics are explored in more detail than in PH 581. Band structure calculations, Green's functions, density-functional methods, superconductivity, and disordered materials. Offered according to demand.
- PH 591 Advanced Laboratory: Experimental work in modern physics at an advanced level.
- PH 595 Nanophysics *:

* taught from UAB over video link
** these courses are listed under independent study number, they don't have formal course numbers of their own yet.