UNDERGRADUATE STUDIES IN MATERIALS SCIENCE AND ENGINEERING

STUDENT HANDBOOK

Department of Materials Science and Engineering
The Pennsylvania State University
124 Steidle Building
University Park, PA

Fall 2008

Accessible on the web at: www.matse.psu.edu

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Introduction

The roots of the Department of Materials Science and Engineering at Penn State date back nearly 100 years to the formation of academic programs in metallurgy and ceramic technology. With the addition of academic programs in polymer science in the 1970's and electronic and photonic materials in the 1990's, the Department of Materials Science and Engineering enjoys a rich history, and a lasting legacy of a myriad of scientists and engineers to the materials science-related disciplines. Complementary undergraduate and graduate studies programs, combined with a wide array of focused research centers at the University, contribute to the Department being widely regarded as one of the finest and best-balanced materials departments in the United States.

2.0 Mission of the Department of Materials Science & Engineering

The mission of the Department of Materials Science and Engineering is to provide our students with a well-rounded engineering education with specific emphasis on materials science and engineering in order to meet the needs of industry, academia, and government; to conduct research at the frontiers of the field; and to provide an integrating and leadership role to the broad multi-disciplinary materials community.

3.0 Undergraduate Studies Office

The undergraduate office is located at 124 Steidle Building and is open from 8 am to 4:30 pm, Monday through Friday.

Administration of the undergraduate studies is coordinated by the Associate Head for Undergraduate Studies Dr. R. Allen Kimel; 124A Steidle Building (phone: 814-865-5397, fax: 814-865-0016, email: kimel@matse.psu.edu)

The office coordinates all undergraduate course offerings, class scheduling, drop/add, documenting course requirements, outreach, scholarships, etc. Assistance in all matters pertaining to undergraduate studies can be initiated through visiting the undergraduate studies office and speaking with Allison Albinski, Staff Assistant, (814-865-5766; ava10@psu.edu), or Jenneth Layaou, Advising Assistant (814-865-5765; jLayaou@psu.edu).

Academic advisors are appointed to students when they enter the program, option specific advisors are assigned once an option is declared and stay with the student through matriculation. Appendix A lists the advisors for each option and for undeclared students. All advisors are approved honors advisors.

4.0 Organization

The Department is organized into two academic tracks: Undergraduate Studies and Graduate Studies. The Undergraduate Studies track offers a four year curriculum culminating in a Bachelor of Science degree in Materials Science and Engineering, with options in four sub-disciplines: Ceramic Science and Engineering, Electronic and Photonic Materials, Metals Science and Engineering, and Polymer Science and Engineering. Students typically declare their option at the end of their fourth semester, but may do so as early as the start of semester two. Some students choose to concentrate on two options simultaneously, on average only one additional semester is needed to complete a dual option. The Ceramics, Metals, Electronic and Photonic Materials and Polymer Science and Engineering study tracks are fully accredited by the Accreditation Board for Engineering and Technology (ABET) of the Engineering Accreditation Commission.

4.1 Ceramic Science and Engineering (CerSE)

The Ceramic Science and Engineering option culminates with a Bachelor of Science degree in Materials Science and Engineering. The degree requires a thesis based on original research or design.

The undergraduate option covers the processing, characterization manufacture and usage of a wide variety of inorganic materials. The curriculum prepares students for operating, research, and development positions in all sectors of the materials industry where ceramics are used. Graduates also find employment in many industries, such as electronic and communications, energy generation, automotive, aeronautical and aerospace. The option is fully accredited by the Accreditation Board for Engineering and Technology (ABET).

4.2 Electronic and Photonic Materials (EPM)

The Electronic and Photonic Materials option culminates with a Bachelor of Science degree in Materials Science and Engineering. The degree requires a thesis based on original research or design.

The option covers the processing, properties and performance of semiconductor, optoelectronic, and optical materials and devices. These are the materials which form the functional basis of computers, semiconductors, lasers, telecommunication systems, copying machines, faxes, compact disc players, video cameras, and the multitude of other electronic and optical devices that characterize the age in which we live. Graduates find employment in the electronics, telecommunications and computer industries. The option is fully accredited by the Accreditation Board for Engineering and Technology (ABET).

4.3 Metals Science and Engineering (MetSE)

The Metals Science and Engineering option culminates with a Bachelor of Science degree in Materials Science and Engineering. The degree requires a thesis based on original research or design.

The option provides an opportunity to explore a broad range of both scientific and engineering principles as applied to metals and alloys, their extraction, their production and their use. A graduate of this option will thus typically apply basic concepts of chemistry, physics mathematics and engineering science to problems concerning the processing and/or the properties of metals. Graduates find employment in a wide spectrum of positions such as technical sales, research, operations or management. An increasingly large fraction of our graduates are finding employment in a diverse group of industries which use metals, such as those in the electronic or aerospace fields. This option is fully accredited by the Accreditation Board for Engineering and Technology (ABET).

4.4 Polymer Science and Engineering (PlmSE)

The Polymer Science and Engineering option culminates with a Bachelor of Science degree in Materials Science and Engineering. The degree requires a thesis based on original research or design.

The option provides instruction in the basic concepts in chemistry, physics, mathematics and engineering science and how to apply these concepts to the problems involved in the synthesis, structure, properties and processing of polymers. There exists a strong and steady demand for polymer scientists for fundamental research, as well as in applied science and technology, such as in the application of processing methods to manufacturing products comprised of polymer and composites containing them. The option is fully accredited by the Accreditation Board for Engineering and Technology (ABET).

5.0 Faculty

The undergraduate students in all options are taught by a dedicated faculty who are nationally and internationally known for their research, publications and activities in government committees and commissions, and in professional organizations, where many hold high office. Furthermore, the Materials Science and Engineering faculty have strong intercollege and interdepartment associations throughout the University. The faculty maintains an awareness of the needs and problems of industry through industrial research grants and consultation with industry and government. Students have daily contact and dialogue with these faculty members who teach them in small classes and laboratories.

The undergraduate program is strengthened by its association with this vigorous research enterprise, combined with an excellent graduate program. These features contribute significantly to maintaining relevance and timeliness in the curriculum, as well as in providing outstanding opportunities for independent study required in the senior thesis project.

The Materials Science and Engineering faculty is listed in Appendix B (P.17) of this handbook. Further information on each faculty member's research interests can be found on our website at http://www.matse.psu.edu/ .

6.0 Facilities

The Department is well endowed with equipment dedicated to undergraduate instruction. A state-of-the-art computer laboratory, equipped with over thirty PC platforms, color laser printers, scanners, and a wide range of site-licensed software is available 24 hours a day, seven days a week for all undergraduates in the Department. In addition, our classrooms are equipped with computer projection equipment to facilitate the use of computer technology in instruction. The Department provides a Student Commons Room in which students may congregate to socialize, work collaboratively on assignments, and keep up to date on job opportunities, Department announcements, and professional development opportunities.

The Department offers several newly renovated and equipped laboratories, in which all undergraduate laboratory instruction takes place. The Department is well endowed with state-of-the-art research equipment for the processing and characterization of ceramics, metals, polymers, and composites comprised thereof; undergraduates frequently use this equipment in laboratory instruction, independent research as well as in the performance of their senior thesis research. In addition, due to the faculty's extensive interaction with materials research centers campus-wide, our students enjoy access to a broad array of world-class analytical and characterization facilities than would be possible without such a vigorous research enterprise.

7.0 Degree Requirements

7.1 Educational Objectives of the Materials Science and Engineering Program

The general objective of the Materials Science and Engineering undergraduate program is embedded in our mission statement – to provide our students with a well-rounded engineering education with specific emphasis on materials science and engineering that will meet the needs of industry, academia, and government. Specific program objectives have been established to attain this general objective:

a. To produce graduates with the ability to apply the fundamentals of mathematics and the physical sciences.

b. To produce graduates who have a general knowledge of all classes of engineering materials, but specific expertise in one of the sub-disciplines: ceramics, electronic and photonic materials, metals, or polymers.
c. To produce graduates who have a first hand knowledge of the inter-relationships between processing, structure, properties, and the performance of materials.
d. To produce graduates who have the ability to define problems, including design problems, develop and evaluate economically feasible solutions from diverse knowledge bases, and implement an acceptable solution.
e. To produce graduates who have the ability to function effectively in cross-functional teamwork, both within the materials discipline and in multidisciplinary teams.
f. To produce graduates who are adept at using the modern tools of materials science and engineering, including instrumentation for characterizing the structure and properties of materials and computational hardware and software for analysis, design, and communication.
g. To produce graduates who understand the global/societal context of engineering problems, understand their responsibility to their profession and society and the ethics associated with it, and understand the value of lifelong learning.

7.2 Educational Outcomes

The undergraduate curricula in Materials Science and Engineering are organized such that upon graduation, our students shall possess the following skills, which will enable them to perform successfully as practitioners of materials science and engineering. Specifically, the curriculum is established such that:

(a) Graduates will be able to apply knowledge of mathematics and advanced science and engineering principles to materials systems.

(b) Graduates will be able to design and conduct experiments and to analyze and interpret data.

(c) Graduates will be able to design a process, a microstructure, or a component to satisfy system needs.

(d) Graduates will be able to function on multi-disciplinary teams.

(e) Graduates will be able to identify, formulate, and solve engineering problems.

(f) Graduates will understand professional and ethical responsibility.

(g) Graduates will be able to communicate effectively, both in writing and in speech.

(h) Graduates will possess the broad education necessary to understand the impact of engineering solutions in a global and societal context.

(i) Graduates will recognize the need for, and be able to engage in, lifelong learning.

(j) Graduates will have a knowledge of contemporary issues.

(k) Graduates will be able to use the experimental, analytical, statistical, and computational tools for engineering practice in the materials discipline.

(l) Graduates will be able to apply the fundamental principles underlying and connecting the structure, processing, properties, and performance of materials systems.

The educational objectives and outcomes are reviewed annually by the faculty and adjustments are made where necessary to keep the curriculum fresh and timely.

7.3 Academic Requirements

General education academic requirements in all options are specified by the University for all Bachelor Degree programs, these are augmented by additional requirements by the College of Earth and Mineral Sciences and the individual study options within the Department, subject to approval by the Faculty Senate. A list of the undergraduate courses required to satisfy the requirements for each of the options is included in Appendix C: Undergraduate Curriculum in Materials Science and Engineering. The two main concerns for the undergraduate student are the grade point requirements and the course requirements.

7.3.1 Grade Point Requirements

In order to receive a Bachelor of Science degree in any of the options in Materials Science and Engineering, the student must finish with a grade point average (GPA) of at least 2.0. In addition, however, the University Senate has mandated that **students must have a 2.0 or better in courses designated in the University Bulletin as "Requirements for the Major"**. You can also obtain a list from 124 Steidle Building. *Therefore, even if the student has an overall GPA greater than the 2.0, if his/her "major" GPA is less than 2.0, then he/she will not receive a B.S. in Materials Science and Engineering.*

In addition, the University requires that students must receive at least a grade of C in a minimum of 15 credits designated by the major (i.e., you must receive a C in each course). For Polymer Science and Engineering (MatSE 201, 401, 430, 441, 443, 445, and 492W); Ceramics Science and Engineering (MatSE 201, 400, 401, 402, and 492W); Electronic and Photonic Materials (MatSE 201, 400, 401, 402, 430, and 492W); Metals (MatSE 201, 401, 402, 410, 430 and 492W).

7.3.2 General Course Requirements

The Baccalaureate Degree General Education Program
The baccalaureate degree General Education program consists of 45 credits that are distributed among two General Education components: (1) Skills (15 credits) and (2) Knowledge Domains (30 credits) in the Natural Sciences, Arts, Humanities, Social and Behavioral Sciences, and Health and Physical Activity. Every baccalaureate degree student also completes the First-Year Seminar, Intercultural and International Competence, and Writing Across the Curriculum requirements.

A restriction is placed on students in majors that are closely linked to the Knowledge Domains of Natural Sciences, Arts, Humanities, and Social and Behavioral Sciences to ensure that they participate in the full breadth of General Education. These students may not use a course in their academic major to satisfy one of the Knowledge Domains requirements. For example, an Economics major may not use an economics course to fulfill his/her social and behavioral sciences requirement. Also, students may not count courses cross-listed with courses in their major to fulfill one of the General Education Knowledge Domain, e.g., a Theatre major may not register for THEA 208 (GA, GI) / AAAS 208 (GA, GI) and have it count in the Arts requirement.

SKILLS (15 credits)

Writing/Speaking (9 credits)
Courses designated with the suffix GWS satisfy this component.

Quantification (6 credits)
Courses with the suffix GQ satisfy this component. (3-6 credits are selected from mathematics, applied mathematics, and statistics; 3 credits may be selected from computer science or symbolic logic.)

KNOWLEDGE DOMAINS (30 credits)

Health and Physical Activity (3 credits)
Courses with the suffix GHA satisfy this component.

Natural Sciences (9 credits)
Courses with the suffix GN satisfy this component.

Arts (6 credits)
Courses with the suffix GA satisfy this component.

Humanities (6 credits)
Courses with the suffix GH satisfy this component.

Social and Behavioral Sciences (6 credits)
Courses with the suffix GS satisfy this component.

ADDITIONAL REQUIREMENTS
Baccalaureate degree students must complete one First-Year Seminar (S, T, or X suffix, or PSU abbreviation), 3 credits each of International Cultures (IL) and United States Cultures (US), and 3 credits of Writing Across the Curriculum (W, M, X, and Y). These requirements may be completed by designated courses that also meet other degree or General Education requirements.

FLEXIBILITY OF THE BACCALAUREATE DEGREE GENERAL EDUCATION REQUIREMENTS
Penn State wants students to use General Education to experiment and explore, to take academic risks, to discover things they did not know before, and to learn to do things they have not done before. To that end, the General Education program extends the concept of flexibility to all aspects of the degree program.

Students may, with the permission of their adviser and Dean's representative:

1. substitute a 200- to 499-level course in an area of General Education for a course found on the General Education list. For example, a student may take a 400-level course in history and use it to meet the General Education requirement satisfied by a comparable lower- level history course.

2. substitute a foreign language at the twelfth credit level of proficiency, as measured by the Penn State foreign language offerings, for 3 credits in any of the categories of General Education. Baccalaureate degree students may substitute study in a foreign/second language at the twelfth credit level of proficiency or higher for any three credits in any of the categories of general education only if those three credits are in language study beyond their degree requirements.*

3. substitute a third course in one of the Knowledge Domains areas of Arts, Humanities, or Social and Behavioral Sciences for a second course in one of the other areas. For example, a student might take 3 courses in the Arts, two courses in the Humanities, and only one course in the Social and Behavioral Sciences. This substitution is often referred to as the 9-6-3 sequence, representing the 9 credits, 6 credits, and 3 credits completed in place of the specified 6-6-6.*

4. meet the Intercultural and International Competence requirement through completion of a one-semester or year-long education abroad experience approved through the Penn State Office of Education Abroad or by participating in MatSE's IIM program.

5. meet the First-Year Seminar (FYS) requirement through completion of a FYS course offered by any unit of the University. Thus, a student who successfully completes a FYS course in one college, prior to transferring to another college, will not be required to complete another FYS. However, since there are various modes of offering a FYS throughout the University, students transferring to a new college may find that a required course that is also a FYS must still be taken. Students entering the program as a freshman are required to take the Earth and Mineral Sciences freshman seminar.

*Please note: The use of these two substitutions (#2 and #3 above), either alone or in combination, may not lead to the complete elimination of any area in the skills or knowledge domains categories in the student's general education program.

Students have freedom of choice regarding Social Sciences, Humanities and Arts courses to satisfy General Education course requirements (*). Students are encouraged to use General Education courses to sample other interests or to explore the possibility of a minor. For information on GenEd courses go to www.psu.edu/dus/handbook/gened.html

***Not all General Education courses satisfy ABET requirements. Please consult your advisor.**

7.3.3 Prescribed, Supporting and Additional Courses

The prescribed, supporting and additional courses for the each of the options in the MatSE major constitute the discipline-specific coursework. The prescribed and additional courses are specified by each option's curriculum, but additional courses can be selected from an approved list of technical electives. The Accreditation Board for Engineering and Technology (ABET) requires that each engineering option has a strong emphasis on design in the prescribed and additional courses.

7.3.4 Technical Electives

A minimum of six credits of technical electives are required in each option's curriculum. Technical electives are courses which should be carefully selected, in conjunction with the student's advisor, to add depth beyond the basic MatSE curriculum.

The Accreditation Board for Engineering and Technology (ABET) favors a flexible approach to curricular content, but expects coverage in: 1.) Mathematical and Basic Sciences, 2.) Engineering Science and Design, and 3.) Humanities and Social Sciences contributing to a student's appreciation of the economic, environmental, manufacturability and sustainability, ethical, safety and health, social and political constraints on engineering. **At least 37.5% (48 credits) of the coursework credits to satisfy the degree for a given option must be engineering courses (i.e. contain Engineering in the course title).** This requirement and the following guidelines should be applied by the student in the selection of their technical electives, in consultation with their advisor:

1) Depth in Engineering Sciences and Design

   These are courses that enhance a student's depth in a particular area of materials engineering. Naturally, all MatSE courses not already prescribed by a particular option's curriculum are acceptable electives for each MatSE option. In addition, up to three credits of Cooperative Education work experience (ENGR x95 or SC x95,) in increments of one credit per semester of COOP, may be used as technical electives.

Many other courses outside of the department are also acceptable technical electives. Appendix D lists some courses which the MatSE faculty have suggested for satisfying technical electives in a variety of materials related specializations (e.g. electronic materials, processing science, structural materials, biomaterials, computer science and engineering, etc.)

2) Depth in Humanities and Social Sciences

These are courses that do not fall necessarily under the General Education requirements of the University but will allow engineers to be more aware of their social responsibilities. These fall into two categories.

a) Foreign Language.

In a global economy, there is a strong need to communicate, understand and interact with people of other cultures. For students choosing this approach, all six (6) elective credits must be advanced level courses in a language other than the student's native tongue.

b) Technology-Related Courses.

These are courses that consider the relationship between the engineering profession and other human affairs. This could include courses on professional ethics, occupational health and safety, social responsibility, product safety and design, etc. Of particular interest are courses that consider realistic, non-technical constraints on the engineering design process; e.g., economic factors, safety, reliability, aesthetics, ethics and social impact. Careful consultation with the student's advisor is recommended in selection of appropriate courses to satisfy this approach.

3) Military Training

Students may use up to six (6) credits of upper division ROTC courses (Air, Army, NAVSC) which must contain a substantial leadership or management component, to satisfy the technical elective requirement.

In summary, there are many ways to satisfy the technical elective requirement in each curriculum. Other courses than those listed here may be used with the approval of the student's advisor and the Associate Head for Undergraduate Studies.

7.3.5 Honors Courses

Most 400-level courses can be taken with an H-option (honors option). The H-option requires that the course coverage contain advanced information/knowledge, additional in-depth material and an integration with other courses in a general topic area. More information regarding the Honors track can be found in Appendix E. Students interested in taking an honors course should consult the honors advisor for their option.

7.3.6.1.1.1 Senior Thesis

ABET accreditation requires that the curriculum contain a senior capstone project. Each senior in Materials Science and Engineering is required to complete a research project, which is then documented in the form of a thesis. The senior thesis involves selection of a research topic offered by a faculty member at the end of their. The planning and design of the research program is typically initiated in the fall semester and performed over 1 1/2 semesters of the senior year. To perform the research, the student must do a literature review, outline a

research plan and, in most cases, process and fabricate samples, followed by the measurement of properties relevant to the thesis objective.

The senior thesis requires the student to integrate knowledge learned in their undergraduate option courses. An important component of this integration of knowledge is a demonstration that the student has considered the following engineering standards and realistic constraints:

- economic issues
- environmental impact or relevancy of the research
- sustainability of the knowledge derived from the research
- issues regarding manufacturability of materials or devices from the research
- ethical issues governing the performance of the research or implementation of the results
- health and safety issues related to the research
- social and/or political implications of the research

The literature review incorporated into the thesis must address most, if not all, of these issues.

The thesis is a high quality, bound publication that will be shelved and available for review in the Earth and Minerals Science Library (105 Deike). The format for the thesis should follow the guidelines set forth in Appendix F. It is critical that students formulate a set of program milestones for the thesis, in conjunction with their adviser. A draft of the thesis is due to the thesis adviser approximately six weeks prior to the end of the semester and the final version, signed by the adviser, to the Undergraduate Office for review by the Associate Head of Undergraduate Studies for ABET review approximately two weeks prior to the end of the semester. Final copies of thesis for binding are due to the Undergraduate Office approximately one week prior to the end of the semester. Deadlines for thesis will be announced for each semester during the first half of the semester. For graduating seniors, failure to meet this last deadline will lead to removal from the graduation list. In addition, the department hosts an undergraduate poster competition in the Spring Semester, at which time all seniors are required to present their research in poster format.

7.3.7 Cooperative Education Curricula

Cooperative (COOP) education is an option for a student who wishes to gain professional experience prior to graduation. Coop students participate in three semesters of work assignments in industry, for which they earn academic credit as well as being paid. In general, the Cooperative Education process will require one additional academic semester for graduation, but the student will have one full year of industrial experience by graduation. This has proven to be a significant advantage to students when seeking full-time employment.

Students are eligible for the Coop program starting in their fifth semester. Careful coordination of the student's academic scheduling with Coop assignments is highly advised to ensure timely graduation. The program is coordinated through the College of Engineering (Cooperative Education office is in 205 Hammond Building.) Students are highly recommended to consult with their academic advisor prior to planning a Cooperative Education track.

8.0 Academic Integrity

The Faculty of the Materials Science and Engineering Department believes strongly in the importance of academic and professional integrity. Section 49-20 of *Policies and Rules: A Handbook For Students* states:

Definition and expectations: Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with this principle.
Consistent with this expectation, the University's Code of Conduct states that all students should act with personal integrity, respect other students' dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts.

Any form of academic dishonesty is a very serious matter, and it will not be tolerated. The policy handbook states that evidence of academic dishonesty will be dealt with by notification of the student and, at the prerogative of the course instructor, (a) a zero on the entire assignment will be given; (b) the student will be invited to a special oral exam, the result of which will determine the student's grade; (c) the student will be given a course grade of F and will be referred to the Committee on Academic Integrity; (c) the student will be given a course grade of F and will be referred to the Office of Conduct Standards.

Among the penalties that have been agreed upon by the various options faculty are the following:

- *Any evidence of plagiarism will result in a zero for the entire assignment.*
- *Any evidence of cheating on examinations will result in a zero grade for that test. No material pertinent to the course may be written on any article of clothing, portion of the body, or other material brought into the exam unless explicitly permitted by the faculty member. A violation of this policy will be considered cheating regardless of whether of not the material is visibly referred to during the test. Similarly, talking during the exam or looking at another student's paper will result in the same penalty.*

Other types of academic dishonesty will be dealt with in a similar fashion, within the guidelines established by the Faculty Senate, and documented on the Senate website at http://www.psu.edu/ufs/policies/

9.0 Safety Examination

Prior to participation in any laboratory work, including use of the computer lab, students are required to obtain and read a Safety Manual that describes appropriate safety procedures. The manual can be found online at www.matse.psu.edu/safety/safmain.htm Each student must pass an examination before they can participate in any laboratory classes or research activities in the department of Materials Science and Engineering. Contact Scott Henninger (henninger@matse.psu.edu) to schedule your safety exam.

10.0 Scholarships

Various scholarships and loan funds are available "in-house", as well as, through the Earth and Mineral Sciences College and the University itself. In general, scholarships are based on academic merit and/or financial need. Decisions on scholarship allocations are made in May for the following academic year. Students interested in being considered for scholarships must file an application electronically on the College website. Scholarships with financial need criteria are only available to students who have filed the necessary financial aid disclosure forms (FAFSA) with the University.

Scholarships are typically distributed over two semesters in the academic year. Students participating in Cooperative Education are not eligible for scholarship support during the semester they are on COOP rotation. Students participating in the IIM program are not eligible while abroad.

Scholarships are also available from professional societies. Students are encouraged to join and to be active in their respective societies, and to apply promptly whenever such scholarship announcements are made.

Application Link: http://www.ems.psu.edu/students/application.html

11.0 International Internship In Materials

The goal of the Materials Study Abroad experience is to enrich the learning experience of undergraduates by immersing them in an international research activity. Likewise, by providing reciprocal opportunities for undergraduates from host institutions at Penn State, our students will benefit from international students' perspectives and cultures.

The students selected for the program will be offered research internships based on collaborations of Materials Science and Engineering faculty with faculty at host institutions such as the ones listed below. Because the internships will be highly structured research programs, students may be able to use their research in support of technical electives and/or senior thesis; a requirement for all MatSE students. Chosen students will receive a Bayer International Internship Scholarship and/or Alcoa grant to subsidize their expenses.

Please note the criteria for our students to participate:

- Majoring in Materials Science and Engineering
- Full time undergraduate, semester standing 5 or above
- Completed MatSE 201 and MatSE 460
- Completed MatSE Safety Training
- GPA, foreign language experience, additional laboratory experience also under consideration
- Approval from MatSE advisor

Locations:
Darmstadt, Germany (www.tu-darmstadt.de/fb/ms/)
Erlangen, Germany (www.ww.uni-erlangen.de/)
Leeds, England (www.materials.leeds.ac.uk/)
Limoges, France (www.ensci.fr)
Padua, Italy (www.dim.unipd.it/materiali/index.html)
Sheffield, England (www.shef.ac.uk/materials/)
Zurich, Switzerland (www.mat.ethz.ch/)
San Sebastian, Spain (http://www.sc.ehu.es/powgep99/polymat/homepagi.html)
Clausthal-Zellerfeld, Germany(http://www.studium.tu-clausthal.de/en/natur-und-materialwissenschaft)
Tokyo, Japan (http://www.titech.ac.jp/)

Contact Jenneth Layaou (jLayaou@psu.edu) for more information
Also visit the IIM website at www.matse.psu.edu/iim/iimhome

12.0 Employment Opportunities

Obtaining employment in the field of Materials Science and Engineering requires significant planning and effort throughout the course of a student's academic training. Students who have obtained prior experience in the field through cooperative education and/or summer employment compete most successfully for permanent positions. Now is the time to get going on finding a summer position, which will improve your technical breadth in the field of materials science and engineering!

12.1 Summer Internships

Opportunities for summer employment as research and/or engineering interns exist in industry, national laboratories, and universities. The Department highly encourages students to review these opportunities frequently. Job opportunities are frequently sent to our students via email as well as being posted on the web at www.matse.psu.edu/jobopp/jobs.html

The types of positions, and monetary compensation, vary significantly. A student's success at obtaining the best positions is generally dictated by two factors: 1) good grades, and 2) willingness to relocate during the summer if necessary. The Materials Science and Engineering faculty can assist you in making a suitable marriage of your skills and background with available internship opportunities. However, a significant part of the process is the level of effort the student puts into: 1) defining his/her academic and career goals, 2) compiling and frequently updating a resumé and transcript, and 3) informing the faculty of their interest in securing an internship position. Fall semester is the time to compile your resumé and transcript, and to discuss your interests with your academic advisor. Be sure that your resumé contains no misspellings or grammatical errors, as these are sure to "shoot down" any internship application. Assistance in compiling a resumé can be sought from the College's technical writing tutor Mr. Joe Schall, 863-6077 and through your academic adviser.

12.2 Cooperative Education Program

Cooperative education is a more formalized version of an internship. Coop students participate in three semesters of work assignments in industry, for which they earn academic credit as well as being paid. In general, the Cooperative Education process will require one additional academic semester for graduation, but the student will have one full year of industrial experience by graduation. This has proven to be a significant advantage to students when seeking full-time employment. Please refer to section 7.3.7 of this handbook for more information.

Students are eligible for the Coop program starting in their fifth semester. Careful coordination of the student's academic scheduling with Coop assignments is highly advised to ensure timely graduation. This option is coordinated through the College of Engineering Office of Cooperative Education www.engr.psu.edu/coop , and the College of Science Office of Cooperative Education science.psu.edu/career .

12.3 Full-time Employment

Materials scientists and engineers are employed in industries involved in the entire life cycle of materials, including synthesis and processing, component design and product development, manufacturing, use, and reclamation and recycling. They hold positions as process engineers, research scientists, production managers, marketing engineers, quality control engineers, plant managers, technical sales representatives, etc. Penn State Materials Science and Engineering graduates are employed at all levels in prominent industries, laboratories, and universities worldwide.

Finding a job requires a concerted effort by the student in maintaining an up-to-date resumé and transcript, reviewing job postings, interacting with professionals in the discipline wherever and whenever possible, and using all of the job placement resources available at Penn State. Again, it is never too early to start the job-hunting process. It typically takes several months of preparation and interviewing to land the first job offer.

The Department highly recommends starting the process with a consultation with staff at the Career Development and Placement Services at Penn State late in your junior year to get a perspective of what a well-structured job search process entails. This is an important step to ensure that you understand what CDPS can offer to you in your search, and will be invaluable later when job openings and interview schedules are posted.

An equally valuable resource in your job search is the Undergraduate Studies office and your faculty! The Department routinely posts job openings via email announcements as well as on the web as we learn of them. The department also often coordinates on campus interviews throughout the year for our students. In addition, faculty are frequently aware of job openings in industry, and can be a valuable resource in helping you hone your interests and career goals.

Other resources are available through a variety of professional organizations, such as the American Ceramic Society and ASM International, among others. For example, Ceramic Futures is the ACerS's resumé database system for professionals and students seeking employment in the ceramics and related materials industry. Companies with job openings turn to Ceramic Futures for a list of qualified candidates. The database is linked to other materials-related societies for increased employment opportunities. In addition, the ACerS provides an on-line resumé service; this service is free to ACerS members. Contact the ACerS at http//www.acers.org for more information.

12.4 Penn State Career Days

Career Days is a networking and recruiting event for all Penn State students of all standings, in all majors at all campuses. It is jointly sponsored by Career Services and the academic and colleges at Penn State's University Park campus. Career Days invites organizations to visit campus, set up a booth in the Bryce Jordan Center where representatives share information about their organizations.

Students then have the opportunity to talk with company representatives, hand out resumes and possibly schedule interviews and for full-time, co-op or internship employment. This event has become one of the largest university-run career fairs in the country with nearly 500 employers participating, and more than 8,000 students attending. Preparation workshops are offered to aid students in preparing a resume, interview skills and networking at the career fair. It is your first (and largest) opportunity to explore career opportunities, network and begin your full-time, internship or co-op job search.

For more information on Penn State Career Days visit http://www.fairs.sa.psu.edu/

12.5 Professional Development

Numerous professional societies exist to serve the technical and professional needs of materials scientists and engineers. The Department strongly encourages undergraduates to become active in the student and national chapters of a professional society early in their stay at Penn State. Such participation dramatically enhances professional development, and offers a myriad of opportunities to build friendships and technical contacts, which are of utmost importance in one's career, and to have fun!

The student-run chapters of professional societies are organized under the Material Advantage program run by the American Ceramic Society, ASM International, The Metallurgical Society (TMS), and the Association for Iron and Steel Technology (AIST). As members of the Material Advantage chapter, students receive membership in each of these professional societies, copies of their monthly technical publications, notification

of upcoming technical meetings nation-wide, eligibility for academic and professional development scholarships, discounts on books and publications etc. More information can be found at www.materialadvantage.org. The department subsidizes the annual membership fee for undergraduates who are active in the Material Advantage chapter.

In addition to Material Advantage, there are several honorary and professional fraternities active within the Department: Keramos National Professional Ceramic Engineering Fraternity, Alpha Sigma Mu, and the Polymers club.

The student groups generally meet monthly, and are active in coordinating technical seminars, professional development activities such as poster sessions and speaking contests, coordinating travel and participation in national technical meetings, educational outreach, recruiting, and fun social activities.

Students are also encouraged to pursue becoming licensed professional engineers after graduation. To achieve this, students must take the 'Fundamentals of Engineering' examination to be certified as an Engineering Intern, followed by the 'Practice of Engineering Exam' after fours years of engineering experience.

Appendix A. Academic Advisors in the Department of Materials Science and Engineering

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING
UNDERGRADUATE ADVISORS
Fall 2007/Spring 2008

Advisors for Freshman and students who have not selected an Option, including honors students:
Dr. Paul Howell: Howell@matse.psu.edu 863-3363
Dr. Allen Kimel: Kimel@matse.psu.edu 865-5397

Advisors for students who have declared an option including honors students:

CERAMICS	EPM	METALS	POLYMER
Dr. David Green Green@matse.psu.edu 863-2011	Dr. Suzanne Mohney mohney@matse.psu.edu 863-0744	Dr. Paul Howell Howell@matse.psu.edu 863-3363	Dr. Paul Painter Painter@matse.psu.edu 865-5767

Students with dual options are assigned to the advisor in the option listed first on their audit.

Appendix B: Faculty in the Department of Materials Science and Engineering

(See http://www.matse.psu.edu/)

Department Head: Gary L. Messing
Associate Head for Graduate Studies: Joan M. Redwing
Associate Head for Undergraduate Studies: R. Allen Kimel

MatSE Faculty

Adair, James
Allara, David
Brown, Paul W.
Chen, Long-Qing
Chung, T. C. (Mike)
Colby, Ralph
Colina, Coray M.
DebRoy, Tarasankar
Dickey, Elizabeth
Gopalan, Venkatraman
Green, David J.
Hedden, Ronald
Hellmann, John R.
Hickner, Michael
Howell, Paul R.
Liu, Zi-Kui
Macdonald, Digby D.
Manias, Evangelos
Mohney, Suzanne E.
Muhlstein, Christopher L.
Osseo-Asare, Kwadwo
Painter, Paul C.
Pantano, Carlo G.
Randall, Clive A.
Runt, James P.
Schlom, Darrell G.
Trolier-McKinstry, Susan
Vogler, Erwin
Wang, Qing

Courtesy Faculty

Boehman, Andre
Cole, Milton
Crespi, Vincent
Du, Qiang
Eklund, Peter
Grimes, Craig
Lanagan, Michael
Lvov, Serguei
Maranas, Janna
Motta, Arthur
Ruzyllo, Jerzy
Schobert, Harold
Sofo, Jorge
Wang, Chao-Yang
Xi, Xiaoxing
Zhang, Qiming

Adjunct Faculty

Colombo, Paolo
Elmer, John W.
Englehardt, George
Hirano, Shin-Ichi
Reaney, Ian
M.Weiland, Hasso

Dual Title Faculty

Flemish, Joseph
Juska, Thomas
Meyer Jr., Richard J.
Palmer, Todd A.
Shrout, Thomas R.
Wolfe, Douglas E.
Zhang, Shujun

Emeritus Faculty

Coleman, Michael
Harrison, Ian R.
Hoke, John
Koss, Donald A.
Newnham, Robert E.
Pickering, Howard W.
Rindone, Guy E.
Roy, Della
Ryba, Earle R.
Spear, Karl E.
Stubican, Vladimir

Appendix C. Undergraduate Curriculum in Materials Science and Engineering

The first five semesters in the undergraduate curriculum are essentially identical among the four options, with minor differences in the math and chemistry sequence. Subsequent semesters become more option specific. The curriculum for semester 1-4 is presented in the following section; the curricula for semesters 5-8 for each of the options will be presented separately in subsequent subsections.

Undergraduate Curriculum in Materials Science and Engineering
(EFFECTIVE as of Fall 2004)
(Revised Fall 2008)

SEMESTER 1 **15-17 Credits**

• CHEM 110	3	CHEMICAL PRINCIPLES
• CHEM 111	1	EXPERIMENTAL CHEMISTRY
• MATH 140	4	CALCULUS WITH ANALYTICAL GEOMETRY I
• EM SC 100S	3	FRESHMAN SEMINAR IN EMS♦
• SHA-1	3	SHA ELECTIVE **€**
• GHA –1	1-3	HEALTH AND PHYSICAL ACTIVITY ELECTIVE **€**

SEMESTER 2 **16-18 Credits**

• CHEM 112	3	CHEMICAL PRINCIPLES Δ
• CHEM 113	1	EXPERIMENTAL CHEMISTRY
• MATH 141	4	CALCULUS WITH ANALYTICAL GEOMETRY II
• PHYS 211	4	MECHANICS
• ENGL 15	3	RHETORIC AND COMPOSITION
• GHA-2	1-3	HEALTH AND PHYSICAL ACTIVITY ELECTIVE **€**

SEMESTER 3 **17 Credits**

• MATH 220	2	MATRICES§
• MATH 231	2	CALCULUS OF SEVERAL VARIABLES **§**
• PHYS 212	4	ELECTRICITY AND MAGNETISM
• MATSE 201	3	INTRODUCTION TO MATERIALS SCIENCE #‡
• COMPSC 201	3	COMPUTER PROGRAMMING FOR ENGINEERS (CerSE, EPM, and MetSE option)
• SHA-2	3	SHA ELECTIVE **€**
• CHEM 210	3	ORGANIC CHEMISTRY (PlmSE option only)

SEMESTER 4 **15-17 Credits**

• EMCH 11	3	STATICS (required for CerSE)
• E MCH 210	5	STATICS AND STRENGTH OF MATERIALS (MetSE option) *****
• MATH 251	4	ORDINARY AND PARTIAL DIFERENTIAL EQUATIONS
• PHYS 214	2	WAVES & THERMODYNAMICS
• COMPSC 201	3	COMPUTER PROGRAMMING FOR ENGINEERS (PlmSE option)
• CHEM 213	2	LABORATORY IN ORGANIC CHEMISTRY (PlmSE option)
• CHEM 212	3	ORGANIC CHEMISTRY (PlmSE option)
• ENGL 202C	3	TECHNICAL WRITING (CerSE and EPM options only)
• SHA-3	3	SHA ELECTIVE **€**
• SHA-4	3	SHA ELECTIVE (EPM and MetSE options only) **€**

***** EMCH 211(3) and EMCH 213(3) may be taken in place of EMCH 210

‡ Commonwealth Campuses students should schedule MATSC 201 for Semester 5

♦ Students on the Commonwealth Campuses should schedule CAS100A instead.

§ Math 230 may be substituted for Math 220 and 231

Students must obtain grade C or better in these courses.

** Students on the Commonwealth Campuses will need to schedule MATSE 201 this semester and move IE 424 to a later semester.

Δ MatSE 112 may be substituted for CHEM 112

€ Course can be scheduled any other semester. A total of 3 credits are needed in GHA, 18 credits in SHA, and 6 credits in technical elective categories. Scheduling of SHA and GHA courses can be shifted as needed in order to permit registering for the particular course or section desired by the student.

Ceramic Science and Engineering Curriculum
(EFFECTIVE as of Fall 2004)
(Revised Fall 2008)

SEMESTER 5 16 Credits

- MATSE 400 3 CRYSTAL CHEMISTRY
- MATSE 401 3 THERMODYNAMICS OF MATERIALS #
- MATSE 430 3 MATERIALS CHARACTERIZATION #
- MATSE 460 1 INTRODUCTORY LABORATORY IN MATERIALS
- IE 424 3 PROCESS QUALITY ENGINEERING **
- SHA-4 3 SHA ELECTIVE€

SEMESTER 6 16 Credits

- MATSE 492W 3 MATERIALS ENGINEERING METHODOLOGY AND DESIGN #
- MATSE 402 3 MATERIALS PROCESS KINETICS #
- MATSE 410 3 PHASE RELATIONS IN MATERIAL SYSTEMS
- MATSE 413 3 SOLID STATE MATERIALS
- MATSE 436 3 MECHANICAL PROPERTIES OF MATERIALS
- MATSE 462 1 GENERAL PROPERTIES LABORATORY IN MATERIALS

SEMESTER 7 14-16 Credits

- MATSE 411 3 PROCESSING OF CERAMICS
- MATSE 412 3 THERMAL PROPERTIES OF MATERIALS
- MATSE 4XX 3 MATSE ELECTIVE (Choose any MatSE course)
- MATSE 468 1 CERAMICS LABORATORY
- MATSE 494W 1-3 RESEARCH AND DESIGN SENIOR PROJECT (at advisor's discretion; must total 3 credits for graduation)
- TECH EL-1 3 TECH ELECTIVE **€**

SEMESTER 8 16-18 Credits

- MATSE 417 3 ELECTRICAL AND MAGNETIC PROPERTIES
- MATSE 435 3 OPTICAL PROPERTIES OF MATERIALS
- MATSE 494W 1-3 RESEARCH AND DESIGN SENIOR PROJECT (at advisor's discretion; must total 3 credits for graduation)
- TECH EL-2 3 TECHNICAL ELECTIVE **€**
- SHA -5 3 SHA ELECTIVE €
- SHA-6 3 SHA ELECTIVE €

TOTAL CREDITS 127

Electronic and Photonic Materials Curriculum
(EFFECTIVE as of Fall 2004)
(Revised Fall 2008)

SEMESTER 5 16 Credits

- MATSE 400 3 CRYSTAL CHEMISTRY
- MATSE 401 3 THERMODYNAMICS OF MATERIALS #
- MATSE 430 3 MATERIALS CHARACTERIZATION #
- MATSE 460 1 INTRODUCTORY LABORATORY IN MATERIALS
- IE 424 3 PROCESS QUALITY ENGINEERING **
- ESC 314 3 APPLICATION OF MATERIALS FOR ELECTRICAL ENGINEERS

SEMESTER 6 16 Credits

- MATSE 492W 3 MATERIALS ENGINEERING METHODOLOGY AND DESIGN #
- MATSE 402 3 MATERIALS PROCESS KINETICS #
- MATSE 413 3 SOLID STATE MATERIALS

OR

- PHYS 237 3 INTRODUCTION TO QUANTUM MECHANICS
- MATSE 417 3 ELECTRICAL AND MAGNETIC PROPERTIES
- MATSE 436 3 MECHANICAL PROPERTIES OF MATERIALS
- MATSE 462 1 GENERAL PROPERTIES LABORATORY IN MATERIALS

SEMESTER 7 16-18 Credits

- MATSE 450 3 SYNTHESIS AND PROCESSING OF EPM
- MATSE 455 3 PROPERTIES AND CHARACTERIZATION OF EPM
- EE 441 3 SOLID STATE DEVICE TECHNOLOGY
- MATSE 494W 1-3 RESEARCH AND DESIGN SENIOR PROJECT (at advisor's discretion; must total 3 credits for graduation)
- TECH EL-1 3 TECH ELECTIVE €
- SHA-5 3 SHA ELECTIVE €

SEMESTER 8 14-16 Credits

- MATSE 435 3 OPTICAL PROPERTIES OF MATERIALS
- MATSE 463 1 CHARACTERIZATION AND PROCESSING OF EPM LAB
- MATSE 494W 1-3 RESEARCH AND DESIGN SENIOR PROJECT (at advisor's discretion; must total 3 credits for graduation)
- TECH EL-2 3 TECHNICAL ELECTIVE €
- TECH EL-3 3 TECHNICAL ELECTIVE €
- SHA-6 3 SHA ELECTIVE €

TOTAL CREDITS 127

Metals Science and Engineering Curriculum
(EFFECTIVE as of Fall 2004)
(Revised Fall 2008)

SEMESTER 5 16 Credits

• MATSE 400	3	CRYSTAL CHEMISTRY
• MATSE 401	3	THERMODYNAMICS OF MATERIALS #
• MATSE 430	3	MATERIALS CHARACTERIZATION #
• MATSE 460	1	INTRODUCTORY LABORATORY IN MATERIALS
• IE 424	3	PROCESS QUALITY ENGINEERING **
• SHA-5	3	SHA ELECTIVE

SEMESTER 6 16 Credits

• MATSE 492W	3	MATERIALS ENGINEERING METHODOLOGY AND DESIGN #
• MATSE 402	3	MATERIALS PROCESS KINETICS #
• MATSE 436	3	MECHANICAL PROPERTIES OF MATERIALS
• MATSE 410	3	PHASE RELATIONS IN MATERIALS SYSTEMS #
• MATSE 462	1	GENERAL PROPERTIES LABORATORY IN MATERIALS
• ENGL 202C	3	TECHNICAL WRITING

SEMESTER 7 14-16 credits

• MATSE 421	3	CORROSION ENGINEERING
• MATSE 422	3	THERMOCHEMICAL PROCESSING
• MATSE 471	1	METALLURGICAL LABORATORY I
• MATSE 494W	1-3	RESEARCH AND DESIGN SENIOR PROJECT (at advisor's discretion; must total 3 credits for graduation)
• MATSE 425	3	PROCESSING OF METALS
• SHA-6	3	SHA ELECTIVE

SEMESTER 8 14-16 credits

• MATSE 426	3	AQUEOUS PROCESSING
• MATSE 417	3	ELECTRICAL AND MAGNETIC MATERIALS
• MATSE 472	1	METALLURGY LABORATORY II
• MATSE 494W	1-3	RESEARCH AND DESIGN SENIOR PROJECT (at advisor's discretion; must total 3 credits for graduation)
• TECH EL -2	3	TECHNICAL ELECTIVE
• TECH EL -1	3	TECHNICAL ELECTIVE

TOTAL CREDITS: 127

Polymer Science and Engineering Curriculum
(EFFECTIVE as of Fall 2004)
(Revised Spring 2007)

SEMESTER 5 16 Credits

- MATSE 401 3 THERMODYNAMICS OF MATERIALS #
- MATSE 441 3 POLYMERIC MATERIALS I #
- MATSE 443 3 INTRO TO THE MATERIALS SCIENCE OF POLYMERS #
- MATSE 460 1 INTRODUCTORY LABORATORY IN MATERIALS
- IE 424 3 PROCESS QUALITY ENGINEERING **
- TECH EL-1 3 ENGINEERING TECHNICAL ELECTIVE €

  OR
- MATSE 430 3 MATERIALS CHARACTERIZATION #

SEMESTER 6 16 Credits

- MATSE 492W 3 MATERIALS ENGINEERING METHODOLOGY AND DESIGN #
- MATSE 436 3 MECHANICAL PROPERTIES OF MATERIALS #
- MATSE 445 3 THERMODYNAMICS, MICROSTRUCTURE, AND CHARACTERIZATION OF POLYMERS #
- MATSE 462 1 GENERAL PROPERTIES LABORATORY IN MATERIALS
- ENGL 202C 3 TECHNICAL WRITING
- SHA-4 3 SHA ELECTIVE €

SEMESTER 7 13-15 Credits

- MATSE 444 3 SOLID STATE PROPERTIES OF POLYMERIC MATERIALS #
- MATSE 447 3 RHEOLOGY AND PROCESSING OF POLYMERS
- MATSE 494W 1-3 RESEARCH AND DESIGN SENIOR PROJECT (at advisor's discretion; must total 3 credits for graduation)
- TECH EL-2 3 ENGINEERING TECHNICAL ELECTIVE €
- SHA-5 3 SHA ELECTIVE €

SEMESTER 8 15-17 Credits

- MatSE 446 3 MECHANICAL AND ELECTRICAL PROPERTIES OF POLYMERS AND COMPOSITES
- MATSE 473 1 POLYMERIC MATERIALS LAB - SYNTHESIS
- MATSE 474 1 POLYMERIC MATERIALS LAB - CHARACTERIZATION
- MATSE 448 3 ADVANCED PROCESSING TECHNOLOGY
- MATSE 494W 1-3 RESEARCH AND DESIGN SENIOR PROJECT (at advisor's discretion; must total 3 credits for graduation)
- TECH EL-3 3 TECHNICAL ELECTIVE €
- SHA-6 3 SHA ELECTIVE €

TOTAL CREDITS: 127

Appendix D. Suggested technical electives

Reminder: At least 37.5% (average 48 credits) of the student's prescribed coursework must be engineering courses (contains "Engineering" in the course title) to satisfy graduation requirement in MatSE. Carefully select technical electives to ensure this requirement is met.

Some courses have pre-requisites; please consult your advisor before you enroll. Required courses within option may not also count towards technical electives.

MATERIALS SCIENCE

MATSE 403	Biomaterials
MATSE 404	Surfaces and Biological (Host) Response to Materials
MATSE 417	Electrical and Magnetic Properties
MATSE 427	Ferrous Physical Metallurgy
MATSE 430	Materials Characterization
MATSE 435	Optical Properties of Materials
MATSE 441	Polymeric Materials
MATSE 442	Polymer Synthesis
MATSE 443	Introduction to Materials Science of Polymers
MATSE 444	Polymer Science I
MATSE 445	Polymer Science II
MATSE 447	Rheology and Processing of Polymers
MATSE 450	Synthesis and Processing of Electronic and Photonic Materials
MATSE 455	Properties and Characterization of EPM
MATSE 463	Characterization and Processing of EPM Laboratory
MATSE 468	Ceramics Processing Lab
MATSE 471	Metallurgy Lab II
MATSE 472	Metallurgy Lab III
MATSE 473	Polymeric Materials Laboratory-Synthesis
MATSE 474	Polymeric Materials Laboratory-Characterization
MATSE 5xx	Graduate Level Courses (consult advisor)

ELECTRONIC MATERIALS

E E 210	Circuits and Devices
E E 212	Introduction to Electronic Measuring Systems
E E 310	Electronic Circuit Design
E E 352	Signals and Systems
E E 320	Introduction to Electro-optical Engineering
E E 330	Engineering Electromagnetics
E E 350	Continuous Linear Systems
E E 441	Solid State Device Technology
E E 442	Solid State Devices
E SC 314	Engineering Applications of Materials
E SC 445	Semiconductor Optoelectronic Devices
E SC 456	Introduction to Neural Networks
E SC 481	Elements of Nano/Micro-electromechanical Systems Processing and Design
PHYS 237	Introduction to Modern Physics (not for CerSE or EPM)
PHYS 400	Intermediate Electricity and Magnetism
PHYS 401	Intermediate Electricity and Magnetism II
PHYS 402	Electronics for Scientists
PHYS 410	Introduction to Quantum Mechanics
PHYS 412	Solid State Physics I

PHYS 413	Solid State Physics II
PHYS 419	Theoretical Mechanics
PHYS 420	Thermal Physics
PHYS 443	Intermediate Acoustics
PHYS 458	Intermediate Optics

PROCESSING SCIENCE

CH E 410	Mass Transfer Operations
CH E 435	Industrial Organic Chemistry
CH E 438	Bioprocess Engineering
CH E 441	Polymer Processing
CH E 446	Transport Phenomena
CHEM 202 or 210	Organic Chemistry
CHEM 408	Computational Chemistry
CHEM 410, 411	Inorganic Chemistry
CHEM 430	Structural, Analysis of Organic Compounds
CHEM 448	Surface Chemistry
CHEM 452	Physical Chemistry
CHEM 450	Thermodynamics of Chemical Systems
CHEM 464	Chemical Kinetics
EGEE 301	Thermodynamics and Fluid Mechanics
I E 310	Principles of Deformation Processing
I E 311	Principles of Solidification Processing
I E 312	Product Design and Manufacturing Processes
I E 322	Probabilistic Models in Industrial Engineering I
I E 323	Probabilistic Models in Industrial Engineering II
I E 328	Production Engineering
I E 414	Materials Joining Processes and Principles
I E 426	Industrial Automation
I E 428	Metal Casting
I E 438	Metal Cutting Principles and Practice
MATSE 402	Materials Process Kinetics
MATSE 410	Phase Relations in Materials Systems
MATSE 411	Ceramic Processing
MATSE 412	Thermal Properties and Refractories
MATSE 415	Introduction to Glass Science
MATSE 422	Thermochemical Processing
MATSE 425	Processing of Metals
MATSE 426	Aqueous Processing
MATSE 442	Polymer Synthesis
MN PR 301	Elements of Mineral Processing
MN PR 401	Mineral Process Engineering
MN PR 413	Mineral Processing Laboratory
MN PR 421	Particle Technology Laboratory
MN PR 425	Interfacial Phenomena and Flotation

STRUCTURAL MATERIALS

E MCH 315	Mechanical Response of Materials

E MCH 400	Advanced Strength of Materials and Design
E MCH 402	Applied and Experimental Stress Analysis
E MCH 403	Strength Design in Materials and Structures
E MCH 407	Computer Methods in Engineering Design
E MCH 408	Elasticity and Engineering Applications
E MCH 440	Nondestructive Evaluation of Flaws
E MCH 446	Mechanics of Viscoelastic Materials
E MCH 461	Applied Finite Element Analysis
E MCH 471	Engineering Composite Materials
E MCH 473	Composite Processing
E SC 261M	Computational Methods in Engineering
E SC 314	Engineering Applications of Materials
MATSE 420	Corrosion and Degradation of Engineering Materials
MATSE 421	Corrosion Engineering
MATSE 424	Deformation, Fracture and Alloy Design
MATSE 446	Mechanical Properties of Polymers and Composites

BIOMATERIALS

BIOL 141	Physiology
BIOL 472	Mammalian Physiology
BIOE 201	Analysis of Molecules and Cells
BIOE 401	Introduction To Bioengineering
BIOE 406	Medical Imaging
BIOE 419	Artificial Organs and Prosthetic Devices
BMB 251	Molecular and Cell Biology

MISCELLANEOUS

ENGR x95	Engineering Internship and Cooperative Education
SC x95	Science Cooperative Education
BMB 474	Physical Properties of Biological Macromolecules
CE 370	Introduction to Environmental Engineering
F SC 401	Introduction to Fuel Technology
F SC 422	Combustion Engineering
IE 302	Engineering Economy
IE 426	Industrial Automation
MATH 405	Advanced Calculus for Engineers and Scientists
MATH 406	Advanced Calculus for Engineers and Scientists II
MATH 411	Ordinary Differential Equations
MATH 414	Introduction to Probability Theory
MATH 416	Stochastic Modeling
NUC E 401	Introduction to Nuclear Engineering
STAT 401	Experimental Methods
STAT 414	Introduction to Probability Theory
STAT 415	Introduction to Mathematical Statistics

Appendix E. Honors studies in Materials Science and Engineering

H-option Courses

Most 400-level courses can be taken with an H-option (honors option). The H-option requires that the course coverage contains:

(a) Advanced information/knowledge
(b) Additional in-depth material
(c) An integration with other courses in general topic area

MATSE 4XXH H-option courses are structured as follows:

1. An honors student takes the normal MATSE 4XX course, with the following additions/changes making it an H-option course.
2. At the beginning of the course, the honors student is given a listing of several (2-4) advanced topic areas related to the course, along with handout/reading materials related to each of these areas.
3. The faculty member meets one-on-one with the student for 1 to 2 hour tutorial discussions of these advanced topic areas on at least 3 occasions during the semester.
4. The honors student takes each normal class exam at its designated time, but with the following changes in to make them H-option exams. At least one normal exam question, which is related to one of the H-option advanced topic areas, is replaced by a more challenging question.

Honors Thesis (MatSE 494M)

The honors thesis is an extremely important part of the honors program at Penn State. The honors thesis in Materials Science & Engineering, is structured as follows:

Student works with their thesis advisor in conjunction with the Shreyer Honors College to perform research and write a thesis more rigorous than the typical MatSE Undergraduate thesis.

Students wishing to honors option any MatSE class please contact Allison Albinski in the Undergraduate Office ava10@psu.edu

Appendix F. Format for bachelor's thesis in Materials Science and Engineering

Basic formatting for senior thesis:

Text in the body of the thesis should be no smaller than 11 pt and no larger than 14 pt
Chapter headings should be no larger than 16pt
Pages should be single spaced, not 1 ½ or double spaced
Margins: top & bottom 1“ right and left 1.25”
Printing should be single sided, not double sided
A blank page at the beginning and end are required for binding

(EXAMPLE)

The Pennsylvania State University
College of Earth and Mineral Sciences
Department of Materials Science and Engineering (14 point)

Proper Thesis Title/Signatory Page Format for Bachelor of Science Degree in Materials Science and Engineering (16 point/bold)

A Thesis in Materials Science and Engineering

By

Josephine Q. Author

Submitted in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Materials Science and Engineering (XXXXX Option)

Date (14 Point)

I (we) approve this thesis: (14 point) Date of Signature:

_____ _____

Joe Q. Advisor, Academic Title
Thesis Advisor (14 point)

Add other co-advisor signatures as needed

(EXAMPLE)

TABLE OF CONTENTS

LIST OF FIGURES

And so on.

Then go to a separate page for:

LIST OF TABLES

REFERENCES

Follow the citation format from the most prestigious Journal in your subdiscipline.

If you can't find a good description of the proper citation format, then use the Journal of the American Ceramic Society format

For an excellent example of how to build figures, tables, citations, use of SI units, etc., see:

J. Am. Ceram. Soc., 83(12)3235-3238(2000)